Section I:

Executive Perspectives

Investing in America's Future: Problems and Prospects in Deploying Broadband

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Editor's note: This essay is adapted from a speech delivered by Mr. Ackerman in Washington, D.C., on March 3, 1998 to the Economic Strategy Institute.

The telephone industry for years has had the government as a full partner. That is not a complaint, just a statement of fact. Communications infrastructure is so critical to a vibrant economy and so capital-intensive that the government has understandably had a strong and compelling interest in what we were doing, how we were doing it, and ultimately what we charge for it.

Contrast that with the short but successful history of the computer industry, which has to this point stayed as far away from the hand of government as possible—to the point where Silicon Valley would be under water if it got any farther away from the nation's capital.

When you look at these two industries and how they originated, it is not hard to understand how there has been a lot of miscommunication between the two up to this point in our history. The one, telecommunications, regulated at the state and federal level down to being told the useful life of any one piece of the network; the other, the computer and information industry, free to pursue their business with few if any government strings attached. Now the two are bound together in a society increasingly tied to the latest in information technology—technology that is critical to this country if we are going to continue to lead the world's economy and vital to the leaps in productivity necessary to sustain this incredibly long business cycle.

It is going to be a New World. In fact, it seems to be a New World on almost a daily basis. And that means many of the old ways of our industry will have to change if we are to survive in this new age. Which brings me to the topic of investment, or, as we call it when we examine the efficient use of capital in BellSouth, resource allocation. Because that is really what managers are all about, when you get right down to it: How are we going to use the capital that our shareholders have placed under our stewardship to grow our business in a profitable way? How can we provide a competitive return to shareowners and do it in a way that accomplishes the social good that the government expects and the private good that the computer industry expects?

Fifteen years ago when people in the telephone industry discussed investment, there were not a lot of choices. The capital on hand went into the wireline telephone business. Then, just about the time of divestiture, along came another choice: wireless communications (and, thank goodness, much less regulation).

It was really a new day for telephone companies, one that offered the opportunity to build telecom systems without the stifling hand of regulation at every turn. We liked it. And we built quickly. The customer liked it too. It seemed to be a pretty good model.

Then along came PCS and more opportunity and freedom. Gradually, international opportunities became available and were part of the mix too. Then came Internet access, and now managed data networks, mobile data networks, video services, and information services. Suddenly it's not so easy anymore to decide where to put the capital with which our shareholders entrust us.

That is a good problem to have if you think you are good at what you do and your customers seem to like how you do it. So if BellSouth wants to deliver Wall Street and our shareholders the consistent and double-digit growth they expect, where should we invest? Will it be the same place that regulators want us to invest? Will it be where the computer industry wants us to put our capital?

Contrary to what many in Silicon Valley write, think, or say about us—and they say plenty—the fact is we on this side of the communications industry can figure out that Internet data growth looks a lot more exciting than voice traffic growth. Voice traffic growth doubles every twelve years; the Internet, almost every quarter.

We want a share of the Internet pie; we expect to get it. The question is how quickly and whether we get there quickly enough.

I'd like to share with you our basic understanding of the situation. First, communications and computers are not just technically converging in data networks like the Internet, the industries increasingly depend on each other for growth, which is a natural result of this marriage in information technology. This means that the computer industry is

increasingly dependent on networks as an avenue of growth, as evidenced by how the Internet jump-started that industry's financial performance. Back in 1993, the computer business was facing a five-year stock market slump. Between 1988 and 1993, the average stock price of the top computer companies actually dropped 36 percent. And this drop occurred as the Standard & Poor's 500 grew by 120 percent. Then, along came a little thing called browsers that made the World Wide Web accessible. Suddenly, people had a reason or an excuse to upgrade their computers. The computer business took off like a rocket.

Since 1994, the stock price of the top fifty U.S. computer companies has surged by 318 percent. At the same time, incidentally, the S&P rose 143 percent while the index for the top fifty telecom companies climbed a scant 78 percent.

So the first point is that when computers became married to communications networks—especially through the Internet—the wedding produced amazing growth in the computer industry.

Second, it's pretty clear to us that even as the Internet becomes more important to the computer industry's future, the Internet will soon outgrow the capabilities of the public switched telephone network. Until now, the technical capabilities of personal computers, modems, and the Internet itself have enabled most users to get pretty much everything they wanted through dial-up 28.8-kbps connections over standard, voice-grade telephone lines. But we don't think that will continue, simply because the next generation of Internet applications will require substantially more bandwidth than can be had over a regular analog telephone line.

If the Internet is to continue to fuel rapid growth in the information sector and growth in the economy more generally, telecom carriers will have to deliver much bigger, faster data pipes at prices that consumers and small businesses can really afford.

Bill Gates, Andy Grove, and others in the computer industry have been telling us this for some time. They understand that on-going improvements in personal computers and prepackaged software alone won't do the trick. They understand that bandwidth is imperative. We couldn't agree more.

We also understand that we will have to work more closely with computer manufacturers and Internet service providers to make the web more friendly and valuable to consumers. We have some efforts underway along these lines. We are pleased to be working with Microsoft, Intel, and Compaq through the Universal Working Group on a framework for digital subscriber line (DSL) standards. Our recent agreement on the DSL Lite prototype is a breakthrough that should allow us to avoid many of the problems that slowed delivery of ISDN to market.

Our aim is to use this technology to offer residential customers an easily installed high-speed connection of 1.5 Mbps at a widely affordable rate beginning later this year. If we succeed, ADSL will give Internet service providers and users the bandwidth they need to take the Internet to another new level. The appearance of a widely affordable 1.5-Mbps ADSL connection will hasten the deployment of high-speed Internet applications that we have been hearing so much about for so many years.

In any case, the DSL Lite cooperation shows how the computer and communications industries can work together to advance broadband.

As to BellSouth's own broadband efforts, I should also point out that we are doing more than you might think. We have already installed 150 frame relay data switches and over a dozen ATM switches, and we are continuing to install more. In order to improve the service delivery of managed services, unbundling applications, and computer infrastructure, we have created a managed network services alliance with EDS.

In 1998, we will invest over $7 billion to grow our business. About $3.4 billion of that will be spent on our local, wireline telephone networks but not as much as you would like to keep up with the new broadband networks.

What then will it take to spur billions more investment in broadband capacity? Well, Walter Wriston, the former chairman of Citicorp, often said something that seemed to go down pretty well: "Capital goes where it is welcome, and stays where it is treated fairly." And it seems to me there are two things that need to be done in order to ensure companies can make the kind of investment that the computer industry wants and the American public and our economy need.

The first thing regulators need to do is declare a "regulatory moratorium" before they saddle tomorrow's networks with the same old rules and regulations. The second step that regulators need to take is to eliminate rules that restrict the ability of telecom carriers—including my own company—from using our networks anyway that serves the customer.

This country has well over $300 billion—one-third of a trillion dollars—invested in communications plant and equipment. The last thing we need is for the government to ration the use of that resource. We need to encourage network use, not restrict it.

The more we do with our network, after all, the lower the cost of providing service to individual customers. The broader the universe of customers and traffic we have, the more we can spread our network costs and the lower prices will become.

Too many government rules directly or indirectly have the impact of curbing how much traffic can transit our networks. Or, these regulations still prevent us from working directly with manufacturers to upgrade our networks. It's as if the government tried to restrict how efficiently United Airlines could use its planes, how much natural gas Colonial Pipeline could pump, or how CSX could use its trains.

A regulatory moratorium on advanced networks and removing prohibitions on the use of existing networks— these twin measures would spur more investment, accelerate innovation, and unquestionably contribute to the economic welfare of all Americans. If America's computer and software companies were under the kind of regulation that BellSouth contends with, where would this country be?

Suppose, there were another FCC in Washington—a Federal Chip Commission. And suppose this commission decreed that Intel should introduce a new generation of chips but could only earn the prime rate plus four or five hundred basis points. Believe me: federal law would have trumped Moore's Law long ago.

When I talk about artificial regulatory restrictions on network use, I include all the limits on our ability to carry interLATA traffic, including data. Just last month, the World Trade Organization's Agreement on Basic Telecommunications went into effect. That Agreement is supposed to reflect today's commercial realities: seamless networks, global markets, and the worldwide Internet. Meanwhile, back in Washington the regulators are debating whether or not BellSouth can compete in just South Carolina!

The regulators seem wedded to a system of "no-trespassing zones" that was cooked up in 1982—four years before the personal computer debuted—and which was based on the switching technology of the 1970s. It's almost as if the computer industry were forced to deal with punch cards, or had scores of regulators worried that technology might bring competition and change.

I believe America needs to be as pro-competitive and progressive as the rest of the world. America's regulators must be prepared to take the risk of competition.

Our free enterprise system depends on competition and customer choice. We ought to try that same approach in telecommunications and stop trying to inhibit new services, new jobs, and new investment.

As Congressman John Dingell said on March 2, 1998, the current chairman of the FCC confronted a wonderful opportunity. He could repair the extraordinary damage done by his predecessor. He could sweep away barriers to competition, unleashing the forces of free enterprise, and begin the job of building the much-maligned bridge to the 21st Century.

I couldn't agree more with Congressman Dingell. Like him, I also wish Chairman Bill Kennard well. I believe the FCC's decisions in this area over the next year or two may prove to be far more consequential than we might think.

Right now, the computer industry is obviously riding pretty high. The run-up in U.S. computer stock prices since 1994 has created nearly $900 billion in shareowner wealth.

But how long will the good times roll? Let's remember, a lot of that shareowner wealth reflects future expectations. And many of those expectations are premised on a belief that our telecom networks will keep pace with Internet.

My message here today is that none of this is a given. Whether our networks keep pace with users needs and how fast that happens will depend heavily on the willingness of regulators to contain their appetite for more regulation.

As a communications executive, I certainly do not want to see the computer bubble or the telecommunications bubble burst. I see our futures securely bound together to our friends and critics in the information technology sector. We create value for each other. We can benefit from the demands created by digital revolutionaries. We will be dependent on the whole complex of Internet products and services.

But that relationship runs both ways. After all, we re all in the same digital boat and everyone in that boat has to cooperate and pull their own weight.

Some say, why bother? After all, BellSouth is regulated while other suppliers of digital infrastructure are not. They say regulation is our problem. Live with it. Sometimes, I wonder if that is correct.

Can the FCC regulate the supply and data capabilities of telecommunications carriers without impacting the demand for software, computers, components, and the whole array of Internet services? Can regulators create disincentives for network investment without adversely affecting companies that use those networks to create value for their customers and shareholders? Merely asking these questions is to answer them.

There is much that our industries can do together to hasten the deployment of broadband, and our work on ADSL is a beginning. Work by both traditional and non-traditional suppliers for long-term broadband solutions is another critical step. But regardless of how much we can do together, there are some basic things we simply cannot do: We cannot unilaterally redraw the regulatory environment to encourage investment in broadband.

To realize our expectations of a digital future, we need to persuade regulators to avoid imposing an outdated and largely discredited regulatory model onto the Internet. Instead, we need to convince regulators that the benefits of not regulating new data services such as ADSL include increased investment, better jobs, and more rapid innovation, and that not regulating such services will far outweigh any conceivable cost to consumers.

If we are to make that case, however, we will need the active support of our partners and competitors who provide other parts of the digital infrastructure. I want to tell you that we look forward to that debate.

Fifteen Years on the Road to Quality

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Let me begin by giving you a very brief snapshot of Corning—for those of you who may not know us well. October 18, 1983, was a historic day for Corning Incorporated. That was the day that my predecessor, Jamie Houghton, gathered the company's management team together to announce that he was committing Corning to total quality.

That was fifteen years ago.

We had been in business for 132 years. We had a history rich in technical innovations. We had helped Thomas Edison mass produce the first light bulb. We had invented fiberglass. We had even invented optical fiber. But we were not a healthy company. Many of our key businesses were mature or declining. Competitors were hurting us. And our earnings were anemic. Jamie Houghton, however, was convinced that quality could turn things around for us.

His first key decision was to name one of our senior managers as our first director of quality—giving quality the respect and muscle it deserved. The second decision he made was to commit $4 million to quality training, which included the creation of the Corning Quality Institute, our own quality school. The Institute's charter was to introduce every one of Corning's more than 20,000 employees to total quality. They were introduced to the Quality Management System, which includes our four principles and our ten actions. Our four principles are simple: meet the requirements of our customers, do error-free work, manage by prevention, and measure by cost of quality.

Our ten actions are the things we do to support a healthy environment for people to apply the four principles. These include setting goals, making commitments, measuring and displaying results, and giving recognition for a job well done. It's that simple. As you can see, education and training would prove to be one of many tools—or initiatives—we would use. I'll describe many of the other initiatives we've employed along the way as well.

The next year we conducted our first survey of employees to assess the climate within our company. We also held our first company-wide event to talk about quality and to share and celebrate our successes. Our start-up phase would last for two years. During that time, we provided employees with skills training. We also put our seven corporate values down in writing. By the end of 1985, we had completed phase one of our quality journey. I still remember people thinking that quality was just another flavor-of-the-month program that would fade away when an alternative program came along.

How wrong they were.

Corning's quality program did not go unnoticed. Jamie Houghton was named chairman of National Quality Month by the American Quality Society and *Fortune Magazine.* Mind you, Jamie received this honor a year before the creation of the Baldrige Foundation. In our second phase, which we call our break-out phase, we put greater emphasis on our external customers. We provided some very specific skills training for our people to help them understand customer requirements, including listening, questioning, and clarifying. We also introduced our innovation process that we use today to manage the development of new products. As a result of all of this, we began to see improvements in unit leadership and team effectiveness.

Phase three, world-class quality, helped move us toward greater process discipline. We chose the Baldrige criteria as our standard—and continue to conduct demanding company-wide self-assessments every two years. In fact, we have incorporated ISO 9000 criteria—along with Baldrige—into our internal audits. From these assessments have come measures. We call them key results indicators (KRIs). We review them once a quarter. And we use them to tie pay to employee performance. We call this goalsharing.

The year 1991 was a big one for new quality initiatives. We introduced a training course called IMPACT used to map, measure and improve processes. We borrowed the course from Westinghouse—who called it Westip—and modified it to suit our purposes. We introduced a course called SOLUTIONS used to add rigor to our decisionmaking and problemsolving. And another course to help us develop a method for benchmarking other companies.

In 1992, our businesses geared up to go after ISO 9000 certification, the universal quality standard. It was important to us because it helped us define our processes. We entered phase four of our journey in 1993, taking a long, hard look at our major processes. Our reengineering effort, which we called Corning Competes, looked at our operations from top to bottom. We wanted to make certain—in the bright light of day—that our major processes were aligned to meet

future customer requirements and our own long-term goals. We also wanted to eliminate work that did not add value or give us a competitive advantage.

And so here we are in the midst of the phase we call quality integration—where quality is not a set of policies or procedures, but a process for achieving extraordinary performance. Quality is no longer a process that we apply to the business. It is the business. It is simply the way work gets done. I would also like to mention two exciting quality integration initiatives that are still very much evolving at Corning today. The first of these is manufacturing effectiveness. Like any manufacturing company, we have always brought our manufacturing heads together for regular meetings. In the past, they tended to be more of an exercise in reporting than a means of addressing far-reaching day-to-day problems.

Now we have what is called the Manufacturing Council, a peer group made up of eight manufacturing heads and two staff leaders, one from employee relations and another from technology. There is no official leader—just a facilitator with an agenda for meetings that take place about every six weeks. The meetings have become open, interactive, and sometimes very loud. Disagreement is good. Strong opinions are good. Most important, the results are very good. The members of the Council rarely talk about quality per se. They talk about customer satisfaction, cost reduction, technology resources, work environment, manufacturing leadership, systems. They talk about continuous improvement—which is an important quality principle—the most important principle of all. One of the first pieces of intelligence that came out of the Council was that you can actually have too much of a good thing.

For example, we had jumped into employee empowerment with both feet. But we found at some of our plants—and one in particular—that we had allowed responsibility to get out ahead of controls. In fact, in some cases you might even say we had chaos. Our people were making some critical decisions on their own, and they were not always the right decisions. So performance at some plants that had been cruising along nicely, suddenly fell off the edge of a cliff. After going into one of the plants and taking apart the problems piece by piece, the Manufacturing Council concluded that front-line decisionmaking is good. But it has to happen in the context of a strong system.

This thinking brought us to a system that has dramatically changed manufacturing. The formal name is the Manufacturing Effectiveness Pyramid; it is a bottom-up process that starts a five-year progression to a high-performance organization. A plant at the top hits or exceeds its targets, is totally focused on the customer, operates in teams, keeps a lid on costs, provides opportunity for its people. In other words, it is an operation that hits on all cylinders simultaneously. We see the basics of the pyramid as process control and discipline, work rules, safety, and simplicity. You have got to be solid in all these areas, or sooner or later, the factory is going to collapse.

We conduct exhaustive plant audits. We rank each individual segment on a scale of one to five, with one being terrible and five being best practice. We keep finding major opportunities to improve efficiencies and cut costs in every one of our plants. To help plants improve, the teams go back in after the audits are completed and explain exactly where the plants are falling short and what they need to do to improve their ranking. The purpose of the audits is not to dictate what the plant should do. The purpose of the audits is to help the plants identify what they need to focus on to make them a better operation. It is up to them to make it happen. But today we limit our audits to the fundamentals—the bottom two levels of the pyramid.

The cost savings and improvements we have seen implemented in the past two-and-a-half years have been extraordinary. That is why we have decided to delay expanding our plant audits to include the top two levels of the pyramid until next year. When a plant moves up from level one to level two, it will be challenged with more sophisticated human resource issues. For example, the plant may need to conduct a battery of math and reading comprehension tests to ensure that the right people are in the right job. They may need a certification process that ensures that people know their jobs and are recognized for their skills. They may need measurements that assess the performance of the line-shift team. When audits show those are in place, a plant is ready for advanced work systems.

It has become a cutting-edge organization of innovative work design, team-based measurements and rewards, coaching versus supervision, and flexible teams made up of people equipped with multiple skills. A plant that reaches level four is one that brings it all together—people, work, information, and technology. Employees who work in teams and are stakeholders in the business have direct accountability for customer satisfaction. But to be perfectly honest, we believe that just one or two of our more than forty plants today are operating at the top of the pyramid.

But the coordination of the Manufacturing Effectiveness Council and the discipline of the pyramid has had a significant impact. We are seeing consistent improvement in yields, quality, productivity, and customer delivery—resulting in significant gross margin improvements. In fact, we have moved our gross margin percent up by seven full points in the last four years.

Our reengineering process taught us that our future well-being depends on our ability to grow. It is, after all, growth that gives us the basis for continuous improvement of both our capabilities and our assets. In order to grow, we need an operating environment that encourages and facilitates growth—growth of our earnings, growth of our shareholders' value, and growth of our people. We needed an operating environment that was conducive to change. And we needed an operating environment that embodied our corporate values, not the least of which is valuing the individual. How each of us behaves, as individuals or as leaders, is critical to our success as a company.

There are eight dimensions that define the new environment or culture. The first five relate to how we run our business.

The next three focus on how we work with one another. Together, they are intended to provide an operating environment that ensures that we know exactly what is expected of us to grow with our customers. The following are examples of the behaviors that may bring them to life.

Customer focused is the first dimension on the list. It comes right out of Total Quality 101. It says that our first priority is to anticipate and respond to the needs of our customers better than our competitors. A customer-focused person is someone who meets with customers regularly to understand what they need, someone who measures performance against customer requirements and best practices—and really knows how our products and services affect the customer's ability to grow and prosper. If we are customer- focused, we will be results oriented, because our customers will keep us honest based on the products they choose to buy from us.

A forward-looking person focuses on ways to sustain competitive advantage by anticipating where markets, technologies, and the needs of customers are heading. It is a person who is proactive, not reactive. In today's competitive global economy, we must be entrepreneurial, we must anticipate the market need, and actively promote our ideas. Critical to this is being ready and willing to jump on an opportunity as soon as you recognize it.

A rigorous person communicates performance expectations clearly and insists on disciplined processes to meet expectations. There is a fine line between rigorous attention to detail and nonvalue-added bureaucracy. It takes good judgment to know the difference.

The last three dimensions, which in many ways are the toughest to implement, are as follows.

Open people encourage constructive debate and the expression of different points of view. They capitalize on the diverse backgrounds and experience of the people around them. They remove the barriers that inhibit everyone from participating in the challenges and opportunities of the group, and they foster a climate for continuous learning.

Engaging behaviors are designed to unleash the full participation and power of all of us. They ensure that we are fully involved with, fully participating in, and connected to producing customer solutions.

Finally, an enabling person is someone who meets regularly with people to share information and to listen. It is a person who creates processes and structures for involving the right people in key decisions. And it is a person who responds constructively to suggestions.

These last three dimensions are the most difficult because we are not talking about systems and tools; we are talking about people, and, in many respects, about changing people's behavior. Samuel Clemens said, "Old habits can't be thrown out the window. They have to be coaxed down the stairs a step at a time." He was right.

In a company as big as we are, with a firmly established culture, that coaxing has to be well-organized, clearly supported, and must start at the top—with good leadership.

We wanted to give the dimensions, and the changes they represent—a symbol, a point of focus—so we aligned the dimensions with our growing Growing Corning initiative. It is simple, easy to remember, and helps connect the tools with the desired outcome. Behavior and skills do not transform overnight. They need to be acknowledged. They need to be worked on. For a change in behavior to occur at Corning, we had to focus our attention on the people who are in a position to most greatly impact the program's success or failure—our leaders and supervisors.

First, we ran more than 250 of them through an evaluation process. We asked their peers, their supervisor, and the people who report to them to rank them on how well they are living the eight dimensions. I can tell you from firsthand experience that it is a humbling process. Because we all have things to work on, habits to change, and skills to develop. As a result of the 360-degree feedback they received, each person has developed their own plan to improve on the areas where they are weak. In addition, we acknowledged that many people need skills to be better leaders and supervisors. So we developed two courses—one to give them the basic knowledge they need to be a supervisor and another course to teach them the basic skills they need to be a good supervisor. We are now two years into the process, and acceptance is growing. We are moving the 360-degree feedback from senior managers to next-level supervisors. We have even built the 360-degree feedback process into every employee's annual performance evaluation.

We were not a healthy company when we started this journey fifteen years ago. But we are a healthy company now—by just about any measure. Every step we have taken on our quality journey has been essential. Nothing we have done—none of the risks we have taken—have lacked value. They moved us forward and changed us in fundamental ways. It is for this reason that I am convinced that our on-going pursuit of quality will prove to be the catalyst for Corning's continued success.

Moving Technology to the Land of Simplicity

Lester M. Alberthal

Chairman, President, and Chief Executive Officer
EDS

Somewhere on the far side of Complexity lies a land called Simplicity. It is a place where users can focus on their business, not ours. It is a place filled with all the wonder of new technology and where complexity is no longer a hindrance to the user. It is a place where the end benefit is everything, and the means of achieving it is transparent.

And it is a place in which merchants and consumers deal in an electronic marketspace, where consumers of all ages access company Web sites to do everything from researching products, buying products, or even filing complaints about products. To a small extent, this place exists today. But it is confined to a small group of companies and Internet users.

Some companies, like Federal Express, have been at the forefront of the electronic business revolution for years. But for the most part, electronic business has been embraced by only a small group of companies and Internet users, most notably, our children. While those under the age of twenty have taken to the Internet very quickly, the technology is still underutilized by the majority of businesses and consumers. Why? It is because we as an industry have not made the Internet easy enough or fast enough.

In fifty years, the way people shop, buy, and even socialize will be dramatically easier because of the Internet and its associated technologies. To accomplish this goal, we in the technology industry must steady the three legs of the Internet stool: ease of use, bandwidth, and behavioral change.

Creating an Effortless Internet

Saying that the Internet in general, and software specifically, is not easy enough to use is borderline heresy in our business. I certainly do not want to pay short shrift to the software that has been developed to date. A tremendous amount of time, talent, and energy have gone into developing the word processors, graphic programs, and spreadsheets we have today. Today's off-the-shelf spreadsheets can complete complex calculations in seconds, which at one time took hours with a calculator. But these are functions, and we cannot confuse function with ease of use. The software that exists today is fairly easy to use—for those who know how to use it.

The Internet is no different. If you can turn on your PC and launch your Web browser, using the Internet is relatively simple. But merely saying "launch a Web browser" sounds complicated to the Internet novice. More energy needs to be directed toward making the Internet easier to use, just as we have poured energy into developing sophisticated software functions.

We all need to do our part to address ease of use. At EDS, for example, we are introducing new skill sets to our Internet employees. For the first several years in our industry, we employed thousands of engineers who painstakingly wrote miles of code for text-based programs. But today, we are creating a picture-linked paradigm, where the Internet becomes more intuitive. When people access a Web site, they will see pages rich in graphics, not text. While we still have scores of engineers working in our Internet group, we are also populating that team with people who have titles such as creative director, video director, and audio director. They have what author Howard Gardner calls "aesthetic intelligence."

In his book, *Frames of Mind: The Theory of Multiple Intelligences,* Gardner describes how each individual has different affinities, or "intelligences." Systems engineers, like myself, have what Gardner calls "compute intelligence." We are logical problem solvers, and we have the skills to do the painstaking work of writing code and programming. But to make the Internet interface more natural to more people, the technology industry needs more people with aesthetic intelligence—people whose roots are in creative thinking, rather than mathematics.

Increasing Bandwidth

Bandwidth is the second leg of the Internet stool. In a recent study, 76 percent of respondents cited speed as their number-one problem with using the Internet. High-speed access is a function of bandwidth. Every year, the industry has attempted to increase bandwidth—increasing modems from 14.4 Kbps to 28.8 Kbps, then to 56 Kbps. But doubling access speeds every twelve months will not continue to satisfy Internet users.

To that end, Intel, Microsoft, and Compaq have joined with most of the larger telephone companies to accelerate Internet access speeds by a factor of thirty. This technology, known as digital subscriber line (DSL), has been in various states of development for years. But what should help speed this technology to market is the fact that the new consortium wants to establish a technical standard for DSL, much like hypertext markup language (HTML) has become an Internet standard.

The closest competition DSL has is the cable modem, which in theory could provide Internet access that would make DSL seem sluggish. But because the cable modem technology is only available to about 10 percent of America's households, DSL is still the best option for a universal access solution.

Inspiring Behavioral Change

Behavioral change is the third leg of the Internet stool, and it is the issue over which we have the least control. However, indirectly, we can increase public Internet use by solving ease-of-use and bandwidth issues. The issue of behavioral change is an issue of generations. Our children need not change their behavior regarding the Internet because they are already immersed in the technology.

However, the fifty-something generation is just beginning to change its behavior regarding the Internet. People in this age group tend to be better educated and have more assets than average. They are beginning to adopt the Internet out of curiosity and, in some cases, because they do not want to pay a broker $200 to buy a stock that they can buy over the Internet for $8.

But on-line investing is a unique situation. We still must give all fifty-somethings a substantial reason to use the Internet by resolving ease-of-use and bandwidth issues, which, in turn, will result in widespread behavior change.

The Digital Economy: Its Effect on Business

Moving away from the individual consumer, it is important to examine what the Internet means to businesses. Imagining competitively superior benefits for on-line business endeavors is not difficult.

Consider Amazon.com. Many individuals buy hundreds of books each year, and until recently, they had little choice but to buy these books from traditional bookstores. When they switch to Amazon.com from the traditional bookstores where they have bought hundreds of books over the years, the bookstores are unaware that these consumers have even left. Yet, the on-line merchant is very much aware of their arrival. Amazon.com keeps track of all new clients' purchases and rewards them with delivery upgrades and discounts.

Few businesses are immune to this "customer skimming." Through the Internet, businesses have an unprecedented opportunity to know their customers and exchange information with them. Thanks to the Web, businesses are learning that information flowing across the boundaries of their enterprises is as important as the information that remains inside the companies. The Web is changing the way information is shared.

Take customer service as another example. Until recently, the primary way for businesses to communicate with their customers was by a toll-free phone number. For virtually any product you buy, you can use a toll-free number to contact the company with questions or complaints. The shift is obvious. Thirty years ago, companies like Proctor & Gamble asked consumers to mail in their comments and questions. Then, they asked customers to call their toll-free numbers. Today, Proctor & Gamble wants customers to use their Web site.

One of the first applications of Web technology was to support customer service. Federal Express was among the early adopters of Internet-based customer service and was a harbinger of the three most significant ways that the Internet will change business.

Inverting the Customer Service Model

The first is that the Internet will invert the customer service function, just as FedEx did several years ago. Before applying Web technology, FedEx customer service representatives fielded telephone calls. They then put the customer on hold and accessed the company's information systems to find an answer, whether it was tracking a package, determining a shipping cost, or locating a drop-off site. Today, all shipping information is available on FedEx's Web site, and both the business and the customer benefit.

Now, customers access FedEx's information systems directly through the Web. They are given the power to find their own answers. If they are still unsatisfied, they can contact a live customer-service representative. FedEx has truly embraced the electronic age. While the company still receives more than 600,000 calls daily, it averages more than 54 million electronic transactions each day. The 1997 FedEx annual report states that the company "remain[s] our industry's premier innovator in developing information technologies that help customers manage and grow their businesses, which in turn helps fuel our own growth. Today, nearly 60 percent of all FedEx packages are generated by customers linked to us electronically. To remain successful, providing outstanding service while managing our costs, we will continue using technology to move bytes and boxes with optimum speed, precision, and efficiency." By tying information technology to transportation, FedEx has become the global logistical backbone for many of its corporate customers.

Changing the Sales Model

The second Web-driven business change is how the Internet affects sales forces. For years, consumer-product companies boasted sales forces in the tens of thousands. Commission-hungry sales people would scour the earth in search of customers. But if these forces are selling consumer products

that can be bought from a catalog, then why can't the product be purchased from a Web page?

The traditional function of the sales and marketing departments—finding customers—is changing. Today, they must focus on making themselves easy to find. Amazon.com has built a billion-dollar business without a sales force, demonstrating that good business is no longer about deploying a massive sales force. It is about deploying information that makes a business attractive and easy to find.

Inverting Customer Loyalty

The third Web-driven business change is the one I find most interesting. The corporate motto of the 90s has consisted of customer loyalty, inundated with strategies to keep customers faithful. I believe that, like the customer-service function, the Internet will invert the customer loyalty proposition. If through the Internet, companies become more familiar with their customers, then it is the companies that need to show more loyalty to their customers.

Through the Internet, businesses now have the tool to demonstrate their loyalty. Again, consider Amazon.com. If a potential customer attempts to log on to Amazon.com and finds the server down, the customer later will open his e-mail and find an apology from the bookseller containing a 10 percent discount on his next purchase to make up for the

inconvenience. That e-mail costs Amazon.com fractions of a penny; in return, Amazon.com demonstrates its loyalty.

Taking this concept one step further, businesses can use the Internet to give their customers a detailed breakdown of the services for which they are paying, to tell them what they are getting for their money, and, in some cases, to tell them what they are getting on a complimentary basis because they are valued customers.

Using information to manage proactively how a customer feels about a company is a powerful technique enabled by the Web. In sharing that information, businesses are inverting the customer-loyalty proposition by demonstrating their loyalty to the customer. The chances of their customers returning that loyalty are high.

Conclusions

In order to move technology to the land of Simplicity, we in the technology industry must work together and focus our energies on dramatically boosting Internet access speeds and developing easier-to-find and easier-to-use Web sites. By doing so, we will hold up our end of the Internet bargain, make on-line business a must for companies, and give the average consumer a reason to adopt electronic business as a better way.

Competition and Cooperation: The Story of a Merger

Robert Annunziata

Chief Executive Officer

Teleport Communications Group

Everyone has read about the AT&T merger with TCG, and many have wondered why I agreed to it. I did it because I wanted to go back and pick up my $9,000-a-year pension. Because I have worked here for seventeen years. In addition to the pension, I am very excited about this development because I see it as a very dynamic merger for our country as we go forward. In this paper, I would like to address the reasoning behind the merger, but beyond the merger, I would to like to discuss TCG's take on local competition, which informs an understanding of our business decisions.

If we take a look at the local telecommunications marketplace, it is in excess of $104 billion per year. Ninety-nine percent of that is still controlled by the incumbent local exchange carriers (ILECs). The reluctance, of course, to open those markets is because, for over 120 years, a wire has been built into every home. And now we are building a new infrastructure. Of course, some feared that the ILECs would be reluctant to comply with the 1996 Telecommunications Act and open their markets. I would like to discuss the Act and its impact on the telecommunications industry.

Actually, the Act consolidated preexisting precompetitive policies that were tested in many, many different states; TCG helped with some of these trials. The FCC watched the trials in cooperative environments, and the outgrowth of this observation, of course, was the Telecom Act. It also was to remove the restrictions that were in place to prevent competition in the local marketplace. Again, there was an attempt to modify the local telephone companies, particularly the RBOCs' behavior that was anticompetitive. But, as we all know, we are on the anniversary of the Telecom Act, and it is unrealistic to think that one Act would immediately open up the door to competition in the local marketplace. It will take time. Again, the RBOCs have been laying their wires for 120 years. Inevitably, it will take time to open up and build these markets. And it will also take some time—unfortunately, it has already taken longer than we would have liked—to have better cooperation between competitive local exchange carriers and the RBOCs. However, what is local competition? We have all heard a lot of discussion about total service resale, or rebranding; and in my mind, since the beginning of Teleport and TCG, we have always thought that rebranding is not true competition, insofar as it does not provide service to our customers. Reselling of the unbundled networked elements seems to be another option, but again, the last mile would be controlled by the incumbent local exchange carrier. So, again, it is not true competition.

Since 1983 and 1984, when we started Teleport, we believed in facility-based competition. All our work with Congress to help this act get passed attests to our dedication to developing an environment that fosters true competition—true competition that requires a second network to customers, be it business or residence. This is why a facilities-based local competitor is a truly competitive environment. You control your service, you control your costs, and you can control the quality.

There are different requirements that have evolved from the Act. Section 251 talks about how the ILECs must provide quality performance that is at least equal to that which the OSS systems have put together. We are all aware that when making a call from one part of the United States to another—even when it was under one Bell system—the cooperation of many independent telephone companies was required. As we go forward with new technology, these OSS systems are imperative for this process. Our goal now is to enable OSS systems to take orders electronically in order to avoid any mistyping or misrepresentation of what was ordered. The escalation of services, however, is still up to each department and each company. What remained crucial in the Act, though, were performance parity measurements, and there were measures put in place to ensure that swift justice would ensue if they were not equitable.

The Act also demanded fair ILEC pricing—which meant no cost subsidies—and that bottleneck services be fairly priced. This brings to mind the unbelievable pricing for co-location and cross connects we have all heard about, where 10 x 10 feet of a central office would cost $87,000. That is improper, inappropriate, and anticompetitive. We also need unbundled looping prices that are not cross-subsidized, and we are believers in reciprocal compensation that allows calls that are terminated on our network to receive compensation, as we are entitled to compensation when we terminate on ILEC networks.

It seems to me that, for TCG, that is what local competition needs to be. As I discussed earlier, we believe that a facilities-based system is clearly in the best interest of the United States, our customers, and our subscribers. We were the first competitive access provider nationwide when we started back in 1984 and 1985. We first built an essential business district to help give us an initial backbone. Then we expanded further out of the essential business district into regions and then complete LATAs as it went forward. Today we are in sixty-six MSAs nationwide, the largest competitor to the RBOCs. We have more than 9,000 fiber cable miles. We own a company, formerly called Bistel, that holds 213 38-GHz broadband wireless facilities nationwide. We are, geographically, the largest holder of those licenses, which means the most on net as well as the most access lines. We are proud to say that TCG, soon to be AT&T, is the least dependent on the RBOCs to access their customers than any other company in the United States.

We think there are just a few fundamental principles. If companies own and control their basic infrastructure, that minimizes their dependence on competitors. As an example, in the following discussion, I would like to touch on how we provide our services. First and foremost, we maximize both the quality of our products and services and the responsiveness of our customer service team. But perhaps most importantly, we at TCG are always ready for change, and in today's world, companies must be very good at adapting to change as the market evolves.

When you take a look at our extensive fiber footprint, we are the largest wireless network nationwide. Many companies began concentrating on CLECs, but it seems to me more crucial for a company to maintain systems that allow it to operate effectively and efficiently as it grows. Again, we made our presence known in the Northeast corridor when we acquired Eastman Telelogic in Philadelphia, Pennsylvania. TCG now has fiber linked from New Hampshire to Virginia. We have embarked into the long-distance marketplace where we can provide local access to a customer in the Northeast corridor and then terminating access to another customer on net—which, of course, gives us tremendous economic advantage. On the West Coast, we have the MSAs, as well as our own fiber link between San Diego and Los Angeles. TCG also holds the Chicago–Milwaukee MSA. We expect to continue to grow at the rate of eight to ten markets a year—if not more. As a result of all this traffic, we now must work with AT&T.

Returning to my earlier discussion of recently acquired companies, Bistel's 38-GHz, 45-megabit broadband capacity point-to-point network is to be point-to-multipoint, which, again, gives TCG tremendous broadband access. As I mentioned, TCG is invested in both broadband fiber and broadband wireless; we strongly believe that broadband is the way to capture and control the marketplace. And here is how we do it, step by step: first, clearly, we resell the RBOC. We will always resell the RBOC because we do not have our wires in every home and every business in the United States. So if there is a small volume of service, we resell from the local serving office out, and then we send our sales force

back in to upgrade the amount of facilities for that customer base. Second, we build our fiber to that customer, so we qualify where to put that fiber in order to best utilize it. Then we send the sales force back in again, and we sell them Internet, ATM, local calling, dialing, and long-distance services. We simply provide every product and service available. Our goal of using 38 GHz was not to acquire a company in itself, but an access vehicle into the network, a technology to bring customers on the net.

Our system's infrastructure has set TCG apart from the competition. For example, the Securities Industry Association (SIA) sends us all their orders via the Internet and links directly to our computers. We also have produced a CD-ROM disk bill for our large-volume clients. Instead of reams of paper or mag tape, customers receive a small CD with their entire bill on it. Twenty-five percent of all our orders are turned up in less than an hour. In fact, it takes six minutes to complete the whole cycle. At TCG, we feel strongly that competitive systems will ensure a successful future.

Finally, I would like to address the true reason for our success at TCG and Teleport: our action culture. Some people refer to it as the headware. We train all our managers and associates to be action oriented, and, for us, every letter of the word means something. Our training asserts that we must be "close to the client" and have "teamwork" and "individual initiative." But the "n" always stands for "never-ending improvement." We have all our employees go through training at least ten days a year in cultural issues as well as system issues and equipment issues so we can be the very best as we go forward.

We think the model for any forward-thinking company is the one we have designed where you have broadband networks—be it fiber or wireless—and all the products and services available today. We acquired Internet products when we bought Surfnet. We believe in wholesale and retail. We sell to all the long-distance carriers, and we expect to continue to sell to all the long-distance carriers because we have the best cost structure to offer them. But while you have broadband networks, broadband product lines, and a broadband customer base, I believe the key is the system and the infrastructure that allow a company to use technology to go forward, integrate its operations, and help employees do the job a lot faster and a lot better.

As I mentioned, TCG now will be merging with AT&T, and we are working very hard to have the merger go as smoothly as possible. We think we have done a great job for our shareholders, our employees, and our customers. We will become the local unit for AT&T, exploring all the access opportunities and looking at all the new products and services that we must apply. My biggest challenge is to access every premise in America without the RBOC. That is our goal. And that is a big job. But, we are determined to become the local services unit of AT&T.

Looking at facilities-based competition, we can see that, first, we have created high-capacity networks and have

large-volume clients on our networks, and second, we will expand those networks to different customer bases using different technologies. We have fiber-to-businesses, fiber-to-hub points using 38 Gbps for each—be it wireless or wireline—to bring all customers on the net. We are in the process now, of course, of achieving economies of scale as we look at all the access services that are out there. Then, of course, we must acquire mass-marketing capability.

I truly believe the combination of AT&T and TCG will allow us to provide tremendous opportunities in the business community, where we can do both ends of the access and have the greatest long-haul network in the country. And we have the largest expansive network that allows us to carry most of the calls on net. When we look at AT&T's resources and its traffic volume, we think the acceleration is going to be tremendous. And, of course, the quality of the AT&T brand name will allow us to get business on the network more easily.

It is an ideal platform to address the mass market, but we still have to interconnect with the RBOCs nationwide. We were the first to achieve interconnection because interconnecting networks is crucial, as we all know from the Bell system. But the regulators still have not demonstrated that they can keep control. If a company is prevented from interconnecting—if the charges are too high to use the RBOC networks—then these costs must be brought back into line so our country can truly build out a second local network.

The mass-marketing competition, the ILECs, really must help support this. The ILECs truly must work within the parameters and examine the fourteen points before they get into long distance, according to law. Through the introduction of this law, we came up with an agreement, and we must follow that law as we go forward. More importantly, we must always interconnect to serve remote locations.

What will the telecommunications world be like in 2001? If the ILECs comply with the 1996 Telecommunications Act, we will see vigorous one-stop shopping companies being created nationwide. There will be substantial technology investments. We must have seamless interconnections. Of course, there will be less regulation when we all cooperate to serve the customers at our best. If the ILECs do not comply, there will be fewer consumer options because there will be only a few companies that will have the money to put into the network. Without ILEC compliance, there will be less innovation and slower deployment and litigation and regulation will increase.

In closing, we are confident that the AT&T–TCG merger is a very positive step toward providing serious competition in the marketplace. But, as I have mentioned, the success of our merger and, in effect, a bright future for the telecommunications and information industry, depends on local competition, which will require the sincere, dedicated cooperation of all industry players.

Implementing the Vision of the Telecom Act

C. Michael Armstrong
Chairman and Chief Executive Officer
AT&T

People in government and in the telecom industry are understandably focused on federal court decisions, Congressional intent, and the nuances of telecom policy. But the people with the biggest stake in the Telecom Act of 1996 are America's consumers. And most of them aren't talking about UNE-P or TSRs. To them, Section 271 sounds like a seat assignment at a football game.

These people are interested in the Telecom Act. But their interest is practical. They want to know when they will see the benefits they were led to expect two years ago. They want the tangible benefits of a competitive market in local phone service, and I believe the Telecom Act can deliver those benefits.

I myself am a true believer, even if a somewhat recent convert. Up until the end of 1997, the Telecom Act frankly was not living legislation that dominated my daily life, so my prejudices are short-lived. Thus, I hope to offer a factual assessment of five fundamental questions that today require objective understanding:

1. Why does America need a Telecom Act?

2. How is the Telecom Act supposed to enable local competition?

3. What has happened since it was passed?

4. What is needed for the Telecom Act to succeed?

5. What will Americans miss if the Telecom Act is not made to work?

First, why does America need a Telecom Act? The answer is simply to benefit consumers by opening the monopolies of regional Bell operating companies to competition. The Bell operating companies have had a protected market for the better part of this century; they have the only telephone wire that connects to the consumer; and they had, and still have, 98 percent of the consumer local exchange market.

The purpose of the Act is to enable local competition, attract investment in new local service facilities, and give consumers better local value. At least in the short term, this will only happen if new competitors are given a fair chance to reuse or compete for the only wire that connects customers to the telephone systems.

In contrast, the Act was not primarily designed to let the Bell operating companies into long distance. Long distance in America is already competitive with over 500 companies. This long-distance competition has attracted new investment, new technology, new companies, and new jobs. Plus, it has driven long-distance prices down by 55 percent since the break-up of the old Bell System monopoly In 1984.

The Act holds RBOC entry into long distance as a Acarrot@ for opening their local markets to competition. The regional Bell operating companies' entry into long distance is to be a consequence of opening their markets. The RBOCs have been protected from market forces for close to 100 years. For market competition to work, they must allow competitors to use their facilities on an economically viable basis. And that is exactly what the Telecom Act requires.

Second, how is the Act to enable local competition? The most important principle to recognize here is that the regional Bell companies own the only connection to the consumer. There is only one wire to the home. It is a ubiquitous wire that was paid for by America through the protection of the monopoly Bell operating companies.

So the only short-term means for local competition is an economically viable resale of the only consumer connection available. Initially this was to involve what the industry calls total service resale (TSR). This means that a new competitor buys the existing local company's whole service package at a discount off retail prices and resells it—no modifications, no differentiation.

TSR was to be followed quickly by the unbundled network elements platform, known fondly as UNE-P. This scenario is much more attractive. It lets new competitors lease just the relevant facilities they need from the local company at cost plus a reasonable profit. In this arrangement, competitors can lease all elements needed for local service, or combine the elements they lease with capacity of their own and thus make a differentiated offer.

It defies logic, history, and common sense to say that competition will happen without economically sound resale of the wire. It was the economically viable resale of the long-distance wires that took America from long-distance monopoly to competitive long-distance markets. It is the economically viable resale of power that will lead to compe-

tition in the electric industry. And it is the economically viable resale of local exchange facilities that will result in local service competition.

However, local resale at an average of 22 percent discount means that no one can afford to go into the local exchange business. And a 22 percent average discount is the current and only Bell company offer. With a discount like that, no one would be competing in the long-distance market either. Today, long-distance competitors—including the RBOCs— buy service at discounts of between 50 and 60 percent from AT&T. That is about what it takes to cover the costs of competing in the telephony resale business.

The assertion that the Bell company markets are open but no one is showing up flies in the face of market principles and the experience of the long-distance business. When the local communications market opens, investment and competition will happen. And the Telecom Act requires appropriate market opening that will attract investment and result in competition.

As to the third question—what has happened since the Act was passed?—let's look at AT&T's experience.

We applied for certification to provide local service in all 50 states within 30 days after the Act was signed. That was the easy part. In the two years since then, we entered into 78 negotiations with regional monopolies for TSR terms in different sections of the country. Exactly one of those negotiations resulted in a voluntary agreement. That was in Alaska. The other seventy-seven negotiations all went to arbitration.

We made forty-one interconnection agreements to connect with local company networks. Every single one of them is under appeal.

Keep in mind that TSR is the uneconomical way into the local market. UNE-P promises an economically viable path into local competition, but the regional Bell operating companies have filed a federal suit that would cripple UNE-P altogether.

We remain committed to local service. We have spent $3.5 billion on it over the last two years. I think we have more than demonstrated a good faith effort to invest in local service. We signed up more than 300,000 consumers, more than any other new competitor. And thanks to the uneconomical discounts of TSR and the lack of UNE-P, we are losing $3 a month on each customer.

AT&T will not spend money on this fool's errand, and that is what TSR is today.

So we have been compelled to temporarily stop actively marketing consumer local service. MCI and Sprint have done the same thing, and no RBOCs have shown up to compete anywhere for local service. However, AT&T will provide consumers with local service anywhere that we can get UNE-P at economically viable rates, which is just what the Telecom Act requires.

The fourth question is, what is needed now for the Telecom Act to succeed? The answer is: just give it a chance to succeed! The Telecom Act defines how to economically share the local wire to get local competition started. It opens a path from simple resale to UNE-P to other forms of competition. But the Act is in court. It has never been in the market.

The RBOCs have sued, challenging the constitutionality of the Telecom Act they helped fashion and publicly supported; and they have sued, challenging the right of the Act to require economically viable facility resale nationally. These challenges will be heard and the will of the Congress continued or redefined.

Yet these same challenges refocus us on the Telecom Act as a product of our Congress to achieve local competition. It is a product that was shaped by industry agreement, regulatory agreement, and an overwhelming legislative agreement.

Like all new products, the Act needs to be tested in the market in order to be properly judged. We should surely not judge it by the protests of the local monopolies resisting competition. And we should surely not try to fix it until we know what does not work.

I am not denying the right of the RBOCs to use our legal system to resist the Act. We have to live with that. We have little choice but to honor due process, even though it usually delays things. But submitting the Telecom Act to due process does not make the Act wrong, in either purpose or implementation.

This Act was written for consumers and competition. We should not let its benefits to consumers and competition slip away simply because we became tired of removing the obstacles created by the opponents of competition. If we want the benefits of local competition, we need the patience and perseverance to put the Act to work in local markets.

Finally, what will Americans miss if the Telecom Act is not made to work? First, of course, if there is no economic opportunity to reuse the Bell company facilities, then by definition there will be no local competition for years to come. Second, consumers will miss the market benefits of local market competition, such as:

• better service
• new investment
• more functions and services
• one-stop shopping and greater value

And third, consumers will miss one or the most powerful drivers of the market system in a democratic society— choice. Consumers deserve that. If it is denied to them, it will not be denial by the market. It will be a denial of the many, engineered by the self-interest of a few.

I really do not think that will happen. The communications industry has a vision for the future that revolves around the benefits of real competition. It is a vision

worth sustaining. And that vision will be advanced by the Telecom Act of 1996.

In conclusion, the power of this industry profoundly affected my last industry: defense. I believe that it was the power of communications more than anything else that ended the Cold War. It was the power of communications that flew over the wall. Thanks to modern communications, people from Budapest to Beijing could see and hear for themselves what democratic capitalism was all about.

An industry that can open the hearts and minds of almost 2 billion people can certainly open up its last bastion of monopoly to competition.

Wireless Intelligent Networks: Gateway to the Growth of Enhanced Wireless Services

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AG Communication Systems

Wireless intelligent networks (WIN) will become a reality, and hopefully sooner rather than later. What is WIN, and why is the industry pursuing it? This paper describes the WIN technology in quite a bit of technical detail, along with some of the background leading to the emergence of this technology. First, it will give an overview of today's telecommunications networks and the major differences between wireline and wireless networks. The discussion will then focus on the challenges facing the wireless industry and some of the drivers prompting service providers to meet that challenge using WIN. The commonality between WIN and the existing intelligent networks (IN) and advanced intelligent networks (AIN) are explored. A brief look at WIN implementation and industry support follows, along with a more in-depth look at the first phase of WIN— which implies additional phases with additional enhancements to come. Finally, the potential evolution of WIN and opportunities for the future are covered.

Today's Network

Today's network can be broken into two major parts: the wireline side, which is the old network that has been in place for some time, and the wireless side (see Figure 1). The classic wireline central office (CO) contains all the intelligence to handle calls, including the service-logic, call-control, and call-switching functions. When wireline intelligent networks were developed, the industry realized that if intelligence was centralized in certain network elements, then those elements could control all the switching systems over a whole area. By changing logic in a central element, the provider could offer new services to all customers ubiquitously in a service area. Services could be deployed and changed quickly by upgrading the logic in the central element rather than upgrading each of the COs in the service area. These are the fundamental bases for the development of advanced intelligent networks. The wireline side, then, basically includes a network element platform called the service control point (SCP), which handles the service logic; an intelligent peripheral (IP), that provides

specialized resources, such as text-to-speech, voice recognition, and voice announcements, which are used during processing of the call; and, optionally, a service node (SN), that combines service logic and intelligent peripheral functionalities. Also, the COs are upgraded to become service switching points (SSPs) that have the ability to interact with intelligent network elements such as SCPs, IPs, and SNs.

The wireline side, with its distributed intelligence, is feature-rich. The biggest drawback of a wireline system, however, is its limited support for mobility (e.g., cordless phones). Wireless networks began to develop because of the critical need for mobility. Intelligence had to be put into a central location in the network in order to provide mobile services that allow a customer based in New York to switch on his or her phone and get the same package of services when in a different city. Wireless networks are inherently rich in mobility management but generally poor in supporting features when compared to wireline networks. All the features in wireless networks are provided by the wireless central office, also called the mobile switching center (MSC), which is potentially working in conjunction with its visitor location register (VLR) and the home location register (HLR).

The wireless and wireline sides of *Figure 1* do have some common elements, such as the public switched telephone network (PSTN) that carries voice traffic between the two, and the signaling system 7 (SS7) network that carries signaling messages between the elements. However, wireline uses the IN application protocol (INAP) in processing a call, whereas the wireless side uses the cellular intersystem operations protocol (IS41) for its mobile application part (MAP) protocol. That is like saying one network speaks German and the other French to query intelligent network elements during call setup. What is important, however, is that the two networks have the ability to talk to each other using a common bearer channel protocol, such as the signaling system 7 (SS7) integrated services digital network user part (ISUP) protocol, to set up calls between them.

FIGURE 1
Today's Network
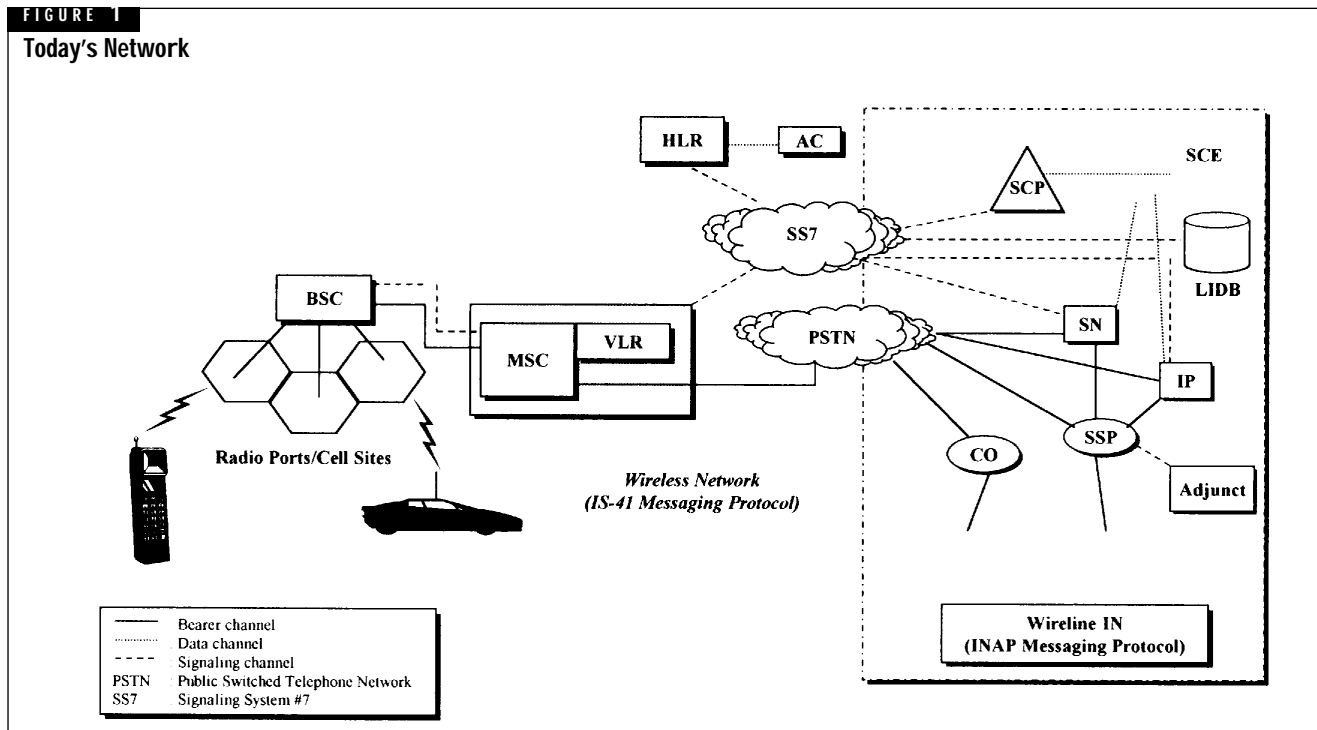
Challenge for the Wireless Industry

The challenge for the wireless industry is to incorporate the IN technology of the wireline side, such as the network service platforms and intelligent peripherals, into the wireless network in order to offer enhanced wireless services while continuing to support the unique wireless network functionalities such as mobility. This combination could enable customers to receive services with the same look and feel in one seamless operation, regardless of whether they use the wireless or wireline network. At the same time, it would enable wireless service providers to offer services with less effort and lower deployment costs. They will also be able to decouple their dependence on the current MSC/VLR/HLR–centric architecture. The wireless industry is defining WIN to meet that challenge. WIN supports the use of IN capabilities to provide seamless services, such as terminal services, personal mobility services, and advanced network services, in a mobile environment.

Drivers for WIN

Clearly, the industry wants to exploit the existing IN capabilities of the wireline network while obtaining independence from the existing MSC/VLR/HLR generic cycles. By separating the service intelligence from the call switching functions, the switching or call processing can be maintained at the lower level and the intelligence at the higher level, which allows vendors the flexibility to develop new and customized services that can be quickly deployed by service providers on a network-wide basis in their serving areas. The industry can use WIN to control fraud—a billion-dollar industry—through enhanced features such as speaker verification through voice prints. By placing voice prints in intelligent peripherals, the supplier can offer customers veri-

fication through speech rather than personal identification numbers (PINs). In addition, the well-known IN technology advantages, such as time-to-market, rapid deployment of services, customization, interoperability and compatibility, and third-party service creation are also drivers for WIN.

WIN Implementation

The first step in implementing WIN is to migrate intelligence away from the MSC and HLR and introduce some of the IN elements used by wireline services, such as the service control point, intelligent peripherals, and service nodes. The move involves defining a standard call control model within the MSC that enables it to stop a call that it is processing at certain well-defined states (called trigger detection points [TDPs]) and query an intelligent network element, such as an SCP or SN, for directions on how to process the call further. Thus, when an MSC sends a query to one of these intelligent elements, the element knows exactly the state of the call and associated data. Additionally, to support mobility, WIN requires the ability to download triggers and SCP addresses for IN services to the serving MSC on a per-call basis. This enables the MSC to send the same query to the same service logic no matter where the customer is, thus providing the same service to the customer.

The wireless industry also must define standard, service-independent interfaces between network elements so that service providers can buy from different vendors and be able to put all the components together to produce new and customized services. This step requires interfaces between the HLR, SCP, SN, IP, and MSC/service switching point (SSP). It also requires enhancing the IS41 messaging protocol.

In addition, WIN provides for multiple points of service control, i.e., distribution of service logic between several network elements. This requires the definition of a service interaction manager (SIM) within the intelligent network element that receives the initial query from an MSC to manage all of the services subscribed by a customer at the TDP from which the query emanated.

Finally, WIN will eventually require support for third-party service development. The industry must define the standard service-independent building blocks (SIBBs) and allow their use in creative ways.

All of the WIN requirements will not be met right away. But WIN will develop incrementally.

Industry Support

The Cellular Telecommunications Industry Association (CTIA) is behind WIN development, and WIN has strong industry support. Almost every major service provider and vendor has been involved with developing WIN standards. CTIA has been pushing for wireless intelligent networks because of all the advantages they offer, and the Universal Wireless Communications Consortium (UWCC) has been pushing WIN not only locally within North America but also internationally.

The WIN standards are being developed in the ANSI-accredited Telecommunications Industry Association (TIA) TR45.2 Standards Committee. TIA intends to use the WIN standards to influence the emerging International Telecommunications Union (ITU) IMT-2000 standards for the next (i.e., third)-generation wireless networks.

Clearly, there is substantial industry support for WIN.

WIN Phase 1

Network Architecture and Interfaces
The first phase of WIN will not include all the features it will ultimately provide, such as a service creation environment (SCE), but it will involve three major elements: the SCP, SN, and IP (see *Figure 2*). Phase 1 involves standardizing those elements to support IS41. When the SCP, SN, and IP understand IS41 and the enhanced messaging and standard interfaces, they can provide service not only to wireline users, but also to wireless users. WIN Phase 1 will standardize interfaces between the new elements and the existing elements, such as the HLR and the MSC in the wireless network. *Figure 3* simplifies *Figure 2* to show these interfaces.

Service Drivers
The WIN standards committee is using some service drivers as a framework in defining WIN, Phase 1. CTIA's chief technical officers chose three very popular services to define the initial wireless IN model: calling name presentation (CNAP), incoming call screening (ICS), and voice-controlled services (VCS). The ICS service provides call screening and routing services based on time-of-day and day-of-week, caller identification, called-party location, and called-party status. VCS includes voice dialing, feature control, voice-based user authentication, and speech-to-text conversion.

WIN Call Models

A call model, which is implemented in the CO switch, allows call processing to be stopped at certain fixed points while the system queries external elements to determine how to proceed. A WIN call model is a high-level model of call control functionality in the MSC that defines MSC capabilities, not the services themselves. The call model makes
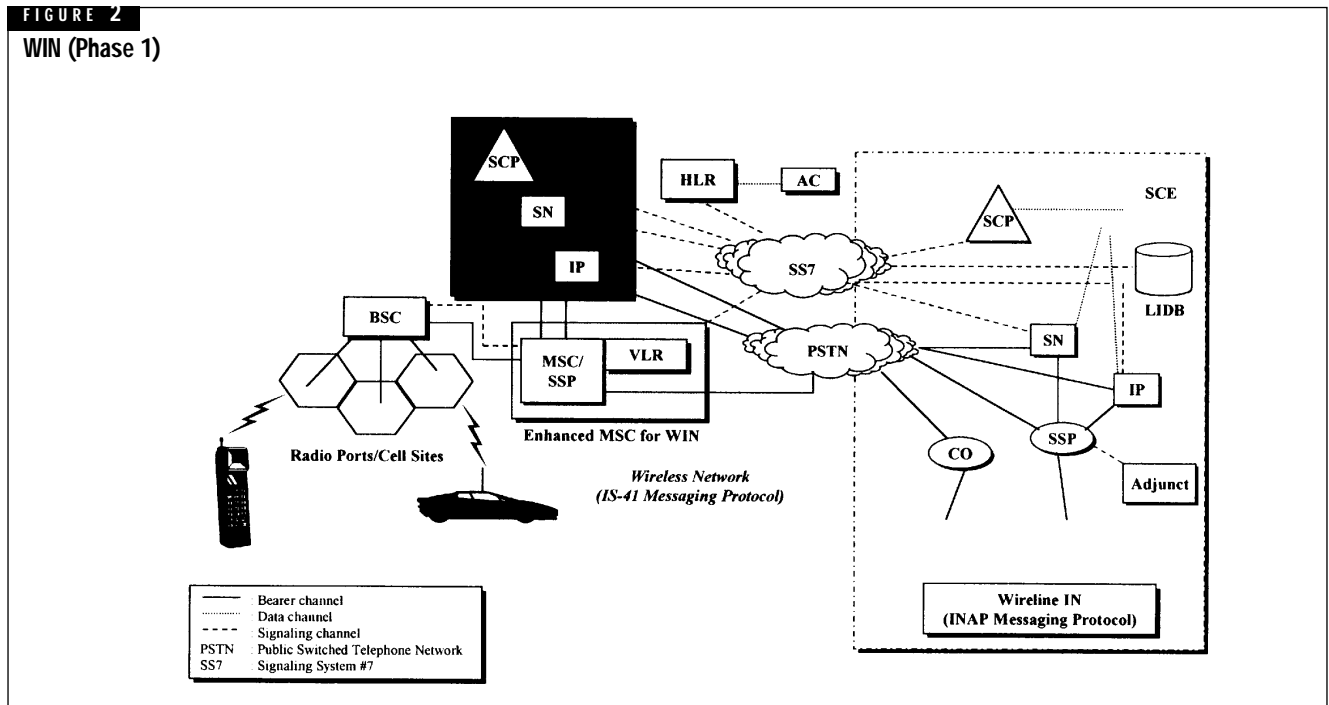

FIGURE 2
WIN (Phase 1)
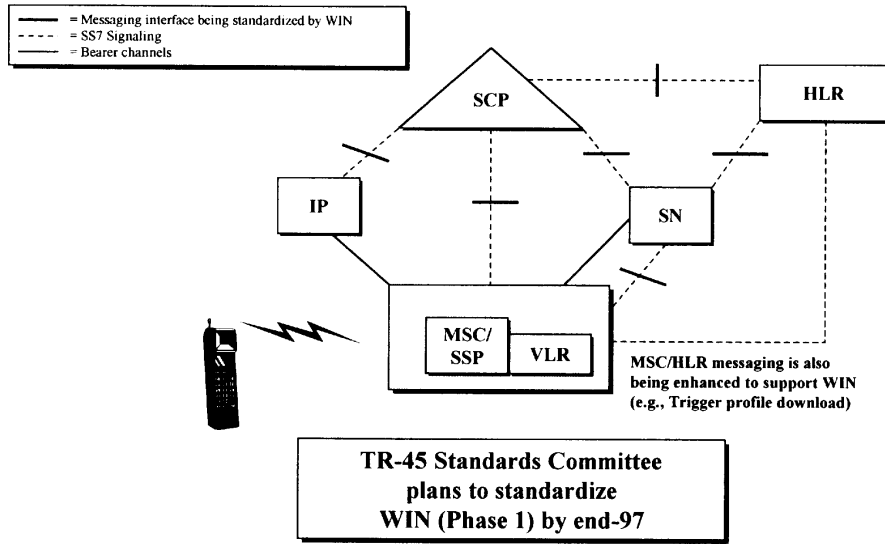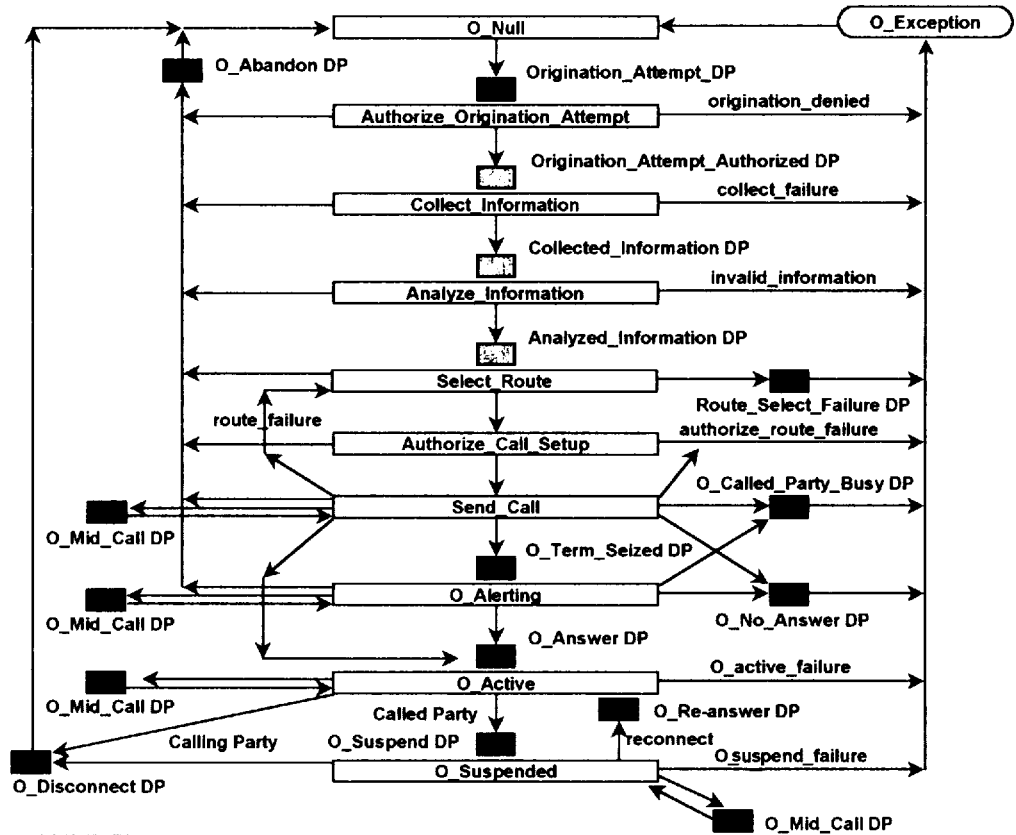
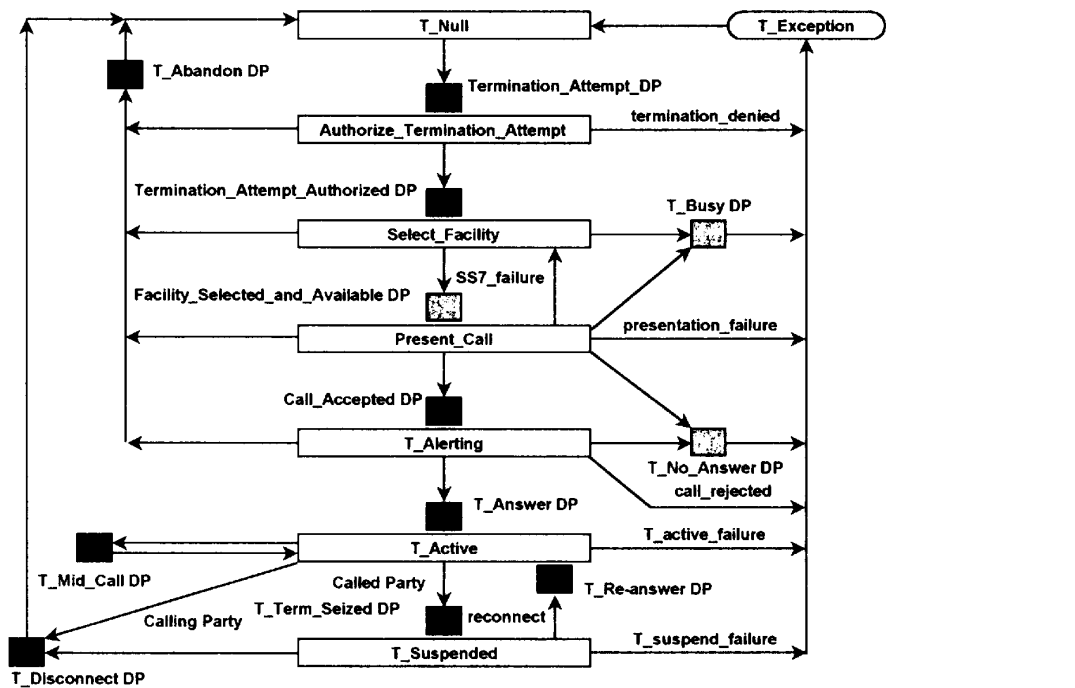**FIGURE 3**

WIN (Phase 1) Interfaces

FIGURE 4

Originating BCSM

NOTE Reproduced under written permission of the copyright holder TIA (Telecommunications Industry Association) At time of publication, the standard which contains this figure was not finalized, please check with TIA for the correct version.

■ **No triggers defined for the DP in this standard**

Terminating BCSM

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■ No triggers defined for the DP in this standard

information concerning the call state and associated data visible to external IN elements such as the SCP and HLR so that they can use their logic to process the call. Because the service logic and call switching functionalities are separated, external IN elements can control services.

WIN currently has two call models, originating and terminating, based on the International Telecommunications Union (ITU)-T IN Capability Set 2 (IN CS2). WIN call models are based on ITU-T because the industry wants WIN to become not only a North American standard, but also to influence and align with the emerging next-generation international standard, called IMT-2000. WIN also has plans to define a location registration state model in the future. This model is intended to standardize mobility and radio access control functionalities for use in providing non-call associated services, such as short message service.

The WIN call models are still being refined by the TIA WIN standards committee and hence are subject to modification.

Figure 4 depicts the originating basic call state model (BCSM). The large rectangular blocks, called points in call (PIC), represent call processing occurring in the MSC, and the small blocks, called detection points (DPs), are call states at which switch call processing can be stopped so that an external element, such as an SCP or SN can be queried using an IS41 WIN message to determine how to process the call further. As can be seen in the figure, there are many possible detection points; however, WIN Phase 1 plans to open only a few.

Phase 1 of WIN opens up three origination detection points that can, in general, be used to provide services to the calling party. The Origination_Attempt_Authorized DP represents the point in the call when an external element can be queried prior to the dialing of digits by the calling party, such as when an authorized customer picks up the phone. It can possibly be used for a service, such as voice-activated dialing, that does away with the need to punch in numbers. When the customer picks up the phone, the MSC queries an SCP (or SN) which can then direct it to make a connection to an intelligent peripheral that has the customer's voice prints. Thus, when the customer says "call Mom," he or she gets his or her mom, not someone else's. Another detection point is Analyzed_Information DP, which can be used to provide incoming call screening at a customer's home MSC. Calls from specified parties such as the user's boss or spouse are allowed through, but others are not. A third detection point is Collected_Information DP, which can be used to provide services to the calling party, such as allowing the customer to activate and deactivate special features (e.g., call forwarding) by using voice commands. Other triggers are available but have not been opened yet; they can be expected to be opened in the future phases of WIN.

A model is also available for the terminating BCSM (see *Figure 5*). The terminating call model handles services for the called party, such as calling name presentation, which provides calling name information during the alerting cycle. In WIN Phase 1, three detection points are available for intelligent processing in the terminating BCSM. The Facility_Selected_and_Available DP can be used for provid-

ing calling-name service to the customer. The T-Busy and T_No_Answer DPs can be used to route calls to a voice-messaging system or to special announcements/tones when the customer is busy or does not answer a call, respectively. Other DPs in the terminating BCSM are not available in WIN Phase 1, but this technology can be expected to grow and develop in future phases of WIN.

Potential Evolution and Opportunities

The discussion so far covers WIN Phase 1. As the technology progresses, more triggers, trigger criteria, and messages will be standardized to support innovative services demanded by customers, such as calling party pays and freephone. These triggers will also be able to enhance existing services, such as call screening based on enhanced location information that can be obtained on a real-time–demand basis. Enhanced WIN also can support other novel features, such as pre-paid calling service and associated notification service that can give a customer specific information during a call (e.g., when a time limit is reached on a call).

Another WIN opportunity is to include a trigger in the call model to meet the Federal Communications Commission's local number portability (LNP) mandate through querying a wireless number portability (WNP) service logic program. This may be included in WIN Phase 2. Future phases of WIN may define service-independent building blocks that can be used with a service creation environment (SCE) by third party application developers to create new services.

The incremental, market driven, bottom-up approach being used to standardize WIN technology is expected to help speed up deployment of the technology. This approach puts something in the field and allows it to evolve rather than starting the other way around and developing standards that may never be deployed.

A final area for evolution is WIN convergence with North American and international IN standards. Convergence with the North American IN standards will permit service convergence between wireline and wireless networks. From an international perspective, not only the industry itself, but also service providers with licenses both inside the United States and abroad, are pushing for a compatible standard. Vendors can take advantage of such a standard to develop a single generic system that can work nationally and internationally, thus saving on development costs. Service providers can reduce deployment costs by having a single generic system. Because of the global push for a single standard by the UWC Consortium, TIA, and others, WIN concepts can be expected to be incorporated into the emerging ITU-T IMT-2000 standards for next (third)-generation wireless systems.

Conclusion

WIN can be used to leverage existing wireline products and services, such as number portability, incoming call screening, calling name presentation or restriction, and voice-controlled services, into the wireless arena. Many of these services are already available on wireline networks in many places, and if they can support the IS41 WIN protocol, the wireless industry can leverage from what is already in place rather than starting from scratch. This is desirable from a customer's perspective as well since the customer will receive the same service, with the same look and feel, whether he or she is using the wireline or wireless network. The WIN market can continue to grow as WIN evolves in phases to support other advanced services and service-independent building blocks. This will be advantageous to both vendors and service providers. WIN is definitely coming, and it presents a revenue opportunity for everyone.

Internet Innovations: From Global Chats to Government Commitment

Steven M. Case
Chief Executive Officer
America Online

So much is happening with the Internet these days that it is almost mind-boggling. There are new ideas, new services, new technologies, and new companies—all competing for our attention. The pace of innovation is intoxicating—but there is a very real risk that we can all be caught up in the announcements of the moment and lose sight of the bigger picture. Sometimes I find it helpful to take a step back, and try to look at the emerging interactive media—and the future—through an historical lens.

When you look back, you are struck by a very simple but compelling observation: every leap forward in communications has dramatically changed the lives of people all around the world. Just look at the telephone. When the telephone emerged almost a century ago, it enabled people to connect with others—not just in their neighborhoods, but around the world—and daily life never was the same again. A few years ago, another new communications technology—the fax machine—provided ordinary people in the former Soviet Union with the information that helped bring down that government and end the Cold War. Last year, the first pictures transmitted from the Sojourner Mars rover were broadcast simultaneously throughout the world—over the Internet. There were no filters. Each person who saw those photos saw exactly what the scientists at NASA were seeing, exactly when they were seeing them.

The Internet's success in becoming increasingly important to people's daily lives is drawing more and more attention from legislators and policy makers in the United States and internationally. In the 103rd Congress, we saw only twenty-five bills that were related to the Internet. In this 105th Congress, more than 200 bills relating to the Internet have already been introduced. Some would add regulations, some would impose new taxes, some would increase liability, some would restrict our use of certain technologies, and some would require the use of other technologies.

As we continue to work through all of these issues, we will be guided by two principles. First, this medium offers enormous benefit to consumers, and we will do everything possible to ensure that our policy environment enables all consumers to have access to those benefits quickly, easily, affordably, and safely. Second, this medium has the potential to improve our communities and our society, and we will do everything we can to ensure that it meets this potential.

For a decade, we have spent a great deal of time and energy focusing on the growth and potential of the interactive medium in the United States. But it is important to recognize that the interactive medium is a global phenomenon. Two years ago, just over 23 million households were on-line around the world, the vast majority in the United States. That number has almost doubled in the last two years to 45 million households, with much of that growth driven by new Internet users in European markets and Japan. And the opportunity for this medium to really stretch its wings is increasingly overseas, in countries that are just now getting on-line, in highly populated countries such as Russia, India, and China, which account for only about 3 percent of the on-line population today. Two years from now, as we enter the next century, the number of on-line households is expected to grow to more than 66 million, with almost half outside the United States. Of course, there will be tens of millions of others connected to the Internet through schools and businesses. But numbers tell only part of the story. Of greater importance is what a truly global medium like the Internet can do to build a community for "ordinary" people all over the world.

As AOL helps build this medium, we are aware of the growing number of public policy challenges we all face: respecting diverse cultural and national sensibilities; safeguarding privacy and security; ensuring that children have rewarding and safe experiences on-line; ensuring affordability and accessibility; and avoiding piecemeal country-by-country regulation of this borderless medium. With each additional ocean and threshold the interactive medium crosses, these challenges only grow.

When AOL launched its first service outside of the United States—in Germany in November 1995—we knew that we had to keep the elements that make the interactive medium so compelling intact: community, convenience, and instant communications. But we also had to develop an experience that offered local content and a unique look and feel—in short, a German service designed for Germans. There were those who doubted that popular services in the United States, like chat rooms, would be popular elsewhere in the

world. As it turns out, people tend to use the interactive medium for the same things overseas that they do in the United States—to get and share information quickly and efficiently and to communicate with each other. We have found that Europeans love to chat as much as Americans.

When you give this discovery a little more thought, it is not so surprising. People are people. They want to communicate, share ideas, and be a part of their community and their world as much in Dusseldorf, Germany as in DeKalb, Illinois. Given this common bond, the opportunities for building a stronger global community through the interactive medium are enormous. This means enabling people to interact with a wide variety of others, from many different social and economic classes, all over the world. Of course, you can just use the medium to stay in touch with friends and relatives, and that is tremendously useful, especially in our increasingly mobile society. But what really boggles the mind is the ability of this medium to connect you to people whom you otherwise would never have had a chance to meet. This provides us with a powerful tool for understanding other cultures, for developing relationships with people far away, and for engaging in commerce across borders.

When we launched that first German service, we did so because we saw the wonderful opportunities that would result from a global electronic gathering place. In those two-and-a-half years, we have grown to well over a million members outside of the United States—a feat that took nine years for us to achieve in this country. We now offer services with localized content and flavor in eight countries and four languages, as well as access numbers in more than 100 countries and 1,000 cities. Together with CompuServe Interactive Services, AOL Europe is now the largest pan-European provider of Internet on-line services with two million members. AOL Canada has become one of the lead-

ing services in Canada, and AOL Japan just passed 100,000 members a year after launch. We will soon be adding to our international services when we launch in Australia and Hong Kong.

For our members, this means an incredible array of ways to share across cultures. Already, members need only click on AOL's International Channel to follow the progress of German soccer teams, tour the museums of Amsterdam, or read a British newspaper. You can even log on to AOL to listen to the Marseilles on Bastille Day or brush up on your Swedish without leaving your living room. One of our most popular services in the AOL International channel is Country Information, where you can find sites on just about every country around the world from Latvia to Lesotho. On the individual country sites, members will find maps, travel tips (know how much to tip a taxi driver in Bangladesh?), information on culture and traditions, links to pen pals, language pointers (learn how to say hello in Magyarul) and more.

AOL is making it easy to travel the world and visit our global community, bringing guides to restaurants, hotels, sight-seeing, entertainment, and much more to some of the world's most majestic and well-traveled cities, such as London, Paris and Toronto. We are only just beginning to realize the benefits of this global medium. As we add more ingredients, more services and more access to the world—and as the Internet continues to become more robust and populated—we will continue to build a service that offers greater and greater opportunities to become members of a true global community. When you are on-line, take a moment to reflect how we are all pioneers building a brand new global community. We are, quite simply, creating something very unique and special in our lifetime.

Everything on the Net

Vinton Cerf

Senior Vice President–Internet Architecture and Engineering
MCI

Current Trends: The Internet Gold Rush

The telecommunications industry is in the middle of an Internet gold rush of great proportions, and decision making must take place within this context. Statistics regarding Internet usage, hosts, domains, etc. continue to grow rapidly, and it is possible to make some projections based on these trends. For example, by the end of the year 2001 there will be between 100 and 200 million hosts connected to the Internet (see *Figure 1*); in comparison, there are currently about 828 million telephone terminations in the global telephone network. Between one and two hundred million hosts is actually not a bad showing, considering the short amount of time over which Internet penetration has taken place.

The number of domain registrations reached approximately 2.1 million by January 1998, which significantly exceeded the number of existing networks. The reason for this is that many Internet users register multiple domain names per network. For example, Procter & Gamble registered 121 trademarks as domain names, including pimples.com and diarrhea.com.

What has been driving this high level of activity? If one were to take a 30-year view of the situation, three basic waves of connectivity can be seen. The first wave was simply the effort to connect computers to each other; all we cared about was transmitting bits from one machine to another. The second wave is the drive for information: people are using the Internet to reach out and get information, or in some cases information is reaching out to them via push technologies. This is the wave that we are in right now. The third wave of connectivity will be the desire to automate processes within a company and make those processes work across corporate boundaries. This will be a major concern for business, especially if one includes voice communications in these computer connections.

There is other evidence of gold rush activity on the Net. *Table 1* presents projections from the Yankee Group regarding business on the Internet through the year 2000. Although $40 billion and $134 billion may seem quite high, these numbers may not be unrealistic at all if one considers the total value of business transactions conducted on the Internet. Forrester estimates that year 2002 value of transactions on the Internet

FIGURE 1
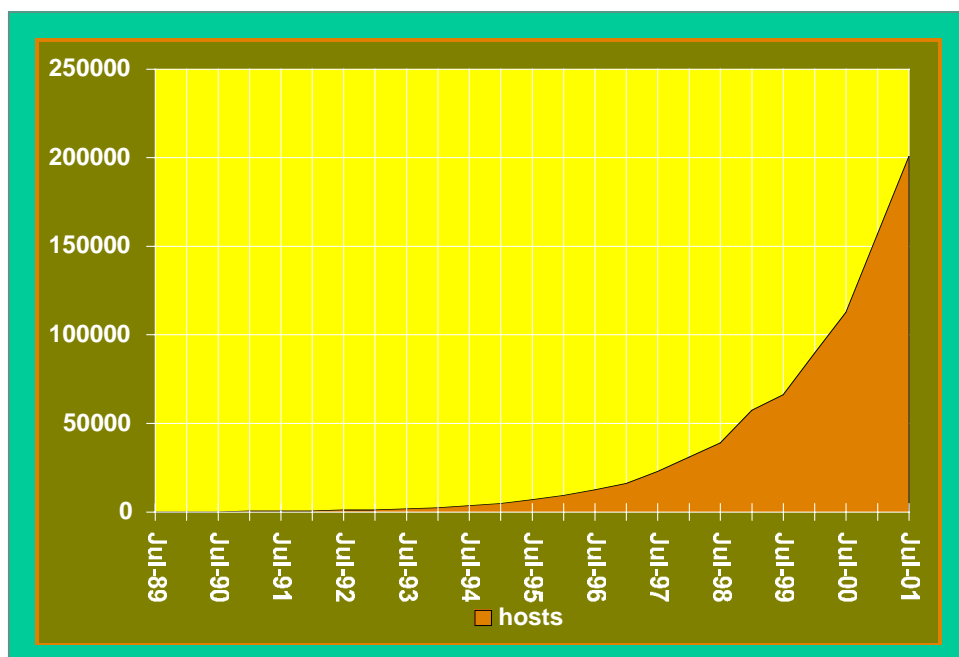
Internet Host (000s) 1989-2000

TABLE 1
Business on the Net

Year	Consumer	Business
1996	$ .73B	$ .12B
1997	$2.74B	$ .54B
1998	$4.93B	$3.20B
1999	$7.21B	$ 40B
2000	$ 10B	$ 134B

will reach $327 billion. The figures do not necessarily represent the amount of money that can be made selling communications services or equipment.

Some have attempted to project what the total number of Internet users will be by 2001. Estimates range from 300 million to 1000 million users.

Implications for Business

What do these numbers mean for large service providers? For the purposes of this paper, MCI will be used as an example, having had experiences no different from those of any other service provider. When MCI first began its Internet service in October 1994, the rate of traffic growth for the first fifteen months was 5600% (a factor of 56). However, such a statistic is never a good measure of real growth, because when you start with something small, any growth looks

spectacular a few months later. The company measured the 12 months of 1996 and determined that there was a bona fide traffic increase of 15% per month, or a growth factor of about four to five for the year. However, if one were to be conservative and assume that a growth rate of only 100% per year will be sustained, this means that traffic will grow by a factor of four every two years—or by a factor of 64 in six years. This, by any reasonable measure, is an incredible amount of growth. Yet one wonders: when will this market reach its saturation limits, and how? Will all classes of IP traffic be affected, including voice?

Figure 2 shows how much of MCI's relative fiber capacity is used for voice traffic versus data. Voice is driving the use of the company's fiber by a factor of 5%–10% per year, which is approximately a global average. The Internet, though, is driving requirements at 100% or more per year. If one assumes that 1% of all of MCI's fiber capacity was being used for Internet traffic in January 1996, then the demand for capacity from the Internet, regardless of what it is carrying, equals the amount that will be needed for voice traffic in about November of the year 2001. From there, demand goes skyward.

The Need to Grow the Network

The immediate implication of these projections is that the size of the network must be tripled within a couple of years. Not only is this possible, but MCI has already done it several times over. On the fiber side it is now possible to drive fiber on a commercial basis at 40 gigabits per second per fiber. MCI currently is providing this between St. Louis and Chicago—ironically the first route that carried MCI's microwave traffic when the company was started in 1968.
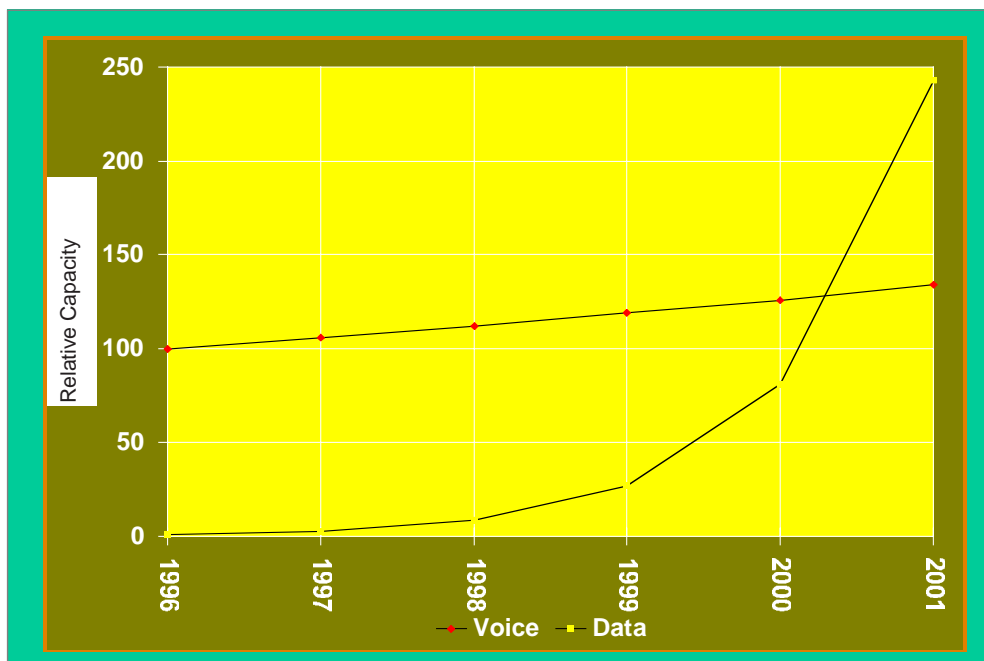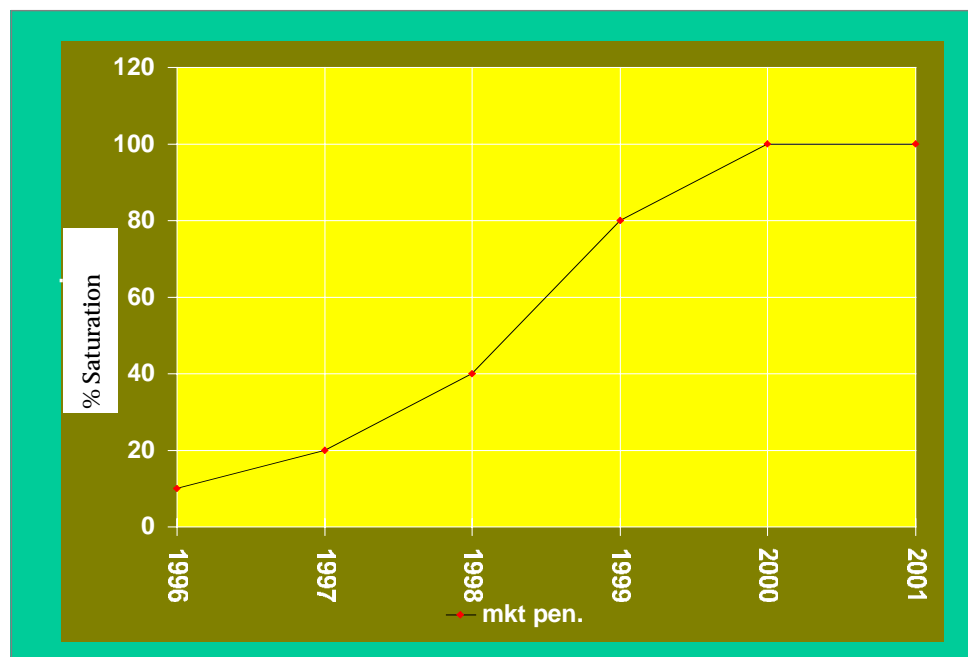
FIGURE 2
MCI Voice over Internet: 1996-2001

FIGURE 3

U.S. Market Penetration: 1996-2001

The company, then, does not anticipate running out of fiber capacity; rather, they are more concerned about running out of switching capacity. The ability to push packets at multigigabit speeds through any single device is a nontrivial exercise, as any router, frame relay, or IP switch vendor will assert. Nevertheless, the industry will need every one of these types of routers in order to keep up with this kind of traffic demand.

Figure 3 presents a projection of how quickly the Internet will penetrate the U.S. market. In 1996, the penetration of residential and business markets was about 10%, and this level will nearly double every year until 1999, after which it will reach 100% in 2000. There are two reasons why this particular kind of prediction might be wrong. The first one is that the penetration rate might not be as fast as the figure would predict. Maybe the early adopters have all adopted, and everybody else will be slow to get on the bandwagon, in which case the curve could flatten out over time. Another possibility is that the market could actually become much bigger than this calculation suggests, in which case the level of penetration might be lower (although the total number of devices connected to the Internet would be greater). This may indeed happen, because Internet-based appliances—not just personal computers and laptops—may turn out in the long run to be the bulk of the devices that are on the Internet.

In October 1994, MCI started with a 45-Mbps network. By April of that same year the company found it necessary to run all of the main circuits at 155 Mbps. At that time it was still clear that this capacity would not be adequate for long, so in July 1996 the company started overbuilding a 622-Mbps (OC-12) backbone, and completed it in December. They then built a second round of OC-12 capacity, completed in December 1997. Currently, they are looking very hard at deploying OC-48 and are hoping that some vendors will be able to produce switches that can operate at those speeds during 1998.

Current Internet tariffs favor communications from other countries to the United States, as opposed to communications between other countries directly. As a result, there is incredible demand for access to the U.S. backbone by Internet service providers and other multinational customers overseas. The result is the situation depicted in *Figure 4*, in which the United States is at the center of global Internet connectivity.

Leadership is finding out where everyone is going and running hard to get out in front. This is a lesson from the political world that is also relevant for business. Within the last two years voice on the Internet has had some element of this lesson in it as well. It is necessary to pay attention to what everyone is doing on the Internet, and the Internet is the best tool for seeing that. When someone does something, it is generally very visible to almost everybody. This means that when someone gets a good idea everyone can run hard with it and attempt to get out in front. A wonderful characteristic of the Internet is that it allows for this.

Internet Appliances and IP Telephony

There are about 2,000 radio broadcasters on the Internet today. These service providers use one-way transmission, which actually works pretty well. Two-way interactive transmission, which makes visible the latencies and delays in the network, is somewhat harder to offer. It is very diffi-

FIGURE 4

The Internet
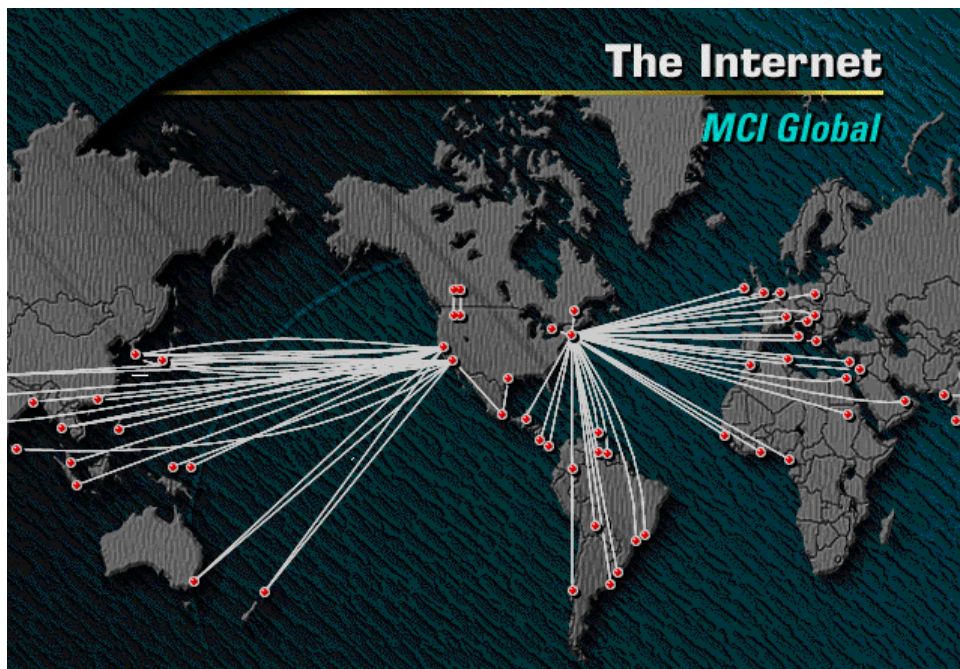
cult to reduce latency down to the minimum, and propagation delay must be accepted as a round-trip problem. Nevertheless, making everything run fast enough so that propagation delay is the only factor is a big challenge.

There will be a great deal of Internet transport showing up in other media than it has in the past—including traditional media such as video, which can carry IP packets embedded inside of the vertical retrace. Intercat from Intel is a good example of this. Many of the media that are not normally associated with the Internet will become a part of the overall system, even as one-way services for multicasting over satellite and conventional television cable systems. In the long run, all of this will happen in the public network, but from the standpoint of trying to control quality of service, many of these applications will show up first in internal networks, intranets, and environments that have more control over the allocation of bandwidth and more uniform equipment.

Of course, in the long run such media and services will have to work in the public environment too. In March of 1997, MCI announced its Vault, which is designed to bridge traffic between various IP networks and the public switched telephone network (PSTN) (see *Figure 5*). The point of this architecture is that there is much more to the integration of telephony and the Internet than simply running voice over the Internet. Those in the telephony business know that there is an incredible amount of computing that goes on when a phone call is placed—not just in terms of call counting, but rather the service profiles that customers expect their service provider to manage and follow. There are all kinds of data storage systems that are part of the environment, which have little to do with the actual physical transport of voice from one place to another.

The industry is starting to use Internet technology inside of the voice network, as well as exposing some of the control functions of the voice network to Internet access. It is this collusion between the two systems that excites many providers and drives architectures like that used in Vault. In figurative terms, we are beginning to tease apart the fibers of each of these network canvases and reweave them together into a single canvas on which we can start painting products and services that could not exist or be implemented on either network separately. That is where technology such as Vault is heading.

Some examples of the kinds of services that could be built include:

• personal communications management (command and control, multimedia mailbox)

• conferencing (reservations, document conferencing, video mail)

• fax (never-busy fax, fax broadcast, fax mail)

• call centers (Website call center link)

Command and control services use Web-type technology to allow users to access the functions they want to manage—e.g., where do you they want their calls routed, and at what time? Do they want their faxes sent to a fax mailbox or to a fax machine? Do they want to be paged whenever an important message comes in? How do they want their communications to be managed, and do they want this to change with time? Do they want this to change as they move from one place to another? These kinds of functions today are

FIGURE 5

Call Center Internet Connection
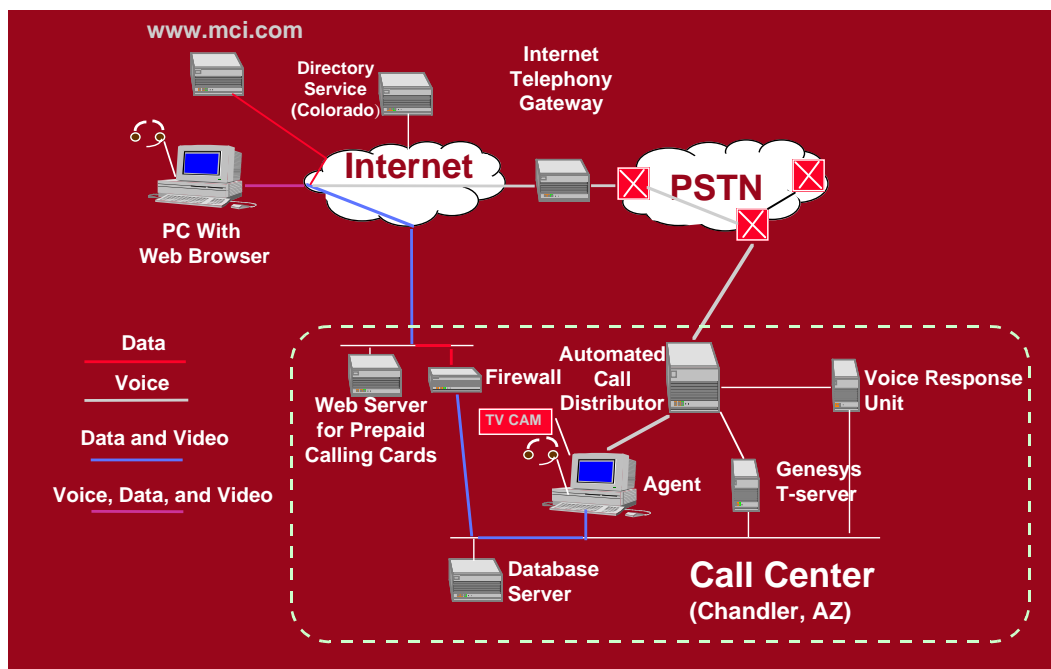
often managed by automated voice response systems, which are inconvenient to use because pushing one wrong button puts the user back at the beginning.

Web-type interfaces are much more convenient. Using these interfaces, it is possible for users to have all their multimedia communications transmitted to a single electronic mailbox, which they can access remotely. These types of services include the following:

• accept calls / do not accept calls

• guest menu options (find-me, voicemail, pager, fax options)

• find-me routing (1st, 2nd, and 3rd numbers and final routing)

• override routing (disables guest menu)

• caller screening

• pager notification of voicemail or fax messages

• mailbox status paging

• speed dial numbers

For example, one Website offers customers the opportunity to purchase pre-paid calling cards on the Internet. After selecting and ordering the type of card desired, the customer can click on a button that places an Internet phone call to the company's customer service center. A video image of the representative is transmitted to the user,

enabling the customer to see and talk to the representative in real time via the Internet. The agent discusses the individual's purchase and presents new options as Web pages to the customer.

The call center for this service is typical, except that it is equipped with Internet capability as well as conventional 800-number switched telephone service, as shown in *Figure 6.* The interesting feature is that only one circuit is needed: the one through which the user is connected to the Internet. This is the connection through which all the applications are transmitted—the video in one direction, the voice in both directions, and the Web surfing all take place over the common IP connection.

It is not clear whether the video image is actually very important for this particular application, but interestingly enough we have discovered that videomail may turn out to be quite important for certain uses. For example, a claims adjuster who is trying to deal with an automobile accident might film a video of what has happened and send it along with the report that is filed. The same might be true of an insurance adjuster who is trying to record what people have in their houses for the purpose of issuing insurance. Many of these applications exercise the ability of the data network to carry all types of media, regardless of how the network may have started out.
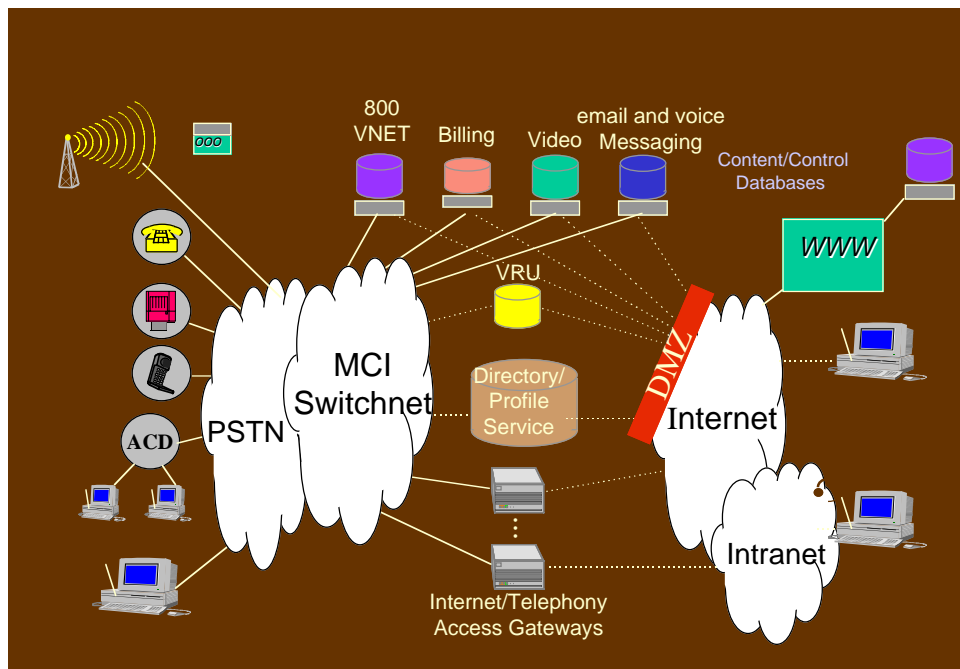
VON Challenges

Current challenges facing voice over the Net (VON) include the following:

FIGURE 6

Vault Architecture Call Processing View

- Internet quality of service
- absolute Internet capacity
- available Internet capacity
- absolute gateway capacity
- ubiquity
- "always on" convenience
- regulatory constraints and anomalies
- business models

First, although quality of service capability is not currently in the Internet, it must be there. Some service providers look forward to putting it in the company's backbone, but since many customers are not all connected to the backbone, this quality of service must be present everywhere on the Internet. Second, there must be much more capacity on the Internet than there is today. However, while it is easy to accept the argument that the Internet must become much bigger, somebody has to invest in it in order to make it big—it will not happen because the numbers say it must; it will only happen because somebody makes the investment. It is also critical to have adequate gateway capacity to accommodate traffic flow between the voice network and the Internet. It is not a good idea to launch a service with gateways that cannot expand to carrier grades and sizes. Furthermore, voice over the Net must achieve ubiquity, and it must be "on" all the time; users should not have to boot up Windows 95 in order to make a phone call.

There are many kinds of regulatory constraints and anomalies that will shape this business. Right now the regulations are not uniform at all. For example, the FCC recently announced a proposal to charge extra for a second telephone line that might be used for Internet service. Such a charge would not make much sense, though; hopefully they will reconsider this idea. Nevertheless, the marketplace will be distorted for some period of time by various regulatory models in different parts of the world.

A final challenge facing the VON industry is that business models for the Internet must be worked out. It is not clear into exactly what business model the Internet fits. Perhaps different models are involved, depending on the applications employed, but as someone once said during a heated exchange with reporters, "This is the Internet, and there aren't any business models." The fact of the matter is that it is a new technology, and so new business models must be developed.

Conclusion: Everything on the Net

As Star Trek fans will know, on the Holodeck of the Enterprise, anything is possible. The Internet is mostly software; despite what we hear about the hardware, fibers, etc., it is mostly the protocols and software in the various PCs and servers that enable the Internet to function. Since anything that can be programmed is possible, the conclusion is that the Internet must be today's Holodeck. We have met the 24th century, and it is around the corner.

This essay is based on comments delivered by Mr. Cerf at the Fall '97 Voice Over the Net conference.

The Global Networked Business: A Model for Success

John Chambers

President and Chief Executive Officer

Cisco Systems

How companies use information technology will define their success in the coming era of virtual business.
—Glover Ferguson, Andersen Consulting (11/96)

The pace of business worldwide is accelerating rapidly. Product cycles are shrinking. Just-in-time manufacturing abounds. Decisions are made on the fly. In this environment, access to relevant information is essential to remaining competitive and will mean the difference between survival and extinction for many companies. Yet many organizations still cling to an outdated model of information technology that builds walls around corporate information and systems (see *Figure 1*), limiting access to a select few. Even when internal systems and information are shared, it is often limited to point-to-point applications such as electronic data interchange (EDI). Applications with broader accessibility are needed.

The level of competition has been stepped up in today's global, networked market. Businesses that fail to take advantage of what the network has to offer are missing opportunities and allowing competitors to gain important economic advantages. Companies must foster interactive relationships with their many constituencies (prospects, customers, partners, suppliers, and employees), opening up internal systems and the flow of information. Achievement

of this higher level of competitiveness requires the openness and information accessibility of a new model—the global networked business.
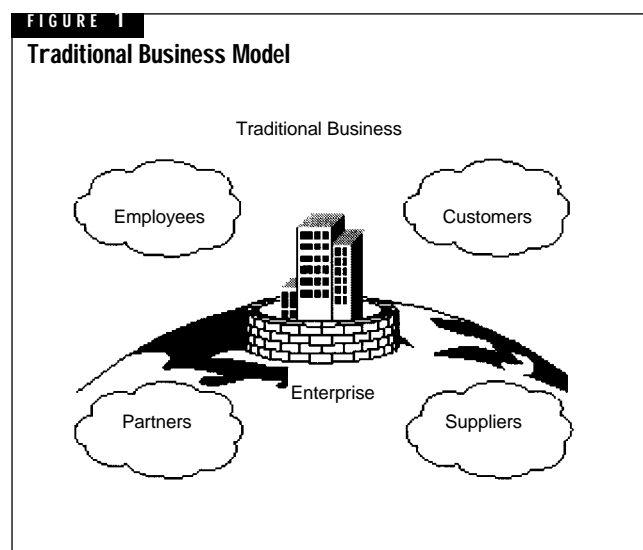
The Global Networked Business Model

The global networked business model is based on three core assumptions:
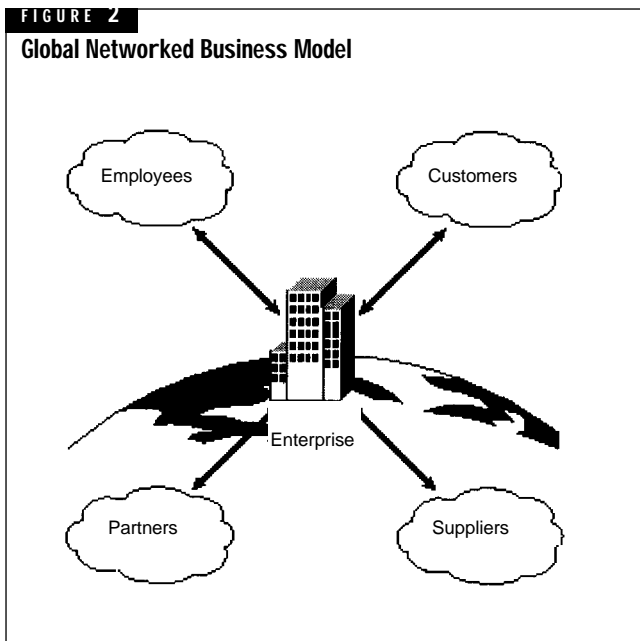
- The relationships a company maintains with its key constituencies can be as much of a competitive differentiator as its core products or services.

- The manner in which a company shares information and systems is a critical element in the strength of its relationships.

- Being "connected" is no longer adequate. Business relationships and the communications that support them must exist in a "networked" fabric.

The global networked business model opens the corporate information infrastructure to all key constituencies, leveraging the network for competitive advantage. A global networked business is an open, collaborative environment that transcends the traditional barriers to business relationships and between geographies, allowing diverse constituents to access information, resources, and services in ways that work best for them (see *Figure 2*). The global networked business model employs a self-help model of information access that is more efficient and responsive than the traditional model of a few information gatekeepers dispensing data as they see fit.

The global networked business sets new standards of efficiency and productivity within business relationships. By simplifying network infrastructures and deploying a unifying software fabric that supports end-to-end network services, companies are learning how to automate the fundamental ways they work together.

The new global networked business model maximizes the value of information by sharing it, cultivating ongoing relationships between all parties. Employees have access to information and tools that allow them to do their jobs more

FIGURE 1

Traditional Business Model

Traditional Business

Employees

Customers

Enterprise

Partners

Suppliers

FIGURE 2

Global Networked Business Model

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proficiently, and prospects have ready access to information that aids in purchasing decisions. Partners have ready access to a variety of information and interactive applications that help them sell more effectively. Customers have better access to support capabilities that enable them to resolve problems in less time, and suppliers have improved access to inventory levels and manufacturing needs.

The global networked business model is also a better fit with the current business environment. Organizational restructuring is creating leaner companies that can react more quickly and compete more effectively. Corporations want scalable, manageable business systems that allow them to do more with less. The leaders in any industry will be those who effectively employ technology to reach the goals of improved productivity, reduced time to market, greater revenue, lower expenses, and stronger relationships.

But simply throwing money at technology is not the answer. Information technology (IT) expenditures in 1995 amounted to 43 percent of capital spending in the United States, a figure expected to exceed 50 percent by the turn of the century. As the investment in IT continues to grow, chief information officers come under increasing pressure from management to justify expenditures. The global networked business views the network as a means of generating revenue, reducing costs, and improving customer/supplier relationships. Cisco, for example, will save $360 million a year in business expenses through its networked applications. The first challenge is moving beyond viewing the network only as an information-sharing tool to using the network as a foundation for applications linked to core business systems that serve all business constituents. Cisco is not only the worldwide leader in networking, having supplied over 80 percent of the Internet backbone equipment; Cisco is also a leading example of a global networked business, leveraging its IT and network investments by marrying them with core business systems and operational informa-

tion to better support its prospects, customers, partners, suppliers, and employees.

Benefits of a Global Networked Business

Networked applications in a global networked business provide a wide range of benefits to the company and to its prospects, customers, partners, suppliers, and employees. As a successful global networked business, Cisco can point to numerous examples of networked applications that help the company meet the needs of all its constituencies. Cisco is not alone, however; examples of global networked businesses can be found in many other industries as well.

Prospects

When facing a buying decision, organizations are often presented with many choices. A key competitive differentiator is the ease with which prospects can access company information to simplify and facilitate their purchasing processes. Cisco's prospects can use the Cisco connection online (CCO) Web site. CCO is the foundation of the Cisco connection suite of interactive, electronic services that provide immediate, open access to Cisco's information, resources, and systems anytime, anywhere, allowing all constituents to streamline business processes and improve their productivity.

Through CCO, prospects gain immediate access to information on Cisco's products, services, and partners. Nearly a quarter-million prospects log in to CCO monthly. CCO allows prospects to purchase promotional merchandise and Internet software, read technical documentation, and download public software files. CCO even allows prospects in fourteen countries to register for seminars. A new and enhanced global seminar registration system, which debuted in October 1997, accepted over 10,000 registrations in its first month, and anticipates registrations of more than 150,000 during fiscal 1998. The system offers participants easy access to over one hundred seminars in five languages.

Customers

With expenses rising and qualified sales people in short supply in many industries, many companies are studying ways to reduce the cost of sales while maintaining closer relationships with customers. Cisco's dramatic growth caused it to evaluate alternatives to traditional sales ordering methods. One solution was to create the internetworking product center (IPC), part of CCO. IPC is an online ordering system for direct customers as well as partners. In its first six months of operation, IPC processed more than $100 million in orders, and Cisco continues to see dramatic increases in the percentage of orders received through the application. The percentage of orders received by Cisco via the Web increased between September 1996 and May 1998 from 4 percent to 52 percent. During that same period, the annualized dollar run rate of orders received climbed from $30 million to $4.1 billion. Cisco currently receives over $11 million in orders each day.

IPC assists direct customers and partners in configuring equipment, leading to shorter delivery intervals and more accurate orders than those typically received through traditional sales methods. The end result: customers receive exactly what they need in less time.

IPC is one of many networked applications that support a multipoint, interactive fabric of networked relationships and applications. Customers have enthusiastically embraced Cisco's networked commerce applications. Charles Miano, a purchasing agent with Cellular One, states that the site played a key role in his company's decision to standardize on Cisco equipment. While a successful pioneer in networked commerce, Cisco will not remain alone. Market researcher International Data Corporation (IDC) predicts that, by the year 2000, sales on the Internet will grow to $116 billion, with more than 70 percent of that volume being business-to-business transactions. In short, the Internet is becoming a key distribution channel. "To remain competitive, all corporations must have a strategy for sales and support over the Internet," says Michael Sullivan-Trainor, an analyst with IDC.

Cisco also provides technical assistance to its customers worldwide through the CCO Internet Web site. Over 20,000 support cases are opened or queried each month. The online service improves the support process, speeds resolution of problems, and provides immediate global access to Cisco's support systems and engineers around the clock.

Cisco has improved access to critical information systems and tools in yet another way, allowing customers simply to download software electronically via the Internet. Through CCO, customers and partners download more than 70,000 pieces of software each month, drastically lowering distribution costs while giving users immediate global access to mission-critical information 24 hours a day, 7 days a week. Users also receive interactive guidance in selecting software, simple interfaces for downloading, extensive documentation, proactive defect alerts, and access to updates and new releases.

Another company adopting the global networked business model is Merrill Lynch, the country's largest brokerage firm. To increase its share of the discount brokerage market, Merrill Lynch is deploying Web-based network applications that support transactions over the Internet, giving its customers and its financial consultants access to portfolio files, multiple market data streams, and research information.

Another company that is widely known for its use of technology for competitive advantage is Federal Express. The concept of networked commerce and connecting its customers is nothing new to this company. Federal Express began migrating its customers in the early 1980s to what it calls "Powership" systems that provide automated pickup, delivery, and invoicing services. Today, through Powership, the company has over 500,000 customers on line. "We've found in the express business that the ability to provide information about a package is just as important to the customer as the delivery of that package," says Keith McGarr, Director of Internet Engineering with Federal Express.

The growing presence of the Internet provided a natural extension to what the company had been doing for over a decade. The addition of package tracing and tracking functions over the Internet is benefiting both Federal Express and its customers. By eliminating calls to its customer call centers, Federal Express estimates a savings of $3 to $5 per call, reducing the cost of doing business. More than $1.5 million in orders have already been received through the Internet. Most importantly, however, customers find the service faster and more convenient, and any customer, large or small, located virtually anywhere, has access to these services. The recent addition of international shipping services via the Internet makes Federal Express a truly global networked business.

Suppliers

Globally networked companies rely on successful partnerships with suppliers. Through Cisco Supplier Connection, Cisco has created an extranet application that increases productivity and efficiency in the supply function. For example, Jabil Cicuit Inc., a contract manufacturer of Cisco products, uses Cisco Supplier Connection to streamline the order fulfillment cycle. Through a direct link to Cisco's manufacturing resource planning (MRP) system, Jabil can "see" orders almost as soon as Cisco customers place them. Jabil assembles the parts from stock and ships right to the customer. After assembly is completed, the system prompts Cisco to pay for the parts used.

The purchasing function—ordering, delivery, and billing—can be time and labor intensive as well as expensive. EDI is one networked application that can benefit both suppliers and customers. Suppliers networked to Cisco, for example, have a competitive edge over other firms, potentially leading to increased sales. They are also able to better manage manufacturing schedules, improve cash management, and respond more quickly to Cisco's needs.

Cisco, as a customer, benefits from EDI. Cisco has leveraged its networking expertise to create EDI links to a growing number of its suppliers, resulting in more than $80 million in purchases per month processed electronically (as of January 1997). As a customer, Cisco has

- Gained real-time access to supplier information

- Experienced lower business costs in processing orders (an estimated $46 per order)

- Improved the productivity of its employees involved in purchasing (78 percent increase)

- Seen order cycles reduced substantially

Deploying networked applications such as EDI allows suppliers and customers truly to become partners.

Employees

For companies to compete successfully, information must be readily available to their employees. Intranet applications provide the backbone for immediate access to current information and services. Cisco's intranet Web site, known as Cisco Employee Connection (CEC), addresses the unique needs of its 10,000 networked employees, providing instant global communications. Cisco's marketing department, for example, uses CEC to distribute the latest product and pricing information, saving many thousands of dollars in printing and mailing costs, and decreasing time to market. CEC also streamlines business processes, reducing the time employees spend handling repetitive tasks. Employees can use CEC to enroll in internal training courses on line anytime, from anywhere, without ever speaking with a training department employee. Another networked application enables Cisco employees to view meetings broadcast over the network backbone. All employees, regardless of where they are located, can share the same information simultaneously through the power of networking.

French carmaker Renault had much the same objective in mind when it implemented a campus-wide network to tie employees together. Product cycles are shrinking in many industries, largely because of increased competition. This scenario is particularly true in the automotive industry, where manufacturers must become competitive on a global scale. Renault set out to reduce development cycle time by over 30 percent within two years, from eight years to five years, and eventually to just three years. It relocated its disparate design, engineering, and R&D functions, to a single campus connected with a high-speed network, allowing the company to easily move people and equipment between workgroups and enabling more efficient cross-functional teamwork.

Global networked businesses leverage their networks to focus on critical organizational goals such as employee productivity. One large insurance firm saw an opportunity to increase the productivity of its telemarketing representatives through networking. Making these representatives more productive is critical to success in a competitive industry where quality of customer service is often the key to retaining customers. With the new network and client/server applications, representatives will be able to pull up a caller's client history and frequently asked questions and answers on their screens before they ever answer the phone, providing faster response to customer requests. John Deere and Company, the leading agricultural equipment manufacturer in the United States, has also adopted a global networked business model, implementing numerous networked applications. One application has greatly improved access to information for John Deere employees. At one time, when design engineers needed to view drawings or parts descriptions, they had to retrieve images physically on microfiche. Today, those images are maintained on a server connected to John Deere's worldwide intranet. An engineer at a company design facility in Germany, for example, needs only to enter a part number to instantaneously access drawings of any part. "This has made us much more productive," says John Potter, Team Leader, Architecture, in John Deere's Information Services department.

Moving Toward a Global Networked Business

There's more to a global networked business than a company intranet and Internet site. Developing an implementation path toward a global networked business model should be incremental and logical, starting small and growing as success builds on success. Cisco, for example, selected customer support as the critical area because the company foresaw the potential of the network as a means of getting closer to its customers. This area may not be the most critical one for other companies. Order entry, documentation, or purchasing, for example, might be higher priorities.

A company should begin by selecting one application with the greatest impact on its business, keeping in mind that the global networked business model is not about incremental improvements in existing tasks. Rather, it is an approach that looks for breakthrough ways of sharing information, tools, and systems in order to build stronger business relationships. Movement toward a global networked business model usually requires a change in attitudes about the role of information, tools, and systems, as well as reengineering of some internal processes. The critical success factor, ultimately, is a reliable, secure, and manageable network that delivers the network services necessary to enable networked applications that support critical business functions.

After an application is selected, the implementation team must be multidisciplinary, with representatives not only from IT, but also from all stakeholders. Input from users, for example, ensures that the application will be easy to use—a critical success factor. When implemented, the application should be constantly monitored, modified, and improved. Then it's on to the next global networked business application.

Open access to information, resources, and services through a networked business environment sets new standards for relationships with customers, prospects, partners, suppliers, and employees. The global networked business represents a new business model, removing barriers to relationships and ensuring mutual success to all.

International Roaming: Easier Said than Done

Martin Cooper

Chairman of the Board
ArrayComm, Inc.

Abstract

It can be a source of frustration to the widely traveled mobile phone user that roaming capability is neither ubiquitous nor uniform. Now that the telephone has become untethered, wireless users can reasonably expect to use their phones with complete freedom. They should be able to initiate a call wherever in the world they happen to be, and a party trying to reach them should do so merely by dialing their telephone number with no knowledge of their location. The cost to achieve this mobile connectivity should be no more than that for a comparable landline call—easier said than done!

A roaming wireless service, while traveling outside of one's home area, exists in one form or another in many places in the world. Indeed, some of the roaming service approaches the ideal described previously. However, roaming capability today is not ubiquitous or uniform, and it is not likely that it will ever be.

This paper will provide a brief description of the situation today and its likely future evolution. In this description, the scenario in which a subscriber carries a half dozen phones and each subscriber is in a different country, covering a unique territory, and receiving a separate bill is rejected. This scenario is not reasonable, practical, or economical.

What Is International Roaming?

There is a hierarchy of different degrees of roaming capability:

- the simplest form of roaming is merely the ability to make credit card calls when a roamer is traveling in a technically compatible area

- the ability to make phone calls without credit card intervention

- the ability to make and receive calls where the landline caller knows the location of the wireless subscriber

- fully automatic roaming, so that a phone call to a subscriber will reach him wherever he may be with no knowledge of the subscriber's whereabouts by the caller

- as in the above, but the user has access to a predetermined feature set whether traveling or at home

Overlaying this hierarchy is the matter of cost. The ideal roaming service would provide service anywhere at the same price. It is interesting to note that, in the ideal roaming service, it no longer matters where subscribers have their "home." A Taiwanese subscriber could sign up, perhaps over the Internet, with a Philippine carrier and experience no difference in service than if he/she had subscribed locally. International roaming today is a mish-mash of an unpredictable combination of variations of this hierarchy.

When the cellular radio telephone was introduced in the United States in the early 1980s, the intent was the creation of a "nationwide compatible mobile and portable telephone service." Implicit in this objective was the ability to make and receive telephone calls anywhere in the United States. Now, 14 years later, some roaming capability exists almost everywhere in the United States, but the service is far from uniform and is costly in most places. Outbound calling (calls to cellular users) are still awkward in some places, and cellular subscribers pay air-time charges even when others call them. At the other extreme, at least one U.S. carrier offers nationwide roaming at no extra charge. At the time of writing, roaming between the United States and other countries is virtually nonexistent.

The international situation today is not very different from the situation in the United States. About 45 million subscribers use global system for mobile communications (GSM) in over 100 countries. Although GSM offers a high degree of roaming capability, charges vary from one country to another, and roaming is constrained to compatible GSM systems. Meanwhile, narrowband call division multiple access (CDMA) is being applied in a number of countries. Advanced mobile phone service (AMPS) is still a very widely used system, and its sister, total access communications systems (TACS), is also used in several countries. Other standards also exist. None of these systems is developed widely enough to provide practical in-system roaming.

One would think it would be a simple matter to permit a wireless telephone that is registered in any one city to be usable in other cities that embrace the same standards. Yet, this is far from being true for the following reasons:

- A great amount of coordination is required between carriers so that each phone call is registered and validated before the connection is made. Wireless fraud is a serious problem in some systems today and a continuing threat for all systems.

- Coordination between carriers is required to communicate usage details and to settle charges between carriers.

- The wireless subscriber and the party calling the subscriber must both be appropriately billed.

- The telephone numbers must be coordinated between carriers to ensure that the same numbers are not used in different cities or countries.

- Each carrier has to determine, in some fashion, the nature and types of service to be provided to each subscriber who attempts to initiate a roaming call so that the carrier can offer (and bill) comparable services to this roamer.

- The subscriber's home carrier must know that subscriber's location. There must be a provision for routing of calls to the subscriber in a nonambiguous way.

It is clear that, if a number of countries are involved in trying to offer international roaming, a third-party service is needed to rationalize all of the communications that are required between the various carriers. Just think of the difficulties involved if each carrier had to sort out the subscriber information and billing records associated with roaming and send them to every other carrier with whom roaming compatibility is desired. And yet, this is precisely how roaming was accomplished in the infancy of the industry and still is by some major carriers. Today, however, most coordination and settlements are accomplished by one of several service bureaus dedicated to these functions. But even today, call records are often delivered by sending physical tapes from carriers to the bureaus.

Wireless Fraud

Carriers cannot offer service to anyone who requests it before determining that he or she can reasonably expect to be paid for the service. The theft of service—cellular fraud—is a large problem in analog systems today. In the systems, it is possible to eavesdrop on calls, copy the identification of a legitimate subscriber, and make calls using that identification. The digital systems use complex encryption techniques to thwart potential air-time thieves but none of these is ultimately foolproof.

The analog fraud problem is being solved in several ways but real-time validation is a fundamental requirement for all systems. In most wireless systems today, validation and service-enabling occur in real time over existing networks and are sometimes facilitated by third-party service bureaus. Even with real-time validation, the fraud problem is not completely solved. Carriers continue to fight the subscription fraud that occurs when individuals subscribe to the service with no intent to pay for that service.

Technical Compatibility

Roaming wireless subscribers must have equipment that uses the air interface of the country they are visiting; they must be technically compatible. There are at least three forms of technical compatibility, including:

- *Natural compatibility.* The roamer's telephone uses the identical air interface and frequency band of the visited location's infrastructure.

- *Dual (triple, or more) mode wireless phones.* The roamer's phone is capable of operating in one of two or more air-interface protocols.

- *Multifrequency band wireless phones.* They operate on a single air-interface standard but can shift frequency bands to adapt to the visited area.

When natural compatibility exists, roaming is achieved by solving the administrative tasks discussed earlier. Insofar as roaming is inhibited by the existence of different air-interface standards in different countries, dual modes—and perhaps triple-mode phones—are a potential solution. Several such phones exist today, and more will be offered in the future. Dual-mode phones can be useful for reasons other than roaming. As some carriers in the United States, Japan, and other countries convert to digital operation where 900-MHz AMPS service is prevalent, it is a great advantage to the carriers to build their system infrastructure gradually.

Part of the spectrum in a given system is devoted to the legacy air interface, and the rest is converted to the new air interface. Users equipped with dual-mode phones are unaware of which system they are communicating on.

It is also possible, although not without additional cost, to have a phone operate in one of several frequency bands. Thus, a GSM user from Europe (who operates in the 900-MHz band) could achieve technical compatibility in a PCS 1900 (operating in the 1.9-GHz band) system in the United States.

A Scenario of the Roaming Future

There are a wide variety of options for international roaming, not all of which will be economically viable. Here is the scenario describing a technically compatible arrangement that manufacturers have announced they will support.

The hypothetical user has GSM service at home. The user wishes to communicate everywhere in the world and can afford to do so with some premium in both equipment and service cost. The dual mode, two-band telephone is GSM compatible at home and in 100 or so other countries; it is PCS 1900 compatible when traveling in certain areas of the United States and AMPS compatible in the rest of the United States. In the rest of the world, at sea, or in a private plane, the user removes their Iridium adapter, slides the phone into place, and makes satellite calls. Such a person would rarely be without some form of wireless telecommunications.

Although the equipment to achieve this scenario is already being demonstrated, a complete solution of the administrative problems discussed earlier has not yet been undertaken—and the solution is enormously complex. Consider what happens, for example, when our hypothetical

subscriber is on an extended trip in which every mode of their extraordinarily versatile equipment has been exercised. A friend calls the subscriber in his/her home city. The intelligent network traces the location through the maze of the subscriber's last calls but ultimately concludes (perhaps, because he/she cannot answer or does not wish to answer) that this person is now at home. For a second time, the home number is rung, and the complex process is repeated again ad infinitum.

This "tromboning" scenario is solvable in the future intelligent network, but there are many variations and entities involved. Only when the demand for these exotic services becomes widespread and the market attractive enough for carriers and manufacturers to respond will the problems be solved and the market addressed.

Prognosis

The pervasive impact of a new competitive era in the telecommunications industry is finally beginning. The benefits of competition to the subscriber and the public are manifold and generally undisputed. Insofar as "universal" standards facilitate international roaming, achievement of widespread and effective roaming will be more difficult than would be the case if standards were mandated. However, the network and management challenges to widespread roaming are far more difficult than the standards problem. The necessity for competitors to differentiate themselves by offering unique and valuable niche services to their customers will be a much greater influence toward progress than the lack of standards is an inhibitor.

That segment of the wireless subscriber market that has a need for roaming will find that need fulfilled in more than one way. The choices will include multimode and multifrequency as well as truly ubiquitous roaming by some operators and services. Ubiquity will, however, have its price. High mobility and widespread roaming will always cost more, everything being equal, than low mobility and local-only services. In the near future, no one carrier or service will offer worldwide ubiquitous roaming. One should not underestimate the ability of the international subscriber to demand specialized services and to understand the choices—and neither should the ability of the industry to respond to these demands be underestimated.

Cable Modems—A Multiple System Operator's Perspective

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In the evolving world of telecommunications, an increasing number of connection service options are becoming available as alternatives to traditional dial-up modems and 56-kbps leased lines. These include integrated services digital network (ISDN), asymmetric digital subscriber line (ADSL), microwave multipoint distribution system (MMDS), local multipoint distribution service (LMDS), direct broadcast satellite (DBS) and others. Along with these predominantly circuit-switched alternatives, another option is now being introduced that uses a different communications exchange method to offer broadband access with the potential for vastly higher data speeds and efficiency at lower cost. That service option is cable modems. Using the perspective of a cable television multiple system operator (MSO), this paper outlines the early efforts to develop cable-modem technology into a business through consumer trials, technology development, market definition and segmentation, competition assessment, and product positioning for what has become known as data-over-cable service (DOCS).

Cable-Modem Trials

The Internet, telecommuting, Intranets, and interactive multimedia are all in the foreground of market opportunities today. Comcast, the 4th largest MSO, was the first to seriously consider the use of its fiber-coax network infrastructure as a source of high-speed data access. As early as 1993, Comcast began discussions with Intel Corporation to determine whether this form of data access was practical and cost effective. As a result of these discussions, Comcast and technology partner Intel conducted a trial of cable-modem technologies which began in April, 1994. The trial was conducted in Lower Merion, Pennsylvania, a suburb of Philadelphia, to examine the suitability of the cable infrastructure to carry two-way data and to test the cable-modem technology with third-party users. The trial involved 64 households with approximately 225 users. The participants were well mixed demographically because the goal of the trial was to achieve a general assessment of usage. Participants ranged in age from 9 to 76, with computer experience roughly divided in thirds (i.e., "expert," "moderate," and "novice") with some participants never having used a computer.

Comcast conducted this trial with the assistance of a number of technology and service partners. In addition to Intel, Hybrid Networks and General Instruments developed the modem protocols and RF components respectively for use in the trial. Comcast also had a number of content and service partners who provided content for the trial, including Prodigy and America Online (AOL). In addition, participants were given unlimited access to the Internet. Content was basically limited to the Internet, Prodigy, and AOL in order to facilitate monitoring and trouble-shooting of the technology. Dealing with predictable applications aided in the separation of troubles between network/hardware and application software to allow a better assessment of the modem technology.

One of the things Comcast concluded as an aside to this study was that most everything seen today on the Internet or the World Wide Web is really an attempt to make the network appear to run as a broadband service: true color and sound requires broadband data rates so the mind is thinking broadband, the senses are thinking broadband, there is a desire to see broadband (graphics and multimedia), but the current Internet and conventional access options (e.g., dial-up modems) to the home cannot accommodate those desires. Proxy agents, caching services, and other related techniques are employed to attempt to emulate broadband network performance on a narrowband network but with very limited success. In a pure broadband environment, very few of these techniques are needed to provide a rich, rewarding multimedia experience. These early Pennsylvania trials began to show that the cable infrastructure held exciting options for deploying broadband service.

The trial in Lower Merion was conducted for a period of about two years. This period was chosen to ensure that the novelty of broadband access was allowed to level off, the seasonality of usage was accounted for (i.e., vacations during the summertime; children away at college during the Fall), and that changes in the modem technology itself were introduced. Participants became increasingly expert users and critics and were very helpful in developing Comcast's approach to this technology and its market potential. At various intervals during the trial period, participants were asked to rate the service, discuss problems, make suggestions, and keep track of their usage on the network.

FIGURE 1
How They Liked It

- Far Better Than Teleohone (78%)
  - Downloaders
  - Internet Surfers
- A lot Better Than Teleohone (12%)
  - Online Users
- About the Same (8%)
  - E-mail/Chat
- Liked Teleohone Better (2%)
  - Fax/E-Mail

2%
8%
12%
78%
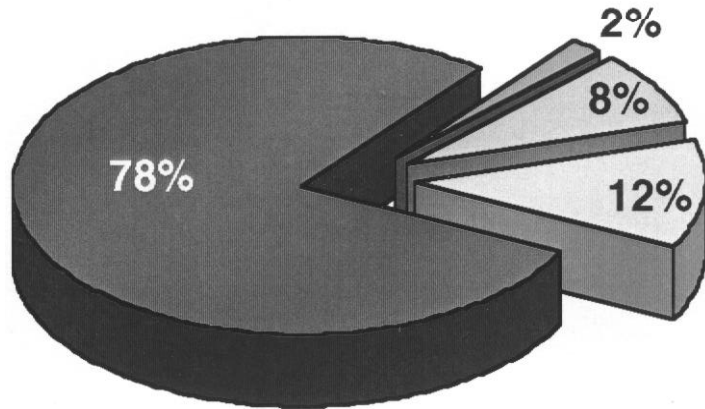
☐ *Same* ☐ *Better* ■ Much **Better** ☐ **Less**

At the end of the trial, a summary questionnaire was conducted, and answers were analyzed against the trial demographics. For example, participants were asked to rate how they had liked the modem service in relation to telephone as an access medium, choosing between "far better," "better," "about the same," and "less." As seen in *Figure* 1, 78% of the subjects felt it far exceeded both telephone return and ISDN. As it turned out, they were, for the most part, the people who were downloaders and Internet surfers. Twelve percent of the participants rated the modem system better than telephone. These were mostly on-line users who accessed the Internet for chats which require little bandwidth. Understandably, they did not appreciate a vast difference or value in speed except with respect to immediate access with no dial-up requirement. Eight percent found the service to be about the same as telephone service. Those turned out to be e-mail and chat room users who noticed no difference since little bandwidth is needed for those services and once connected they tended to stay on for hours so the "always on" feature of cable modems wasn't as important. Two percent actually liked a telephone connection better. Probing this response, it was found that they primarily used it for inbound/outbound fax which was not offered in the trial, and so they did not see cable modems offering much value to them specifically.

However, this response was crucial for developing later strategy for the data market. Additional research discovered that most users would opt to get a second telephone line to deliver such services, at an average cost of $20/month for another residential line and up to $50/month for a home-office line. That may not appear to be a phenomenal discovery, but it confirmed a growing trend. Five or ten years ago, consumers generally purchased a second telephone line because they had teenagers in the house. Now, the second line is increasingly used for data and fax, and second-line penetration has become a prime area of growth for the local telephone companies, more than doubling in recent years.

Therein lies the secret that could make cable modems a very viable strategy against the second-line market. It hinges on the issue of consumer economics. If a cable modem can deliver 90% of the services that users need a second line for, but users must keep the second line to get that other 10% which they deem essential, there is no opportunity for the consumer to save the extra money for the second line which couldthen be diverted to the cable-modem service. Therefore, to be successful, cable modems would have to offer things like inbound/outbound fax and other services that today are provided over a second telephone line, including IP telephony. It became clear that additional service development beyond just fast access to the World Wide Web would be a key to success.

Trial participants were also asked to discuss what they liked about the service, and this is outlined in *Table* 1. All of them liked the speed. They had never seen anything like it, and it changed the entire on-line experience for them, both in accessing the World Wide Web and even in using services like America Online. This trial used the very early Intel/Hybrid technology, which was running at only 10 Mbps downstream shared, and the upstream was not much better than a dial-up modem. Even so, the actual performance versus a dial-up was so dramatic that people did not

TABLE 1
What Users Like About Modem Service

• Speed	100%
• Fixed Price Internet Connection	89%
• Multimedia/Graphics Capability	83%
• Ability to Download Big Files	77%
• Doesn't Tie Up Phone Line	69%
• Instant Access No Dial-up	61%

want to give it up, offering such comments as "if you want it back, you'll have to pry it out of my cold dead hands... ." Because the technology was connectionless, and not a circuit-switched architecture that requires dedicated assets (e.g., switches) during a session, it could be offered as a fixed-price, unlimited-usage Internet connection—a feature that appealed to 89 percent of the participants. The improved multimedia and graphics capabilities appealed to 83 percent. The ability to download big files was also very attractive to 77 percent of the participants. 69 percent appreciated the fact that the phone line was not tied up, and 61 percent liked the instant access ("always on"), or not having to dial up. Some likened it to having an ISDN line, only about 80 times faster, and, as we were to determine later, much less expensive. That was extremely important to the participants.

Another interesting trial finding was that 40 percent of the participants upgraded their system hardware, which was a side benefit of having Intel involved. Once in the trial, participants were not told to upgrade any equipment. However, they would see a service that they had used working even faster at a neighbor's house or at Comcast's trial demo center and discover that it was the PC (due to a faster processor and/or more memory), and they had to have it. What we determined during the trial was that cable-modem technology suddenly shifted the "bottleneck" from the network to the PC itself, and the faster the PC the better the experience. Eventually, everybody was using a 486 PC or better with most stepping up to Pentiums as the trial concluded. A conclusion to draw is that, if given a good reason, most everyone will voluntarily upgrade their systems. The trial sponsors (Comcast and its trial partners) grossly underappreciated this fact at first.

During the trial, participants doubled their on-line time on average over the two-year period (7.6 hours per week versus 3.8 hours per week). Where did they get the extra time? Forty-nine percent watched less TV (which seems to substantiate research suggesting that in the year 2000, more people will be on-line during prime time than watching cable channels), 23 percent got less sleep, 20 percent spent less time on other leisure activities, and 8 percent spent less time doing other things.

Results of the Study

Several fundamental things were learned from the trial. One of the most important is that the technology really does work. Cable modems often have been considered the impractical product of futuristic hype, but this technology has now been proven to work, and it works quite well. The experience is addictive and compelling. It was also found that the platform offers many revenue opportunities, particularly for video and multimedia access.

However, to get the most from the platform, content must be authored for the broadband platform. Just showing simple text-heavy HTML Web pages is not very exciting and does not require the bandwidth available with cable modems for using graphics and sound. It is very dynamic. One nagging question Comcast wanted to answer going

into the trial was what kind of customer-service effort would be required. Industry pundits have often criticized the cable industry's customer-service record and Comcast knew that, for it to be considered a serious data provider, this image would have to change. So, to assess a worst-case scenario, Comcast opted to be closely involved in all facets of customer service. What it learned may be best summarized as what it did not want to do as a commercial service provider rather than the opposite. For example, Comcast found that whenever it was required to modify a participant's PC, even if it was simply to install a network card (NIC), set parameters or install software, participants had a tendency to hold those conducting the trial accountable for every problem they had ever had with that PC, no matter how creative, improbable, or in some cases incredible it may seem. Touch the user's PC and you own all its problems, no matter what the source. But for trial purposes, Comcast was a bit lenient with the participants in determining accountability and fixed most problems to keep participants running and to garner useful customer-service information for later use. It was clear that it would be desirable to have a demarcation point at the back of the PC to keep the MSO from having to go inside the customer's PC, yet MSOs needed to ensure that the PC was properly configured for cable-modem service. This would be a factor that would influence later strategies regarding cable-modem service installation and maintenance. It would also strengthen the desire to have cable modems move to a retail- distribution channel at some point. The other conclusion drawn from the trial was more of a validation that the data-services business was a fundamentally different business than traditional linear cable television, requiring different skill sets and different values.

Technology Factors

Cable modems are, first and foremost, about speed. Eventually, content and context become important, but their attraction is their incredibly dramatic speed. A typical speed test was run in which a 10 megabyte video file was downloaded, and the results are shown in *Table 2.* On telephone, it took 2.1 hours at a relative data rate of 28.8 kbps. With ISDN at a rate of 128 kbps downstream (2 B channels), the time required was 52 minutes. ADSL took 3.1 minutes at a rate of 1.544 Mbps downstream. The cable

TABLE 2

Speed Comparisons

Technology	Relative Data Rate	Measured Time to Download 10 MB Video File
Telephone	28,000 bits/sec	2.1 Hours
ISDN	128,000 bps Down	52 Minutes
ADSL	1,544,000 bps Down	3.1 Minutes
Cable Modem	10,000,000 bps Down	55 Seconds

modem took only 55 seconds at a nominal rate of 10 Mbps downstream. The only reason it was not faster was that the PC itself slowed it down. Having a cable modem that is really fast with today's PCs and the current Internet can be something like having a Ferrari in the middle of Manhattan: there is no question that it is fast, but there is no place to take it to "open it up." PCs are getting faster, but the Internet remains a problem.

The current Internet was never designed to handle the increasing bandwidth requirements of a growing number of users. Some analysts astutely predict an impending Internet meltdown. There are already major capacity problems. The World Wide Web has changed how people use the Internet: more people are signing up and signing on, and there is an increasing demand for data-intensive multimedia. Undercapitalized Internet service providers (ISPs) are underpowered and oversubscribed. Network response is declining; there is a lower quality of service, and there seems to be very limited troubleshooting ability.

On the surface, none of this bodes well for those with cable modems: during the trial, participants had reached the point where they had to know when to go onto the Internet. As soon as the West Coast wakes up, the Internet becomes virtually inaccessible, because 40 percent of the total traffic comes from there. At about 10:30 or 11:00 a.m. ET, access and usability numbers drop significantly, in some cases to dial-up speeds. In this case, the lack of speed is not the fault of the cable modem or the PC: it is the fault of the Internet and underpowered host servers.

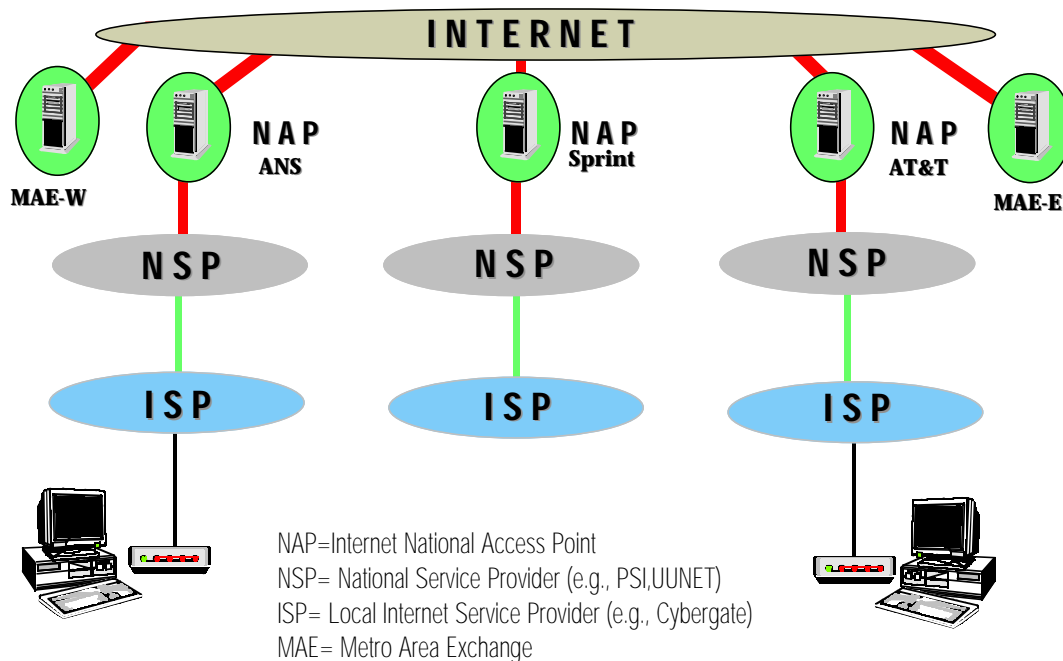The Internet has long been one of the biggest potential problems for cable-modem service providers to provide a successful commercial service. To be successful, service must be available and predictable and at speeds that match the potential of the cable-modem technology. That led Comcast and other MSOs to a dramatic conclusion: if data-over-cable (DOCS) is to be a commercial-grade service offering a multimedia platform, DOCS cannot depend on the conventional Internet as its backbone. It appeared that users would need a private virtual network (PVN) backbone to circumvent the Internet. That issue was one of the key reasons Comcast became involved in the "@Home" Network.
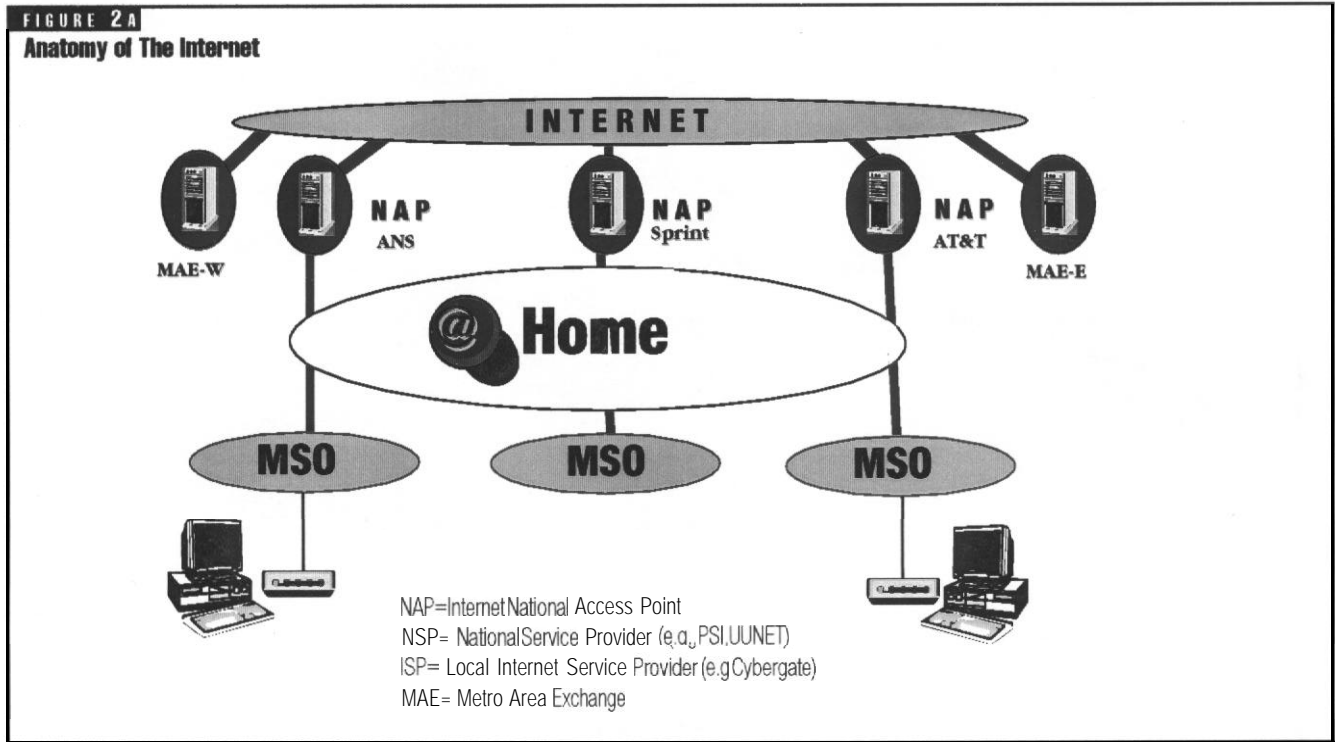
The Internet has been likened to the secondary road system in the United States because it was built over a long period of time and connects virtually every location. And like the secondary road system, it is comprised of various size and quality roadways with numerous points of congestion, some planned and some not. So, while it is possible to get from any location to another, one risks hitting every stop light, speed bump, and stop sign in-between. Cable-modem users need the equivalent of an interstate highway system: high-capacity and high-speed thoroughfares with on and off ramps. One approach to the PVN concept is the one employed by Time Warner called "Road Runner." Road Runner uses a private high-speed asynchronous transfer mode (ATM) backbone to connect the national pieces of its network.

Comcast has taken a similar approach by joining @Home, which is a joint venture funded by Telecommunications, Inc. (TCI), the country's largest cable operator, Comcast Corporation, Cox Communications, and Kleiner, Perkins, Caufield & Byers, high-profile investment-capital group.

FIGURE 2

Anatomy of The Internet

INTERNET

NAP
ANS

MAE-W

NAP
Sprint

NAP
AT&T

MAE-E

NSP

NSP

NSP

ISP

ISP

ISP

NAP=Internet National Access Point
NSP= National Service Provider (e.g., PSI,UUNET)
ISP= Local Internet Service Provider (e.g., Cybergate)
MAE= Metro Area Exchange

FIGURE 2A
Anatomy of The Internet

NAP=Internet National Access Point
NSP= National Service Provider (e.g., PSI, UUNET)
ISP= Local Internet Service Provider (e.g. Cybergate)
MAE= Metro Area Exchange

@Home's mission is to provide high-speed, fully integrated, multimedia services that will revolutionize the way people interact with information and each other at home, at work, and at school. It is a front-end information service with a private ATM backbone which ensures speed and availability.

The @Home offering is best shown by examining the typical layout of the Internet today, which is shown in Figure 2. Bottlenecks occur when local ISPs undersize their access connections from the local telephone companies and to the regional or national ISP to which they are "homed." At the top of the Internet, national ISPs are interconnected through peering agreements, generally at the national access points (NAPs) and the government's two access points, Metropolitan Area Exchange-East (MAE-East) and MAE-West.

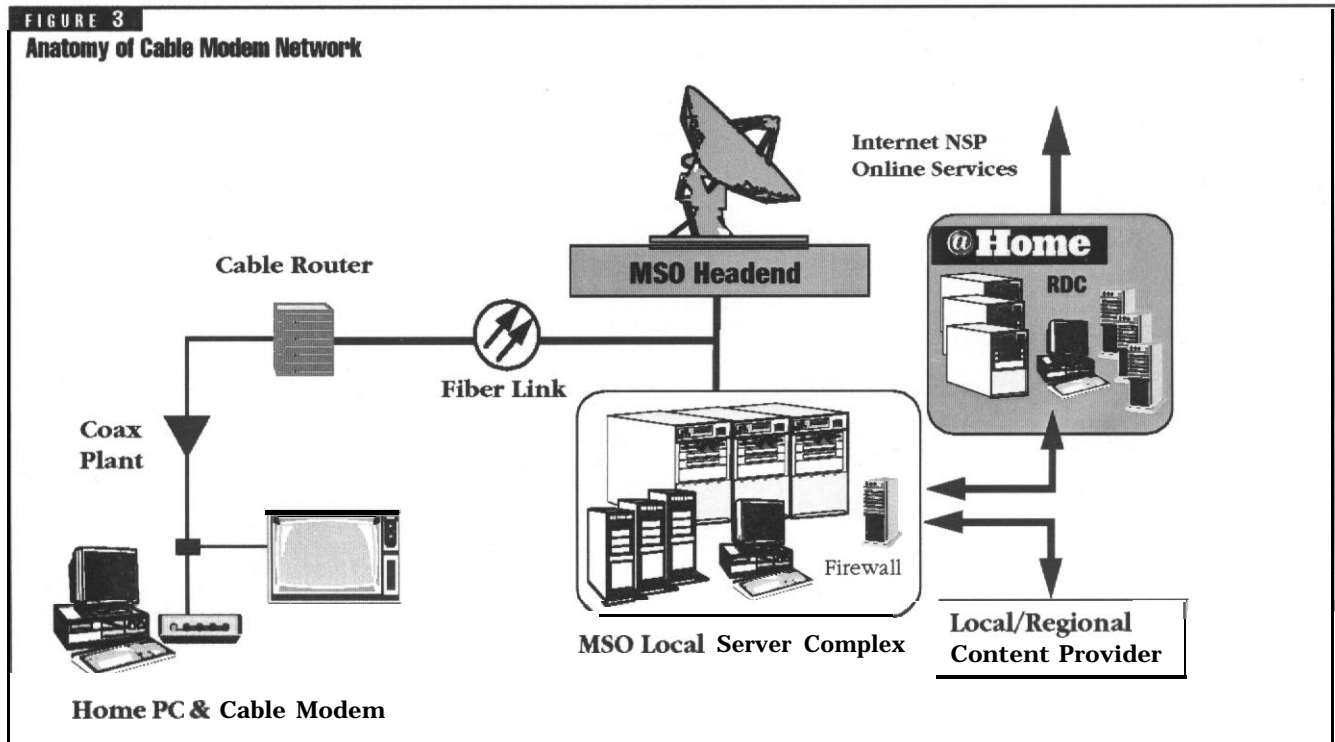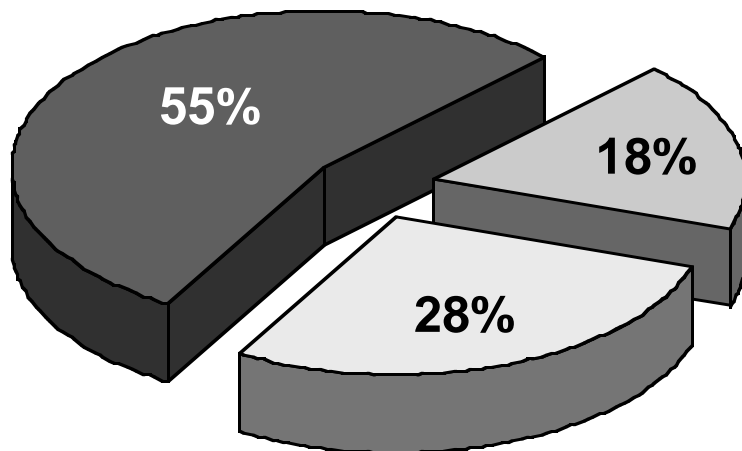The @Home service overlays those two pieces as shown in

FIGURE 3
Anatomy of Cable Modem Network

FIGURE 4
Consumer Market Segmentation

- Progressives
  - Early Adapters
  - Professionals
- Moderates
  - PC Users
  - Moderate Modem Users
- Mass Market
  - Later Adapters

□ **Progressive**   □ **Moderate**   ■ **Mass Mkt**

Figure 2a: the local ISP is bypassed. Anything coming out of a cable-modem installation hits the @Home network. @Home maintains locally based replicating and caching services, but then its private ATM network is used to access remote sites. @Home is peered at the top of the Internet structure, at the NAPs and MAE-W. It is very efficient, very fast, and there are no speed bumps.

Figure 3 shows the anatomy of a cable-modem network. The user's PC is equipped with a standard Ethernet network card (NIC) which is connected to the cable modem through a standard RJ-45 jack. The cable modem changes the Ethernet data stream into a format suitable for transmission over the cable network. It is transmitted to the head end where it connects to a cable router which provides RF supervision and changes the RF data stream back into conventional data format. Today, the cable modem and the cable router must be compatible since they must communicate. As they are generally made by the same vendor and use proprietary protocols. The cable industry is now engaged in a standards process known as MCNS, the goal of which is to provide open standards for these pieces of equipment to promote interoperability. This is essential in order to move cable modems to the retail distribution channel. From the cable router, the connection reaches a local MSO server complex, which has local caching servers and replicating servers which ensure that all cable subscribers in a metropolitan area will receive speed and performance. There may also be local content servers and mail servers. From the MSO server complex, there are direct connections to local and regional content providers through the PVN of choice.

Market Definition

Market segmentation is fairly straightforward. The five basic areas are business-to-business, small business, home office, telecommuting, and consumers. Most of the focus in

the market today has been on consumers, because that has the natural overlap with the core business of cable, which is a consumer business, and it is where the market hype has been. Further research to analyze consumer market segmentation, shown in *Figure 4,* indicates that 18 percent of the consumer market can be considered "progressive." These subscribers are early adapters and professionals who are already familiar with technology. "Moderates" represent about 28 percent of the market. These people are PC users and moderate modem users. The moderates and progressives are the core target market for cable modems and @Home: they make up 46 percent of the addressable market, which is more than enough to get started in business. The other 54 percent are the mass market, later adapters who will probably come around eventually.

Table 3 shows the characteristics of each of the three groups. It became apparent that the progressives want speed and raw bandwidth. They want to access the Internet, download

TABLE 3
What Do They Want?

- Progressives
  - Speed, File Downloads, Graphics, E-Mail, Fax, Work at Home, Information, Buy Things
- Moderates
  - Multimedia Content, Libraries, Catalogs, Interactive Media (Games), Transactions
- Mass Market
  - Community, Ease of Use, Transactions (Stocks, Tickets), Online Library, School Connection

files, and they want no intrusions and no sudden stops. The progressives frequently work at home and need e-mail, fax capabilities, information availability, and the ability to shop at home. The moderates, on the other hand, seem to appreciate multimedia content. They like to see videos and graphics. The moderates use libraries, catalogs, interactive media games, and on-line transactions. The idea of a multimedia platform appeals to them.

Interestingly enough, research showed that the mass market is the segment that wants relevance. They are the people who want to be involved in the community and connect to libraries and schools. They will also utilize on-line transaction capabilities, like trading stocks or buying tickets. For the mass market, ease of use is essential.

Competition

Almost all consumers want to be able to do anything and everything on-line. Cable modems were designed to permit this. However, there are many potential competing technologies that may also allow it: LMDS, ISDN, ADSL, switched-digital video (SDV), MMDS, direct broadcast satellite (DirectPC), dial-up modems, and intercast/VBI. All of these provide different ways to access the Internet. However, there are tradeoffs. In truly assessing what we believe will be the bandwidth needed to deliver multimedia services in the near future and then plotting bandwidth against the time it takes for any of these technologies to have a marketable critical mass deployed, only a couple of technologies are potentially viable options (see *Figure 5*).

Switched-digital video is considered the best of these technologies. It is also the most expensive and takes the longest time to deploy. It is probably a viable option only if earlier technologies fail to gain market share. Looking at the kinds

of things that can deliver broadband within a reasonable time, three different technologies seem likely, although how LMDS will be employed seems uncertain. xDSL services will certainly be used by local exchange carriers (LECs). It is the only practical technology that can keep up with cable modems, but it is also a circuit-switched technology that requires a matched pair of modems on each end, so it is inherently more expensive. There is also a significant amount of plant-conditioning costs, as well as constraints in how and where it can be used. Many proponents of xDSL have said that it is better than cable modems because it allows a user to have a dedicated facility instead of sharing the capacity, as with cable modems. Of course, this argument ignores the economics of shared assets and overlooks the potential for congestion and service degradation of xDSL at points of concentration within the central office at the digital subscriber line access module (DSLAM). Regardless, xDSL will be used, but it will definitely be a more expensive and less flexible solution for doing what can be done with cable modems.

Other potential service competitors besides the LECs include direct broadcast satellite, national on-line services going local (like AOL with Digital City), long-distance providers bundling access, and local media companies (e.g., newspapers). It is apparent that every service provider will want to get into this arena.

The Internet is growing and ways to connect to the Internet seem to be growing as well. However, there are still only three basic ways to connect to the home: wireless, cable modems, and telephone lines. Direct broadcast satellite (DBS) connections like DirectPC claim capabilities of up to 400 kbps downstream and a telephone return of 14.4 kbps. Through a telephone connection, a dial-up modem can provide 33.6 kbps with an analog modem with the potential

FIGURE 5

The Bandwidth Reality
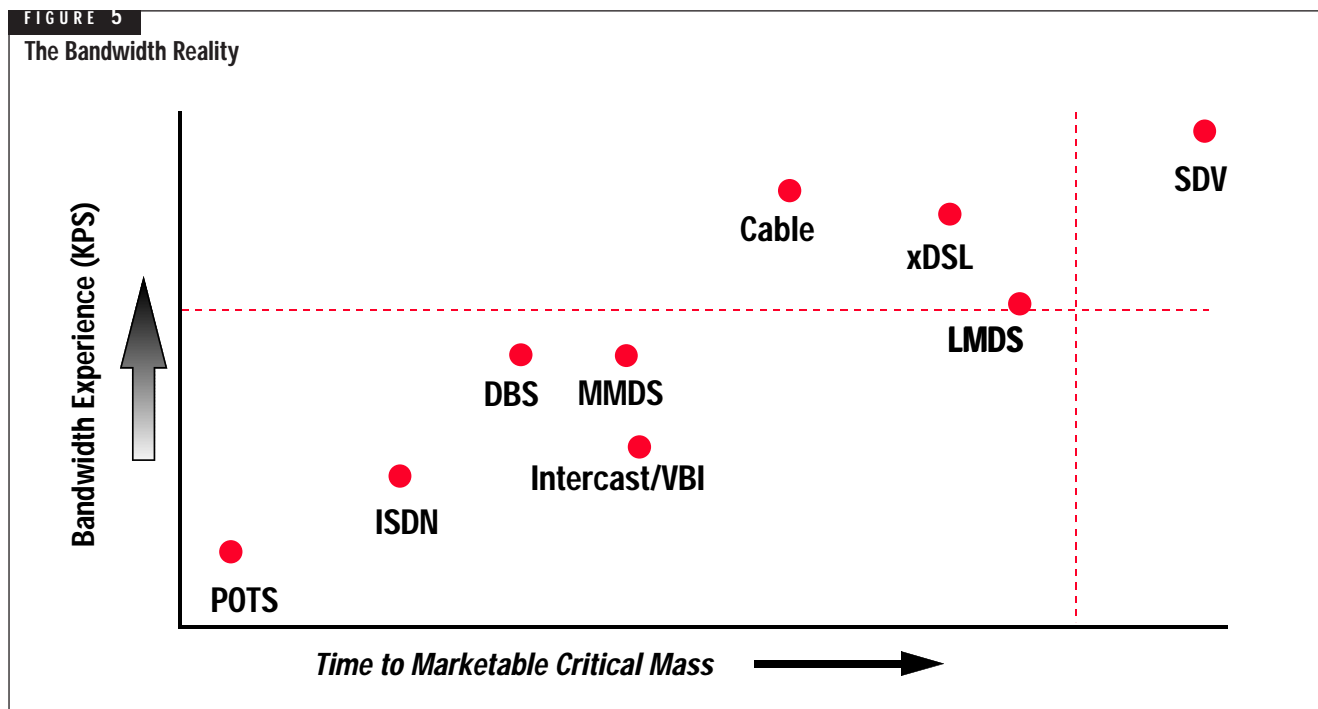
for 56 kpbs using proprietary methods; ISDN has 128 kbps capability using special electronics and a special modem; and xDSL can operate at 3-6 Mbps with special electronics and a special terminal. Cable modems, on the other hand, can operate in a number of configurations, the most typical being an asymmetric configuration of 27 Mbps in a shared downstream with 768 kbps upstream. Soon, this will increase with the use of 256 QAM technology and more-symmetric upstream carriers. Designing cable infrastructure with 500 home nodes makes this configuration a very practical and efficient one.

Cable modems can also offer a competitive alternative to the second telephone line, as discussed earlier, which is where a very large segment of consumer dollars go today, and also where the growth is going. One regional Bell operating company (RBOC), for example, estimates that there is over a 9 percent penetration of second lines in its market. While that may seem low, consider that in most major markets, everybody has 2.7 telephone lines. Second-line penetration is forecasted to grow to 20 percent over the next three to five years. If cable modems can deliver the same services at a better economic value to the customer, this may prove to be a very lucrative market. Bear in mind that this primary voice telephone service is the subject for another discussion. This is data, fax, secondary voice, and conferencing. But cable modems also offer features and services that are not practical over a telephone. The modem is always on; there is no dial-up; and there is instant access: factors which create multiple opportunities and permit multi-tasking over the network. The speed of cable totally overwhelms its only real competitor today, which is ISDN. If cable can create a "first mover" network with superior bandwidth, it will be difficult to unseat by xDSL or SDV. Finally, by entering the data-service market, cable has even covered its cross-elasticity with linear television.

Content and Product Positioning

In content marketing, it is necessary to realize that different people are looking at and for different things. With the cable-modem system, there is a basic tier of services. That might include the rental of the modem, the @Home network, local services, e-mail and chat, and enhanced access to the Internet. Through focus groups, it has been found that offering speed alone without content may discourage quite a few demographic groups. Senior citizens, for example, may not know how to utilize conventional browsers and news groups. Research has also shown that many residential users would use on-line services if they can be made simple, graphical, and easy to use. Cable can also offer enhanced access to national line services. For example, consumers can get a transmission control protocol/Internet protocol (TCP/IP) connection to AOL so they

do not have to dial up—hence no busy signals. There may also be premium local services offered, as well as optional communication services and utilities like conferencing and inbound/outbound fax services. Another goal is to make the installation extremely simple and to minimize any truck rolls.

As the technology evolves, cable will begin to offer real-time streaming of audio and video and downloads that are far faster than might be imagined today. It will even be trivial to routinely download movie trailers—an impractical task for dial-up modems today. High-quality graphics in real-time, interactive gaming, IP multicast, targeted marketing, secure transactions, and software rentals and sales are just a few of the possible services made practical by cable modem technology. Software could be purchased or rented on-line and installed in realtime. Today, trying to download a 3.5 or 4 megabyte file from the Microsoft Web site can take a tremendous amount of time. With cable modems, downloading the 40-60 megabytes necessary to install a software application suite is very practical from local servers in the MSO server complex. The cable provider could even keep track of version control and register the customer for the software distributor.

Market Entry

Cable modems appear to offer MSOs a very good business opportunity. Getting into the market now targets the progressive subscriber segment, which is attracted to the fastest service and fixed-price options. That is a segment that should not be allowed to escape to the inferior performance of ISDN. Cable can also hold the market for the moderates while new features are being added. These are the consumers who are interested in the broadband platform for content as well as the increasing inventory of multimedia content. Entry into the market now will also help to develop the mass-market subscriber segment which is interested in an increasing amount of local content and ease of use.

Research has suggested that of the addressable market discussed here, almost 50 percent said they would take a cable modem within two years of availability, a phenomenal number. Many companies are making a move toward providing Internet access and developing local content, like America Online's Digital City, Interexchange carriers, and regional Bell operating companies. The market is there for the taking: it only remains to be seen whether cable can step up and take advantage of the window of opportunity provided by cable-modem technology to gain the necessary market share to become successful.

The Effect of Internet Telephony on Business

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As industries become more global and as more people work outside the office environment, communications have taken on even greater importance. Basic telephony is essential, but many are beginning to want more from their communications services. While hearing someone's voice can be effective, how much more effective would teleconferencing be if speakers could communicate through other media simultaneously? Many believe that once Internet telephony has been experienced, it is almost impossible to revert to regular-voice telephone calls. This paper will outline the effect of Internet telephony on business, focusing first on what is generally required in the industry to move Internet telephony along. It will then describe specific applications.

For the purposes of this paper, the phrase "Internet telephony" will be replaced by "Internet protocol (IP) telephony." This differentiates making calls over the Internet from using IP technology for intranet or virtual private network (VPN) calls. IP telephony helps carriers answer corporate and individual customers' needs for greater communications services, thereby ensuring that they become all-encompassing communications providers.

There are some fairly stringent standards for business telephony. Voice communication is mission critical—it must always work. There must also be high degrees of quality, resilience, and system and call management. There has been some question about the quality of IP telephony. Although IP–telephony sound quality may not be as high as standard telephony, many feel that the cost savings outweigh this dichotomy. Users, then, must decide which of these choices is more important for them.

Communication Issues and Opportunities

There are many challenges in communications, and many opportunities associated with these challenges. As companies have begun to downsize, communications companies have worked to enable corporate divisions to communicate from disparate locations. There is no longer reason to replicate groups throughout company branches, as telephony allows groups in London, New York, Hong Kong, and/or Tokyo to work together as if they were a part of the same group. IP connections make this happen. One party can begin on his or her PC and send information to the other parties in real time; these parties then can add their input. Through IP telephony it is possible to have voice connection, application sharing, and data transfer simultaneously.

Another challenge is increasing responsiveness to the customer. People are trying to become more responsive to customers both within and outside of the corporation. IP telephony allows a great level of responsiveness. If a representative is traveling and a call comes through to the office, IP telephony would allow the intelligent forwarding of the call to whatever location necessary. If the customer wants to talk to another member of the staff, it would be possible for the representative to transfer the call remotely. This will increase timely customer response, also allowing employees to work from anywhere as though they were in the office. People can now hear, see, modify, and present information concurrently in real time.

A final challenge involves cost effectiveness. IP telephony is one of the most efficient ways to utilize available bandwidth, and it also allows for a reduction in travel and planning costs. Through the use of IP telephony, companies can maintain competitiveness, improve effectiveness, and reduce telephone costs.

Sophisticated Call Processing

There are many things that an IP network should provide, such as sophisticated call processing. This includes system and call management, billing and commissioning, decentralized control, and centralized services such as class of service, a numbering plan, and features and common-access codes. Sophisticated call processing involves the ability to deal with a name, a telephone number or extension, or an IP address. It must also be possible to talk to people on an IP network and through a gateway via the regular telephone network, while also handling high-volume traffic. This process should involve nothing more complicated than picking up a telephone and dialing a telephone number.

What is necessary for this sophisticated call processing? Traditionally, the call-processing experts were the central office (CO) manufacturers and the private branch exchange

IP Telephony—API's Add Flexibility

Language
Directories
Least Cost Routing
Call Centers
IVR
Web Calls
etc……………..

LAN/WAN

Call Processing

GATEWAY
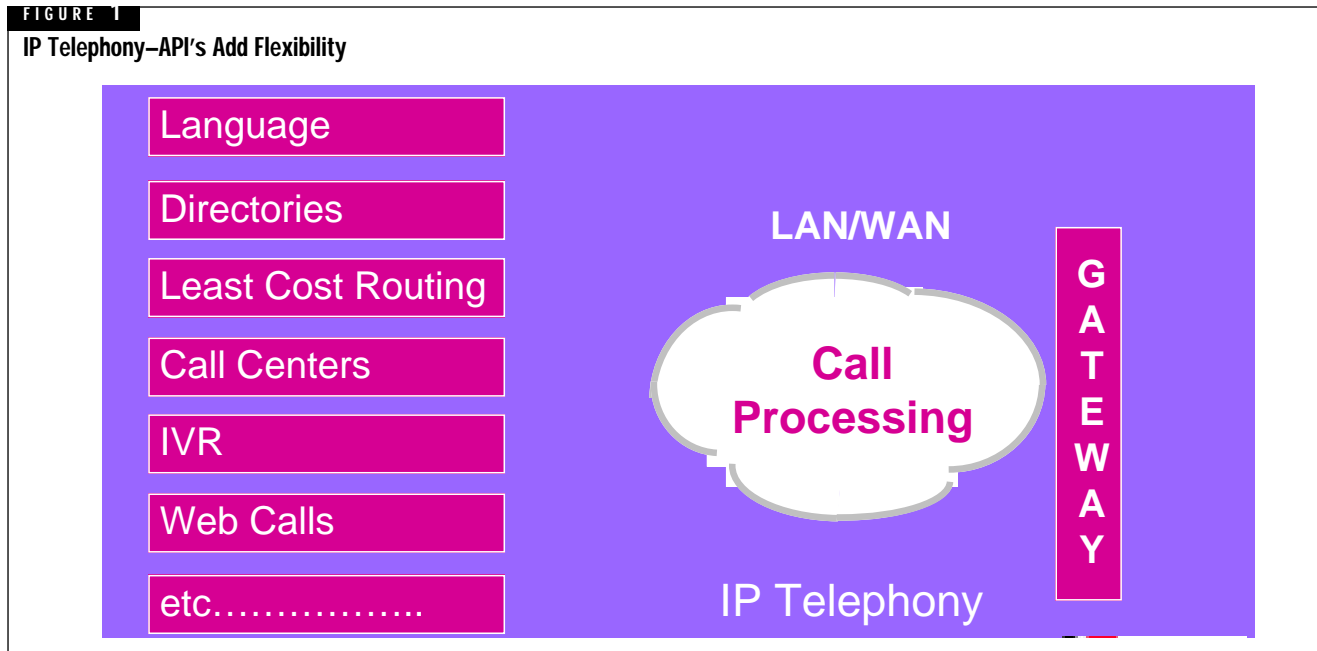
IP Telephony

(PBX) manufacturers, and call processing resided in the PBX or CO. Call processing must rest in IP, in the LAN environment, to be effective for call processing in an IP environment. This is the first step, but there are still over 800 million telephones that must be connected. A gateway that allows all users to communicate is needed. This would complete the loop to all locations worldwide.

Temporary Benefits

There are many benefits associated with IP telephony. One of the most popular in the short term is the ability to bypass tolls. Through IP telephony, it is possible to make a long-distance call over a local connection. While this is certainly attractive, it is probable that this will only be available while tariff anomalies exist. Despite this, however, the ability to save money, even for a short period of time, is driving the adoption of this new technology. When users invest in IP telephony technology for the temporary benefits, they also take the added available services. Hopefully, even when cost savings are no longer as great as they are today, other benefits will sustain and increase the customer base. These could include voice, data collaboration, and application sharing.

IP Telephony Additions

When computer telephony integration (CTI) began, one of its most attractive features was that it encouraged or allowed enhanced communication. Because call processing can occur in an IP environment, the features that would normally be seen in that environment—transfer, hold, conference, multiple line, interference, and the like—reside there. This means that the opportunity exists to access and utilize other IP-based applications such as language, directories, intricate voice response, call centers, and so on. By putting a simple API in place, third-party developers can be given full access and control of telephony features that rest

in IP (see *Figure 1*). A third-party developer who knows very little about telephony can use components to reach through the call processor and drive the application. This also provides access to the full features of the API as opposed to the few that are available in typical scenarios involving traditional CTI.

IP Telephony Service Solutions

IP telephony offers many things. If IP telephony cannot offer free calling, something that many believed it would, it can at least provide many intriguing alternatives. For example, there may be a carrier that currently sells regulated services. If IP telephony is regulated in terms of bandwidth, then it seems probable that, outside of tariffs, the cost of bandwidth would be the same. Now a carrier has a new opportunity by installing a gateway behind a CO (see *Figure 2*). In this manner it becomes possible to make a regular telephone call across the top line or to make a call in an IP environment that the carrier could make available at a G723.1, for example. This might not be toll quality, but it would still involve a tightly compressed voice packet. Once again, sometimes cost is more important than quality. In any case, this scenario would allow users to choose the type of service they want. The other extreme is also possible—there could be a 128-kilobit voice connection in an IP environment that would sound stereophonic depending on the amount of bandwidth available. This scenario gives carriers the opportunity to sell a wider suite of services.

Choosing a quality of service is also possible in a corporate environment (see *Figure 3*). A company with operations in New York, London, and Hong Kong can have these same services—regular telephone service on the corporate voice network or different kinds of compression across the corporate IP backbone. It would even be possible to give employees Internet access for the best quality of call available.

New Carrier Services
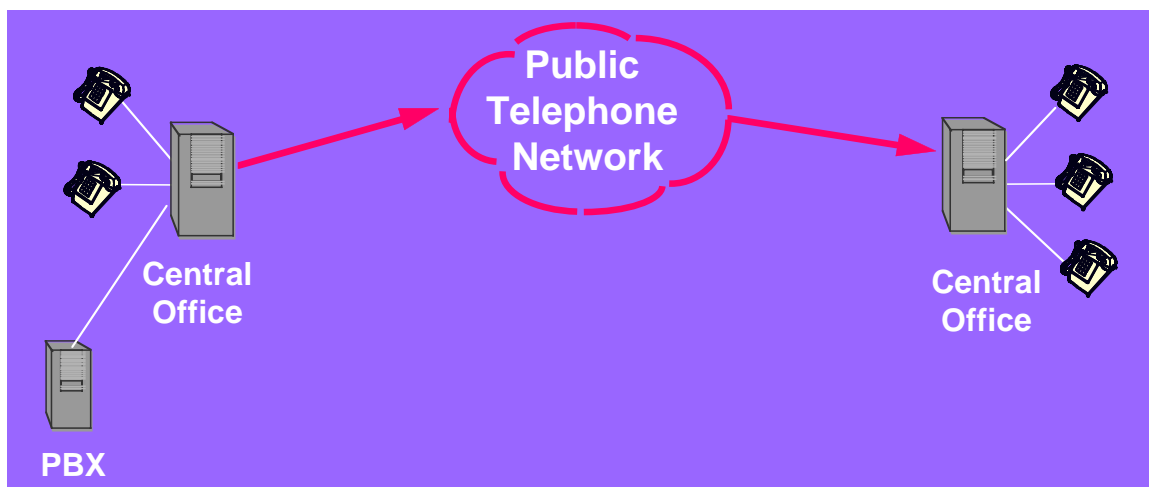
These services could also be used for small offices or branches (see *Figure 4*). There are PBXs in major centers around the world, between which there is a great deal of traffic. Therefore, a corporate network is created that allows three- or four-digit dialing worldwide in a corporate network. This is fine for the large offices, but if there is a small office in a small town, it is unlikely that a high-bit connector will be installed. This office may be important, however. The IP solution involves a gateway in each of those places. If there were a dedicated pipe at the branch office, it would be possible to set up an IP pipe that connects from one gateway across an IP network into the gateway attached to the PBX network. Through this solution, everyone connected to the branch office can also have a four-digit dialing extension. It is, therefore, possible to quickly set up a dynamic, worldwide network that allows simplified dialing across an entire corporate network.

Most corporations today have a PBX and a data network, as well as a multiplexor. In addition, they have usually leased bandwidth between their corporate organizations. After conducting a traffic profile, companies can decide how much bandwidth should be devoted to voice traffic and how much should be devoted to data traffic. Then they can code the backbone between these two modes. A problem can arise, however, when the voice traffic area is full while the bandwidth allocated for IP traffic is under-utilized. Conversely, it could be that at night there is a great deal of data traffic utilizing that part of the bandwidth, but the voice area is not being used. This means that bandwidth has been paid for unnecessarily. Companies would like to use these portions of their bandwidth, but they cannot access them.
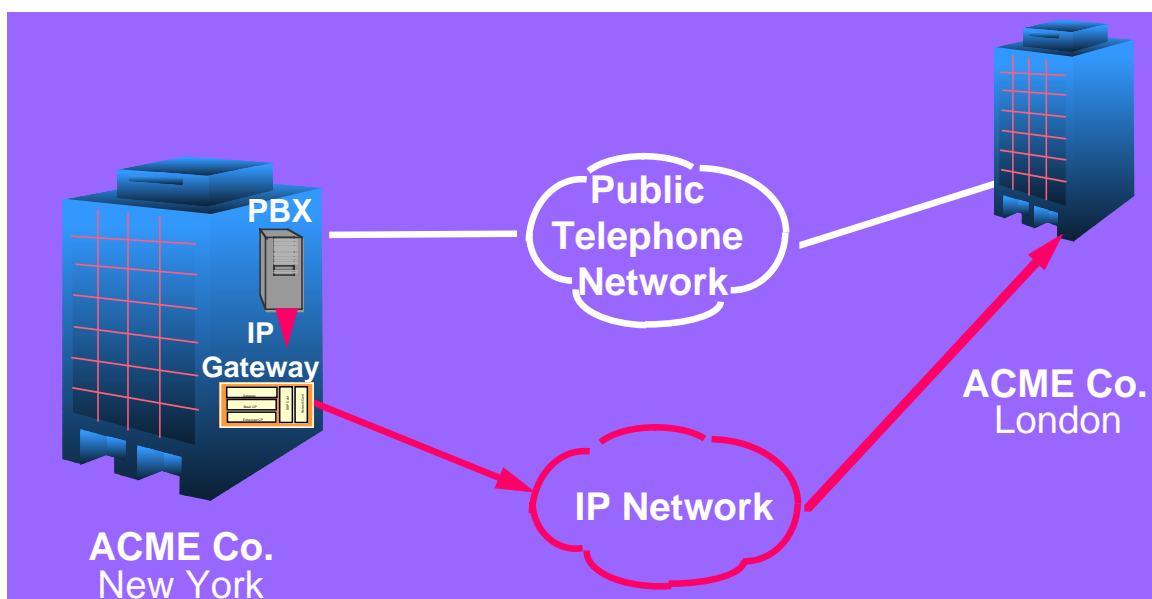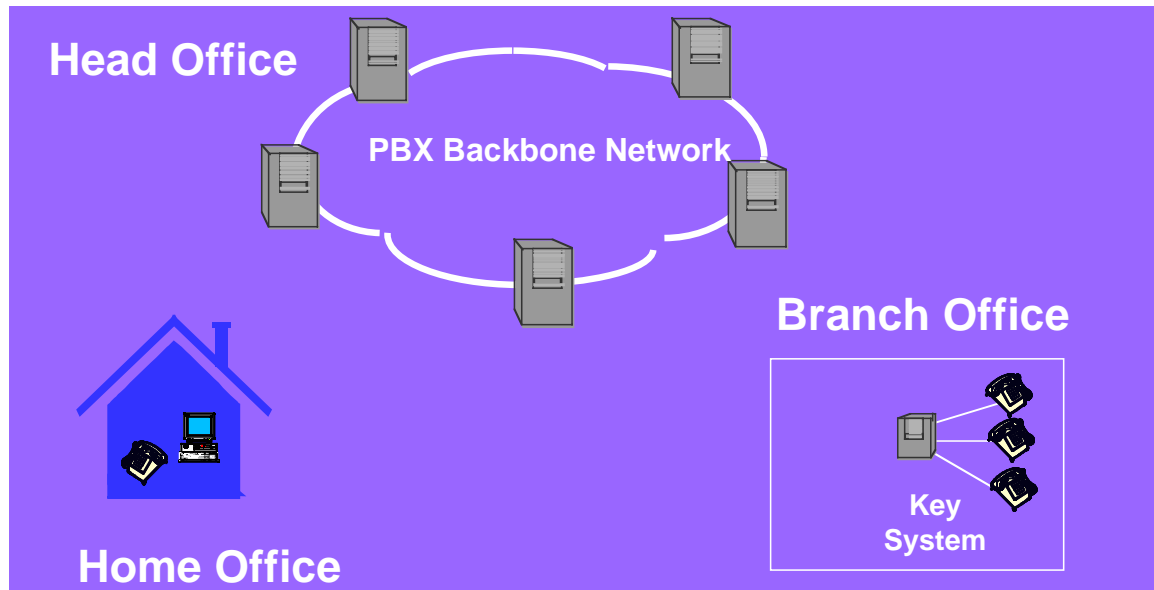
Corporate Backbone Network

FIGURE 4

Small Office/Branch Solution

Through IP telephony, it would be possible to put a 323 gateway behind the PBX (see *Figure 5*). The entire backbone can be converted to IP—it is an entirely shared backbone, negating the need for coding. In this environment it would be possible to use the entire bandwidth for primarily voice calls during the day and for data calls at night, or any combination thereof.

A final possible IP telephony solution is shown in *Figure 6.* Here there are two local area networks (LANs) connected by a wide area network (WAN). If a gateway is connected to that IP network, then there is no need to be near the call processor, as would typically be the case in a telephone network. In this scenario, there is a gateway and a gatekeeper. The call processing service is part of the box connected to one of the local area networks, and the system includes a wide area connection that links to the central office or PBX.

This scenario allows a remote employee to perform a dial-up connection on a 28.8 modem and register with the gatekeeper as the holder of a permanent IP address. As soon as the dial-up connection is completed, the server would be informed of the temporary IP address being utilized. This enables remote access to phone messages, data updates, and the like. Almost anything can be converted to IP and delivered across the wiring network to any point of connection. The bandwidth is still being paid for, but in this scenario it is being utilized far more efficiently.

Advantages and Accessibility of IP Telephony

One of the most attractive things about voice over IP is that, once a connection has been set up, to any number of recipients, all of the IP addresses have been resolved. It is possible to dial a simple telephone number, connect, and work

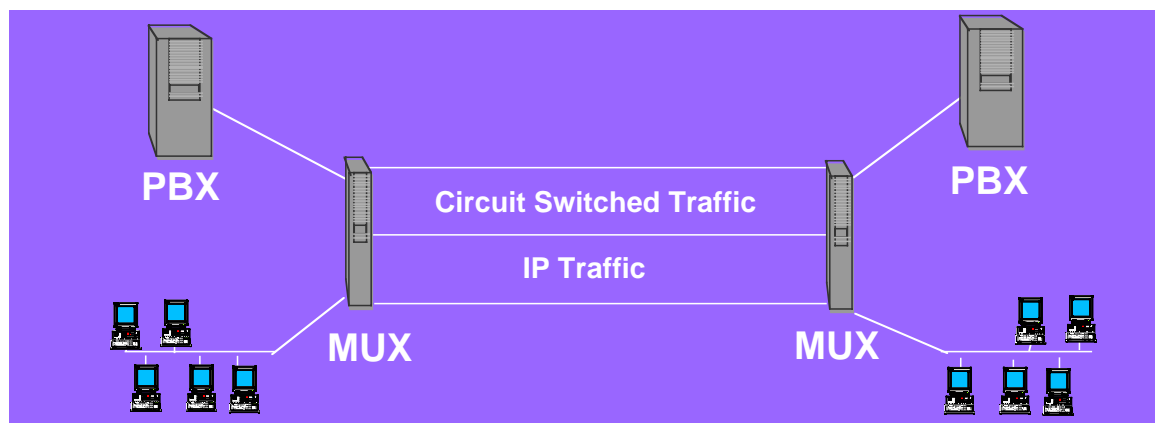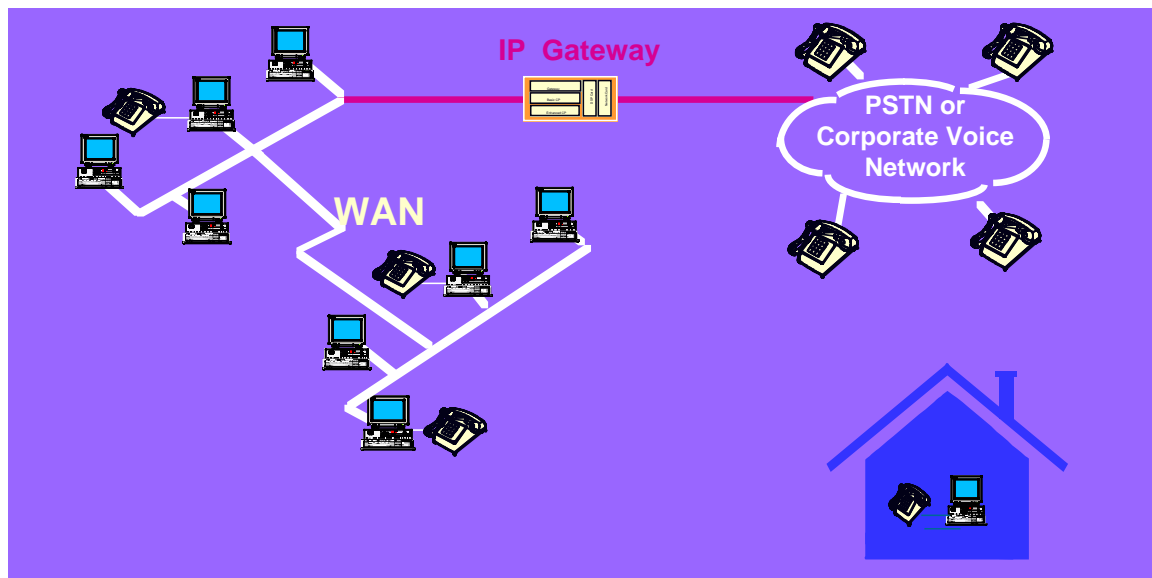**FIGURE 5**

Bandwidth Efficiency

FIGURE 6

Remote Access Solution

together on any application. It also allows file transfer, video conferencing, and other valuable services.

IP telephony is also attractive to carriers. Many carriers are trying to enhance services without radically changing existing technology. One thought was to leave the telephony network exactly as it is. It would be possible to put a gateway at the other side of the CO and treat the twisted pair entering the home as the equivalent of a 10-based T that is always up. Realistically, with IP telephony, one line coming to the house, and one wire in a network, it would be possible to provide several IP telephones that do not require a PC. If a call came in, it would be possible to speak on the same 10-based T-wing even while someone else was making separate calls. This means that providers can enhance services to the home without complex technological updates. It would even be possible to add an IP fax machine. A PC that is connected over the IP network could connect to that box and, thereby, directly to the ISP, never routing through the central office. There are tremendous opportunities in linking voice over IP with other services that optimize delivery. Other significant activities supported by IP telephony include voice over corporate intranets and facsimile over the Internet.

Effects of IP Telephony

IP telephony will have a major effect on the market. In the short term it offers cost savings. More importantly, however, will be the long-term opportunities. IP telephony will allow increased flexibility in business operations. People around the world will communicate without costly and time-consuming travel. Distanced employees can solve

application or code problems as effectively as they could if they were in the same room.

Another benefit of IP telephony is increased responsiveness. Sales personnel will be accessible, regardless of their location, through one IP address. Employees can also communicate with each other more easily, sharing tactics, technology updates, and trial results. Essentially, it allows real-time video, voice, and application conferencing, which will change the way people work and communicate. The ability to respond quickly, as well as the ability to use bandwidth more efficiently—whether in a corporate backbone or on a dialed connection—will make employees more productive, increase providers' range of offerings, and please customers.

Example

Many companies are already using IP telephony. For example, Vienna has a high-volume IP/public switched telephone network (PSTN) gateway, which is modular and able to handle 96 simultaneous calls per chassis. IP can offer PBX-like call processing. Vienna can have a call-processing server manage multiple gateways around the world as if it were one network. Vienna also has the ability to perform sophisticated address resolution, and the company has a powerful API that allows third-party developers to drive telephony features in the IP environment.

With this type of service, any PC can become a desktop terminal for any office application. True IP telephony can bring a data desktop and a voice desktop to any location. This is where IP telephony's greatest opportunity rests.

Practical Versus Visionary Telecommunications Technology

William T. Esrey

Chairman and Chief Executive Officer
Sprint

For years, people like me have been talking about all the amazing things that technology will bring. These are the visionary speeches that pander to the possibilities. Personally, I am a bit tired of them. The situation has reached the point where you would probably like to stone to death anyone who gives a visionary speech—and be found totally innocent on the grounds of justifiable homicide.

I believe we must have our eyes on the rocks and the sands and the horizon, not just the North Star. So in this essay, I would like to talk about practicalities. What has to happen in telecommunications to make all these great visions a reality?

As you know, the common complaint is that we could do all these wonderful things on our computers and over the Internet if only it were not for the skimpy bandwidth provided by the old phone companies. We have all these creative visionary applications just waiting to be put to use on the desktop, but they cannot fit through the pinhole called the public telephone network.

You know the problem: On one end we have all these breathtaking applications swirling around in a great, cosmic universe of possibilities. This is the typical vision that says, In the future, the homebound elderly will be able to select breakfast, lunch, and dinner on their computer. Then at the scheduled time, their nutritious hot meals will be sent to them directly over the Internet. In fact, so the vision goes, all this could be done today if it weren't for those damn telephone companies.

You have heard that scenario a million times.

Now, on the other end of the network is the consumer. The consumer is eager and anxious for all these wonderful technological applications that are dammed up at the front end of the pipe. But puny bandwidth prevents consumers from realizing their technological liberation and their George Jetson destiny.

The thin line between the consumer and the applications is the public phone network. This is the telecommunications bottleneck. And, without a doubt, it currently is a bottleneck. The capacity of the old systems was not designed for

anything more than a few minutes of voice, not the cascades of data we need today.

So how will we ultimately solve the bandwidth problem? First, let me answer more generally by means of an analogy. The Harvard paleontologist and zoologist Steven Jay Gould appeared on Nightline recently. He said that evolution is full of odd shifts of function, where things that evolved for one purpose in one environment become co-opted for a different use in another environment.

Take Darwin's dilemma of a bird's wing: How did the wing structure ever develop, since what is the purpose of a small evolving wing that cannot aid flight? Well, the initial function of the feathers and the small wing must have been for something else, and there is evidence that it was for thermal regulation to keep the body at the right temperature. Eventually the wing was co-opted for flight.

This is pretty much what I believe our industry will do. Using recent technological advances, I believe we will co-opt the evolutionary telecommunications structure. It is true that the local loop was not designed for the data world, but advances such as DSL now make it possible to adapt to the new evolved needs of the modern era.

What is not widely appreciated is that the fundamental technology exists right now to solve the bandwidth bottleneck. We are not talking about vapor visions of the future. We are not talking about a massive rewiring of the nation's infrastructure. The solution is in integrating IP, frame relay, SONET, ATM, DSL, and other technologies in the right way with the right kind of network design.

With the fundamental technology we already have, the next-generation network will provide bandwidth that is wider than the applications. In fact, we will soon be going from a situation where the network has not been fast enough to a situation where the applications are not fast enough. The bottleneck will be in the applications and the servers.

It is a little like the Dan Ryan Expressway in Chicago. They re-built the expressway to give it more capacity. And by analogy, they now have all the capacity they need in the

backbone. But there is still congestion, because there is not enough capacity in the exit lanes.

In terms of the actual network, let me ask this question: What if everyone had dedicated T-1 direct access to their Internet servers? Would the servers that support Web sites and search engines withstand the demand? We will soon find out. This is about to happen to all kinds of applications. Customers will be able to devote as much bandwidth as they want to any application, which will make applications and server access the bottlenecks.

The big question, of course, is who will get us to the point where we need to worry about this new bottleneck? Will it be the start-ups, some of whom are making little more than bogus claims? Or will it be the old guard, some of whom grudgingly think that the Internet has ruined 100 proud years of telephone history, because people now want to be on the line for more than six minutes?

Recent media thinking has cast the struggle as basically between new systems based on Internet Protocol (IP) and old-guard legacy systems. *Business Week* did a major article recently, entitled "The New Trailblazers." The sub-heading read, " band of upstart companies armed with digital data networks and Net know-how could outrun the old phone giants." When we called up *Business Week* to ask why Sprint was not mentioned, they said it was because we did not fit into either category.

To this I said, Amen.@ Our network vision transcends both of those limited points of view. While the start-ups are supposedly overtaking the old guard and the old guard is looking over its shoulder at the start-ups, if they both looked ahead they would see Sprint.

My mother always drilled into me that you should not talk about yourself too much, but I hope you will forgive me for going a little heavy on Sprint's accomplishments for a few moments. I believe these accomplishments give an indication of where the future is headed. Sprint has a solid record of firsts:

- the first all-digital fiber optic network
- the first public data network
- the first coast-to-coast and international fiber-optic transmissions
- the first national public frame relay service
- the first carrier to offer commercial TCP/IP service
- the first carrier to offer ATM service nationwide
- the first coast-to-coast SONET ring route
- the first carrier committed to deploying WDM on nearly 100% of its fiber miles

And, let me predict this: Sprint will be the first to integrate voice and data services over a common nationwide infrastructure. We have been transitioning to a broadband delivery capability since 1993. That is why we have more SONET rings and more WDM in service than any other carrier in the world. And according to the research firm IDC, Sprint commands 40% of the revenues generated from digital data

services in the United States—more than double each of our main two rivals.

We have great confidence in practical technology and a definite opinion about which way the future is going. So, from Sprint's perspective, let me explain where we see the industry right now.

The RBOCs have been trying to figure out how to separate out Internet traffic from their voice traffic in order to preserve their voice infrastructure. They want to stay with the old technology and live comfortably in the old world. No major risk-taking for them. They remind me a bit of the cautious fellow in the seventeenth century who wrote, "I would rather ride on an ass that carries me than a horse that throws me." The RBOCs need to get a horse and learn how to ride. Furthermore, they need to take the near-term risk of making ADSL available at reasonable rates, or witness the medium-term disaster of forcing other carriers to build new plant around them.

AT&T and MCI are trying to figure out how to consolidate data and their voice networks. One of them is now constrained in providing data capacity to its customers. The other lacks an architecture vision. Sprint is way ahead with an integrated architecture.

On the start-up side, much of the buzz about the new companies is totally overblown. In fact, I think many people are simply in love with the idea of these new start-up companies. In some cases, I suspect there is more interest in IPOs than in IP. But, let's face it: people truly are frustrated that they do not have the speed they need.

I am reminded of the case of Dr. Dionysus Lardner, who was a professor at University College, London, in the first half of the nineteenth century. The eminent professor said that rail travel at high speed was not possible because passengers, unable to breathe, would die of asphyxiation.

Some of the start-ups believe in a tangled twentieth-century version of this. They seem to think that high speed is not possible on any network other than their own, and that any other network will be so slow as to asphyxiate all visionary applications riding on it.

That simply is not the case. We do not have to build new networks to get the speed that the future requires. At least Sprint does not have to build new networks.

When it comes to the start-ups, there is more visionary verbiage than true value. In fact, they are trying to build what Sprint already has—and often much less than that. Many of the start-ups are putting out a best-effort network rather than a guaranteed quality network. Pharmaceutical companies do not operate with a best-effort standard. Neither do airlines. And neither should the telecommunications industry.

It is a myth that the start-ups have the corner on bandwidth. In the immediate future, Sprint will have the capability to

give customers whatever bandwidth they want when they want it. They will have bit speed. They will be able to burst traffic. In the 1999 time frame, will be able to carry all the voice traffic of AT&T, MCI, Sprint, and all the other IXCs on a single fiber pair. By the year 2000, we will be able to carry 16.5 times that much. Or, if you prefer, use that same capacity for data.

All of this will be available with predictable service. Our entire network as of early next year will be SONET. We do our SONET technology in rings. If a fiber is cut—and they do get cut—traffic automatically reverses and there is no loss of service. Others are building SONET in a linear fashion, which does add speed and capacity, but which also means that if the fiber is cut, service is out.

In conclusion, I am very optimistic about what practical technology—not visionary technology—will allow us to do very soon. I am optimistic that we will not have to wait for breakthrough technologies or a totally new telecom infrastructure. Highly sophisticated forms of current technologies will do the job. Sprint is totally confident that we can satisfy the ravenous appetite for voice, video, data, and Internet services, and that we can do it in an integrated, practical way.

Let me quote the poet W. H. Auden, who wrote, "The true men of action in our time, those who transform the world, are not the politicians and statesmen, but the scientists." I believe that wholeheartedly. And within a surprisingly short time, science along with economics will make integrated, flexible bandwidth a practical reality, not just the subject of visionary speeches.

Megatrends in the Wireless Industry

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Megatrends are overarching drivers of change within a particular industry. This essay discusses the top ten megatrends in the wireless industry and the significant impact they are having on the business. It will also define five challenges for the wireless industry in the new millennium.

Increasing Demand

The first wireless megatrend is increasing customer demand. The acceptance of wireless service and phones has been phenomenal. *Figure 1* shows the current penetration figures for the wireless industry in fifteen countries (published by Financial Times, Mobile Communications, in January 1998). The first cellular services were introduced in about 1978 in Scandinavian countries with a system called Nordic Mobile

Telephone. Scandanavia retains the lead in world penetration of wireless. Forty percent of the population of Finland uses wireless. In Norway and Sweden, 37 percent use wireless.

In Stockholm, Sweden more than 50 percent of the population uses cellular phones every day. The next leading countries for wireless use are Hong Kong with 34 percent and Israel with 30 percent. In the 20 percent range are Denmark, Australia, Japan, Singapore, and the United States. More than 50 million Americans are wireless subscribers, and growth continues.

Customer expectations of wireless service are increasing, as is demand for service. Levels of service that were acceptable

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FIGURE 1

National Wireless Penetration Levels – 1997

Country	Penetration
France	8.6%
Belgium	8.7%
Germany	9.9%
Netherlands	10.4%
Spain	10.5%
United States	20.2%
Singapore	23.3%
Japan	27.0%
Australia	27.0%
Denmark	28.2%
Israel	29.6%
Hong Kong	34.2%
Sweden	37%
Norway	37%
Finland	40%
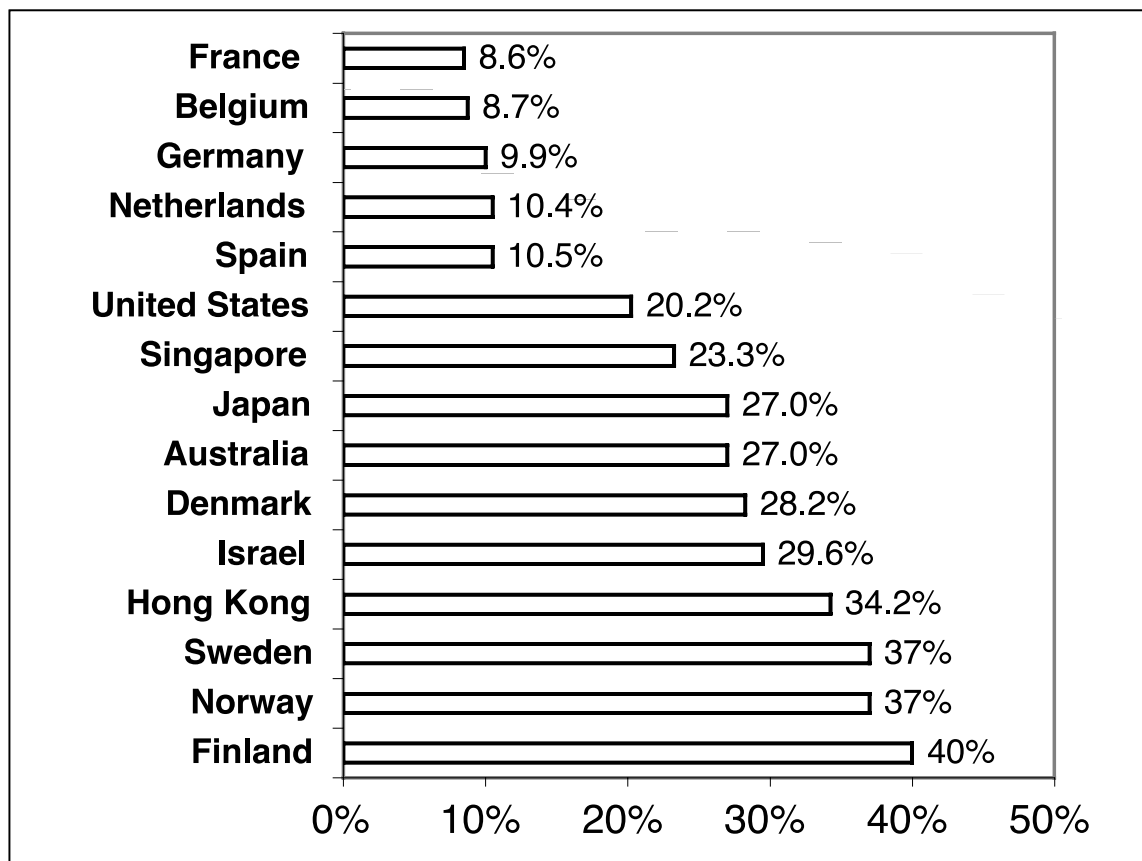
Source: Financial Times, *Mobile Communications*, January 1998; December 1997 figures

in the 1980s are no longer acceptable to today's users. Wireless users have expectations in five basic areas. First, they expect coverage and mobility anywhere, anytime. This is a key benefit of wireless, and the demand for better coverage continues to grow among the wireless customer base. Customers also are demanding continually improving quality of service. This demand includes voice quality, noise reduction, and the elimination of dropped or blocked calls. Users expect 99 percent of calls to go through on the first attempt. Lower costs from year to year is another expectation. The cost of service has dropped more than 70 percent since the inception of wireless, and because phones are now free in many markets, the cost of phones has dropped 100 percent.

A fourth expectation is that available features and functionality continue to increase. Such features include faster call setup, privacy, ease of use, short messaging, and numeric paging. Finally, a new area of demand is for increasing connections between people, computers, and information. Not only are people speaking to people, but people are speaking with machines, machines are speaking with machines, and information databases are sharing information. This is a development area for all wireless networks.

Intensifying Competition

The second megatrend is intensified competition. In every market around the world, wireless competition is increasing. Many U.S. markets now have five or six wireless competitors with personal communications services (PCS) operators entering the market. Satellite carriers will begin competing within the next year, and a growing number of equipment suppliers are emerging from inside and outside the United States to serve the growing wireless market.

Decreasing Regulation

Decreasing regulation is a third megatrend. In this area, unprecedented breakthroughs are occurring. In 1995, the first spectrum auctions were held in the United States, raising $12 billion. Since that time, auctions have occurred in many other countries. In 1996, the first U.S. Telecommunications Act (enacted nearly 70 years ago) was revised in order to reform many of the practices in U.S. telecommunications regulation.

In wireless, one interesting trend is technology-neutral licensing. Many countries today, particularly in Europe, license technology as well as carriers. They allow only certain technologies to be used. Free trade and the reduction of foreign ownership restrictions is another positive trend. The World Trade Organization (WTO) Trade Agreement of 1997 is a landmark agreement that breaks down barriers. The European Community also is liberalizing services in a way that many felt would never happen. Long distance, local exchange, and cable television currently are being liberalized in Europe.

Digitization

A fourth megatrend is digitization. Wireless is becoming digital worldwide. In the 1990s, new digital systems and digital transactions have been deployed rapidly in hundreds of markets and countries. The first transition is analog-to-digital. This transition is occurring in the United States today and has been largely completed in Europe and many parts of Asia. Digital wireless provides high capacity, advanced services, privacy, lower costs, and a platform for long-term growth. Digital-to-digital conversion will be coming soon and has begun already in Japan. The first generation of digital is reaching its capacity limits, and new digital services are emerging in new spectrum and on new infrastructure platforms, including packet-based networks.

There are a number of projections for the future of digital. Analysis by BIS and Strategy Analytics show that in 1996, more than 65 percent of the estimated 141 million wireless phones in use were analog. The last year of growth for analog cellular is projected to be 1998. From this point, analog will decline and digital will begin incremental growth. By the year 2002, an estimated 90 percent of phones will be digital, and nearly one-half billion subscribers will be using wireless service. Some feel this number is conservative.

The Internet Revolution

The Internet revolution is a fifth megatrend. The Internet has created a global information infrastructure largely outside of government regulatory boundaries, which may be why it has grown so quickly. The future will bring commerce, entertainment, and information research at the touch of a button. These services will revolutionize the wireless industry as people come to expect access to those same services from a mobile location.

In the past, familiar products such as electricity, air travel, telephony, and the automobile required 30 to 35 years to be accepted in a meaningful way. According to Forbes magazine in its July 1997 issue, reaching 40 percent of the population required 50 to 85 years. In contrast, more recent products and services such as the television, radio, microwave oven, and video cassette recorder (VCR) were accepted at a much faster rate. Most of these products now have a 95 percent penetration of the U.S. population.

According to Forbes, the time to reach the American population has been cut in half, down to 28 to 35 years to move from 0 to 95 percent penetration. The Internet is the fastest-growing service ever, faster than cellular telephones or personal computers. Personal computers are approaching 40 percent acceptance at about 20 years out, cell phones are at 25 percent after 14 years. Six years after the formation of the World Wide Web, acceptance of the Internet is at 25 percent. It is estimated that the Internet will grow to 40 percent penetration in less than ten years, reaching 100 million Americans.

FIGURE 2

Long-Range Subscriber Projections
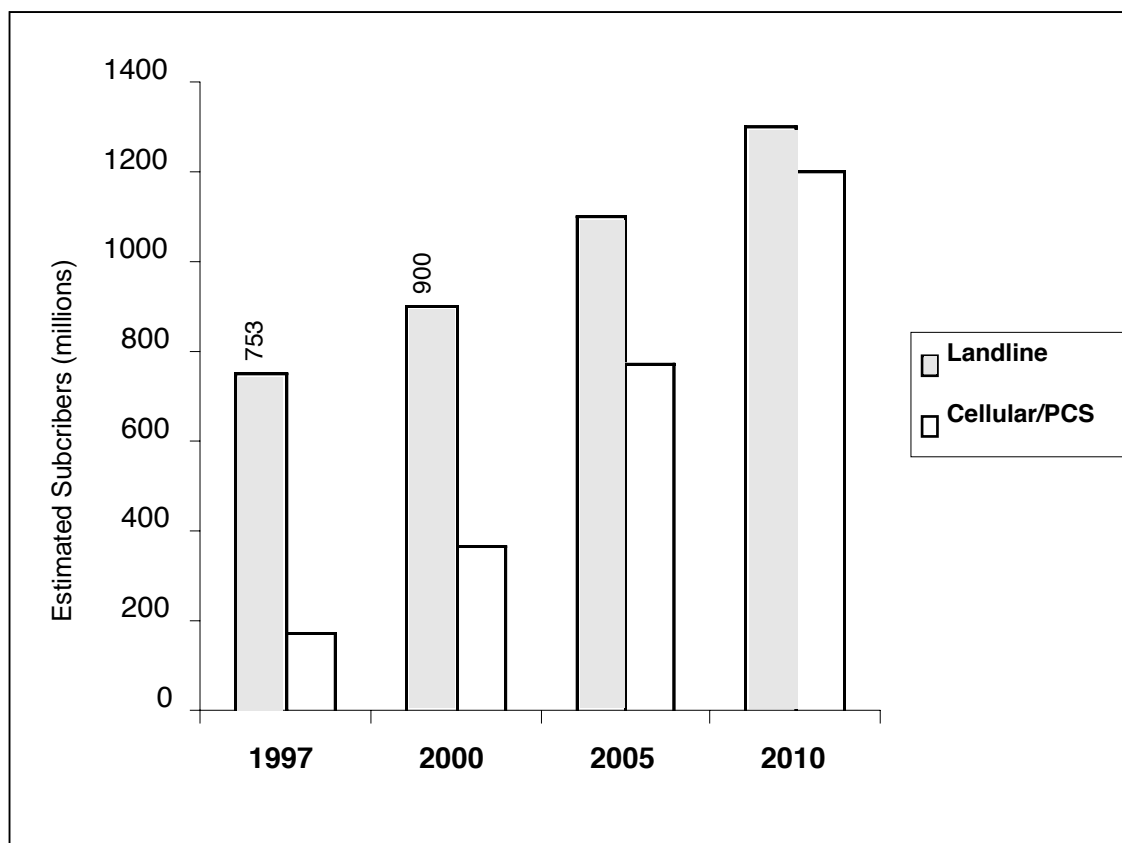
Minute Migration

Minute migration, megatrend number six, is an unfamiliar concept to many. It refers to the increasing percentage of minutes transferred from wireline networks to wireless networks. This megatrend is one of the most important occurring today. The minutes moving from wireline to wireless could not have occurred previously because there was no device to carry them. By one estimate from the Yankee Group, in 1996 the number of wireline voice calls placed in the United States constituted 98 percent of the total voice calls, whereas wireless accounted for only 2 percent. By 2004, it is estimated that 20 percent of voice calls will occur on wireless networks and 80 percent on wireline. This competition will create a larger amount of telecommunications minutes and will provide more minutes for wireless.

Figure 2 shows longer-range projections by Telegeography, Datquest, and Deloitte & Touche in terms of subscribers rather than calls. It is projected that the number of wireline subscribers worldwide will grow from 753 million in 1997 to 1.3 billion by 2010, which is a 73 percent growth rate. In contrast, wireless is projected to increase during the same time frame from 169 million subscribers to just under 1.3 billion, which represents a growth rate of 710 percent and 48 percent of the total worldwide subscribers to telecom services.

Moore's Law Benefits

A seventh megatrend, Moore's Law, comes straight from the computer industry. Semiconductor advancements translate directly into better, faster, and lower-cost wireless devices and infrastructure. Some manufacturers think that Moore's Law will be sustained well through 2010. Intel has said that Moore's Law already has been broken—rather than taking 18 months to double capacity and cut prices in half, it may now take nine months. Continued growth will bring performance improvements, price reduction, and size reduction. This will enable the wireless industry to achieve the level of minute migration discussed above.

Diversifying Subscriber Equipment

Diversifying subscriber equipment is the eighth megatrend. Because of the Internet revolution, customers need a device that allows them to enter text and display graphics and text in addition to having voice capability. This trend stems from the addition of wireless information sources. Off-shore suppliers are pursuing this market quite aggressively, and Japanese and European vendors will be instrumental in this area.

The first dimension of this trend will be single-purpose appliances, which is a necessary simplification for wireless. According to focus groups, many of today's devices—even cellular phones—are too complicated for many users. Vendors are developing simpler telephones, akin to home cordless phones. On the high end of the market, there will be more advanced, multi-purpose equipment with video and color graphic capabilities. An example of such a device is the global system for mobile communications (GSM) palmtop computer.

The Broadband Revolution

The broadband revolution is coming to the wireless network. Not long ago, the ADSL Forum was announced as a good example of the need for a common approach to expanding the bandwidth of copper pair. Broadband is intended to offer instant access for high-bandwidth, high-speed services, and the transition of the core networks will be at the heart of this particular megatrend. The transition of core networks in wireless will include the overlaying of broadband access (or radio technology), broadband switching, and broadband transmission.

The Information Technology Revolution

The final megatrend is the information technology revolution. To enable growth and expansion and to enable the core networks to move data and information on a fast and efficient basis, new software and database technology will be needed. Service delivery, network management, business information, and customer support are four main dimensions that need significant work yet offer significant opportunities for business development. In addition, the applications that customers need must be made simpler and more convenient. These higher-speed transactions will require not only bandwidth, but greater simplicity.

Challenges for the New Millennium

These ten megatrends leave the wireless industry with five challenges for the new millennium:
• globalization
• convergence
• coopetition
• cost reduction
• interoperability

Companies, markets, competitors, technologies, and standards are becoming globalized, and there is a need for convergence regarding standards. When economy of scale and geographical scope of the technology can be achieved, customers will benefit. A third challenge is coopetition, or having a competitor in one consortia who is a partner in another consortia. Coopetition is very common in the wireless industry, and it likely will become very common throughout the telecommunications industry in the future. Coopetition requires the ability to work gracefully with a competitor in the market and in the boardroom.

The fourth challenge is the untapped market for wireless. If 1.2 billion people will have wireless by the year 2010, costs must continue to decline. Interoperability between wireless systems will be a significant challenge for the wireless industry. It has been a challenge in the digital transition, and with the conversion to packet, interoperability will continue to be a challenge.

Megatrends are leading to positive changes in the telecommunications industry, and customers are benefitting. The future for wireless is very bright.

Overcoming the Barriers to Financial Transactions on the Internet

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In a world that thinks a lot about money, there are many network-based financial transactions that have become second nature—drawing cash from an automated teller machine (ATM), for example; swiping a debit card through a point-of-sale (POS) terminal; inserting a credit card in a self-service gas pump; using a push-button phone to initiate a stock purchase or sale.

Ever since these kinds of transactions went on-line, they have moved across highly reliable private networks. Information services managers at banks, payment processing networks, brokerages, and stock exchanges have done all the hard thinking and worrying for us. Massively parallel computers line the walls of their data centers to handle high volumes of concurrent transactions. Fault-tolerant systems ensure continuous availability. Hardware and software security technologies have made these private networks something we can implicitly trust with our money and our businesses. It all works.

Now comes the Internet. An increasing number of corporate Web sites are adopting a transaction-based model, taking orders and accepting payments on-line. Transaction volumes, while still small by the standards of the physical world, are beginning to mount. Bell-weather Amazon.com, for example, grew its on-line business from US $16 million in 1996 to US $148 million in 1997. As business-to-consumer commerce starts to take off on the Web, entities involved in business-to-business commerce are taking note.

Nevertheless, while today's financial networks are private, closed, and secure, the Internet is just the opposite. Before either business-to-consumer or business-to-business electronic commerce can truly flourish on the Internet, we will have to transfer the fundamental capabilities of our private financial networks to what is essentially a porous and, by business standards, unfriendly networking environment.

Barriers to Internet Financial Transactions

The problem is, almost everything that is a critical requirement for card networks and exchanges is a barrier to high-volume financial transactions on the Internet.

- Continuous availability
- Transaction integrity
- Transaction security
- Scalable performance

Customers, weaned on 24 hour ATMs and POS systems, expect the new generation of networked applications to be just as available and to perform just as reliably—even though we are now dealing not with private networks, but with the public Internet. Computer vendors, communications carriers, financial institutions, and corporations engaged in electronic commerce all need to cooperate in order to overcome these barriers and "make it work."

Architecturally, the Internet is a communications backbone and a set of applications. The backbone is relatively reliable. Where communications reliability breaks down is usually between the Internet point of presence (POP) and the consumer. This will undoubtedly change over time as more reliable and higher-bandwidth links are introduced by communications carriers. Where corporations and their financial institutions need to focus is on the reliability of the Internet financial transaction processing infrastructure—that is, what goes on at the commercial Web site and between that Web site and the world of private, closed, and secure financial networks.

Providing Continuous Financial Transaction Availability

The Web server maintains a corporation's presence on the Internet, as well as its critical commercial databases. Not being open for business twenty-four hours a day flies right in the face of the Internet's much vaunted convenience and can severely compromise success, particularly as a site's transaction volumes mount to high levels around the clock. Thus, as corporations extend operations across time zones and expand their service hours through the Web, they are seeing their downtime windows shrink to next to nothing.

Only a few years ago, high-availability computing was a niche market—albeit a very important niche encompassing such business-critical applications as ATMs, stock trading, credit and debit card settlement, directory assistance, and emergency call systems. Today's emerging Internet applica-

tions have now placed high availability and even continuously available computing very much in the mainstream.

The massively parallel, fault tolerant systems—and associated parallel database and transaction management software—that underpin the vast majority of the world's financial transactions are not an insignificant investment. However, the near 100 percent uptime they are designed to provide is essential. They are certainly within the reach of Internet service providers (ISPs), Web-hosting services, financial processors, and large corporate Web sites. Hosting services, ISPs, and processors, in particular, have a commitment to multiple customers to provide continuous electronic-commerce services and can thus justify the system investment.

Just as important for smaller installations is the news that high availability is moving rapidly downstream. High availability clusters of two or more commodity-priced Windows NT® Server systems, enabled by fail over and rapid transaction recovery software, are now feasible and extremely cost-effective in a Web serving environment. Should one server in the cluster fail, others seamlessly pick up the work and the site's payment processing, database, and other operations continue, usually without discernable disruption.

Transaction Integrity

There are two types of transaction integrity on the Internet. The first is traditional data integrity. Even a continuously available database is useless if it contains corrupted data. While most systems provide a limited form of data integrity checking, there is much more that can be done to keep corrupted data from propagating. This includes complete checking of microprocessors and internal buses and drivers, lock-stepped microprocessor chips running the exact same instruction stream, end-to-end checksums before data is written to disk and more.

While the average financial transaction on the Internet today falls somewhere between US $75 and US $250—thus making it difficult for some people to get worked up over data integrity—these numbers will rise as business-to-business commerce and electronic data interchange (EDI) traffic starts to flow. At that point, lack of data integrity safeguards will become a major sticking point.

The other type of transaction integrity has to do with fostering and maintaining a different sort of confidence. The entire public key infrastructure has been developed to fulfill on the Internet the social safeguards (photo IDs, handshakes, and so on) left behind in the physical world. On the Internet, the opportunity for mischief during a financial transaction is far greater than in the physical world—stolen or counterfeited credit card numbers can be used with machine-gun speed at numerous Web sites. Hence the processing-intensive cycle of hashing, encrypting, hashing with digital signature, encrypting, hashing with certificates, encrypting that, and so on. It is this aspect of transaction integrity that leads us to a discussion of security barriers.

Security Concerns

The public Internet is shared and thus much more susceptible to unauthorized entry than private financial networks. Even so, there are many Web-savvy consumers who now believe that security issues on the Internet have been adequately resolved. After all, secure socket layer (SSL) encryption is widely used for credit cards transactions. The Secure Electronic Transaction™ (SET™) protocol, meanwhile, has been posited as a standard for financial transactions on the Internet. However, even though such rock-solid security measures exist, there are still some barriers to overcome.

SET™, which relies on RSA public key technology along with symmetric key algorithms, is on the right track in that it handles a transaction as a series of events—an encrypted session that incorporates authentication, authorization, and so on. In commerce—electronic or otherwise—all parties involved want to have an audit trail for nonrepudiation and payment assurance. The SET protocol, by defining a payments and a security environment, provides this in the digital world. SSL, on the other hand, provides point-to-point security. You end up with a series of events that is more difficult to audit as opposed to SET's unified session, or family of events.

The trouble is, the SET protocol and its public key technology can be expensive because it is a heavy consumer of processor cycles. Corporations are naturally resistant to deploying applications that will not perform acceptably because of caused by heavy queuing for cryptographic computations. This has greatly limited the widespread deployment of applications that require the various forms of security that can be implemented by using public key technology.

In addition, software-based approaches to cryptography decrypt sensitive messages in a server's unsecured memory, displaying both keys and algorithms in readable form. This represents an unnecessary and unacceptable exposure.

One answer to this dual dilemma can be found in the outboard, or hardware, cryptography processors that are extensively used to secure the private financial networks—in many cases, for each ATM transaction. These solutions, generally referred to as hardware encryption modules, can accelerate cryptography functions by a factor of five to ten times compared to software-only solutions. Just as importantly, off-loading resource-intensive cryptography functions from the server enhances server response time in processing the business part of a transaction. A hardware solution also provides a logically and physically secure enclosure to prevent the retrieval of keys or data in clear text form. An adversary cannot modify or manipulate firmware or software executing in such an environment.

The final word on securing financial transaction on the Internet is not yet in. No one knows how the SET protocol will ultimately be received. Hardware encryption modules

will go a long way towards making the handling of high volumes of SET transactions economically feasible. Meanwhile, new security technologies continue to be put forward, such as elliptical curve encryption. Will it be as good as RSA, or perhaps faster?

Scalability

A last major barrier to Internet financial transactions is system scalability. Transaction growth on the Internet is ascending a steep curve, and we are only just beginning. Even as transaction volumes grow—propelled by anyone with a browser and a desire to buy—transaction fluctuation can vary enormously, depending on demand in various global time zones on different days at different times of the year. Such rapid, yet unpredictable, growth requires massive, high-speed scalability to support acceptable and predictable transaction processing performance.

This need for scalability will hold true for individual Web sites, hosting services, financial processors with a hefty Web franchise, and the emerging third-party certificate authorities that provide public key management services to support strong authentication and nonrepudiation. All these entities should be looking for system solutions much like those employed by today's leading financial processors—systems based on a parallel processing, building-block architecture that allows the rapid addition of processing resources.

Some parallel systems can provide almost linear scalability. This means that for each processor module that is added, the system gains a full processor's worth of performance. This allows a system to grow cost-effectively to handle an immense number of simultaneous transactions. It was such systems—that handled, in real time, the New York Stock Exchange's record 1.2 billion shares traded on October 28, 1997.

Emerging clustering technologies can provide similar scalability, though not to such a large scale, using clustered Windows NT Server systems. A recent IBM, Intel, and Tandem demonstration clustered six off-the-shelf servers running Windows NT server. The same complex query was run four times against the cluster—first on a single-node configuration, then on two, three, and finally all six nodes. When all six nodes were used, there was a nearly six-fold reduction in execution time.

This type of scalability, using commodity-priced servers, will greatly benefit individual commercial Web sites, as transaction loads can be dynamically balanced across all the servers in a cluster for predictably rapid response and seamless recovery in the event of server failure. Hosting services, financial processors, and certificate authorities are likely candidates for larger massively parallel systems, perhaps in concert with Windows NT Server–based clusters.

Enabling the Next Generation of On-Line Financial Transactions

As they came on-line not too many years ago, ATM networks, followed by POS networks, represented a major paradigm shift. Banks, stock exchanges, and other businesses wondered if their on-line financial transactions would be secure, if they would be processed without delay over the widest area networks, and if backend systems would be able to ensure the continuous availability of critical business processes. Now it is the Internet's turn to trigger the same crucial questions.

Internet-based consumer-to-business financial transactions are growing in volume. To keep these volumes increasing, corporations doing business on the Web and their financial institutions need to replicate aggressively in the Internet environment the high availability, high security, and high performance technologies that underpin today's private financial networks. We are literally standing on the edge of enabling a new generation of on-line financial transactions. When the barriers to Internet financial transactions are completely knocked down, a potentially larger new flood of complex business-to-business financial transactions will start to flow as electronic data interchange (EDI) comes to the Internet in earnest.

The technologies that will make this possible are here or are now falling into place—parallel systems and software, commodity-priced clusters, cost-effective encryption solutions, and more. As an open and public entity, the Internet will cut off and isolate those pockets that do not keep up. Business will flow around them, just as it eluded banks that were slow to embrace ATMs or stores that were slow to embrace electronic POS.

The Future of Mobile Computing

Jef Graham

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This paper discusses future directions in mobile communications, which in this context means a laptop or portable computer communicating with a network. What are the trends in mobile technology versus developments in the communications industry overall? What are the directions for mobile communications in the office, on the road, at customer sites, and at home?

Mobile Technology Trends

To some extent, developments in portable or laptop personal computers dictate the type of mobile communications that are available. Processor changes in new releases of laptop PCs are bringing laptops much closer to the desktop. The IBM 560, for example, is probably the closest model now to a truly mobile replacement for the desktop computer. It is high speed and has a long battery life, utilizing a 3.3 volt battery, although users continue to face a trade-off between memory and processor speed. It offers significant storage capacity with a 2-gigabyte hard drive plus compact-disk capacity. It is very light, just under four pounds, and will probably stay about that size because keyboard and screen requirements limit further miniaturization.

These improvements have made a real difference to mobile communications, and today about a third of all PCs shipped are laptops. That is a significant percentage of the computer market.

One of the interesting things about this generation of laptops is that the laptop's life has been extended. Previous generations offered a life cycle of just over one year, but the life cycle for the new generation is approaching two years. On the other hand, screen technology, other capacities, and speed have not improved to the point where they provide an incremental advantage.

Communications Trends

The first important new communication trend is that Internet access is becoming a local call. Local-call Internet capability will eventually become available worldwide. The expansion of Internet access leads to another important trend, the emphasis on Internet security. Security is probably the biggest issue, certainly for management information systems (MIS) departments. The ability to access a company's home network via the Internet and communicate sensitive information remains a very big hot button. Another trend is high-speed wide-area network (WAN) connections based on 56 kbps, xDSL, and cable modems. These technologies will have a big effect, although MIS departments probably will not use higher-speed technologies until a standard is adopted for them. Another disadvantage with xDSL and cable-modem technologies is that they will be available only at specific locations. For these reasons, analog modems will dominate the future and will be around for a long time. The high-speed technologies of xDSL and cable modems will not be the answer.

Another trend is an increase in wireless networks—local area networks (LANs), metropolitan area networks (MANs), and wide area networks (WANs). Wireless communications for the portable computer have not really arrived yet. LAN communication has been very disappointing. The 802.11 standard for one- to two-megabit speeds has just been accepted, but one to two megabits has proven acceptable only for transaction processing, not for secondary LAN communications. Soon, however, 10-Mbps wireless LANs will be introduced, and this higher speed will allow for wireless LAN communications.

Interesting technologies emerging in MANs in the Seattle, Washington, DC, and the San Francisco Bay areas offer exciting capabilities. Portable communications in WANs are primarily analog; cellular technology has not proven itself reliable enough to be seriously used. In terms of the number of options available for communications, cellular is still very small, although it may grow as improved digital communications are introduced.

Intranet guest services that allow privileged outside users access to corporate intranets will grow dramatically. For example, if sales or support representatives are visiting a customer site, they may be allowed to connect to the customer's corporate intranet and tunnel through the network back to their own corporate networks securely. Along with such services, roaming Internet protocol (IP) addresses will mean that a user will be assigned a single IP address that will go anywhere the user goes.

Computing Environments

Where do all these trends lead? They allow for a new category of worker: mobile workers who rely on the mobile platform for communications. These workers will have access to full-performance mobile computing without the

limits that have existed in the past. They will have information at their fingertips anytime and anywhere. The new mobile worker will be found in several different environments, as discussed below.

In the Office

The office now is predominantly a wire environment, with 90 percent of all networks using Ethernet. The portable computer in the office will be connected to the Ethernet or Fast Ethernet at the desktop via a docking station, port replicator, or PC card to access the corporate LAN. Of course, using those technologies through the motherboard consumes power, but the portable terminal in the office will frequently be hooked up to a wire connection so power consumption is not a significant issue. In the conference room, however, the notebook will require a wireless connection to an access point in order to reach the corporate LAN, which in turn will communicate to an Ethernet access point and from there to a WAN.

On the Road

On the road, the wireless environment will begin to dominate. The notebook will access the wireless MAN or WAN via a cellular node to the Internet, which will also provide corporate LAN access. Metrocom in the Seattle area has developed some interesting ricochet applications, while service providers in the San Francisco Bay area have proven that someone can commute via train up and down the peninsula and remain connected using this type of technology. Thus, commuters will have the ability to work, access information, and browse the Web, although the market for such services may be small.

Wireline services probably will be used primarily for data grabbing—accessing small pieces of information such as stock prices, warnings, calendar changes, etc. The big challenge on the road is managing power in the portable—that is, keeping the unit on as it receives information without draining down the batteries. Power consumption remains a big issue. Adding power, of course, means adding weight, and current wireless technologies have added half the weight of the existing portable to obtain additional power. This tradeoff is unacceptable.

At a Customer Site

When visiting a customer site, an alternative to the analog modem connection is connecting the notebook via the LAN to the customer-site corporate network. But secure tunneling limits guest privileges to the Internet or the user's corporate LAN. Security, both for the visitor's information and for the customer's information, remains a big issue in such communication.

In Hotels

In hotels, the analog modem will remain the dominant standard for a long time to come. But the notebook could be connected to an on-site hub that enables xDSL or cable modem access to the Internet. In most of the United States, the analog connection is all that is available, but in Germany and Japan some integrated services digital network (ISDN) connections are available now. As networks are installed in U.S. hotels, cable modems and xDSL connections will be built in. Those features will allow communication via Ethernet to the network and then out by the cable modem or xDSL connections.

At Home

In the home environment, cable modems will be the technology of choice for residential communication capability. Cable modems are probably about one year ahead of asynchronous digital subscriber line (ADSL) deployments. A notebook Ethernet connection to the Internet via a cable modem is 30 times faster than using analog lines. ADSL may be the primary choice in some areas because of the quality of the cable lines or the availability of cable communications. But, for the most part, cable companies can offer services that are superior to those of ISDN. Cable technology has provided reasonably good performance, as in home deployments by Time Warner, although these deployments were small.

Conclusions

In all these areas—at the office, on the road, at a customer site, in a hotel, and at home—a common theme has been that the Ethernet is the predominant connection between the portable and any high-speed technology, although modems are pervasive. The cable-modem marketplace will continue to grow. In five years, the market still will be 70 percent to 80 percent analog modems in the WAN, and probably no more than 20 percent of the WAN will be shared between cable modems and ADSL technologies and connections.

Digital Technology: A Collaborative Future

Richard R. Green
President and Chief Executive Officer
Cable Television Laboratories, Inc.

Introduction

I would like to share what I hope are timely thoughts concerning the important transition to digital transmission that we face in our respective industries. First, I must confess that I am a physicist and not an engineer.

My background is in theoretical physics but I was smitten by broadcasting early on. I have been very fortunate to be involved in some way in broadcast engineering and production since 1957. I have always admired the engineers in the cable business and the tradition of truly exceptional pioneers like Armstrong, Deforest, and Brown. I have had the pleasure of working in three of the networks and include Joe Flaherty among my mentors. Joe deserves the credit for pioneering many advances in broadcast technology.

Particularly he deserves the credit for tirelessly promoting and fostering the concept of high-definition television (HDTV). Joe got me interested in HDTV in 1979, and I have been working on it ever since. I also owe a debt of gratitude to Julie Barnathan who taught me the operational side of network engineering. He gave me a million dollars worth of education and supported my causes even when he was personally skeptical. The whole industry is indebted to Julie for his contributions.

Arthur C. Clark once said: "Any sufficiently advanced technology is indistinguishable from magic." Some Silicon Valley wag has paraphrased the quote to say: "Any sufficiently advanced technology is indistinguishable from a rigged demo." However, I must congratulate the suppliers to the industry. They have done a superb job of developing the hardware and software that we need for the next generation of broadcasting. I make my living by trying to imagine, realize, and implement practical applications of technology to audio, video and data engineering.

I am privileged to lead a research and development consortium of cable operating companies. CableLabs was founded ten years ago to ensure the proper development of technological initiatives for the cable television industry. Our lab represents more than 85 percent of the cable customers in the United States and 75 percent of customers in Canada. The current portfolio of research and development projects for CableLabs includes specification of advanced digital set-tops (the OpenCable initiative), cable modems, Packet Cable specifications, and improvement of the consumer electronics interface.

The most important project that we have ever undertaken at CableLabs is digital television. We have been working on that topic since the start of the lab in 1988.

We issued what I believe was the first specification for digital video compression equipment for consumer's homes, seven years ago in March 1991. We have been offering digital video service on cable and satellite for the last three years. Digital television is a technology that the cable industry has taken seriously and is deploying quickly. We are in the process of deploying the first 500 thousand digital set-tops and our member companies tell us that a conservative number for year-end 1998 deployment is one million units.

Just beyond that is a 15-million unit order placed on behalf of nine cable operators for advanced digital set-tops. Those units will marry digital programming, high-speed data and Internet content for display on analog and digital TV receivers. Right now we stand at the threshold of HDTV broadcasting. The truth is, none of us is ready for HDTV, even though we have been working hard for the last decade to prepare. There is still a lot to be done but broadcasting will begin in ten large markets in November. The cable networks, including HBO and Discovery, are planning to provide an HDTV service soon after that. In the case of HBO, the plan is to convert 800 movie titles that will run on the network next year, to the 1080i HDTV format. So there will soon be broadcast and cable HDTV service. However, many questions remain including the following: the issue of must-carry applied to the digital environment and the related questions of compatibility of transmission standards and timing must be resolved.

I want to return to this subject in a moment but first I would like to share some things that we have learned at CableLabs while helping prepare the cable industry for the transition to digital technology:

First: The convergence of industries is real, the trend is certain, and we in the technical professions need to be thinking and working collegially with our counterparts in other

industries.

Second: The rate of change of technological development in television keeps increasing and is now approaching the Moore's Law cadence.

Third: Consumers will truly drive the digital evolution. Their interest must be the primary consideration in the introduction of this new technology.

Convergence

The first axiom concerns convergence.

No single industry has a lock on the market for distribution of digital signals. Information can be distributed and manipulated in an unlimited number of ways. As a result of the flexibility of digital technology, traditional market barriers have also begun to erode. Now it is possible for providers of traditionally distinct technologies and services to cross into new markets and challenge each other with an impressive array of applications and services. The concept of convergence, this synergy of industries, became evident about four years ago. It then tarnished and fell on hard times. In fact I thought last year that convergence was dead—DOA. But there has been a resurrection. The new element is business necessity—in the broadcast, computer, and cable industries.

These industries support very successful businesses, and as businesses we really need each other. We are mutually dependent. The cable industry needs the computer software and hardware to put in the set-top box. The broadcast industry needs this same technology in providing advanced data and television service to the home. The computer industry needs connectivity. If the computer industry is to continue to grow at the double-digit rate that it now enjoys, new applications, for example, video, must be built into the PC. Who better to provide digital video and data services to computers than the broadcast and cable industries? All of us need the consumer electronics industry. The next generation of TV sets will certainly add to the entertainment value of services with clearer pictures and improved sound. Television sets are likely to become display terminals for data supplied over the air and through the terrestrial networks.

Rate of Change of Technology

The second point is about the acceleration of technical change.

Nobody really likes change except perhaps a wet baby. But technical change is like a steamroller: if you are not on it, you are destined to be part of the road. The time it takes to create and implement new technology is rapidly decreasing. For example,

- It took 112 years for photography to go from discovery to commercial product.
- The telephone required 56 years for its commercial success.
- Radio required 35 years.
- Radar took 15.
- Television required 12.
- The atomic bomb took only 6 years to become an operational reality.
- Transistors went from the laboratory to the market in only 5 years.

Today, a product can be invented, produced, packaged, marketed, and become obsolete in the course of a year. Not long ago, I had the pleasure of having dinner with Gordon Moore, the author of Moore's Law and one of the founders of the Intel Corporation. He is still very active in research and development activities at Intel. First he told me that he did expect Moore's Law to remain valid through his lifetime, at least another twenty years. He also told me that some products being produced at Intel had been conceived only ten months earlier.

The technology that we use today depends on these processors and memory. This means that television will benefit from the same silicon learning curve that powers the microchip development, with its billion-transistor potential. Therefore, like it or not, those of us involved in the distribution of television are now dealing with Moore's Law changes: a doubling of technical capability every twelve to eighteen months. So we are the buffers between what has been a much slower obsolescence cycle characteristic of the consumer market and the new development cycle, which will bring obsolescence every eighteen months. The computer industry and the consumer electronics industry are on a collision course bringing this dilemma to the retail market. Will consumers be willing to replace their television sets every eighteen months? Will consumers be willing to replace their television sets with computers? I do think that we can address this dilemma by moving toward a software-based delivery system. This means down-loadable, upgradable software in consumer devices, and that is the direction we have taken in the OpenCable set-top specification.

Albert Einstein once said: "The unleashed power of the atom has changed everything save our modes of thinking." His statement was a warning that failure to change our thinking to accommodate technological inevitability was our biggest failing. The communications revolution, like the atomic revolution, is also born of an explosive change in technology. The failure of industry and government to think of the emerging digital revolution as an inter-related, national system of industries is our most significant obstacle. On a somewhat more mundane plane, and another way of looking at this, is illustrated by the take-away message I got from Raiders of the Lost Ark: "Those who live by the sword die by someone else's bullet."

Customer Orientation

The third axiom that has been learned the hard way is that the consumer is going to determine the future. The guiding maxim of our technological efforts must be to determine what the customer wants. There is no business principle more sound than that of keeping an open mind and measuring the customer's needs. Therefore, considering the range

of options available for HDTV and digital broadcasting, it seems likely that the preferred course should be to extensively test a variety of different programming scenarios, to best determine which will ultimately prove most popular with consumers. Cable companies will carry broadcaster signals without modifying video or audio quality. I suspect that there will be wide-scale experimentation by broadcasters and cable companies with different formats and business plans. This is the key to success in the future as it has been in the past.

The Cable Industry Shares Your Views

In many ways the cable industry shares your view of the future potential of digital broadcasting. DTV offers incredible flexibility that was not previously available. We can provide high-definition signals for ultimate picture quality, multichannel standard definition for potentially new revenue streams, data broadcasting for new applications, or a combination of any of these. Data broadcasting for high-speed PC downloads and Internet content delivery are added advantages.

But, as you would expect, making the transition to this new world is not so easy. There are many issues that must be addressed, such as the creation of larger consumer displays for TV receivers, networks' decisions on program delivery bit-rate and format, conditional access, cable set-top converters, and home recording.

In the cable industry, we prefer evolution, not revolution, for deployment of new technologies. It is folly in a capital-intensive business like ours to try to invent a market. Those of us in the cable industry would ask that industry professionals consider the impact of their new services on the cable systems. It is our intention to carry programs in whatever display format is selected, but in many cable systems we are strapped for capacity. A full 19 Mbps HDTV signal will fill a 6-MHz cable channel at 64 QAM modulation. We can pack two 19 Mbit HDTV signals into a six MHz cable channel using 256 QAM. But even at that rate we will not have sufficient capacity to accommodate all the signals. I believe that in all ten start-up markets, cable coverage is currently arranged under retransmission consent agreements. These agreements have formed the basis for broadcasters and cable operators to work out business arrangements. Perhaps this type of bilateral discussion can result in a win-win solution at the digital start-up. Bilateral discussions between networks and cable MSOs and broadcast stations and local cable operators are in progress. I am hopeful that these discussions can go a long way to providing an effective and reasonable start-up plan.

Credibility in Technical Forecasts

This brings me to another aspect of the market emphasis—that is the need to be credible in our technical forecast of future services. A few weeks ago, I came across an article on new video technologies published in a 1978 *Newsweek*. The article was a cover story and predicted that in very short time cable would completely change our daily lives. According to the reporter, by 1985 people would be able to use their television sets for retrieving information on traffic conditions, as a tutor in mathematics, or to provide information on supermarket sales.

This was to be made possible through the magic of interactive video technology. It would mark the beginning of people living in something called "a video Communications Complex (formerly known as 'home')." The notion, fostered by enthusiastic technologists and abetted by the popular press, is that technology can easily be used to drive consumer markets. The tacit assumption is that if you can do it, people will certainly support you to do it. We have learned from long experience that you can lose a lot of money worshipping this false god of technology.

Although many of these developments forecast in 1978 are nearing reality, the misleading predictions that proceeded the reality have reduced the public confidence in our forecasts. We need to strongly factor the consumer needs into our prognostications of future services. There is only one way to do this and that it is to do the homework. It is important, I believe, to make an honest attempt to survey and measure customer preferences and cost thresholds before going public with extravagant visions of the electronic future.

Conclusions

So much for axioms and forecasting. We must focus on the realities of our technical future. There are two points.

The first point: industries are becoming increasingly interdependent. We need a unified will to reorient past efforts into the conditions of today. We must reexamine old turf battles and recognize that the future will not be reached by each segment of our perspective industries continuing to develop techniques and systems in competitive isolation. The technical needs of our intended services are in fact rapidly converging. Properly managed, this trend will serve the public interest, whether the consumer wants entertainment, information, instruction, or interaction with others. It will provide these services at the lowest possible cost, and with the most capable digital broadcast system.

The second, and most crucial, point: First, take a moment to put aside the usual industry-centric, technology-based approach to the future. Instead think of the delivery of television as a system. Based on the convergence of the technology that we are all using and on the accelerated pace of the development of that technology, we are working to build a national digital broadcast system. As individual industries, we each are constructing a component. But the system is made up of many components, including over-the-air broadcasting, cable, satellite, microwave multipoint distribution system (MMDS), etc. The system supplies multichannel television to the people of North America, and each of us provides a part of the distribution. The system gives the customer choice, and we all compete on the basis of such attributes as content, price, and quality. From our technology-based platforms, no one of us directly serves all the television receivers. But we are interconnected because we

must use the same standards. For example, the National Television Standards Committee (NTSC) has been our interface standard and we are now using MPEG-2 and Dolby Audio for our digital services. Because we have different propagation environments we use different RF modulation: QPSK for satellite, VSB for broadcasting and QAM on cable. We do this for technical reasons to optimize our respective distribution.

Competing for viewer attention and dollars is healthy. It builds strong and competitive businesses. Cooperation and collaborations on the technical interfaces within the system builds a sound cost-effective infrastructure. Both are in the best interests of the public and our customers.

In the competition for viewers there will be and should be winners and losers. In the development of the digital infrastructure, the interface definitions should be based on a collaborative, win-win philosophy. On the technical side we have made considerable progress. The Advanced Television Systems Committee (ATSC) has served as the forum to discuss and recommend standards. In addition, we have a solid first-generation specification. All those that were part of that effort should be proud of the achievement. We at CableLabs certainly are. However, the next generation of agreements must take into account the convergence of our industries in a more specific way than it has in the past. The interfaces involved now strongly include the interests of the computer and consumer electronics industry as well as broadcast and cable. These industries each have organizations that consider and develop standards, which serve their respective needs. Taken in aggregate, many of the technical issues needed to continue the specification of the digital system have been addressed in these organizations. It is now incumbent on us to develop a dialogue among these industry-based standards groups so that we might collectively approach the standardization of these inter-industry interfaces. If that is not task enough, the Moore's Law cycle requires that this must be done often and quickly.

There is plenty of work to be done. Fragments of the specification have been completed by various organizations. For example, matters of conditional access and renewable secu-

rity have been addressed in a CEMA group, copy protection has been addressed by a group of manufactures working with the motion picture studios, and the OpenCable process has developed a specification for APIs that will be released to suppliers. It is in everyone's interest to contribute and compile these elements into an integrated specification. We must not individually reinvent the wheel.

I am reminded of a recent statement by John Briesch, President of the Sony Consumer Audio/Video Products Group, commenting on the difficulty of designing and manufacturing digital television receivers. He said: "Imagine a baseball analogy where we as TV manufacturers are the catcher and the broadcast industry is the pitcher. The pitcher possesses a vast combination of pitches. Although we can send the pitcher a clear signal of what we think he should throw in order to win the game, we have no idea what he will deliver until the ball is thrown. Therefore, we have no choice but to be prepared to catch whatever he delivers or lose the game."

This kind of uncertainty can and should be avoided. Inter-industry agreements are preferable to government mandate. But we must remember there is a community of interests now. It is not limited to just broadcast and cable. The convergence has eliminated the days when cable and broadcasting interest could get together and develop specifications for the broadcast system. It is my hope that the cable, computer, broadcast, and consumer electronic industries will all join in this effort, recognizing that the current convergence of technology leads to a convergence of economic self-interest. In dealing with the complex give-and-take issues that characterize digital television, I am reminded of the fable where a dog with a bone comes to a pond and sees its reflection in the water. It thinks it sees another dog with a bone and tries to grab that one, too. In doing so, it drops its bone in the water and winds up with nothing. As the fable suggests, no one side can have it all. None of us can afford to come up empty—without a bone—on an issue as vital as the digital future. However, with cooperation and compromise from all parties, I am confident that we can work out reasonable solutions.

The Education Race

Glenn R. Jones
Founder and Chief Executive Officer
Jones Intercable, Inc.

We have had several years of blissful deliverance from the worries and stresses of the forty-year Cold War. But during this time, a new contest has emerged on the world scene that carries incredibly high stakes. It is not an armed conflict, but the economic impact may be just as great, both for countries and individuals' well being.

We are no longer in an arms race, we are now in an education race.

We are in this race to ensure the economic security of our society and our children. The contest is about providing access to education for individuals who will be part of the best possible set of industries and professions that can help build America into a 21st century bastion of free enterprise and intellectual prosperity. Paradoxically, it is interesting that the pivotal battles are being fought within America's higher-education establishment.

Forty years ago, America launched an education, research, and development campaign to catch up with the Soviet Union in the space race. We succeeded, and that success did far more than just beat the other side to the moon. But there is plenty of evidence that we have wavered in our pursuit of the best education possible for the majority of our citizens. Today, the simple costs of education threaten to relegate our country once more to second-class status. This is not the result of a lack of technology. Instead, it is the outcome of constantly escalating education expenses, which have functioned to place higher education beyond the means of many of our aspiring students.

In the 1980s, the cost of healthcare rose 117 percent and the cost of new cars went up 37 percent. But the average cost of attending a public college increased 109 percent, and the price of an education at a private college went up 146 percent. The cost escalation has continued in the 1990s. In 1996, annual tuition and fees at a public four-year college equaled 9 percent of the American median family income, and that was a 30 percent increase in share in just five years.

I will address this devastating upward higher education cost spiral in more detail further on in this paper, but first I think we should appreciate just what our technology-converged society has made possible.

Today, in this country and, indeed, in much of the developed world, we as individuals can

- design a workday around our personal and family needs.
- modify a job from full-time to part or flex time.
- move children among a variety of public and private school choices.
- purchase an affordable automobile that has been customized on the assembly line so there is no other like it.
- by using a VCR, design TV viewing that is exactly what we want to watch, when we want it.
- design a newspaper for one that reflects exactly what we want to read, delivered by fax or e-mail each day in time for breakfast.
- design a custom retirement plan that exactly fits our needs and to which an employer will contribute.
- plan a college degree program using courses from universities around the world that can be taken in one's own home.

Deregulation of the world's telephone industry is rapidly placing high-quality, affordable communication within the means of even lower class consumers in many countries. More importantly, the technology and market advances in pricing have guaranteed access in locations thought impossible a few years ago, from Northern Borneo to Lapland. These same not-so-isolated customers can now be sold a wide variety of communication services, including distance education–college courses, delivered by telephone line or satellite to any place on the globe with electricity to operate TV sets and computers.

The era of choice has totally immersed us. We are experiencing the communications technology convergence revolution, the second shot heard round the world. If technology convergence has been the great change agent, then education has been the great enabler, placing knowledge in the hands of those who are making convergence happen.

Yet, the greatest waves of advancement are still ahead as we fully apply the forces of cable, satellite, and Internet delivery to educating the world's population. By educating, I mean not only for professional standards and work skills, but also providing education that will eventually help eradicate poverty, control disease and improve understanding among cultures. Is this the world through rose-colored glasses? No, because the obstacles are many. There are big challenges in the world of education today, and right at the top of the list are cost and access.

The world's great universities are bursting at the seams with students. For example, Harvard University enrolls 18,694; UCLA, 35,110; University of Rome, 166,000; Oxford

University, 16,080; and La Sorbonne, over 100,000. But traditional universities are not the only places students learn today. In fact, many take classes in their own homes. The Jones company's Knowledge TV/College Connection now has over 6,000 students taking courses for credit electronically. Not a huge number, but we started with one student a decade ago, and we expect to grow exponentially by the early 21st century.

There is ample reason to support this optimism, including the following facts:

• Distance learning in the United States is now a $825 million industry.

• This figure represents growth of 77 percent since 1993.

• Worldwide, the distance education market was estimated at $8.25 billion in 1997.

In China, there are 1,065 universities enrolling 2.5 million students, and all student vacancies are filled. However, there are about 80 million students in China who are considered to be potential university students. If only 40 percent of these seek university enrollment—which China's higher education establishment fully expects—they will have 32 million students vying for 2.5 million slots. Most homes in China do not have computers, but many do have TVs. Web TV is expected to be a hot, fast-moving product in that market. *Table 1* shows the growth in the number of students enrolled in higher education between 1985 and 1992.

Between 1985 and 1992, the number of students worldwide seeking some form of higher education grew 26 percent, from 58.6 million to 73.7 million—an increase of 15.1 million.

During the late 1980s and early 1990s, governments and taxpayers worldwide increased support to education by only 0.2 percent of their gross national products. By 2000, 50 percent of corporate training will be delivered via virtual technology.

For many individuals, the high cost of a traditional college education makes it all but unattainable. If you are left out of the education system, then you have also dropped from the economic system. The cost of education continues to spiral at double the rate of inflation and mirroring the escalating costs of healthcare. A recent survey of U.S. high school juniors and seniors by our company found that of the roughly 2.6 million high school graduates each year, as many as 1.1 million are unable to continue on to higher education, primarily due to the escalating costs.

The tragedy is that the technology is available to change to make education available to everyone. Cyberschools can be a solution. In fact, the survey showed that more than 45 percent of high school juniors and seniors would consider cyberschools as a viable path toward higher education.

In my recent book, *Cyberschools: An Education Renaissance,* I write about all of the cyberschool initiatives taking place around the world. Over the past ten years, Jones Education Co. has meticulously created a platform based upon a five continent global campus concept. Campuses in North America, South America, Asia, Africa, and Europe all make use of a range of technologies including satellite, television, cable, telephony, and VCRs, and it is all under-girded by the Internet in order for students anywhere, anytime to access accredited academic programs.

The concept behind cyberschools—otherwise known as virtual universities—is to deliver education to people instead of people to education at an affordable price.

The costs advantages, when you are paying for computers and extra phone lines instead of brick-and-mortar classrooms, is considerable, as *Tables 2* and *3* illustrate.

Technology allows us to minister to the growing global educational needs—an estimated 100 million adult learners in the United States alone. Yet residential-based colleges and universities can only handle less than 15 million. Considering that more than 80 million Americans have access to e-mail, one can begin to see the potential that cyberschools have for linking learners to the education they need. How fast can it happen? Very fast. In 1994, the Emeryville, California, consulting firm Global Business Network "went out on a limb" with a scenario forecast for U.S. education in the year 2010. Part of that forecast predicted that, early in the next millenium:

TABLE 1

The Growth in the Number of Students Enrolled in Higher Education between 1985 and 1992

	1985	1992	Percent Change
Asia	17.6 mil.	24.9 mil.	42%
Europe/Russia	17 mil.	19 mil.	12%
North America	13.9 mil.	16.4 mil.	18%
World Education Report, UNESCO, 1995			

TABLE 2

Two-Year Colleges: 1997–98 Estimated Costs Per Semester (12 Credits)

Costs	Public	Private	Knowledge TV
Tuition and Fees	$ 751	$ 3,428	$ 1,664
Room and Board	$ 941	$ 2,272	Existing costs at home
Books and Supplies	$ 305	$ 309	$ 116
Transportation	$ 489	$ 305	Existing costs at home
Other	$ 613	$ 536	Existing costs at home
Total	$3,099	$6,850	$ 1,780 (plus costs at home)

Source: The College Board, New York, NY; Jones Education Co.

TABLE 3

Four-Year Colleges: 1997–98 Estimated Costs Per Semester for Undergraduate (12 Credits)

Costs	Public	Private	Knowledge TV
Tuition and Fees	$ 1,556	$6,832	$2,618
Room and Board	$ 2,181	$2,775	Existing costs at home
Books and Supplies	$ 317	$ 316	$ 229
Transportation	$ 287	$ 269	Existing costs at home
Other	$ 695	$ 522	Existing costs at home
Total	$ 5,036	$10,714	$ 2,847

Source: The College Board, New York, NY; Jones Education Co., 1998

For adults, skill development for new jobs or new job responsibilities is the big market. Education companies battle vigorously in the marketplace to turn out products and courses that permit effective and convenient training. For example, when demand for high-level information skills took off following the conversion of major library collections into hypermedia databases, education companies responded with elaborate tutorials and programs on information retrieval and processing. Retrieval, not delivery, is the operant word for the new education services. Education has been transformed from a producer-push logic of the delivery of standardized skills to a consumer-pull logic of just-in-time retrieval of situation-specific and user-appropriate information.

> As many readers of this paper will recognize, much of that scenario has become fact in just four years, not sixteen. Even global business network, which prides itself on being at the forefront of the wired revolution, can underestimate the acceleration of technology adaptation. Over the last few years, representatives from over thirty-five countries have traveled to our corporate headquarters in Denver to see first-hand what cyberschools can do. Clearly in many of these countries, they are going to leapfrog the traditional models and take advantage of technology.

There simply is not enough funding to educate otherwise. That is not unlike what we see here in the United States. We must have an economic model that is self-sustaining, that people can afford and that delivers quality education to everybody regardless of who they are, where they live, or their condition in life. That is what cyberschools are all about. Why, in addition to profits, should we put a special focus on education? Because it not only will assure us of a competitive work force, but is essential to our continuing experiment with self-government. It is essential to our ability to maintain freedom in our society and our markets. If education is the catchword of democracy, we as corporate leaders can be significant in making quality educational opportunities more equally available to everyone, regardless of who, where, or what their condition in life may be. We can do this. Convergence has brought us this opportunity. We should not shrink from it.

We must act because education is the magic loom through which we weave feelings of dignity, self-worth, and empowerment. Through this magic loom we weave civilization itself. It is a civilization where competition for well-educated workers, however friendly, will continue. Whether we are American, East Asian, Brazilian, French, Russian, or Egyptian, the stakes are the same. As technology and education leaders, we must ensure that the design of our education future is of benefit to our entire global society.

The Evolving Information Network and Its Impact on Management for the 21st Century

Hisashi Kaneko

President

NEC Corporation

Introduction

Today, the world information technology industry is rapidly evolving, as technology innovation and emerging market needs are creating a dynamic process that pushes the industry forward. The driving force is, of course, the rapid advance in computer and communication technologies in the last few decades. We at NEC saw an integration of computer and communications technology as a critical trend that would shape the future of the IT industry. Our late chairman Dr. Kobayashi expressed this vision with the computers and communications (C&C) concept, which was first announced twenty-one years ago at Intelcom '77 in Atlanta.

The recent rapid growth of computer networks has been breathtaking. According to a recent report by the DOC, about 40 million people around the world were connected to the Internet in '96, but the number jumped to over 100 million in '97, and it is estimated that network traffic is doubling every 100 days. Another area of rapid growth is mobile communications. The number of mobile phone subscribers in Japan has reached 40 million, and on a worldwide basis, the total number of mobile subscribers reached 200 million at the end of '97, and it will likely shoot over one billion by the year 2010.

I would like to take this opportunity to discuss the rapid evolution of information networks and the key technology innovations for these networks and, then, explore how the emerging network will affect our global economy and society. The last portion discusses how I believe a globally distributed corporation should be managed in such a networked society.

Evolving Communication Networks

Now we are facing dynamic growth of digital traffic brought mainly by the explosive increase in the usage of the Internet. Such data traffic is growing day by day, almost to exceed traditional voice traffic, and thereby creating various new demands for communication networks. In turn,

such new market requirements are stimulating both a quantitative and qualitative evolution in communication networks. Today, for exploring a variety of advanced multimedia services, Internet users are demanding higher bit rates such as 10 14 bps for the access line, which is more than 100 times higher than the rate of the current telephone lines.

Over the last 100 years, the current telephone network has been laid out so as to optimize it for voice communications. The major features of the traditional telephone network are hierarchical, connection-based, and symmetrical. On the other hand, emerging Internet traffic requires the network to have somewhat different features such as non-hierarchical, connectionless, and asymmetrical. Therefore, there has arisen a paradigm shift in network structure, and current networks have started to evolve in a steady manner to enable them to manage a variety of multimedia information such as data, voice, and video in an efficient and cost-effective manner. Many technological innovations have contributed to promoting this paradigm shift, and I would like to review some of the key innovations in this area.

One of the key components that has made this paradigm shift a reality is asynchronous transfer mode (ATM) technology at network nodes. ATM can handle a variety of information with unified short packets and by routing them together on the same crosspoint. Therefore, ATM is suitable for handling multimedia signals, and it provides advantages in such areas as network efficiency, manageability of quality of service (QoS), and high-speed, high-capacity traffic routing. Owing to these features, ATM technology has been establishing a solid position in backbone network configurations. Already 4O Gbps ATM has been developed, and it may soon evolve up to a l60-Gbps system. One may expect even Terabit ATM with innovative photonic switching technology in the near future, and this will significantly contribute to the cost-effectiveness and flexibility of network infrastructure.

Another key area of innovation is in fiber-optic transmission. During the past two decades, optical fiber has almost replaced traditional copper cables, and transport networks

FIGURE 1

2.6 Terabits/s Dense-WDM Experiment
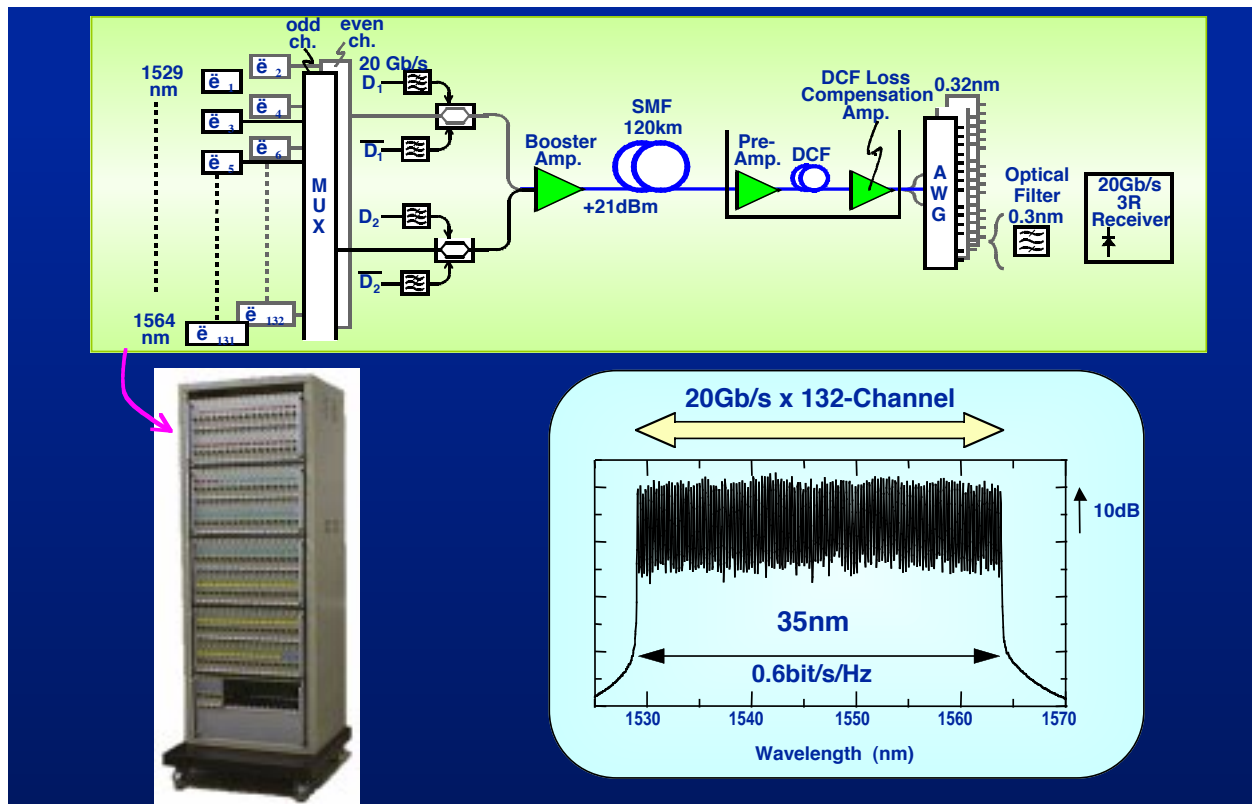
have been digitalized. It is known that the transmission capacity of a fiber link can be increased by adding another optical stream with a different wavelength on the same fiber, which is called wavelength division multiplexing (WDM). Recent technology breakthroughs, particularly in optical filtering and in laser devices, have made it possible to multiplex 100 or even greater number of optical streams in a single fiber. This means that the capacity of existing fiber cable can be tremendously increased without having additional cable installation. Already, dense WDM has started to be deployed in actual transport networks with great cost advantages. It has been experimentally shown that higher than Terabit-rate transmission on a single fiber can be feasible with 132 channel dense WDM of 20-Gbps streams (see *Figure 1*). Not only in regard to WDM, but there have also been breakthroughs in network configuration such as the 4-fiber ring architecture, which is characterized by a self-healing nature that contributes greatly to network reliability.

Access networks are also evolving to meet an increased demand for multimedia usage. The number of ISDN subscribers is increasing rapidly all over the world. The xDSL type of access links has started to be deployed to meet data and video demand. Next-generation mobile access, which allows multimedia applications, is just being discussed, with the aiming of being standardized for JMT-2000, hopefully along with wideband CDMA. Optical fiber access will provide much higher bit-rate capability, and people are expecting to realize even a Gigabit link to the subscribers

with the concept of fiber-to-the-home. An access network multiplexer like NEC VISTA (see *Figure 2*) will constitute an efficient distribution node in access networks interfacing voice, video, and Internet traffic with a 600l4 bit transport. Networking in the small office–home office (SOHO) environment will be another important topic. Plastic optical fiber bus with the IEEE 1394 protocol will carry data at a more than 10014 bps rate and is cost effective (see *Figure 3*).

With such technologies, the home network will be introduced in the home-office environment and will allow integration of communications, broadcasting, personal computing, and home management. Satellite-direct links to the home add another access option for the home network.

It should also be noted that the Internet protocol (IP) is becoming a de facto communication protocol, even outside the Internet world. New applications of IP-based technologies, such as IP telephony and IP routing, are drawing attention as attractive ways of realizing multimedia communications at a lower cost. Such innovations are creating the means for computer telephony integration (CTI). An example of CTI realization is our new PBX: NEAX2400IMX series, which handles both voice and IP-based traffic in a unified manner.

Obviously, there are many more innovations pertinent to network evolution such as those in personal computers, software, semiconductors, and others that certainly merit
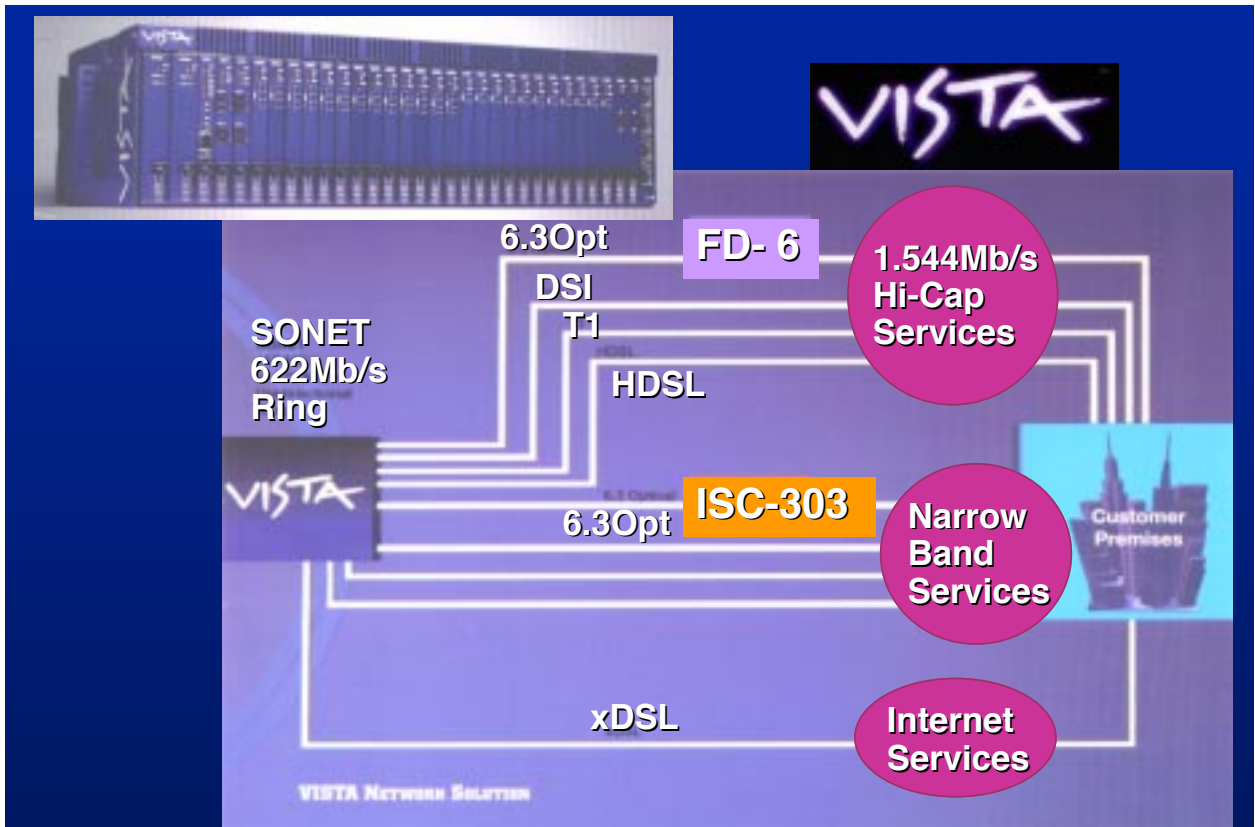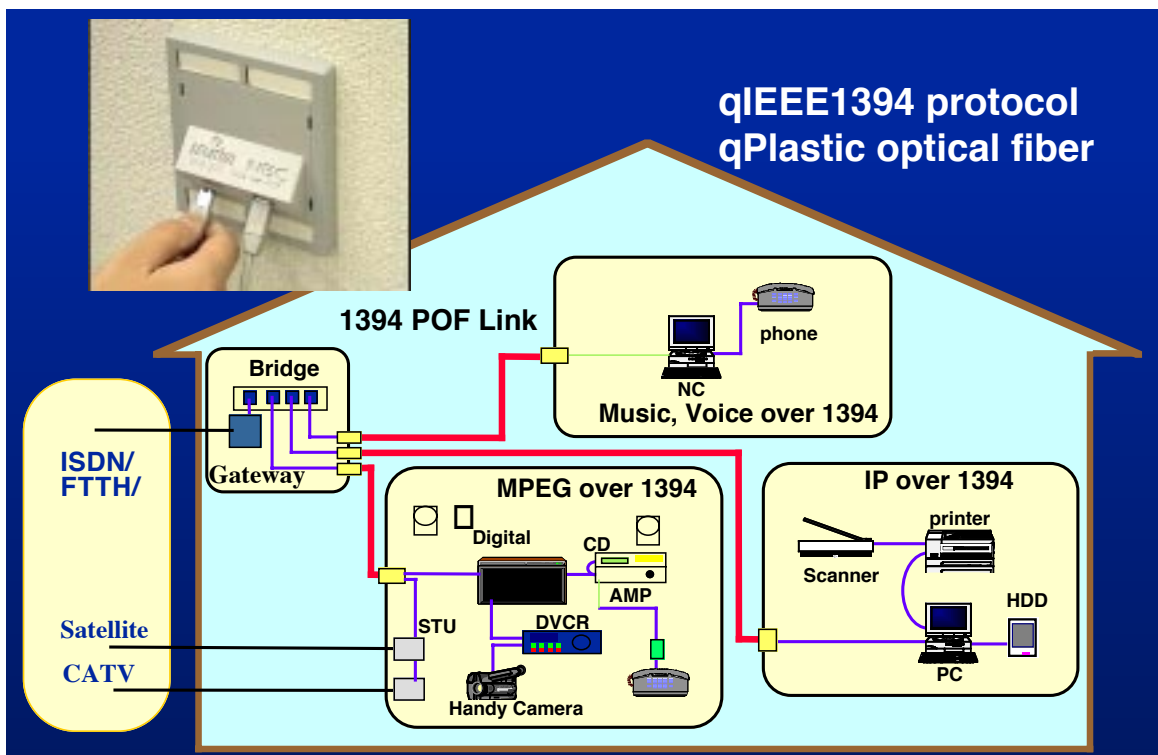
FIGURE 2

Intelligent Access Multiplexer

FIGURE 3

Digital Home Network System

exploration. So far, the network evolution and the evolution in usage are progressing side by side, mutually stimulating each other, thereby bringing about a multimedia network society in the 21st century.

Impact of Network Evolution on the Economy and Society

As networks evolve to provide greater convenience in our daily life, more and more people access and utilize such networks and exchange ideas. As a consequence, various changes occur in the way people think, act, and collaborate. I would like to briefly explore some ways that the emerging network will affect our economy and society.

In these days, PC-LAN networks have been widely introduced in the office and industry environment and are becoming indispensable infrastructures for business process reengineering. They improve not only communications among people through electronic mail, but also provide a great deal of assistance in such functions as planning, technology development, order receipt, production control, customer support, cash management, and so on. These networks have often been laid out initially as corporatewide Intranets, extended to other local and global affiliates, and then expanded to include intercompany extranets. Thereby, information needed for the corporate mission can circulate among headquarters, branch offices, affiliates, customers, and vendors, promoting efficient collaboration beyond organizational boundaries.

In such a widely networked environment, one of the greatest innovations will be the emerging new world of electronic commerce (EC), by which people can process monetary transactions electronically from network terminals. As the monetary transaction occupies a vital portion of our corporate and personal activities, the emergence of EC will have a great impact on us with much improved efficiency, convenience, and security. Electronic commerce will enable such functions as banking, business procurement and payment, and even international shopping, as long as one is connected through the network. One U.S. research firm estimates that the growth of the EC market will explode, going from $8 billion today to reach over $300 billion within the next five years, with Web-based transactions accounting for one percent of the world economy. Key issues for electronic commerce will be the security of the system for handling monetary issues, and the moves toward a possible worldwide, unified standard. Together with the recent development of IC cards, electronic commerce will promote the realization of a cashless society.

Multimedia networks have already been providing various utilities and benefits and creating a more convenient and affluent society. In addition to this, I would like to point out that the network society could help enhance human intelligence and creativity. As information networks bring an enormous amount of information to our fingertips, we encounter the limitations of human capacity for digesting information. Therefore, we have to select only what we need

out of a flood of information and store it in the right file so that we can retrieve it again at any time to reuse it.

I personally would benefit from having effective management software to assist my daily activities in selecting, personal filing, retrieving, and reuse of information. Of course, the purpose of a computer network is not just to collect knowledge, but to utilize that knowledge creatively in the business process. It is noted that the computer network is also a powerful tool for creative thinking, because computers provide the means to undertake trial-and-error on the display and then immediately consult with others through the network. This is nothing other than the process of creation. Therefore, the information network society will enhance human intelligence and creativity.

While the information network is prevailing not only in the office but also in mobile and home environments, we are realizing that most of our daily jobs need not be conducted at our offices, but at any place in the world where a network terminal can be available. This has been generating a new trend in work style. Salesmen visit customers carrying mobile terminals, and office workers do their jobs at home through the network. The traditional work style of commuting to the office is going to change, and a new work ethic will be created in the network society.

Management Innovation Toward the 21st Century

When the emerging information network is extended globally, it is essentially removing the barriers between places, organizations, cultures, and nations. It is creating a new environment in which mutual understanding is readily achievable.

In effect, the world we live in is becoming smaller and the virtual distance between nations is getting shorter. In turn, cultural differences seem to be more distinctive than ever. Through the global network, many more people are frequently faced directly with different languages and cultures. Therefore, global networking is accelerating the globalization trend. These days, industries are distributing their affiliates globally, and there arises a question: then, what should be the management philosophy in such a global and networked environment?

In this context, I would like to outline my company's globalization strategy, and how we attempt to manage our global operational network to leverage regional advantages into a total corporate competence. Today, NEC's global operation comprises forty-six manufacturing facilities in eighteen countries, with ninety-three subsidiaries and affiliates in thirty countries (see *Figure 4*). Our basic policy towards these operations is first to promote localization, leveraging each country's comparative advantages. This includes recognizing cultural differences, following the laws, customs, and practices of the host country; contributing to local employment; meeting customer needs; and bringing about technology innovation. Since we started establishing local affiliates in the late '50s, we have long been developing self-reliant and autonomous business operations in regions

FIGURE 4

NEC World Wide

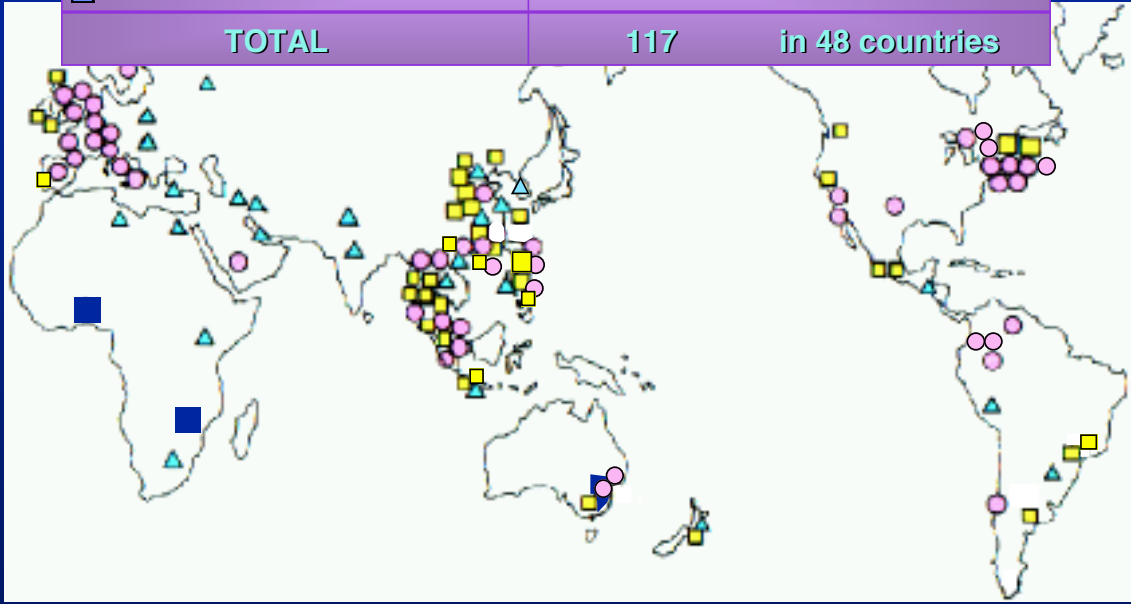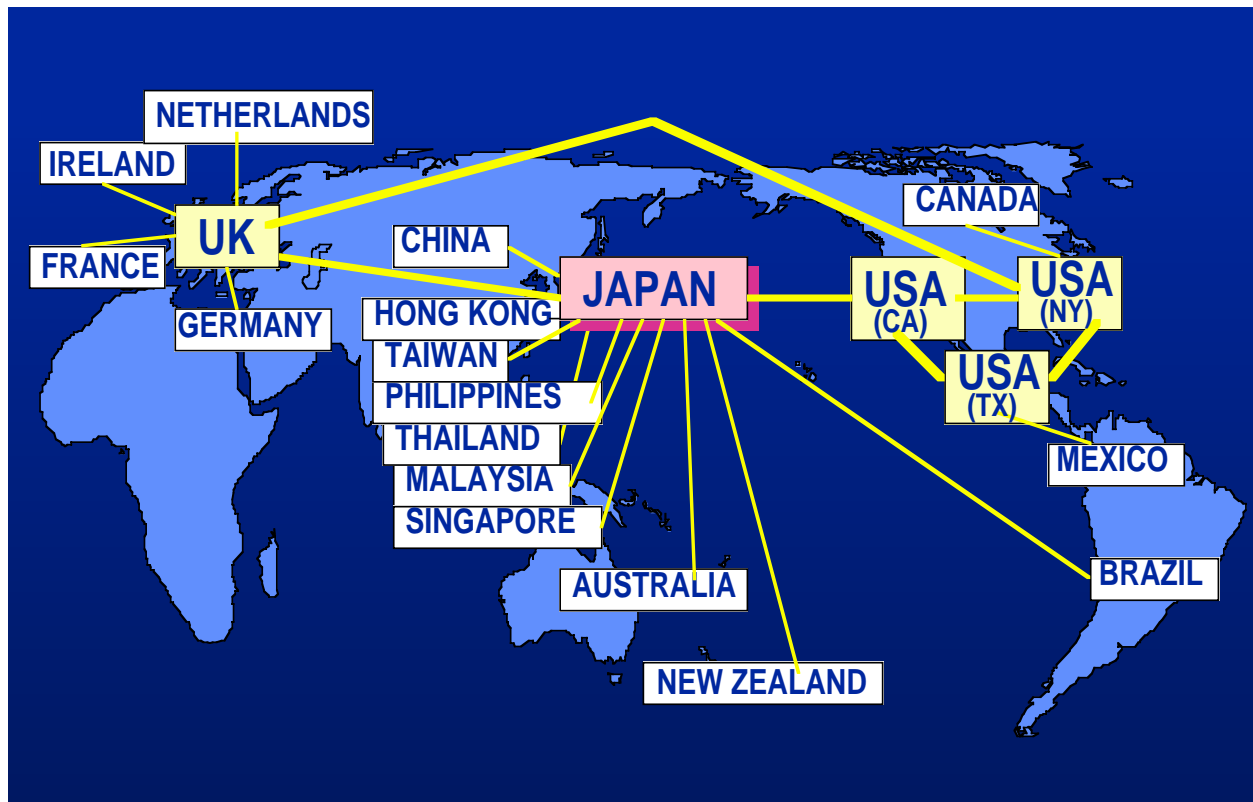|			
■ Manufacturing affiliate	43 (46 Plants)	in 23 countries
○ Marketing & Service affiliate	50	in 22 countries
△ Liaison Office	25	in 23 countries
TOTAL	117	in 48 countries

FIGURE 5

Mesh Globalization

FIGURE 6

NEC's Global Information Network

such as Asia, North and South America, and Europe, through continuous and patient effort. When localization takes root, we encourage our affiliates to form links among them so that overseas affiliates are globally networked to accelerate the mutual flow of materials, components, products, software, technology, and information. Such links are designed to form a structure that optimizes production, sales and development activities. At NEC, we call this mesh globalization (see *Figure 5*).

As we started to promote this mesh-globalization strategy in the '80s, our chairman Dr. Sekimoto came across the idea of holonic management. The word holonic consists of the Greek words *holos,* meaning "whole," and *on,* meaning "individual." It expresses the idea of achieving harmony between the whole and the individual through information sharing. We think that NEC can apply this concept as a guiding principle of management for our global operation network. In this case, holonic management would be to optimize the relationship between the whole of the global NEC group and the individual, meaning each of its operations. This implies that as overseas affiliates strive to generate competitiveness in their own right, they should always consider the broader corporate interests of the NEC group. In other words, while each entity must expand business in

its own sphere, it is critical to consider the possibilities of interregional and cross-divisional business operations with other members of the NEC group. Such efforts will help create more self-reliance and a holonicly linked equal partnership among NEC's global affiliates, creating both local and international competitiveness.

The key to this holonic management is the sharing of information among the affiliates, and, therefore, the global information network plays a very important role. In fact, we have deployed our global network infrastructure all over the world, as shown in *Figure 6.* Through this network, our affiliates are actively exchanging information to strengthen their operations and also to find the best possible strategies for NEC as a whole. I believe that such a holonic management approach is an effective methodology for a globally networked society and will be applicable to those industries having globally distributed entities.

The network society of the 21st century will create many opportunities and benefits for all of us. We at NEC are committed to contributing to the achievement of this objective through promoting further innovation in technology and management.

Cellular and PCS Competition

Ed Knapp
Senior Vice President and Chief Technology Officer
NextWave Telecom

To illustrate the current competitive situation in cellular and personal communications services (PCS), this talk will discuss a national wholesale business model and the advantages that it offers; supported by the two key drivers of the PCS competition: 1) the growing wireless market and 2) the impact of rapid technological change.

NextWave's PCS Model

The current telecom carrier's wireline and wireless business models are dominated by large incumbents with 100% owned networks and retail subscriber control underlying the provision of all products and services. When the NextWave founders decided to enter the wireless market two years ago, they had the opportunity to develop a new business model where retail marketing, which wireless carriers traditionally do not do well (i.e. churn, cost of acquisition) would be the domain of nationally branded companies seeking to bundle telecommunications services.

In this respect, the future of the telecommunications industry parallels what happened as competition in the computer business developed around the shift to the PC. In the early 1980s, a few players dominated the computing value chain. IBM is the classic example of success in the industry. The company supplied all components of computers and distributed them—it was responsible for the whole value chain of bringing computing products & services to market. However, the personal computer industry today is characterized by Intel, the key driver on the processor side, with IBM, Dell, Compaq providing system hardware, add to that the operating systems, dominated by Microsoft along with others providing applications. As a result of the value chain unbundling by IBM in the PC market, a whole new set of players have emerged.

Wireline access control is breaking down as new competition is introduced through wireless options. The value chain is being broken up into its relevant pieces, where value is realized as different players come in. NextWave realized this trend early and decided not to establish a brand, but instead to be part of someone else's services bundle. By focusing on providing a piece of the network, NextWave can deliver high quality. For example, if a carrier does not have wireless assets, but would like to sell within wireless markets, NextWave can deliver quality services that meet the carrier's requirements under the carrier's brand. The carrier also provides the retail marketing. This is a "carrier's-carrier strategy" because any carrier is a potential customer.

This wholesale carrier's carrier model has several advantages. First, it leverages the marketing and distribution assets of existing and emerging telecommunications service providers. It also leverages the telecommunications bundling trend and provides the sole noncompetitive remedy for players without wireless assets. The carrier's-carrier strategy avoids brand and distribution channel development costs/conflicts and supports a tight focus on the design, deployment, and management of low-cost, world-class wireless networks that support both voice and data applications. Finally, it is a proven strategy that has already been implemented by WorldCom and Intel.

Key Competitive Forces

The two forces that have driven the business for a long time have been growth and technology. Accelerated market growth due to PCS competition and service/product expansion is still phenomenal. Rapid technological changes provide opportunities for numerous new players. These changes include digital conversion, the convergence of computer and data communications with telepathy (VoIP, voice over the Internet), and information technology (IT) distributed computing platforms leading to advanced intelligent networks.

What is happening is an explosion of teletravel. This teletraffic currently is riding on a wireline network. Of 3.1 trillion annual minutes of use (MOUs) wireless accounts for less than 2 percent and digital wireless less than 1/2,500th of the total. The market is poised to support a wide-scale migration of wireline usage to wireless as prices fall due to competition.

Projected Growth of Wireless Usage

The key to such a migration is the penetration of wireless devices (see *Figure 1*). As price drops and service improves, people will no longer turn on their cellular phones only when they need them. Cellular calls will perform like a landline phone, battery life will improve, and the number of cellular minutes will increase. Cellular minutes are already displacing other minutes of use as wireless prices drop. The growth of the business is phenomenal just with telephonic uses, but new technologies, such as packet data and voice on a wireless infrastructure, will increase growth still more.

FIGURE 1

Projected Growth of Wireless Usage

FIGURE 3

Top 10 Digital Cellular Markets
% of Total Market Represented by Digital
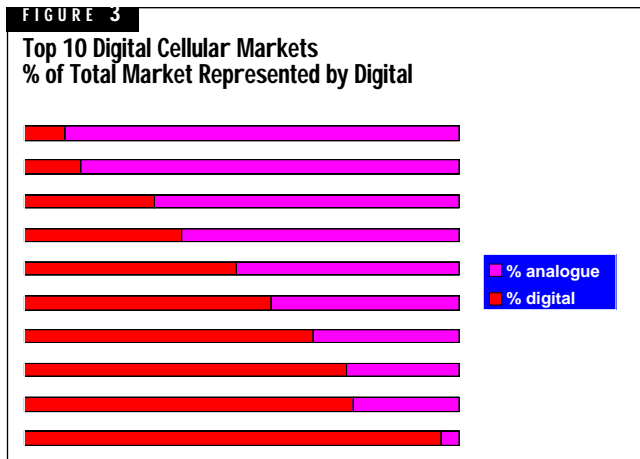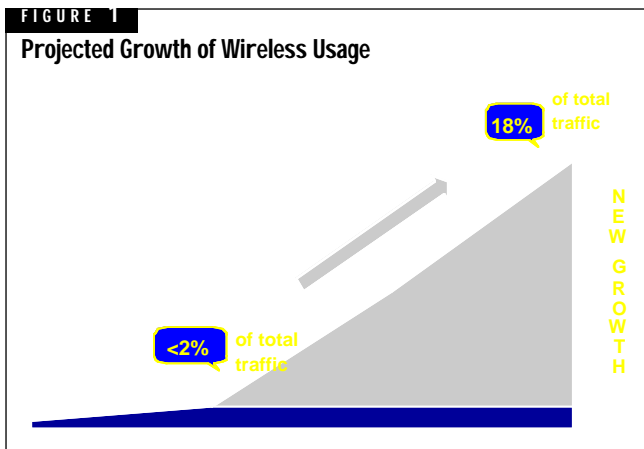
Benefits of Market Growth

In the early phase the marketplace had limited competition and offered relatively low-quality service. History has something to say about who wins and who loses in the new model of competition. *Figure 2* represents the incremental cumulative revenue gain in the long-distance business. Regardless of what the total dollar amount was in 1984, AT&T, as the incumbent, had only one place to go, and their growth was very small in terms of dollar value as prices fell and new players such as WorldCom took the lion's share of new-growth business.

Wireless Access Technologies

Digital technology has been slow to evolve in the United States. The first digital standard developed, TDMA, was not as advanced as it should have been, so new standards such as CDMA have been developed to accommo-

date PCS, data messaging systems, and other future wideband services. Digital is now being offered more aggressively in the United States, although there will always be some who will not find digital attractive from a price standpoint and who will continue to use their analog phones.

Figure 3 shows the top 10 digital cellular markets. The United States represents the smallest percentage of digital usage.

Wireless is not limited to providing mobility such as PCS, or cellular services—other portions of the telecommunications marketplace are being developed by other competitors. The real battlefield is local access, as wireless displaces wireline traffic and becomes more cost-effective. New deployment frequently focuses on countries that lack a wired telecommunications infrastructure. These locations, will be very important for wireless local loop.

FIGURE 2

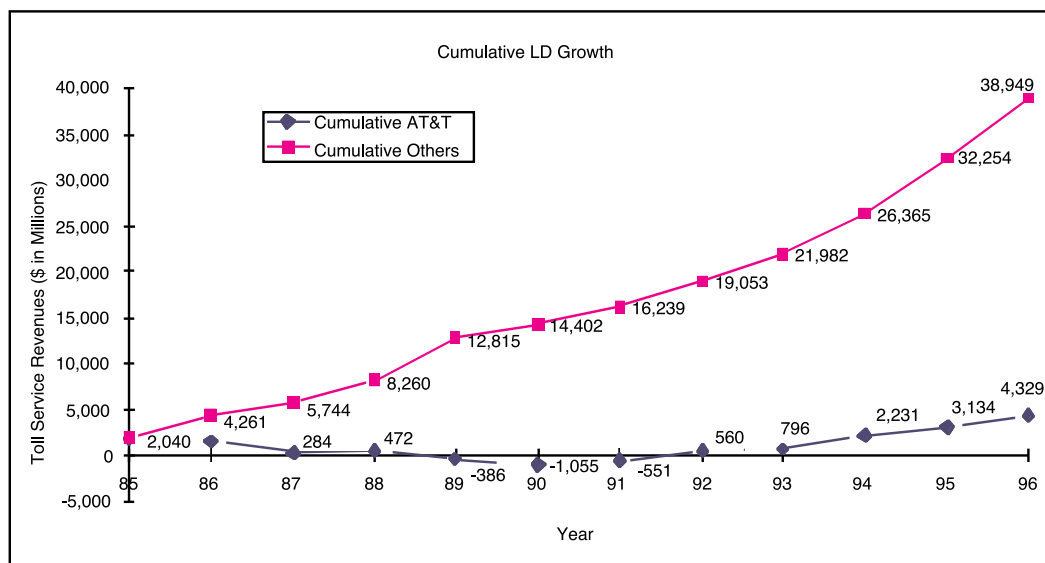**Benefits of Market Growth Accrue Disproportionately to Market Entrants**

Cumulative LD Growth

TABLE 1

Wireless Access Technologies

	High-Mobility Cellular/ PCS	Fixed Wireless Local Loop	Millimeter-Wave Microwave
Technologies	IS-95, IS-136, PCS1900	W-CDMA, AT&T WLL	24/38 GHz radio, LMDS
Operating Frequency	800 / 1900 Mhz	1900 MHz	24/29/38 GHz
Channel Bandwidth	<1.25 MHz	5-15 MHz	>50 MHz
Advantages	high-mobility, non-LOS	moderate data rate (>128 kbps), non-LOS	high data rate (>Mbps)
Disadvantages	low data rate (<14.4 kbps)	no mobility	no mobility, LOS
Major Vendors	Lucent, Motorola, Nortel, Ericsson, Qualcomm, etc.	InterDigital /Siemens /Samsung, AT&T	P-COM, Bosch, HP/STI, etc.

In general, three types of wireless access technology are available. 1) Narrowband systems such as traditional high-mobility technologies, including digital cellular and PCS, which are dominated by Code Division Multiple Access (CDMA), and Global System for Mobile Communications (GSM). They currently offer relatively low data rates. 2) Wideband systems such as fixed access or wireless local loop involve many different access schemes and currently offer limited mobility but higher data rates. 3) Broadband systems (i.e. LMDS) represent emerging technologies such as millimeter-wave microwave (see *Table 1*) that will provide only fixed access.

Table 2 illustrates the development of the various technologies in these three different areas. These current technologies are the starting point, but a worldwide technology battle is being waged over the future standards for 3rd Generation digital wideband mobility systems (ITU-2000). These CDMA based high-rate mobility systems, which are about three to

four years away, represent another generation of technology emerging in the wireless arena that could account for billions of dollars in business. At the same time, however, the fixed-loop piece of the market is growing as technology improves, and a whole host of broadband applications for video and direct Internet-access technology are emerging that will bring new competitors into the marketplace.

Competitive Factors

Finally, *Table 3* looks at key customer-concern areas for today's PCS and cellular competition. Cellular is the hands-down winner in coverage. But there are ways to counteract this advantage. For example, dual-band phones can be introduced to offer PCS in a local, metro-city core area and sell analog service outside that area, effectively providing a national footprint. Another issue with coverage is relative to quality in building. A dense core RF network is better able to displace or replace wireline than thin, wide-area coverage, which offers broad coverage for traveling. Iridium, Globalstar and other satellite-based mobile systems also will provide alternatives to quickly broaden coverage outside of core areas.

On a quality standpoint, digital networks perform better. Other technologies have more interference, which gives the operator different issues with which to deal.

PCS operators also have a much broader set of capabilities than traditional wireless operators do. Other technologies are catching up and will eventually converge to the point that no one will care about which technology is used, whether it is cellular or PCS. The determining factor will be the bundle of services offered and how effectively the carrier deals with its customers from the point on the value chain that it wishes to participate.

TABLE 2

Technology Evolution

	Full-Mobility IS-95A	Full-Mobility IS-95B	Full-Mobility 3G CDMA	Fixed InterDigital TrueLink	Fixed AT&T WLL	Fixed 38 GHz	Fixed 24 GHz DEMS	Fixed 28 GHz LMDS
Technology	IS-95A	IS-95B	3G CDMA	B-CDMA	FDMA / TDMA	p-p / p-mp μwave	p-mp μwave	p-mp μwave
Operating Frequency	800 / 1900 MHz	800 / 1900 MHz	800 / 1900 MHz	1900 MHz	1900 MHz	38 GHz	24 GHz	28 GHz
FCC Allocations	10-30 MHz	10-30 MHz	10-30 MHz	10-30 MHz	10-30 MHz	nx100 MHz	400 MHz	1150 / 150 MHz
Channel Bandwidth	1.25x2 MHz	1.25x2 MHz	5-15x2 MHz	7-15x2 MHz	5x2 MHz	5-50x2 MHz for p-p	not available	not available
Max User Data Rate	14.4 kbps	<60 kbps (practical)	>144 kbps (full mobility), >384 kbps (slow speed)	144 kbps	128 kbps	45 Mbps DS3	45 Mbps DS3	100 Mbps (ATM)
Advantages	full-mobility, non-LOS	full-mobility, non-LOS	full-mobility, non-LOS	144 kbps, non-LOS	128 kbps, non-LOS, IS-136 compatible	DS1 to DS3 data rate	DS1 to DS3 data rate	DS1 to 100 Mbps data rate
Disadvant.	low data rate	low data rate	mid data rate	no-mobility	no-mobility	no mobility, LOS	no mobility, LOS	no mobility, LOS

TABLE 3

Competitive Factors

	PCS	Cellular
➡ Coverage		✓
➡ Quality	✓	
➡ Service Features	✓	
➡ OSS	✓	
➡ Scale		✓
➡ Financial		✓

On the cost side, building a PCS system today is less expensive because equipment for base stations has become smaller and less costly than it was 5–10 years ago. So PCS has an advantage in network cost. We are seeing 30–50 percent declines in equipment costs over the past 24 months.

Operations support systems (OSS) are fundamental to success. The newer PCS systems provide highly integrated network management products and systems, which allow OSS to function better than in older cellular systems where functional departments, such as billing, customer care, finance, etc. utilize stand-alone legacy systems.

The issue of scale, on the other hand, goes to the incumbent cellular providers who have large-scale operations and many resources. They will continue to have the advantage in this area until other players build the scale of business required to meet the fixed and variable costs of the business. With more scale, fixed costs can be averaged over the subscriber base. Cellular providers can do that now, so the financial muscle is with the incumbent.

Summary

Structural changes in the telecommunications industry open up an opportunity for a national wholesale strategy. Clearly, the growing wireless market provides new PCS entrants ample opportunity to compete, and how quickly a competitor responds to those opportunities will determine who wins and who loses. Rapid technology change is fundamental to opportunities in the field because what technology wireless carriers deployed two–three years ago is now obsolete, and what they will deploy three years from now will render today's systems obsolete. This rapid-technology cycle drives value, lowering deployment costs, enhancing products and services, and giving competitors new opportunities for success.

Mobile Internet: Mission Critical Information in Real Time

Joe Korb
Executive Vice President
GoAmerica Communications Corporation

In the real world, where the customers for wireless services are, it is not the technology but solutions for specific business needs that sell. People in the field need to have access to intranet content for their in-house workforce. Providers that sell value-added services must be ready to fill this need to remain competitive.

Where Is the Data?

To send information to a workforce in the field, the provider first must know where the data is located. By 1995, the key trend had already emerged: 50 percent of Fortune 1000 companies had Internet and intranet access. Within one year, that figure went up to 82 percent. Today, 96 percent of companies indicate that they have or will implement an intranet. Terms such as e-commerce have become common. Meanwhile, manufacturers are dealing with technology issues, such as authentication. Everyone is moving toward business connectivity.

This is not a top-down revolution. It is neither the chief executive officer nor the information technology manager behind the move toward connectivity—business managers are demanding access. Those needing data are demanding access in order to gain a competitive advantage in the marketplace. This movement is not unlike the way the Internet itself has grown. It was not the AT&Ts of the world that made the Internet happen, it was the smaller companies. After they created the market, big companies such as GTE and Worldcom recognized the value of their work and acquired the market makers. Similarly, mobile access to corporate data is being driven not by the big names in the industry, but by smaller companies that provide innovative solutions.

Where Are the Workers?

One-third of the U.S. workforce—44 million workers—is mobile today. Statistics indicate that by 2001 half the workforce is expected to be mobile. These trends are inexorable—looking at the 58 million people carrying around cell phones tells you why.

What Is the Problem?

After locating the data and the workers, the problem is clear. Businesses have data in the office and workers in the field who are unable to access it. This need is driving the adoption mobile services.

The technology businesses use to provide mobile data is immaterial, because businesses will use whatever is necessary to connect—from analog modems, to digital packet networks, to proprietary architectures. If people need access to data, they will obtain it at almost any cost.

Market Requirements

Businesses look for several requirements in choosing mobile data services. The decision to provide wireless data services is solution driven, as already mentioned, not technology driven.

Businesses want network independence. Indeed, network independence can differentiate one personal communications service (PCS) company from another, in markets where many companies are selling the same service or technology.

Businesses are also looking for open protocols. Why are companies such as Microsoft and IBM turning away from proprietary infrastructures to Web-based ones? Open protocols are the common denominator across hardware platforms. A personal digital assistant, a smart phone, a laptop, and a palmtop all have browsers. The browser is the common denominator among them, and a window into the data that people are accessing.

Another requirement driving the market is the need for device independence. No one device can meet all the needs that a pager, cell phone, laptop, and organizer can meet separately. With a smart phone, the mobile worker can read e-mail, but not compose it. A digital phone provides voice mail notification, but battery life is an issue, which is not the case with a pager. People want to choose devices that are appropriate for them, and device independence fits that requirement, especially as devices become more robust and fit niche needs.

People intuitively understand efficient use of bandwidth. The wireless spectrum is not free; indeed, companies have paid hundreds of millions of dollars, sometimes billions of dollars, for licenses to it. The wireless spectrum, then, is a limited resource, and the more the licensee can glean from the resource, the better off carriers will be because they will not have to raise rates. From the end-user perspective, efficient use of bandwidth means faster service and lower costs because less data is being transmitted.

Finally, individuals have a limited willingness to pay for data services, and its cost must fall somewhere between what a one-way service, paging, costs, and the cost of two-way voice cellular service. That magic middle is probably somewhere in the $25 to $40 per month range. Data services cannot cost more because people will not adopt them—this is a marketplace reality. On the other hand, the provider cannot offer a flat rate of $50 for unlimited service, because capacity issues will develop. When the carrier cannot support demand, the price to the user will have to rise. Carriers, then, cannot overload their networks without affecting the quality of service.

The Intranet Advantage

Intranets provide the access that the mobile workforce needs. All companies developing intranets will be providing Web type access to everything in the enterprise. Intranets, by definition, offer easy access to corporate data.

On the client side, intranets offer a standard interface through a front-end browser—little or no training is required. Everyone knows how to use a browser. People use it at home, they use it at the desktop, and they can use it in the field.

Moreover, an intranet is easy to maintain through server-based access. Changing or creating a form can be done dynamically at the server. IP is the common protocol across all enterprises, and mobile access using IP should be no different.

Intranet users must have security at the server. Corporations will not connect to the Internet if they feel their data will not be secure, but they can control access at the server and authenticate mobile workers that use the intranet. This approach is similar to the way that cellular carriers deal with fraud protection through instrument identification.

What Companies Are Putting on Their Intranets

Although almost every Fortune 1000 company is utilizing an intranet, many companies are using them only for soft-information uses such as making available application forms, case histories, press releases, organization charts, and white papers. This information will not drive mobile access, because people do not need to view this type of information in real time. In addition, the content often stays up for weeks or months at a time and is considered static.

Some companies, on the other hand, are putting mission-critical data on their intranets, and this is the step that will drive the wireless data industry. Mission-critical data includes product and inventory information so that a salesperson in the field can close a deal by confirming delivery on the spot. Critical data includes: current pricing sheets, account status information, and sales support. This type of information allows a salesperson to deal effectively with customer problems in real time. But mission-critical information does not move in one direction only—it is bidirectional. The salesperson enters account status information, and executives back at corporate headquarters immediately have the information they need to run the business more effectively.

Wireless Intranet Access in Key Industries

One success story in wireless access is in transportation. In very competitive markets, such as the courier market and less-than-full-load trucking, route management is absolutely critical. Access to information can make the difference between profit and loss. If a package delivery is canceled and the driver has gone a half an hour out of the way for nothing, time, energy, and money have been lost.

In field sales, the ability to consummate a deal quickly is the key to profitability. Competitive information, such as up-to-date account information, can allow deals to be closed quickly.

Field service is the most successful category for wireless data. People in the field must be dispatched efficiently and must have access to inventory to work effectively. Businesses in this area are motivated to use wireless services because their competitive edge comes from having accurate, timely information in the field.

Case Study—Honeywell

A case study of a customer using wireless intranet today illustrates its benefits. Honeywell Industrial Automation Control Division, a nationwide field service company, services 15,000 types of equipment using technical documentation and diagnostics. The company's 750 technicians use ruggedized laptops—a significant capital investment—with the goal of reducing cycle time. This boosts productivity—if the technician in the field can meet one customer's needs quickly and go on to the next one, productivity increases.

Honeywell Implementation
Honeywell is performing mission-critical functions on its intranet. All the company's case-based tools, along with a search engine and dispatch, are in a Scopus Technology service-management system with a Web interface. Technicians use Itronix X-C 6250 ruggedized laptops with built-in radios that maximize coverage. Honeywell uses the GoAmerica service, which is valuable to their effort, because after investing in the hardware, no additional up-front investment in server hardware was required. GoAmerica resolves firewall issues by managing the Honeywell mobile workers for the company.

The goal of Honeywell's implementation was to cut service time by 20 percent, boost revenues by 5 percent, and increase customer satisfaction. Any company that is interested in implementing a wireless data solution will have similar goals—productivity, profitability, and customer satisfaction.

Summary

Intranet and mobility trends will accelerate. Manufacturers are now providing devices that fit multiple market segments, and this option will drive the market. No one network will ever provide for all corporate needs. The good news is that wireless data will become faster and less expensive over time. Companies can enter the market now and reap the benefits, while positioning themselves to have a competitive advantage in the future.

Media, Psychology, and the Socio-psychomedia Effect

Bernard J. Luskin

Chief Executive Officer and President

Luskin International; Center for the Study of Media Psychology

Early History

The relationship that has been developing between various behavioral fields and mass media is a phenomenon of the twentieth century. Books, still pictures, telephones, newspapers, radio, television, computers, satellites, dishes, cable, video, motion pictures, and compact discs present a diverse array of media carrying information that is bombarding our senses with sound, pictures, graphics, and text. As Marshall McLuhan said, although he has been often misquoted, "the medium is the massage." McLuhan differentiated the message and the massage, noting also that, "the message is the message." What he meant is that we must differentiate between the content and its manipulation, distribution, and access. The subject/content of programming and services must be considered separately from its telecommunication. This will allow for a clearer perception of issues and a real understanding of how to use media. Messages come to the recipients after being massaged, molded, twisted, softened, and/or strengthened by particular media. Print puts its particular twist on a message; TV puts on a different twist, and so on. Each medium takes the same message, "massages it," and provides user access to the message in a unique form. The term access is used here because distribution comes from a sender's perception; access, from the user's. Choice, options, and access represent the user's view.

New forms of "massaging" resulting from the burgeoning wired and wireless advances in telecommunications have resulted in the creation of digital pagers, cellular telephones, digital assistants, the Internet, etc., all of which provide both choices and access to information, concepts, ideas, and emotional experiences which are changing relationships among people worldwide.

Examples of affected areas include engineering, education, health, environment, travel, language, communication, entertainment, and more. The media alters the very look and feel of lifestyles in all cultures and is having both positive and negative effects. For example, violence, drug use, and other anti-social behaviors presented by the media have allegedly instigated such behaviors in the real world. On the other hand, media, especially the new media, are being touted as vehicles for learning and ever more miraculous means of universal communication.

In health, "the divisible human" type of project, where cadavers have been digitized, enables simulated surgeries, new strategies for learning diagnostics and other breakthroughs. Two-way picture communication is changing the way health teams may relate with patients; computer assisted therapy is advancing in implementing mediated psychotherapy—and these examples represent only a small part of innovative developments.

In the broader context, the media are literally now at the "center of our attention." Advertisers pay for attention, consumers pay with attention. This interplay provides a measuring formula for our social and individual behaviors. The intensity of this commercial drama surrounding attention has been increasing apace, decade by decade throughout the twentieth century. In media, attention is the medium of exchange.

All of this is happening simultaneously and in convergence with advances in many fields, examples of which include neuroscience, psyto- and psychobiology, personality theory, pharmacology, and education psychology.

Further Defining the Concept of Media Psychology

Media psychology has been rapidly evolving since World War II. For the first time in history, advances in radio, growth of motion pictures, and progress in telephony fueled much of our perception of a worldwide war. It was World War II that stimulated the global effects of the technology of mass media.

Today, the effects of mass media communications are everywhere, and growing understanding of the effects of mass media are recorded among the many new advances acknowledged in psychology and neuroscience. Coined in the 1960's, by the late 1980's, the term "multimedia" had simply become part of our everyday language.

With the perspective of the dramatic growth of media, we are only now beginning to understand the real impact of mass media on our lives. New insights are emerging from new interdisciplinary research. We are understanding more and more about the relationship between media and behavior.

Developing and applying new theories is currently helping us understand the complexities of why some people learn

and others don't, and how individuals may be stimulated or persuaded, influenced, or taught. There is growing interest in using media effectively to help people correct deficiencies, achieve personal growth or simply feel better or more satisfied by their accomplishments. It is in the context of this rationale that the importance of understanding the nexus of media and behavior is an emerging new field in psychology, medicine, learning, politics, and commerce. Media psychology is a new knowledge area coming into being by extracting elements from fields such as systems theory, personality theory, cognitive psychology, human development, neuroscience, and so on. This kind of amalgamation is typical of the way in which new fields are born.

Positive and negative addictions and habituations of all types, changes in global communications and understanding, and new types of programs and services manifest themselves through sensory media experiences. The underlying principles related to these phenomena are fundamental to the creation of better programming and services in all facets of our lives. With our present digital technology, we have "the how." Now, we must begin to better understand "the why."

Media Psychology Today

Broadly defined, media psychology encompasses theories and practices regarding the effects and behaviors stimulated by media elements, i.e., pictures, sound, graphics, and content, on the senses and intelligence. More specific definitions may be refined when one examines the psychology of constructing or accessing programs or services on an individual or societal level, using attention, behavior, physical, intellectual, and cultural changes as measures. More and more research is now being stimulated by business, government, social, educational, health, and political interests. Understanding theories and principles of media psychology is becoming recognized equally as important as the technological innovations themselves.

The Importance of Understanding the Theories

To write great music, an understanding of music theory is required. To perform complex musical scores properly, a grasp of music theory is imperative. The same is true in creating media-based programs. To create good programs or to develop valuable services, an understanding of the theory of media psychology is required. There is a dialectic and a doctrine to help us apply what we know. There is a wellspring of principles being brought together through extracting relevant principals from educational psychology, learning theory, cognitive psychology, personality theory, human development, neuroscience, and systems theory. Aspects of each of these individual fields must be welded together in defining this new field.

There is media psychology activity all over the world; in Japan and China, Germany, the UK, France, and the United States. Only through bringing forth a broader theory of media psychology will there be an improvement in the programming and services we all desire. Just as it is important to understand the theoretical principles

in physics, mathematics, languages, and music, just to list several analogies, it is equally important to understand the theory of media psychology. Frankly, our futures depend on it.

Current Research

The American Psychological Association has established a Media Psychology Division (Division #46). This division is currently completing a yearlong study, codirected by the author and Dr. Lilli Friedland, which identifies, examines, and sharpens the focus on the emerging fields. The researchers have identified eleven areas of work requiring a substantial understanding of psychology. They include the following:

1. professional psychologists working in broadcast, cable, print, or various wired or wireless electronic media as program hosts, regular expert guests, writers of books, articles, screenplays, or shows

2. professional psychologists consulting directly with media personnel in any of the following areas:

   • program content

   • strategies for enabling creativity and/or motivation such as in relieving performance stage-fright or removing writer's block

   • general stress management

   • "on-the-air" crisis intervention

3. psychologists and other professionals involved in identifying, examining, developing, applying, and improving the media by:

   • conducting research on artificial intelligence and other branches of cognitive science

   • studying specific intelligence and/or multi-sensory stimulation

   • studying improved techniques in communication

   • researching improved learning performance in both real and virtual environments

4. specialists, including psychologists, working on and with the development, programming, and servicing for the new technologies to make them more effective and more friendly. This includes individuals interested in human factors involving improvement of the following:

   • man-machine interface design and navigation

   • ergonomic enhancement of appliances (hardware)

   • programs to facilitate learning, including personal development

- techniques to motivate the user

- methods of bringing more enjoyment to the user through enhanced self-actualization or entertainment

5. psychologists who study the use of new technologies to enhance the practice of clinical psychology. This work includes, but is not limited to, diagnostics, assessment, treatment, peer review, and supervision in a variety of clinical settings.

6. psychologists and other professionals working with:

- learning, information and education resources in classrooms

- corporate training

- applied areas such as industrial-organizational psychology including: testing, situational learning, training, performance monitoring, consumer feedback, focus group testing, evaluation, motivation, and learning

- integration of theories of involvement and participation

7. individuals responsible for developing media principles, standards, and guidelines based upon psychological research and individuals in various fields who research the effects of different types of program content on viewers or consumers. Examples include researching the effects of:

- violence, sex, and caring behaviors

- characters of different genders, ages, disabilities, and ethnic affiliations

- changing demographic characteristics

8. social psychologists and other professionals who work in commercial fields in the development of various strategies, such as product or company positioning and marketing. Examples include such tasks as:

- evaluating brand-name recognition

- product positioning

- consumer preference, and advertising strategies, involving various techniques such as subliminal influence, manipulation, creativity, sensitization, persuasion, and attention

9. professionals working on the study of sociological and psychological media effects such as:

- intra- and intercultural dissonance

- political strategies

- globalization

- mass communication strategies

- multiple social issues

- emerging global economies

- habitation in a shrinking world

10. psychologists and other professionals using the media in developing concepts and products for education, transportation, living environment, and careers for challenged populations. Examples of such populations include traumatically hand-injured, blind, deaf, physically impaired, and so on.

11. psychologists using the media when working with deviant or criminal populations, examples of which include:

- hostage management and negotiation

- detecting terrorism

- understanding pathological behaviors

- developing safety and security procedures

- conducting forensic evaluation of significant incidents

Media psychology clearly offers an important new area for international collaboration and research.

As with a puzzle, pieces of the media were once scattered. They are all here now. All we need to do is work together to join them into an effective interrelationship and organize the puzzle so we can see a complete picture.

As technology has allowed us to regularly use lasers in surgery, so may media be used more effectively to expand its role into many fields including engineering, education, and training, which itself will cause a multiplier effect. The study of Media Psychology offers us many new frontiers to explore. We can best map out new territory using the technologies at hand to cooperate, collaborate and share our discoveries. So, as we have "used a light beam in surgery and put man into space, we must now integrate behavior and media" to advance society, government, entertainment, politics, and education on a worldwide scale. In a sense, the nexus of media, the individual and culture may be thought of as the socio-psychomedia effect.

Innovation: The Bridge to the Future

John McLennan
President and Chief Executive Officer
Bell Canada

Introduction

Information industry professionals have been the driving force in launching the latest revolution to change the world economy—the information revolution. Through this work at the frontiers of technology, the way people live, work, and exchange information has changed by an order of magnitude that could scarcely be imagined just a few decades ago. That is a remarkable accomplishment, one in which I think we all take great pride. I welcome this opportunity to exchange ideas and perspectives about our industry's role in creating an even better future.

From my perspective, one of the most innovative and crucial moments of this revolution is the Canadian government's recent decision to place information technology and research and development (R&D) at the head of the government's jobs and growth strategy.

This is reflected in the two clear goals it has set out for telecommunications:

One, that Canadians must receive world-class telecommunications services at competitive prices from a strong domestic industry. And two, that Canada strengthens its position in the development and provision of such services globally.

This is an approach we endorse and encourage. The role of the Department of Industry is to form a vital connection between government, business, and the public at large. My world is focused on reaching out to customers with the strongest value proposition in order to enable them to realize their dreams through technology.

But, the world of the industry professional is the most challenging of all: building the vital bridges between customer hopes and desires, and what is technically possible. This can be achieved through basic and applied research and development, meticulous attention to detail, and a persevering spirit that has produced literally thousands of significant breakthroughs in the past decades.

So all of us are united by the fact that we are all bridge-builders, of sorts: governments to people; customers to value; and dreams to reality. We all share the goal of being the best in what we do. Governments are locked in the battle for national prosperity with other countries. I am engaged in a challenging quest to win the hearts of customers by maximizing the amount of value that Bell Canada creates for them. In the future, we will have to do that in ways that represent a dramatic break from the past.

You, as leaders in the technology community, are striving to be first, with breakthroughs, with new ways to tackle persistent problems, and create higher and higher levels of efficiency and power.

But, what unites us? Just this: all of us have to stand up and place our bets on the shape and direction of the future. That is the only way forward. My message is the basis for success in the future will be determined by an even greater focus on and commitment to innovation and investment in risk for all of us: government, business, and the technology community. Innovation is going to be an even more important source of competitive advantage in the future. The question before all of us is, how do we organize ourselves best to achieve it?

Canadian Environment

Before I expand on this premise, let me establish a shared understanding of the business and competitive environment that has given rise to my point of view.

Canada is the most wired nation in the world. Canada also has the lowest Internet access fees in the world. Back this up with a telecommunications infrastructure that is the envy of the world, and you will understand why I am so bullish on this country as an incubator for the global digital economy.

Let me put this infrastructure in context. Today, Bell's network is 100 percent digitized. We run more than 32,000 miles of fiber-optic cable, we offer ISDN to the home and the office, and we are deploying ADSL at speeds up to 2.2 Mbps. We expect that early in the next century, ADSL will evolve to offer bandwidth at 26 to 52 Mbps. That is an important part of the future for which we are preparing.

But there is more to winning the future than technology alone. For instance, recently I heard Bill Gates say that very low-cost, high-speed access connected to equally low-cost information appliances will be available to all of us. I agree with Mr. Gates; that is a vision of the future for which we should all be striving. We may not agree on how quickly we can get there, but we certainly believe in the logic of the market and the nature of the change.

At Bell Canada, we are totally focused on a future in a fully competitive environment. We have had full competition in long-distance service for several years, with many of the world's supercarrier giants active in the Canadian market. Now we have competition in local service, with no telling who will become involved.

That means no company—telco, cable company, wireless provider, or anyone—can hope to become large, serve customers, reward shareholders, and employ people merely by relying on the existence of regulation-based market structures as the basis for their competitive advantage. The bridges leading to Canadian information industry customers are built, competitors are making full use of them as they should, and power and choice have shifted to customers, as they also should.

New Geography of Prosperity

This new environment, made possible by technological bridges of all kinds, is not without its challenges. Take the search for competitive advantage, a search that is of vital interest to governments and companies alike. In the old days—not so long ago, in fact—competitive advantage used to arise from proximity to "good" markets—markets with demanding customers, advanced supporting industries, good skills, and low transport costs relative to shipping weight. For many companies, the existence of tariffs made competing easier.

Now, largely as a result of three fundamental shifts, things have changed. First, the rise of the information economy made distance largely irrelevant. There go the advantages of low transport costs.

Second, the Internet and the consequences of several years of intense competition in telecommunications have eliminated proximity to markets as an advantage. As you well know, on the Internet, everyone is equal—with equal access, and most importantly, equal ability to compete. It does not matter where your server is located, because your customer does not need to know and, frankly, does not care. Your store is on their desktops. Anywhere is close to the customer.

Third, with the advent of globalization through the formation of the WTO, the FTA, and NAFTA, the creation of the European Economic Community, and through deregulation of telecommunications and airline travel almost everywhere, companies are free to set up and do business wherever it makes sense for their customers. No more relying on tariff walls—the future is clearly one of generating competitive advantage through hard work, keen insight, and innovation. Success is not going to be defined by a fortuitous geographic position, protective tariff walls, restrictive market rules, or anything else that stops the value-creating or technology-advancing bridges from being built from companies to customers.

What is left? Strategy. Competitive advantage will be decided by the choices that countries, companies, and indi-

viduals make in the years ahead. For those of us in the technology industries, where freight costs are declining rapidly and where we are exposed to the full force of supercarrier competition, what is the right way forward? How do we build bridges to a rewarding future? What choices will work in markets with no barriers and a dwindling number of sustainable operating assumptions?

The Future Is about Building Bridges through Innovation

I think the choices should be guided by a simple objective: to connect both the present to the future, and customers to their dreams by a bridge of innovation that is continually renewed through technological advancement, made possible by the imagination and determination of the people of this industry.

Innovation is the bridge to the future. It is the best way, in my view, to unite the objectives of industry and the vital technology community in a way that serves fully the needs of society. Innovation-rich countries are leaders in applied and basic R&D, and just as importantly, they are the most desirable places for the architects of the future to live and work. They are export-oriented and help set the pace of change around the globe.

My belief is that Canada is well situated to grow as an innovation-rich country. We can expand to become a place where the most pressing question is not "how much?" but "what if?" We can become a place where the best and brightest people in the world's information industry choose to pursue their craft and build their lives—because we already have a world-leading nucleus of such skills in this country right now. We can become a pivotal player in the most important industry of the future.

We can, that is, if we focus. We can, if we set about to build the most desirable environment to spur innovation, supplemented with a management style that recognizes that good ideas come from many places. We can, if we recognize that the key measure of an innovative company is idea flow—somewhat like cash flow is today.

Idea flow is going to be hard to measure in practice, but I think everyone will recognize whether they are or are not working for companies with strong idea flow. Their peers will recognize such companies as innovators. They will have a high rate of hits to misses, enjoy the loyalty of customers as measured by their willingness to refer friends to use the company's services, and reap the rewards of employee initiative and loyalty.

They will be characterized by formal and informal processes of innovative development, both internally and across company boundaries. They will be companies with whom others seek to partner with, to create alliances with, to learn from and contribute, regardless of differentials in relative size or nationality. They will succeed internationally because they understand that collaboration means partnership, not domination. They will bring the benefits of their

work back to their home country thereby adding further to its competitive advantage among nations.

Quite simply, these companies will be the preeminent bridge builders in their field, and everyone will know it—and they will not have to be the biggest. Being small and nimble is going to be a big advantage in global markets where the winds of change blow with increasing vigor. This is why I feel so confident about Canada's future and our opportunities in world markets. In particular, I believe that Bell Canada is going to play a vital role in making this kind of future happen.

Bell Canada's strategy, going forward, is to create and support a sustained flow of innovation within the company and with our technology partners. Our goal is to help Canada reach the digital economy first, closing the innovation gap that the OECD has said threatens Canada's future, and do so in a way that uses superior knowledge, not size, as a means of encouraging cooperation with our partners. Bell and our partners in the Stentor alliance across Canada have focused our efforts around three strategic initiatives.

One, we must complete the world's first National Area Network—a coast-to-coast, high-bandwidth, all digital, wireline and wireless infrastructure offering access to the world of information to all Canadians. The foundation for this network is already in place. This will have the consequence of enabling everyone in this country, regardless of where they choose to live, to compete for prosperity from the same starting line.

Two, our strategy involves making Canada a living laboratory—a world-leading incubator of communications solutions, focused on creating a robust digital economy, sustained by intense and vigorous innovation. This means reconceptualizing our network as more than a pipeline for moving bits of information.

In the future, our network will seem more like a computer operating system: open to all applications creators, dependent entirely on customer endorsement. This network will be the foundation for an enabled environment right here in Canada to create, attract, and keep the next-generation companies that seek to serve world markets.

The third strategy calls for creating new applications, solutions, and services for the domestic arid global markets. The goal here is to enable others. Small and medium-sized businesses should be able to boost productivity and return on investment through the use of our solutions. Larger companies already have added to their repertoire of solutions and see improvements in operating costs as a result. Governments benefit from an enhanced ability to deliver services, strengthen education, and improve the cost efficiency of healthcare in new and innovative ways.

To my company, winning the battle for the future is more than just getting the costs right, which is a never-ending part of this new journey. It means creating a perpetual cycle of innovation, which will directly improve efficiency and productivity, as well as shorten the product development cycle.

To that end, and consonant with our commitment to use innovation as a core strategy for our future and as I announced recently, we will soon be launching a new software-based service development organization, which will be one of the largest R&D shops in Canada. Details will be forthcoming in the coming weeks, but I can say with confidence that this is a serious commitment—that Bell is backing with a considerable investment. Because, after all, while it costs a lot of money to build a bridge, the benefits over the decades—both direct and indirect—are literally incalculable.

Why now?

You may well wonder why now, and why in Canada?

To the former question I say simply that the customer is demanding more and there is no better time to meet their needs than right now. Power and complexity often increase hand in hand, and the strong signals emitting from the marketplace say that in the future the acceptability of innovation will be conditioned strongly by its ease of use.

Putting this another way, Bell's goal is to innovate in such a way that is powerful and easy. No trade-offs. No compromises. That is what customers want. And it is what I believe will prove successful in export markets, it is what common sense says encourages high rates of adoption and use.

This approach is consistent with other innovations that we are taking, for instance, on local service within a competitive marketplace. Bell's approach will be built around providing the customer with a better value proposition: local calling areas that meet customer needs, local access to the Internet, digital switching, and universal 9-1-1 service available to all municipalities.

It is consistent with a view that says access to and proficiency with new technology will be an important social as well as economic issue for the future. We cannot allow the fragmentation of any society into technological haves and have-nots.

Our view is that the private sector, specifically the innovative sector, is the only force capable of delivering advanced technology at a reasonable price, so that everyone has the opportunity to compete for prosperity and build the bridges to their own dreams and aspirations.

Network Quality of Service: What is Good Enough?

John Millard
President and Chief Executive Officer
Mitel Corporation

Mitel has long recognized that quality of service is essential in order for a converged voice and data infrastructure to be possible. There has been a lot of confusion and hype surrounding quality of service, and it is critical that the issues around this topic be fully understood and evaluated in order to successfully meet enterprise's current and future network performance requirements. This paper explores the quality of service requirements for multiservice networks and compares alternatives for handling those requirements.

Over the past year or so, vendors and the trade press have shown great interest in the topic of network quality of service (QoS). Unfortunately, most discussions have degenerated into technology arguments—should networks be frame versus asynchronous transfer mode (ATM) cell-based, how does RSVP work? The question that goes unasked is, How do various QoS technologies best serve user applications? Even when applications do come up, many people believe that QoS only matters for future multimedia applications like real-time video, yet today's organizations already run several types of traffic on the same local area networks (LANs) and transmission-control protocol/Internet protocol (TCP/IP) backbone networks, causing contention for limited bandwidth. Network traffic congestion is degrading the response times of critical network applications, a problem that must be dealt with today. The good news is that fixing the network QoS problem now provides an added benefit—network infrastructures that are real-time voice and video-ready.

After all, is there a network planner who has not worried about whether the infrastructure being installed today will still be satisfactory the day after installation is complete? What about crucial transaction traffic being squeezed out by file transfers, Web browsing, and push technology like Pointcast? Network planners no longer assume that their company's business will be carried out in stable ways, in stable locations, or for long periods of time. We are also seeing the beginning of an integrated view of connectivity as personal information managers and call-center software are integrated with telephones; this trend will escalate over the next years as groupware, messaging, telephones, and video are integrated into the desktop workstation. A multiservice backbone delivers on users' expectations for fully integrated service without the need to connect to different networks for different data types, and provides an inte-grated backbone for flexibility and economy (see *Figure 1*). But as different legacy networks with unique characteristics and priorities (e.g., legacy IBM SNA-based transaction traffic, workgroup collaboration, and Internet Web browser traffic) are combined to create a single, enterprise-wide network, the combined LAN, metropolitan area network (MAN), and wide area network (WAN) backbone must carry all traffic streams at quality levels acceptable for business. Otherwise, users will not accept the multiservice network, and special-purpose networks will reappear. All traffic flowing across an integrated enterprise network falls into one of three categories, according to transit delay (i.e., latency) needs (see *Figure 2*).

Bulk transfer traffic uses any available bandwidth, but accepts almost any network transit delay; increased bandwidth can sharply decrease transfer times. Transaction traffic, such as on-line transaction processing, remote data entry, and some legacy protocols, accepts transit delays of one second or less. Greater delays decrease user productivity; variations (jitter) cause operator discomfort; and exceeding the allowable delay can sometimes cause sessions to fail. Real-time traffic, such as conversational voice, videoconferencing and real-time multimedia requires very short transit delay (usually less than one tenth of a second one-way), with little jitter. Compressed traffic is sensitive to transmission errors, but because real-time traffic accepts only very short transit delays, errors in transmission cannot be overcome by retransmission. Therefore, transmission must have low error rates.

If network planners cannot allocate enough bandwidth to handle all traffic in a particular category, then they can further subdivide traffic by priority. Priority traffic receives preferential treatment because of its importance to the enterprise (e.g., intranet Web browsing of internal documentation by order-entry personnel having priority over Web browsing for entertainment). Priorities can be used to differentiate among user groups, applications, and users within a group. Service level agreements (SLAs) help to ensure that regardless of priority, users are not all requesting the highest QoS. The result would be expensive overbuilding of the network to provide guaranteed bandwidth and short transit times, even for users who are merely surfing the Web or transferring low-priority files. SLAs allow network administration to create various levels of service based on the network

FIGURE 1
Multiservice Network

Data and Video Servers | Mainframe | PBX

Data and Video Servers | Mainframe | PBX

Multiservice Network

Separate infrastructures

FIGURE 2
Traffic Characteristics

Real-Time

Real-time conferencing
(interactive video, voice)

Transaction

Transaction Processing
(reservations, order entry)

Web Browsing
(HTML/HTTP server access)

Bulk Transfer

Streaming Multimedia
(video/audio from servers)

Email
(SMTP/POP)

File Transfer
(FTP file downloads)

Reduced Latency →

More Bandwidth Required →
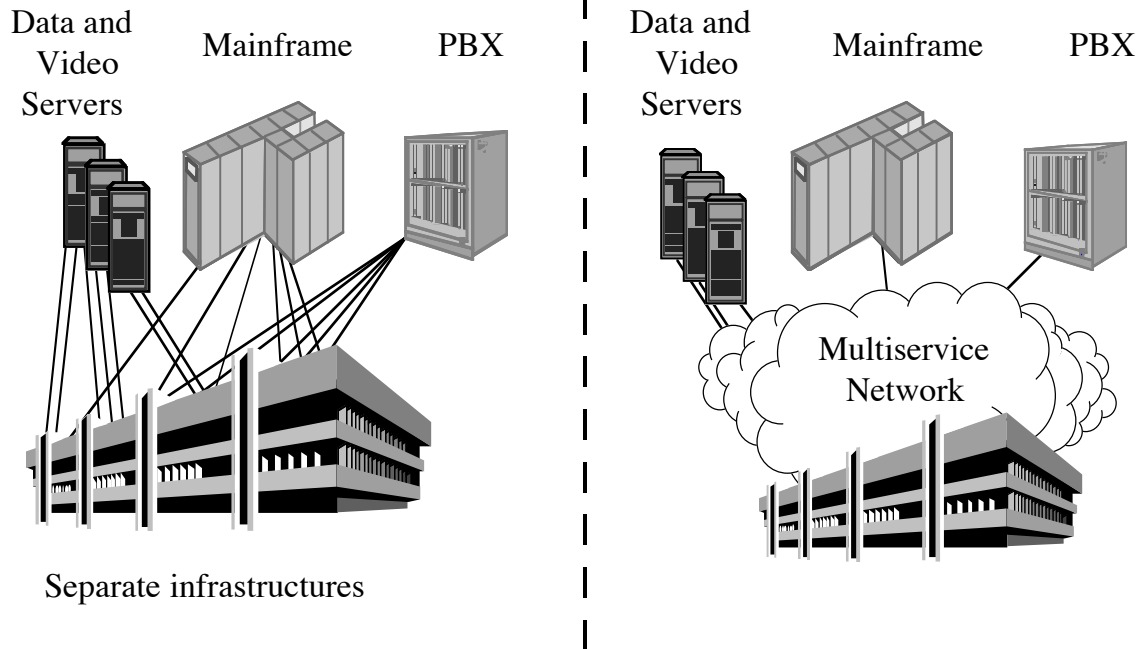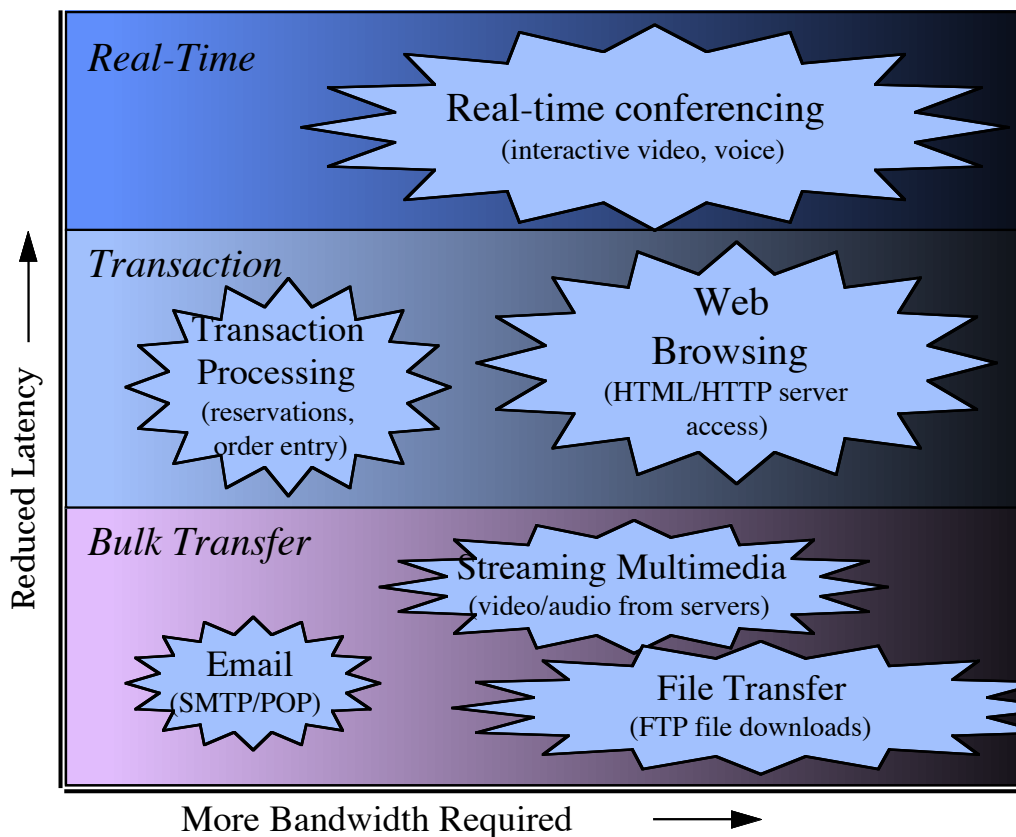
access speed and QoS; each user pays a fixed rate for a certain level of service. Agreements set user expectations appropriately and allow management to control the use (and cost) of the enterprise network.

So which QoS method should the network manager or planner choose? QoS technology is crucial to the further development of the Internet and will therefore receive a lot of attention from vendors over the next years.

Overwhelming Bandwidth

The current crop of Gigabit Ethernet products imply that there will always be the option of "throwing bandwidth at the problem." Adding unlimited bandwidth can provide a simple and effective, if temporary solution for LANs, but it is difficult to scale, flow control methods are underdeveloped, and there is no way to handle contention.

Router Prioritization

Most routers can be configured to give preference to certain traffic based on implied QoS. For example, data traffic going to specific network addresses or sub-addresses (often associated with specific applications) can be given priority or can have internal buffers or bandwidth reserved. Although router prioritization does not easily guarantee latency and error rate, it is usually sufficient for legacy protocol traffic. Using this existing router function can ensure that certain applications have priority, but for higher quality voice and video, it is too difficult to guarantee the necessary low latency and low jitter without expensive overhead in reserved buffer space and complex queuing algorithms.

RSVP

Applications can use the resource reservation protocol (RSVP) to request a particular level of service from the network. RSVP provides four levels of service, which all major networking vendors have begun to implement in their routers and are considering implementing in some switches. RSVP issues continue to focus on limited implementation, high router overhead required for the best QoS, and the inability of IP's routing protocols to consider QoS when building a route.

VLAN Prioritization

The IEEE 802 committees are developing the 802.1Q standard, which defines a method for tagging VLAN packets to allow interoperability among VLANs from different vendors, and the IEEE 802.1p standard, to offer a method for using 802.1Q tags to distinguish among classes of traffic. The minimum 802.1p implementation will provide a few strict priority levels; however, detailed QoS (strict latency or error rate) may not be guaranteed, and network managers would be unable to control users' ability to request prioritization of their traffic.

Frame Relay QoS

Standard frame relay networks provide only one class of service, but there are two types of frames—committed, with guaranteed bandwidth, and burst, with only best-effort delivery. Prioritization is limited because latency cannot be specified, and interoperability is an issue because prioritization can only be implemented through nonstandardized, proprietary extensions to the frame relay standard. The frame relay forum has begun working on QoS standards, using parameters for latency, jitter, and error rate that can be mapped to ATM QoS parameters.

ATM QoS

Well-proven and standards-based, ATM has an inherent QoS feature that recognizes and uses requested QoS requirements to construct a route. Users can select from four network service classes, or specify QoS requirements right down to the parameter level through the newest ATM user interface, UNI 4.0. Unlike routers, ATM switches and technology have been designed from the start to be able to guarantee all service levels, even the most stringent (CBR), allowing very predictable performance.

For any QoS technology option, there are two methods for telling the network the quality of service desired—either the QoS level can be implied by being permanently associated with some characteristic of the data flow (e.g., the addresses of sender and receiver or the protocol used), or the user can inform the network explicitly and dynamically, through the program's application program interface (API). Implied QoS gives the network administrator complete control over the assignment of QoS levels to particular types of traffic flows; however, filters cannot make detailed distinctions among traffic flows. Protocols including SNA and ATM use granular APIs to differentiate among classes of service when a connection is established.

IPv4, the current Internet protocol, has a type of service tag that can be used to indicate simple classes and priority levels. The new IPv6 also includes a flow label for more detailed control. The new RSVP works with either IPv4 or IPv6 to create detailed, dynamic class-of-service reservations for particular traffic flows.

APIs, such as Sun Microsystems' Solstice ™ Bandwidth Reservation Protocol API for Solaris and the WinSock2 API for Microsoft Windows, are oriented towards complete QoS, not just prioritization. When APIs are used for QoS requests, network administration must be sure to put in policy control to enforce how users select classes of service. Policy administration technology is only now being developed for nonATM environments to regulate the assignment of QoS levels and ensure that users are charged for the service that they use.

Despite the apparent complexity of the choices among QoS technologies, there are actually only three major options:

- If the network consists of small workgroups in a small geographic area with low network utilization, overwhelming bandwidth is the best option. It provides simple technology, and the issues of limited applicability (LANs/MANs only) and scaling difficulty are irrelevant.

- In a network that integrates legacy protocols, router prioritization is proven to work well. Network planners must keep in mind that this option is not recommended for high-quality, real-time voice and video and must take into account the required router resources.

- To create a medium to long-term LAN/MAN/WAN multiservice backbone, an ATM core with Ethernet edge switches will provide standards-based, comprehensive QoS. ATM is the only proven technology for guaranteeing low latency and low jitter and provides excellent granularity and network control. By using Ethernet to give users access to the first-level workgroup Ethernet switch, planners can avoid the expense of ATM to the desktop and server access to the ATM network while maximizing the use of built-in Ethernet interfaces rather than purchasing new network interface cards.

In three to five years, the great majority of enterprise networks will move towards integrated network backbones to improve productivity and efficiency. As traffic streams with different characteristics, and priorities are combined to create that single, enterprise-wide multiservice network, performance must still be acceptable for each application. Unfortunately, handling all traffic as if it were of the same importance can lead to major difficulties, and placing new, barely-tested applications on the network because of business pressures increases the probability of network problems. Without a way to distinguish among data streams within a category, critical data can easily be blocked temporarily by large file transfers or by less-important traffic, such as external or internal push technologies (e.g., Pointcast). Virtually all enterprises will need to differentiate among the three traffic categories of real-time, transaction,

and bulk transfer; most will need to make finer distinctions, based on priority, within them.

Network administrators must be able to enforce prioritization to validate requests for particular service levels and to justify bills to customers. The new QoS APIs, which allow users to request levels dynamically, complicate this problem and reinforce the need for central control to help avoid network saturation and a blurred distinction among service classes. Therefore, the integrated network backbone will need sophisticated, industrial-strength QoS facilities.

Preparing for an uncertain future with an uncertain technology is a large risk when considering a major enterprise backbone architecture. Using ATM at the core with 100 Mbps Ethernet at the edge is, therefore, the best solution for those enterprises planning backbones for the three-to-five-year future. Frame-based backbone technologies, such as Gigabit Ethernet, may be implemented on an experimental basis over the next two years if planners can postpone a new enterprise backbone; frame technologies and RSVP may eventually prove usable for providing QoS. Router prioritization is a viable solution for current situations involving legacy protocols. Nevertheless, ATM technologies are the most comprehensive and are currently working in many production environments.

The needs of known current and future network applications, combined with the proven ability of computer technology to surprise all of us with new developments, means that enterprises can no longer postpone intensive consideration, evaluation, and trialing of QoS technologies for use in the multiservice backbone. Organizations must begin today to evaluate the competing technologies and to begin trial and evaluation of some of them. These technologies are at the core of the network, so it will be difficult and costly to retrofit them into a backbone that was not designed with a well-considered QoS strategy from the outset. Network QoS will be essential when establishing a network that can handle upcoming and unforeseen future requirements.

Mining Growth from Mature Markets: Opportunity across the Atlantic

Richard C. Notebaert

Chairman and Chief Executive Officer
Ameritech Corporation

When we consider the sea change underway in the global communications industry, any number of questions might come to mind. Questions such as, how come we still haven't received the benefits promised by the Telecom Act of 1996? Or perhaps more to the point, what on earth is going on in Washington?

I suspect that other industry leaders have had some observations to make about the foot-dragging and micromanagement going on at the Federal Communications Commission (FCC) since the Act's inception. But as time passes, the situation has only worsened. In an effort to manipulate the market, unelected bureaucrats have stymied the promise of Congress's breakthrough legislation. And at this point, no one knows when American consumers might finally enjoy the advantages of a fully competitive communications marketplace.

As you may know, other parts of the world are working hard to avoid this kind of quagmire. Even as we debated, litigated, and grew more frustrated here in the United States, a dozen nations of the European Union opened their communications markets to competition on January 1, 1998.

While expectations of communications customers here in the United States have gone from eager anticipation to disillusionment, expectations in Europe are soaring. As the largest American investor in the European telecoms market, Ameritech is in the thick of that excitement.

The question might occur to you, as it has to others over the last few years: Why Europe? Why would Ameritech turn down high-growth investment opportunities in Latin America, South America, and Asia, and instead pour capital and knowledge into mature, low-growth markets in Europe?

Well, because both of those assumptions—about high-growth prospects in less-developed nations and low-growth limitations in more-developed ones—come with caveats.

The first assumption, of course, is one that has created a good deal of pain in the last few months. The world has been reminded that high-growth potential is often accompanied by high risk. Fortunately for Ameritech, our unwavering focus on shareowner value demands that we take a disciplined approach to assessing those trade-offs.

For example, one of the tools we use when we consider an overseas investment is the country's composite risk ranking: a monthly analysis of political and economic factors as compared to those of other nations. If you were to look at January's ranking of 129 nations, you would find Luxembourg listed as the most stable of all the nations on earth. Where do you think you would find the United States?

We were number 25! Iraq and Somalia vied for last place. No surprise there. But more to the point, in terms of stability, seven of the top 10 countries are located in Europe. Call us crazy, but if we can spur 15 to 20 percent growth in nations deemed even lower risk than the United States, we think that is a great opportunity.

Of course that kind of double-digit growth contradicts the second assumption I mentioned earlier: that Europe is a mature, slow-growth market. In fact, we have actually been told that Europeans really do not want more communications options, as long as there is a working telephone within walking distance, that is good enough!

But experience tells us otherwise. Once government steps aside and gives private enterprise the incentive to be innovative, efficient, and customer-focused, the result is growth. Just in case anyone with connections to the FCC might be reading this, let me repeat that: Once government steps aside and gives private enterprise the incentive to be innovative, efficient and customer-focused, the result is growth!

The most dramatic European example I can offer is MATAV, the former state-owned communications monopoly in Hungary. In December 1993, when Ameritech and Germany's Deutsche Telekom made our initial investments in MATAV, phone density was fourteen lines per 100 people. This was not because Hungarians did not want telephones; nearly 800,000 of them had paid deposits to ensure their place on the waiting list. That wait, by the way, averaged in the neighborhood of thirteen years.

Today, the waiting list is gone. Customers who did not even have phones just four years ago are now asking for second

lines, voicemail, and fax machines. Not only have customer sophistication and expectations grown, but also so have MATAV's profits. They were up 22 percent last year, and we have not even scratched the surface.

We have contributed to similar growth elsewhere. For instance, in Belgacom, which is Belgium's incumbent provider, 1997 profits grew 21 percent. Based on our track record in Hungary and Belgium—along with our contributions to NetCom GSM in Norway and Wer Liefert Was?, our German-based directory provider—our recent $3.2 billion investment in Tele Danmark sent that company's stock price up 30 percent. That was before we even got there.

How does this kind of growth happen in so-called mature markets? I like to use the analogy of the abandoned gold and silver mines that dot the landscape from California to Idaho. Once the richest veins were exhausted back in the 1860s, those mines were boarded up. And most of them stayed that way for more than a century. But in the mid-80s, new technology and extraction methods made it profitable to go back in and take out more ore.

In other words, innovation and efficiency created their own growth. Those attributes, along with financial resources and a strong customer focus, are what U.S. companies can offer European markets. Certainly Chrysler and General Motors have mined growth in Europe, as have various pharmaceutical companies. Others have found Europe ideal for call-center operations, where they can tap the multilingual talents there to cover just about every need. Many of the industries represented in this audience are no doubt succeeding across the Atlantic as well.

Walt Catlow, who is President of our International Operations, tells about attending a conference where a European panelist described America's contribution very succinctly. When asked why his company would welcome Yankee investment and know-how, the panelist did not hesitate. He said, "Well, because Americans just go around making you feel like everything is going to be alright! Europeans face a business problem and think it's all over. We can't do this. We're doomed. But those Americans look at the same problem and say, 'Oh, this is nothing! Let's just sit down here and figure out how to turn this around.'"

Of course, if optimism is the upside, Americans must stay vigilant that our confidence does not slip into arrogance. We have all heard "ugly American" stories, but the one that sticks in my mind was recorded by *The Wall Street Journal* just before Christmas. *The Journal* reported on an American partnership established by a giant telecom provider and a well-known cable company for the purpose of building an extensive communications network in Great Britain. In 1993, a member of the partnership's leadership team went to England to meet with several concerned managers. They warned that the partnership was off track; they suggested more appropriate ways to reach the British market. For their trouble, they were all promptly fired, with the cryptic declaration that "We know what we're doing." The remainder of

The Journal's front-page article detailed the partnership's many problems—including a $450 million loss in 1997.

That article provides a sobering lesson on how not to achieve your company's goals in Europe. But enough of the negative. I would like to mention three positive lessons—lessons that have been critical to Ameritech's success overseas.

We can start with the flip side of the example provided by *The Wall Street Journal:* it is essential that the people who represent your organization overseas possess true cultural sensitivity, and that they serve as coaches rather than taskmasters.

MATAV's 22 percent growth in 1997 was an impressive result. But the greatest achievement there to date has been the blending of three distinct cultures: Hungarian, German, and American. The process included a number of challenges, because each group brought with it the debits and credits of its own heritage and personality.

But everyone concerned has also brought with them integrity and respect for one another. The Germans and Americans have not so much mandated changes as shown the Hungarians alternative ways to make MATAV successful. The Hungarians have been open to new ideas and have been avid students on visits to the United States and Germany to see how such ideas are implemented. None of this would have occurred without cultural sensitivity. That said, though, let me mention that sometimes we need to discern the difference between cultural values and the all-too-human desire to stick to the status quo.

An example that comes to mind involved the way Belgians traditionally ordered phone service or added enhancements like voicemail or call waiting. Before the government privatized Belgacom, this was always done in person. Customers who wished to place an order traveled to one of the company's Teleboutiques. There, they waited an hour or more for a representative to become available. Then they would sit with the representative, fill out a stack of forms, and leave with a tentative installation date. When Ameritech's customer service people questioned whether customers might be happier to accomplish all this by phone, we were told that Belgians were culturally inclined to make such transactions in person. This could not change.

But we persisted and reached an agreement with our Belgian colleagues to trial the phone-in alternative. You can guess the results. What they had described to us as a cultural issue was actually habit. Belgians quickly embraced the timesaving alternative. In the process, they also bought a whole lot more services.

That kind of customer focus leads us into the next lesson: looking at your business through the customers' eyes is just as important in Brussels or Budapest as it is in Boston. This offers an immense opportunity for savvy marketers from the United States to make a tremendous impact in Europe.

In my industry, for example, the high-end European consumer through medium-sized business market has been vastly underserved. Until very recently, there probably was not a customer in that range anywhere on the continent who had ever been contacted by their phone provider! Until late last year, for example, France Telecom had no ability to bill its customers in multiple currencies or to customize bills into various languages. So if you were an international law firm with an office in Paris, your bill came in French, the amount owed was stated in francs—and it was up to you to figure out what all that meant. Not surprisingly, competitors with better segmentation skills and more customized packages have entered the market with multi-lingual, multi-currency billing, and they are signing up customers left and right.

As part of our team-building process between Belgacom's four partners, a Belgian executive transferred to Chicago for six months. He worked in one of Ameritech's business units and attended Northwestern University for a semester before heading back to Brussels. Before he departed, we asked him to name the most important lesson he learned while he was with us. Ironically, he said it was not anything he picked up at Northwestern or at Ameritech. It was what he had experienced as a customer shopping for goods and services throughout the Midwest. He said, "If I could just pick up the whole customer service ethic you have here and transplant it to my country, our entire economy would pick up 10 percent!"

I think his observation holds value for all of us.

Finally, we have learned that Europeans and Americans have a great deal to teach one another about the art of doing business. In addition to customer service skills, we have encouraged our colleagues to make faster cycle time a factor in every process and procedure. This has not always been an easy sell. In fact, sometimes efficiencies have been initially achieved only as a concession to "those work-crazy Americans."

We have exported the concept of shareowner value, which, at least in the telecommunications segment, was never before a priority. Imagine how Hungarian employees reacted when they received stock in MATAV as a bonus. These were individuals who had always worked for the government—the Communist government, no less.

Even profit making is looked at in a different light in Europe. In the Scandinavian countries, for instance, profits can be considered almost gauche. This is probably why a Copenhagen newspaper led its story on our partnership with the following statement: "The style is set for when Ameritech takes over Tele Danmark . . . there must be profits, and they must grow year to year." A few paragraphs into the story was this interesting observation: "Chairman and CEO Richard Notebaert makes no attempt to hide the fact that the goal is continued growth at at least the same tempo during 1998 and thereafter."

We have taught our European partners a lot, and we have learned a lot as well. The educational level and technical expertise of the European employees is very impressive, and they are doing some great things. In fact, the Danes have implemented a terrific new cellular phone feature that may offer real value for our customers here in the United States. We have successfully completed technical trials on the feature and now we are at work to assess its market potential. This could end up being a very successful import for us.

In addition, we have been able to act as a full-service communications provider overseas, an ability denied to us in the United States, at least until the FCC gets serious about making this industry competitive. In Europe, we enjoy the freedom to offer the whole gamut—local service, wireless, national toll, international long distance, and more.

I expect it is obvious to you that we are having a ball. We are bringing enormous value to customers, we are growing our business on behalf of our shareowners, and we are contributing to the prosperity of the nations we serve.

Now we can only look forward to the day when we are allowed to have the same kind of impact here at home.

Nokia's Emergence as a Telecommunications Global Power

Jorma Ollila
President and Chief Executive Officer
Nokia

1997 was the first year Nokia operated almost exclusively in the telecommunications sector. Our net sales, profits and earnings per share were the highest in the company's 132-year history. Our success has shown that the strategic decisions we made early in this decade were on the right track. I am delighted to note that Nokia is now one of the more successful international telecom companies that has also concentrated its efforts on the fastest growing segments of the telecommunications industry.

In line with our strategy, we were able to strengthen our leadership in targeted areas last year. We not only managed to keep pace with the rapid changes, but we often spearheaded them; we anticipated market trends and succeeded in offering our customers many industry-first products and solutions enhancing their growth, profitability, and potential opportunities. We achieved—and in some areas even exceeded—our own growth targets, and we nearly doubled our net profit. We strengthened our global market position in mobile communications, the deregulated sub-sectors of fixed networks, and data communications. It is specifically in these segments that the fastest evolution and growth is anticipated in the future. We reached these achievements with a positive operating cash flow of 10.2 billion finnmarks.

Nokia now has better opportunities than ever to meet the challenges of the future. We believe we are well prepared for the radical changes the telecom industry will undergo in the upcoming years. We thus are well positioned for success in the global arena and are investing strongly in the changes we anticipated in this rapidly evolving industry.

I will discuss two topics in this paper. First, I will review the most important events of 1997, and, second, I will shed light on the opportunities opening for Nokia in its new role as a telecom company with an increasingly global presence.

Nokia's net sales grew by 34 percent last year. We surpassed the 50 billion-finnmark milestone for the first time, and our higher net sales made us Finland's largest company. Net sales by the Nokia Telecommunications business group, which focuses on the design, manufacture and delivery of telecom systems, networks and related products, as well as customer services, increased by 41 percent. Particularly strong growth in sales of telecommunications systems was seen in Europe and China. The business group's systems business order inflow was up 58 percent on the previous year. We continued supplying solutions to our existing customers while gaining a total of seventy-two new network customers through the course of the year. Thirty-five of these new customers are fixed network operators who are very welcome new customers in light of further expanding our operations.

Net sales by Nokia Mobile Phones, which focuses on the design, manufacture, and marketing of mobile communication devices, were up by 28 percent. In 1997, we sold a total of 21.3 million phones. Sales grew fastest in the increasingly digital European markets and in the United States. Nokia's Other Operations business group grew its net sales by a total of 39 percent. Demand for digital multimedia terminals grew when these markets emerged in Europe. Our new monitor models and our first flat screen display increased the demand for our monitors, sold primarily to PC manufacturers. Europe accounted for a total of 56 percent of Nokia's 1997 net sales, Asia-Pacific for 23 percent, and the Americas for 18 percent. Sales grew very rapidly in China, which became our third-largest market, behind the United States and Great Britain.

Growth in sales in China also offset the slowdown of growth that began in certain Southeast Asian markets at year-end. The significance of these markets for Nokia is relatively small in the global perspective, but it is our firm belief that as this region emerges from the current economic circumstances it will play an increasingly important role in the global telecommunications market. We intend to continue investing also in these markets with the aim of securing and strengthening our future market position.

Nokia's operating profit presented in accordance with International Accounting Standards totaled nearly 8.5 billion finnmarks, and the operating margin rose from just under 11 percent the previous year to 16.1 percent in 1997. Nokia Telecommunications' operating profit, which was already at a high level, climbed 36 percent, and Nokia Mobile Phones clearly boosted its operational efficiency. Enhanced capacity utilization, high productivity, renewal of the product range, and continuous cost improvements had a positive impact on the mobile phone business group's profits in 1997, and its operating profit increased 168 percent. Our 1997 financial result was very strong

when you take into account the fact that we also did not compromise on important investments in research and product development. We further strengthened our expertise and increased visibility and Nokia brand recognition. In all these areas we were able to exploit the benefits of our previous growth.

Over the past five years, Nokia has become one of the leading telecommunications companies in the world. Very gratifying is that we are playing an increasingly central role in various projects focusing on solutions for the future. Our position based on competence and good market feedback gives us an outstanding foundation for operational growth.

We will pursue the preparedness for growth also in the future by investing in product development, production, and human resources. We are further strengthening our global research and product development network, which already includes thirty-six research and design centers in eleven counties. Nokia's high-tech nature is reflected by the fact that about 27 percent of Nokia's personnel—which is more than 10,000 people—work in research and development positions. Our objective is to also increase our research and development investments commensurate with other growth. Nokia's research and development investments in 1997 were up 30 percent on the previous year and totaled 4.5 billion finnmarks.

The importance of investing in research and product development—not only within Nokia, but also in general—underscores the fact that competence is becoming an increasingly crucial competitive factor on a global scale. In this conjunction, it is gratifying to state that development in Finnish industry and commerce during recent years, specifically in the high tech fields, has been very positive. Research and development investments in 1997 increased to 2.7 percent of Finland's gross national product. At this rate, the 2.9 percent national target set for 1999 will be realized.

Nokia could not have achieved the good results of recent years without motivated and committed personnel and a strong corporate culture. Our culture is built upon our four values: customer satisfaction, respect for the individual, achievement, and continuous learning. We have made continuous progress in realizing these values, and at the same time they have become an increasingly important part of our everyday work environment.

Expertise is always based on competent individuals, and Nokia's most important resource is its personnel. Not taking into account the business operations divested during the year, we recruited 6,626 new employees in 1997. For the most part, these new Nokians hold research and development, production, and customer service positions. For this year, we anticipate hiring approximately the same number of recruits as last year. We expect that more than half of the growth in personnel numbers will occur outside Finland, which is where 54 percent of Nokians worked at year end 1997.

It is very satisfying that while discussing growth in Nokia's personnel I am able to report that our operational efficiency has been boosted so that the contribution of every Nokian is now more valuable. Where net sales per employee totaled 680,000 finnmarks in 1992, by last year that figure had already climbed to one million 480 thousand finnmarks. The boosted efficiency is also reflected in the ratio of personnel strength to operating profit. In 1992, when the average personnel strength for the year was 26,700, every Nokian amassed operating profit worth around 11,000 finnmarks. In 1997, when our average personnel strength was about 35,500, operating profit per employee escalated to 238,000 finnmarks.

First, I want to point out the changes that have taken place during the past two years in the geographical distribution of institutional investors. Two years ago, in April 1996, more than half of Nokia's institutional investors were Finnish and one-third were in the United States; by the end of 1997, those numbers had shifted. The share of Finnish institutional investors had dropped to less than one-third by year-end and the share of those in the United States had climbed to about half. Another and even more noteworthy factor is the growth in the number of individual shareholders. Nokia now has more than 120,000 private investors, about 100,000 of them are Americans. The great majority of this ownership base has amassed during the nearly four years that Nokia has been listed on the New York Stock Exchange. Ultimately, the share of American shareholders in Nokia's ownership has grown significantly over the past three years.

I have briefly described the past year, and we have every reason to be satisfied with our success and operational result. We have succeeded in strengthening the foundation upon which we can further strive in the intensifying competition. In the latter part of my paper, I do in fact want to review Nokia's strengths regarded as crucial for the future.

The highlights and breakthroughs of 1997 were critical in terms of our future. One of the most important factors shaping our future has been the development of the next generation wireless standard and the related research. By the end of the year, it had become clear that the third-generation wireless standard would be based largely on the work that we had been doing in our own research laboratories and in partnership with other companies in the industry.

In January of this year, the European Telecommunications Standardization Institute chose the GSM core network-based broadband WCDMA solution as the future wireless radio technology. The decision sets the foundation for standard global markets. The solution is also technically strong and provides operators, industry, and, most of all, users of communication services the opportunity to flexibly adopt new solutions. Many of today's services will evolve within the new networks to become more economical, faster, and more personal.

Another major factor driving the future is the growth of data communications in all the sub-segments of telecom-

munications. The emergence of Internet protocol-based services on public networks is changing the nature of communications both in fixed and cellular networks. The difference between the fixed and wireless network is becoming more obscure, and future customers will require the option of using services regardless of time, place, or technical implementation of connections. Our strong competitiveness associated with IP networks also gives us a leading position in innovative wireless data terminals, network solutions, and software products.

Along with the trends I have mentioned, traditional voice communications are increasingly shifting toward wireless networks. The cellular phone density in Finland and Scandinavia in general is above 40 percent, and a substantial majority of the operators' new customers are choosing the cellular phone as their personal communications tool. At more than 21 percent, Nokia has a strong share of the global cellular phone markets, and we have a presence in all the major market areas.

We are clearly in the vanguard of development, and our leadership in many new areas of telecommunications, our global presence and visibility give us a solid base to face future challenges. We believe we are very well prepared for upcoming changes. Being well prepared does not, however, mean that we can rest on our laurels. To succeed we must further improve our competitiveness in current business activities and further boost our capability to be among the first to identify, create, and exploit new business opportunities.

Along with crafting third generation standards into products, we will invest substantially in developing data communications in the upcoming years. We believe the number of Internet users will continue to grow and form markets for new applications and products. We are one of the leading designers of data interfaces in access networks, and our December acquisition of the American Ipsilon Networks Inc. further strengthens also our expertise in Internet protocol switching technology. Our strong position is also supported by the partnership we acquired this February in the Diamond Lane Communications company.

The Nokia brand, which has already proved to be one of our most critical elements of success, is also becoming an increasingly important factor and strength. For several years, we have invested in raising our recognition together with our product distributors and other partners. The results have played an integral role in the creation of our currently strong market position.

We started wide-scale brand building in the early 1990s in Europe, where we are now the undisputed brand leader in cellular phones. During the past few years, we have succeeded in achieving similar results in many parts of Asia and the United States, where global product brands are ultimately created. Our explicit intention is to set our goal even higher and make Nokia the leading brand in the business.

Brand building is persistent work that requires patience. Building a strong brand requires a great deal of attention to detail, and it demands full dedication. The following are among the factors critical to building a global brand name:

The brand umbrellas the entire company, at the same time bridging the different product groups. We have had good results with this, particularly in the United States, and also with multimedia products. A strong brand facilitates the launch of new product groups.

With telecommunications moving increasingly closer to the consumer and end user, the number of brands capable of reaching the top decreases. Conversely, a successful international brand is attractive to local allying distribution chains and operators, further strengthening the brand.

The power of the brand is important also among other interest groups besides those exclusively commercial. Strength is an asset when recruiting, for instance.

Communication that takes place via electronic media and data networks shortens distribution channels, thereby making an independent strong brand a critical competitive factor.

Through our brand, we can defend our position in changes in the distribution and product value chain.

There were 101 million cellular phones sold worldwide in 1997, making the cellular phone industry one of the biggest product groups of the consumer electronics industry. With the simultaneous growth in cellular subscriber numbers, effective marketing and strong brand have become increasingly influential factors in phone choice, right along with technology. We are pleased to state that the long term, systematic Nokia brand building has proved to be the right investment decision.

Research has shown that during the past twelve months more than 40 million Americans have become familiar with the Nokia name. This growing brand awareness further enhances the potential sales of Nokia brand products.

Nokia has quickly strengthened its recognition in the '90s. The next and equally important phase is nurturing the brand, not just increasing the recognition of it. This consists of building an emotional base with which consumers can associate the Nokia brand.

Not only have we achieved a stable and solid market position in cellular phones, we have also continuously updated our product range. Last year we unveiled a total of thirty-one new phones, and we are among the few companies to manufacture phones for all the major systems. Our global cellular phone market share has been over 20 percent for five years now.

The latest additions to our already very competitive range of phones were launched last week in Europe and Asia. We introduced several GSM phones, among them the new Nokia 5110 aimed at consumers, the Nokia 8810, our new high-end model and one of the world's most lightweight phones, and the Nokia 9110, the second generation

communicator. The feedback our products received at the CeBIT exhibition, at numerous customer events, and in the media has been extremely favorable, so our striking force is good.

Our growth and profitability objectives for the future remain high because it is our firm intention to continue our growth at the same pace as the fastest-growing sub-sectors of the telecom industry, or to even surpass their growth rates. We are targeting growth upon which we can build a foundation for profitable continuity in the high technology environment where we operate.

From experience, we know that growth always offers also the opportunity for innovation and change, which in itself is valuable to any organization.

In this period of different barriers being overturned and freedom of competition, an increasing number of companies are becoming global citizens as they constantly feed off the strength of their national identities. Nokia is an example of a company that has throughout its history depended on the strong local communities. Since the 1860s, this center place was the versatile industry community, Nokia, which was built on the banks of the Nokia River. From the past decades, I call attention to two success stories in particu-lar: Salo and Oulu. Both have a distinctive local commu-nity flavor, a sense of belonging and an appreciation for their own history and traditions—a cultural awareness that has been one of the most important driving forces of success. Integrating this appreciation with international-ism and to the foundation of global operations is an opportunity for us.

A good foundation provides a platform for solid efforts aimed high. Our goal is to strengthen Nokia's position as a leading global telecommunications company. With success comes the confidence that even ambitious objec-tives can be achieved, and with this in mind we set our sights on the future.

The Best Defense Is a Good Offense

J. Lyle Patrick
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Everything began at Illinois Consolidated Telephone Company (ICTC), CCI's original base. Primarily due to its location, ICTC was not in a competitive environment. Of the company's 88,000 customers spread out over 3,000 square miles, about half of them are concentrated in 500 square miles. Basically, all of ICTC's business is in what is referred to as "the triangle" of Mattoon, Charleston, and Effingham. This customer base is concentrated and includes Eastern Illinois University and branches of Fortune 500 companies. Certainly, ICTC is vulnerable to competition just like anybody else.

There are several cost concerns associated with serving a rural area. In order to deploy fiber a mile out to a farm, it takes money. There is also historically "social" ratemaking which is inherent in the telephone business. Another concern is the competition's ability to come in and "skim cream," or take ICTC's best customers. While there are some customers that the competition will probably never get to, all the company's users must be served.

The biggest issue for ICTC is the regulated mindset. We had been a telephone company for 102 years in a rural area—why change? The reason is because Illinois, along with New York, California, Michigan, and others, is one of the most competitively positioned states. For years, Illinois has led the move toward competition. The state wanted to open networks, invite new players, shift costs to local, and so on. Discussions began regarding resale and unbundling, and that started a chain of events. In April 1996, the elimination of the primary toll carrier (PTC) began, and the practice of averaging intra-LATA long-distance costs is more or less being stopped. In November 1996, IntraMSA 1+ presubscription began, and in June 1997 there was a restructuring of access charges in Illinois. In January 1998, virtually every telephone company must be unbundled in Illinois, regardless of its size. Competition is unquestionably coming.

Actions for Meeting the Competition

Companies such as ICTC must have a plan of action. To begin with, ICTC started reducing its costs. This involved early retirement programs and anything else that would cut the cost of the regulated entity, since no one can compete in today's environment with the costs of how a telephone company used to be operated.

Another strategy is diversifying and leveraging assets and personnel. CCI has done that by expansion. Beginning in the late 1980s, nine or ten different entities were formed, which have now grown to almost 80 percent of the revenues of Consolidated. The telephone company is now only the third biggest entity of Consolidated. The telephone company makes about $7 million on the bottom line. About $4.5 million of costs that would be shared normally by the telephone company are transferred to the nonregulated entities. Thus, there can be the same number of employees, but they are doing two things, which means their costs can be recovered through other revenue streams. This has been a successful strategy for CCI.

Finally, it is extremely important for any company to understand its weaknesses. In ICTC's case, this means guarding its "triangle" of core customers and changing its mindset. Changing the mindset is a personnel issue. Within the last ten years, a number of key personnel joined ICTC, including the CEO, the CFO, and most of the other VPs, along with a number of other strong people, particularly marketing and technical personnel. In addition, there were already outstanding people at the company who had only worked for one firm, but who had one mindset about running a regulated entity. That had to change.

The Solution

In the mid 1990s, ICTC, knowing that competition was on the way, decided that it was time to take the initiative and move forward. The company went to its board of directors and suggested that the solution lay in the company competing with itself. If ICTC could form a CLEC, it would have more flexibility under Illinois law. Even though something might be lost on each transaction by coming back into an existing territory and competing, the customer could be obtained. It may not be possible to charge customers a dime a minute any more—it might be necessary to go down to eight cents, but that is better than losing the business altogether. Some revenues are sacrificed up-front, but the customer is secured—particularly the bigger, more vulnerable customers.

ICTC has some problems in its jurisdiction in terms of calling patterns. For example, what constitutes a long-distance call versus a local call? To change that from the incumbent point of view, the entire structure must be redone. If a CLEC is formed, the potential exists to treat the best customers uniquely and not completely restructure all rates and tariffs.

FIGURE 1
Fiber Network 1997
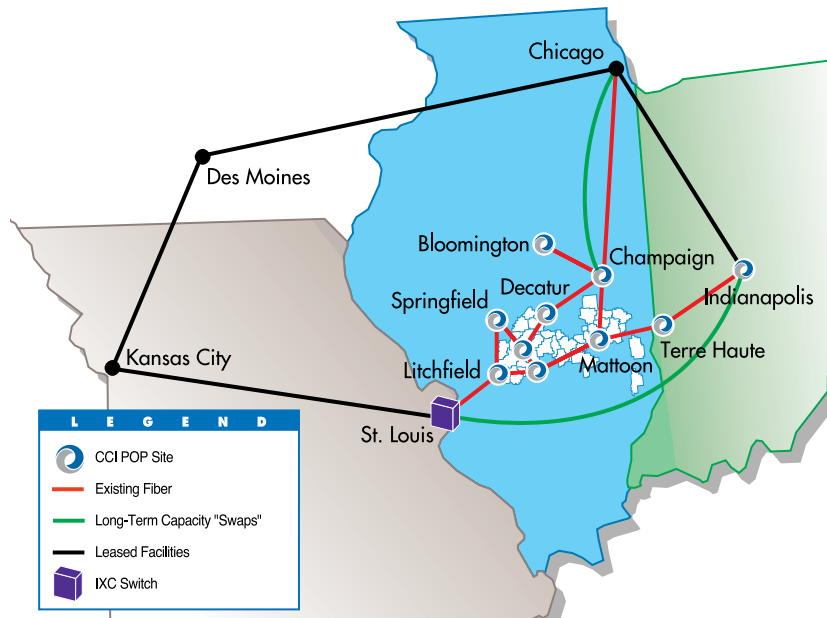
Initially, CCI intends to resell service and then possibly unbundle later. Again, money may be lost initially, but the customer can be maintained. Furthermore, CCI has a long-distance company. Each time a customer joins the CLEC to give them more flexibility on their local calling pattern, they are also invited to join the long-distance company. Through bundling, or linking products together, the company can end up with basically the same revenue stream and bottom line.

While CCI has not invoked all of these actions yet, they make up the company's strategy. In Illinois, when a company plans to come into a territory, they have to file and become certificated, which takes six months. By the time somebody files, CCI/ICTC will have six months to figure out what its implementation plans should be.

CCI Actions

After identifying the strategy of forming a CLEC to protect itself, CCI began to explore if there was not something else that could be done. The company wanted to continue its ten-year strategy of expansion, and to do that it decided to use the expertise it already had. This consisted of experience as a local telephone company, a long-distance company, a billing company, and a paging company, among others. Perhaps the answer would be to bundle everything together and enter into another market—that is, take the offensive and find an opportunity.

Through its Consolidated Communications Telecom Services division, the company began Operation First Choice. Basically, the idea was that if the firm was providing all of these services now in its own territory for existing customers, why not do it for somebody else's customers? The intent is to bundle products, take local and long-distance service to customers in the Midwest, and maybe one day offer cable and/or video.

Fiber Network

Earlier, Mattoon, Charleston, and Effingham were referred to as the "triangle," or the ILEC triangle. However, we at CCI think there is a bigger triangle to be served—from Chicago to St. Louis to Indianapolis. The company considers anything in that larger triangle, except for Chicago itself, to be its territory. Granted, the Company has businesses that operate around the nation and throughout the Midwest, but about 80% to 90% of our customers and revenues come from within that triangle. Primarily, this area is rural, but there are some cities that are intriguing, such as Champaign, Decatur, and Springfield with 100,000 to 200,000 residents each. There is no real intention to compete in larger cities such as St. Louis, Indianapolis, or Chicago as CCI believes it does not need to be in that league and that there is plenty of business downstate.

ICTC only has 88,000 access lines in central Illinois, which is the ILEC service territory. With its long-distance company, the firm laid fiber throughout the main cities in downstate Illinois (see *Figure 1*). With that fiber in place, the company is able to do some new things. We have about 10% to 20% of the long-distance market, and we believe we can sell customers in the triangle more products. CCI believes that bundling is the future of customer service, and that overall customers do want one carrier. However, this may not be true in an urban area. A more sophisticated customer may be more price conscious. They may have one long-distance company, one local carrier, and one pager service. The rural customer seems more satisfied with bundling: thus, if CCI was going to roll out new products, we needed to go somewhere else. We did

so by going into new territory: Springfield is the state capital, Champaign has the University of Illinois, and Decatur has three very large companies that are obviously "ripe for the picking."

How is that sort of a move possible? First, a company must be certificated, which is fairly easy in Illinois. For CCI, it required testifying over the phone twice in order to be certificated as a local carrier. Then, a team was formed who pulled together a bundled product and rolled it out into these markets. The company began discussions with Ameritech about reselling and unbundling, and it tried to assess what the market wanted. The planning was done from the financial and the technology side, which CCI did fairly well. What the company did not do exceptionally well was the backroom planning—that is, the impact on the company that entering these businesses would have on the backroom.

New Company Expectations

What did CCI think the customer wanted from a new company? Expectations included reasonable lower pricing, new products and services, quality, and a community orientation. CCI does not believe that it is possible to move into markets without getting involved in the community. It understands the business aspects of being involved in a community and protecting a territory. For instance, CCI does not extensively advertise, which is a unique strategy for a long-distance company. Some marketing is used, but not a great deal. More is done through the community: CCI gives 5 percent to what are called the affinity programs that give back to the schools. For example, in Charleston, Illinois, the company works with the local PTAs—if members sign up with CCI's long-distance company, the firm will give 5 percent back to the school. That is attractive to parents, particularly in rural areas or smaller cities. CCI did a similar program in St. Louis, where it helped to build a soccer stadium again through a 5 percent donation offer. The company finds out what is important in the town it is targeting, becomes involved, and then donates. The firm believes in communities, but business is also important. We know what works.

Through market research, CCI came up with several interesting insights. In general, it found that people do want services bundled. They want things to be simple, and they think telecommunications have become too complicated. Virtually all are open to change. We found that 5 percent or 10 percent of customers are open to change, regardless of the service provider. For the other 80 percent to 90 percent, there must be a reason to change. We try to give them a good reason.

Expectations and Strengths

What does CCI expect? We expect a customer penetration rate of 3 percent to 10 percent within three years. We expect profitability in years two and three and a decent return over five years. The company assessed its strengths and felt that we understood the business we were going into—it was not new to us. We understood the regulatory requirements of Illinois and how the rules work. The company has billing expertise, which is tremendously important; a firm will have problems if it cannot produce a bill and get it out on time for its customers.

CCI also has a good reputation in its region and an ability to offer unique products. Research shows that some people like measured service, such as the kind offered by Ameritech, while others do not. To become attractive to the latter group, CCI offered a flat rate for up to 500 minutes of use, with the cap in place to account for Internet users.

Market Entry

On May 1, 1996, CCI began its market entry in three Illinois markets: Springfield, Decatur, and Champaign. We used first-class TV advertisements which resulted in good initial customer response. We were not sure where we were going, but we were getting there very quickly. Immediately, however, concerns began to arise. These were not necessarily financial, customer acquisition, or marketing-oriented concerns, and in a sense they were not even technical. They were more involved with backroom operations.

Eventually, everything was straightened out, but it took a while. The biggest problem was understaffing. Nobody was prepared for what would happen when a new entrant came into the marketplace. The strain on the backroom was immense. People were working around the clock. There were two groups (CCI and the ILEC) trying to serve the same customer, which had never happened before. The impact on billing systems was enormous. Finally, there were problems with bad debt. Besides the customers that CCI acquired who wanted to change because of a good product, there were also people who could not get service anywhere else and became credit risks.

Overall, CCI had problems up-front, but the ILEC's process was not built to handle the situation. CCI was the first company in Illinois to make such an offering. AT&T, Teleport, and others had done some similar things in Chicago, but they had focused on business users. Nobody had ever focused on an entire market before, including unbundled residential service.

Today and Tomorrow

Today, CCI is doing fairly well. It has more than 6,000 residential customers that used to be the ILEC's customers and over 1,000 business lines. The company has now started to concentrate on businesses and is moving toward profitability. We unbundle—bring the traffic back to our switch— which works well and provides more versatility. CCI believes that we can control the customer better this way than through resale.

CCI is moving toward our goals. Things have improved: the two companies are working together, CCI is getting new customers, and an interconnection agreement has been signed. Pricing is still an issue, but there may be some

relief coming out of the Telecom Act of 1996. The ILEC's situation is understandable: it is hard to unbundle a loop and price it acceptably when social rates are in effect. All of that will have to change eventually or the emerging system will not work.

Next Steps

The next steps for CCI are uncertain. We are pleased with our success and are considering new markets. We have turned up our advertising again and are seeing more customers. CCI has a good name, and customers are happy with the features they receive. A positive reaction is antici- pated when CCI goes to an expanded local calling area, maybe linking cities. Finally, CCI will continue to review the impact of unbundling a regulated entity.

Everything began when CCI chose to compete against itself. But the company has not had to do that yet, because nobody is competing against us in our markets. We know, however, that competition is coming, and we have already taken some defensive measures.

Through all of its difficulties, CCI gained a great deal of information about what happens when a competitor enters an existing market—information that it will be able to apply to its own existing market. CCI is a good example of the fact that any company entering this new arena will discover new things. It is probable that companies will be asked to do things they have never been asked to do before, probably in conjunction with another company, which will be even more strange. But Consolidated Communications has shown that although the going may be difficult, it is possible to succeed in the new marketplace.

From Dialtone to Webtone: A Historic Turning Point

John A. Roth
President and Chief Executive Officer
Nortel (Northern Telecom)

There is a communications revolution underway that will ultimately touch every aspect of human life. Driven by the convergence of computing and telecommunications, this revolution is transforming the way businesses operate, governments define the public interest, and knowledge is created and shared. It is symbolized by a historic shift in the global telecom industry: the move from dialtone to Webtone.

To grasp the difference between the two and get a sense of how profound the effects of the move will be, consider the dialtone that most of us take for granted despite the fact that, when you really think about it, it is nothing short of miraculous. With a wireless phone in the palm of your hand, you can instantly establish voice contact with anyone, any time, from virtually anywhere in the world. Once connected, your conversation follows a dedicated path through a global network that is reliable, secure, and universal.

Now imagine turning on any one of a variety of intelligent information appliances at work, at home, or on the road and being within easy reach of an immersive, interactive, multidimensional world of sound, video, text, and images, including 3-D and holography. Imagine doing it in real time with no delays and no system crashes. That is the potential of the Webtone experience.

By moving from dialtone to Webtone, we are moving beyond one-dimensional connectivity to an era of multidimensional interactivity with the vast information flows that characterize cyberspace and the networked global economy. We are already seeing how technology is changing the way the world communicates and what the future will bring as the Internet evolves, and it is not just business that is being affected. Here is an interesting bit of data: between 30 and 40 percent of children in the United States have reduced their television time to surf the Net.

A new kind of interaction—the keyboard-to-server model—lets people use customized, private on-line systems or the Web to communicate with suppliers, place orders, and conduct real-time transactions. This capability is behind one of today's most important trends: the growth of electronic commerce, which will really take off as we create a commercial cyberspace environment that has the confidence of individuals, businesses, and governments.

In the new communications ecology shaped by Webtone, individuals will have the power to choose between various media available through a variety of devices, mixing and matching multiple services (at multiple prices) to access information, and a range of experiences in an infinite number of ways.

In this new realm, we will be able to reach into the bit stream and pull out the information we want or need in whatever form suits our purposes. The network itself will have the intelligence to deliver and transfer at high speed the information that will help make our lives more enjoyable, productive, and effective. We will be able to join with others around the world in virtual communities with all the richness, depth, and diversity of our cities, towns, and neighborhoods today. There is a long way to go before we reach that level of interaction, but major milestones have already been reached and the journey is picking up speed.

It is hard to believe that in the early 1990s the Internet was little more than an academic domain, and the World Wide Web was almost unheard of. The rapid emergence of the Internet as a new medium for universal communication is at the center of the shift to Webtone, which is now at about the same stage of evolution the telephone system reached more than half a century ago, when bulky black handsets, operator-placed calls, party lines, and bad connections were the norm.

With simple Internet access—the primitive Webtone we have today—it takes time to connect, navigate, and download graphics and files. Access to audio resources is improving, but, with streaming media software still in its infancy, video content is hard to find and usually of low quality. If traffic on the Net is heavy, as it often is, your session may slow to a crawl or stall as you experience the World Wide Wait. You may even be thrown off the network.

The promise of the Webtone experience is tapping into the dependable flow of all forms of digital information, but navigating the Web today is a far cry from the convenience, comfort, reliability, and simplicity we have come to expect from a dialtone connection. Webtone interaction has to become dynamic and flexible, with easy access, high quality, and security guaranteed.

Delivering Webtone means providing real-time Internet-based multimedia services with the speed, capacity, ease of use, reliability, and integrity of the telephone network around the world and to do it in a way that makes accessing the Web commercially successful and economically viable for service providers. It is the greatest challenge for service providers the global communications industry has ever faced. At Nortel, our goal is to help make the Webtone experience a reality by leveraging our core competencies in key technologies and our experience in designing and developing resilient, survivable, and self-healing digital networks.

The Fundamental Transition

The shift to Webtone has been two decades in the making. The deployment of digital infrastructure over the past twenty years set the stage, and, in 1996, the industry reached a crucial turning point. For the first time, the volume of data traffic on carrier backbone networks exceeded the volume of voice traffic. That historic event signaled the fundamental transformation of networks dominated by voice communication to networks dominated by data. Data networks are the foundation for Webtone.

Data traffic is growing ten times faster than voice, more than 30 percent per year versus 3 percent. At this rate, data will account for nearly 80 percent of all backbone traffic by the year 2000, making voice networks with data overlays an outdated concept. Data networks will carry voice as one among many applications.

The phenomenal growth rate of data communication is creating many challenges for the telecom industry and is already having a noticeable impact on network design. Current architectures are fundamentally inadequate for the growing demand we see coming from the business community and the expectations we all have of what we want our networks to do for us.

Network designs are not capable of supporting 100 percent growth in traffic year after year. Traditional design approaches and separate networks to handle voice, data, and video are becoming obsolete. The Internet is going to be pervasive in all our networks, and the Internet was not designed to carry real-time audio and video streams.

In terms even of today's needs, the capacity of the network is not engineered properly, the reliability of the network is not built to the standards dialtone users have come to expect, and the worst part is that few service providers—from ISPs to long-distance carriers—make money from the Web. Margins, when they exist, are very thin.

To solve the economic and engineering equations, more simplified multimedia data networks will have to be constructed with virtual circuits in gigabit and eventually terabit-class routers, servers, and super-fast switches using asynchronous transfer mode (ATM) and Internet protocol (IP) technologies at their core. These intelligent networks will create pathways that allow simultaneous e-mail transmission, videoconferencing, Web access, and many other services.

We are moving from the current gatekeeper type of network intelligence that allows users to do things within strict rules and at fixed prices to a gateway intelligence that puts the user and the user's applications in charge.

We are already seeing a shift from traditional switched and routed networks to IP and ATM networking, with hybrid architectures that will let networks deliver different levels and qualities of service to many different types of users with different network needs. We have to pay far more attention to personal needs, shifting our thinking and network planning from the group to the individual.

Network-management systems will have to allow storing, filtering, and mobility. Much more information will be moving around much faster, and people will need advanced software tools and access devices to sort through huge amounts of data to find the information they need. Gateways will give users the power to choose how they want to connect and interact with the global flow of information.

In this environment, service providers and their suppliers face a range of challenges and opportunities. Traditional public carriers, with long-established networks engineered to optimize voice communication, have some of the biggest challenges to overcome. They have to cope with rapidly changing technology, new demands from corporate customers to deliver much more network capacity, and, with global deregulation, a slew of fast-moving new competitors offering advanced high-speed network solutions.

At the same time, advanced solutions are being provided more and more cheaply. Moore's Law that the transistor density and processing power of microchips doubles every eighteen months has defined the trajectory of the computing industry. A similar phenomenon in telecommunications means that the cost of transmission is more than halved roughly every eighteen months. This has been going on since Marconi received the first transmission across the Atlantic. Now the cost of hauling information around the world is becoming trivial. Network capacity—bandwidth—is becoming abundant and relatively inexpensive.

The force behind all this is a dramatic advance in fiber-optic technology. Nortel, for example, has commercially deployed OC-192 networks, which carry voice and data traffic at speeds of 10 Gbps. Using multiwavelength-optical-repeater systems for dense-wavelength-division multiplexing, the system can support up to sixteen wavelengths, letting customers expand their network capacity to 160 Gbps. That drops the cost of carrying bits by about 40 percent, making Internet traffic more cost-effective for long-distance carriers.

To meet the future needs of its customers for data, multimedia, and voice communications, MCI recently put live customer traffic on an OC-192 system over a 170-mile stretch of its network in California, using eight wavelengths to deliver 80 gigabits—80 billion bits of information—down the fibers every second.

To appreciate that kind of power, consider what an OC-192 system is doing for Qwest Communications, a carrier's carrier in the United States. Qwest's network can carry 25 million voice calls simultaneously along two dozen pairs of hair-thin strands of glass. In the future, the network's power can be boosted to terabit speeds, moving more than two trillion bits per second. That is the equivalent of transmitting the entire contents of the U.S. Library of Congress across North America in 20 seconds. Qwest will use its capability to haul tremendous amounts of voice and data at low cost to break through the 10-cents-a-minute long-distance price barrier.

WorldCom, Inc. is also deploying OC-192 networks in the United States and Europe, helping reshape the economics of the telecom industry in the process. In a little over ten years, WorldCom has become a $7 billion corporation ready to take advantage of the convergence of the Internet and telephone communications. Its takeover of MCI sent shock waves through the industry, offering a new value proposition that challenges both traditional telecom business models and assumptions about how cyberspace will evolve.

Challenges for Suppliers

For suppliers like Nortel, the transition to data networks and the move to Webtone has created many challenges. Internally, we have to understand the fundamentals of network transformations and the new critical elements such as policy engines and closed-loop feedback network control.

In the marketplace, we have to maximize traditional customers' investments in existing networks and build advanced networks from the ground up for new competitors driven by entrepreneurs with innovative marketing visions. We have to expand the capacity of network backbones, work on improving mass-market access to high-speed data networks, and develop new means of creating services such as reliable electronic commerce.

Much of Nortel's current engineering effort is dedicated to making the Internet a more satisfactory experience for users and a better economic proposition for service providers. There are more than forty Internet-related initiatives for product and business development underway. Ranging from IP telephony product and services to Internet-related network solutions, these programs cross all the company's major products and lines of business.

For traditional carrier customers, Nortel is responding to the promise of the Internet with offerings such as Internet Thruway, a solution to the congestion problem caused by Internet traffic on networks designed for voice. A Nortel spin-off, Entrust Technologies, is delivering data-security solutions to financial services and other industries, enabling more secure Internet transactions. We are supplying leading-edge, sophisticated intranets to enterprises worldwide with the networking and security technologies they need to move from traditional e-mail and file-transfer applications to more advanced real-time voice, video, and multimedia communications.

More than 5,000 scientists, researchers, and administrative personnel at the Argonne National Laboratory near Chicago use a Nortel ATM-powered network to move billions of bits of data per second between the thirty-five buildings on its campus. The network's broadband multimedia capabilities let researchers walk inside simulations of molecular structures, witness the inner workings of a nuclear reactor, test new superconducting materials, and build the world's most advanced x-ray system for research, the Advanced Photon Source.

Nortel built a network for the Dallas Cowboys football team that connects fans, business affiliates, and sponsors. Business-to- business transactions can take place as fans take virtual-reality tours of the stadium, check out stats, and order tickets and merchandise. With VIP private-network access, visitors can access scouting reports and video clips from the archives, have real-time chats with players and coaches, or tune into live streaming video of the team's games. That is the kind of network richness, variety, and flexibility that will move to the public communications network as Webtone evolves.

Webtone networks will start in enterprises where the communications needs are greatest and the investment funds to make the enterprise more productive are available. At Nortel, we are building a Webtone network for ourselves that meets our own standards of performance, then applying the lessons learned to all our products and services so we can help our customers get better value from networking technology.

Nortel is also leading the way in expanding network capacity. We are mining the potential of photonics, developing the core technologies and lead applications for the key elements of all-optical networks, including optical amplifiers, multiwavelength transmission systems, optical cross-connects, and systems for network management and control. All-optical networks have the potential to deliver the huge capacities, networking flexibility, and low network costs needed to support volume deployment of high-speed data services and broadband multimedia services.

Apart from deploying leading-edge fiber-optic networks to service providers, including Qwest, WorldCom, and MCI, we are supporting several initiatives to speed up data networking. For example, we have invested in Juniper, a Silicon Valley company that plans to ramp up Internet communications by combining advanced chips with a new breed of switch router that can process billions of bits per second.

We are also participating in a consortium of more than 100 universities, government agencies, corporations, and other institutions developing what has been termed Internet2. This next-generation Internet will handle multimedia applications a hundred to a thousand times faster than today's Internet, allowing the Net to become the primary medium for business globally.

Complementing our participation in Internet2, Nortel is part of the MIT Internet Telephony Consortium working on the technical, economic, strategic, and policy issues arising from the convergence of telephony and the Internet. The consortium is nurturing new forms of integrated multimedia communication that use the full capabilities of broadband networks.

These networks will demand new forms of access that overcome today's bottlenecks, particularly in the last mile of access to the network from homes and businesses now provided mainly by coax cable or copper wires designed for analog transmission. Cable modems, hybrid fiber/coax, and compression technologies such as digital subscriber line (DSL) enable these networks to deliver high-speed broadband services. Wireless and satellite systems may also bridge the last mile cost-effectively.

Nortel recently announced two developments that bring affordable high-speed Internet access closer to reality. First Nortel's 1-Meg Modem service is a practical, plug-and-play, high-speed solution that is as easy for consumers to install as a modem. Connect it to the telephone network and the service delivers a secure, always-up connection that is seventeen times faster than a 56 K modem. No more dialing, no more busy signals, and no more slow downloads. Users can connect to on-line services at one million bits per second, with simultaneous voice service over a single standard telephone line.

We have joined forces with Rockwell Semiconductor Systems, the worldwide leader in mass-market modem chipsets, to interwork the 1-Meg Modem solution with Rockwell's consumer digital subscriber line (CDSL) chips. The partnership will help establish the industry standard for one-megabit modems, speed the delivery of high-speed Internet access to mainstream consumers, and accelerate the demand for new services.

Second, as a practical, low-cost solution to the problem of high-speed Internet access in Europe and Asia, Nortel and the United Kingdom-based Norweb Communications jointly developed a way for data to be transferred over electrical power lines at speeds of over one Mbps—more than ten times faster than ISDN. This technology breakthrough will accelerate Internet take-up in Europe and Asia, stimulating electronic commerce, telecommuting, Web broadcast media, and Internet telephony on a mass-market scale.

In partnership with Shiva Corp, we have created a remote-access platform with carrier-class reliability to help satisfy end users who want to access the Internet from out-of-the-way locations. We are also developing friendlier ways to tap into the Internet, leading the trend towards a variety of devices to meet personal needs, rather than separate devices—computers and telephones—for communicating with data or by voice. By integrating Java-powered chips, we are creating full-feature Webphones people can use to send and receive e-mail, and browse the Web as easily and transparently as today's telephones use the voice network.

Finally, while developing new technologies, products, and services, we also have a major opportunity to interconnect what is now a largely incompatible mix of data, telephony, enterprise, wireless, satellite, cable-TV, and other networks.

Integrating networks on a global scale is a complex business. It requires competence in dealing with a range of technologies such as photonics, software-system design, silicon, digital signaling, and wireless. It requires advanced skill sets in such areas as network engineering and traffic management. By leveraging our strengths in all these areas, Nortel is helping to weave a world of diverse networks into an integrated global infostructure that can carry any type of information anywhere in the world simply, quickly, and reliably.

The Network is the Business

What makes these tasks more urgent is the rapid rise of the networked global economy. Globalization and digital technologies are transforming business in powerful ways. What is emerging is a new international system running at speeds that few imagined possible several years ago. The global information economy operates twenty-four hours a day, constantly switched on, constantly channeling a real-time flow of instantaneous international transactions.

Because of the power of networks, people are thinking differently about how they run their businesses—where they put their work force, how they build their teams, and how they serve their customers. Networks and applications can bring people and information together in virtual companies that span the globe. Many are realizing that corporate networks are powerful engines for growth, enabling cost-efficiencies, greater productivity, and competitive differentiation. The changing dynamics of how information is communicated and used is also leading many companies to rethink the strategic fundamentals of their business, their business models, and value propositions.

But there is a growing performance gap between the needs of business and network capabilities. The telecom technologies that connect computers have advanced dramatically, but with the expansion of intranets and extranets, network applications have expanded beyond simple data exchange and the sharing of peripherals to encompass client-server computing, Internet access, multimedia, videoconferencing, and remote access.

More and more users of corporate networks are moving off-site, for example. As resources are more widely distributed, the distinction between local-area and wide-area networks is becoming blurred. People are coming to expect the same level of service whether they are in the corporate head office or working from home. The increasing number of users and locations, combined with more complex interactive applications, can limit a business's ability to leverage the full potential of network technology.

Downtime is also becoming a critical issue. The standard for telephone networks is a couple of hours of downtime over

forty years, but some router-based data networks measure downtime in hours per month, sometimes per week. Some data networking companies claim proudly that they can get their systems back up and on the air within four hours. Networks are not supposed to go off the air.

Overcoming such limitations is not just mission critical anymore, it is business critical. Networks are more distributed, complex, and pervasive. Everything is on the network today—production schedules, design files, purchase orders, sales quotes, financial results, and human-resource profiles, to name a few. In a very real sense, the network is the business.

Nortel, for example, depends on a very high-performance ATM- based global corporate network that manages voice, data, and video traffic between 60,000 people and their PCs and workstations at more than 250 locations around the world. The network connects employees, management teams, research and design labs, manufacturing operations, and many customers, partners, and suppliers.

The network and its many interactive Web-based applications are essential to our operation as a global corporation. When Nortel expands into a new country, we get the network in place before we ramp up our research and design efforts and start hiring the sales people. Without the network, the operations staff, researchers, and the sales force will not be productive.

This network has had a far-reaching impact on the way Nortel does business, well beyond impressive productivity gains and cost savings. It has made us a more effective and efficient company, moved us closer to customers, and made us much more flexible in responding to the needs of the marketplace. The network has overturned old command-and-control structures by enabling a flattened, fluid, and fast-moving organization. We are constantly creating cross-functional teams focused on specific opportunities, with the network encouraging greater collaboration in defining the solutions our customers need.

Nortel is not alone in its dependence on networking technology for critical business applications. Boeing Aircraft cut two years and millions of dollars off the creation of its new Boeing 777 by using a highly-integrated, global, multimedia network. The Ford Motor Company's intranet connecting 80,000 professionals worldwide has redefined the company's culture and the way it does business. And consider Federal Express. Is it a courier service or a communications network? Would it even exist without the network?

Beyond creating entirely new network-centric businesses and recreating internal business processes, networks are also driving major changes in the marketplace. The network is clearly the business for any organization using the Web for electronic commerce—booksellers, airline-reservation services, even computer manufacturers.

The exponential growth and diffusion of the Internet and other high-speed, interconnected global networks are providing new ways to conduct commercial transactions, generate new markets and revenue streams, lower transactional costs, and forge new relationships between businesses and consumers. Business to business commerce may account for most network transactions in the near future and drive the widespread acceptance of the technology, but electronic commerce opens up global markets of millions of potential customers to even small entrepreneurial firms while providing consumers with considerable benefits in the form of more choice and greater access to goods and services.

Even the most pessimistic analysts forecast that today's embryonic electronic-commerce market will grow by a factor of ten by the year 2000. By the turn of the century, some 75 million Web shoppers could account for on-line revenues of more than $150 billion.

The Web is already a great vehicle for one-to-one marketing, and when the individual becomes the point of purchase, what companies sell, how they market their goods, and how they deliver the merchandise all change. Traditional middlemen are being increasingly bypassed. Customers can access information and make transactions in a variety of new ways. Cyber-communities of car buyers are emerging to negotiate fleet purchase rates. Some individuals are sending their requirements to multiple car dealerships, with the best bidder making the sale. Rather than dealing with a sales rep who may know the general features of the fifty cars on the lot but not be of much help when it comes to specifics, you can also access a manufacturer's Web site, check out the specs, and even look at some engineering drawings before you head to the showroom. As Webtone evolves and bandwidth—communications power—increases to allow 3D displays, Web sites will acquire the depth and feel of real experience. Then why go to car dealerships at all when you can take a virtual test drive, configure the vehicle on-line the way you want it, and have it delivered?

With Webtone, the potential for electronic commerce increases exponentially. But as global multimedia networks develop, the policy frameworks that support electronic transactions have to be reevaluated. For e-commerce to thrive, secure and simple global electronic payment systems must be in place, raising new challenges in terms of cryptography and the security of the electronic environment, certification mechanisms, fraudulent and misleading conduct, user and consumer privacy, use of personal data, consumer redress, and international cooperation.

Neither businesses nor consumers will embrace electronic commerce unless they can be sure their interactions over open networks are reliable and secure. They must have confidence that their transactions will be safe and private. When the network is the business, we have to make sure networks have the security, as well as the capacity and reliability of service to support applications that meet future needs and make businesses more competitive in the dynamic global networked economy.

Realizing the Promise

Although there is still much work to do and many obstacles ahead, the promise of Webtone is being realized. Optical capabilities are transforming public networks optimized for voice into a global broadband multimedia platform that supports electronic commerce and services such as distance learning, telemedicine, telecommuting, videoconferencing, home shopping, and home entertainment.

In education, new ways of teaching and learning are already being created as networks let students access the Internet, send e-mail, transfer data files, and access global libraries, while teachers and administrators hold desktop videoconferences. With Webtone, students, educators, alumni/ae, and families will be able to participate in new kinds of enriched educational communities.

Networks with broadcast-quality video are already improving healthcare delivery by enabling remote diagnosis and linking physicians with outlying facilities to exchange x-rays and share medical files and ideas. With Webtone, providers of home healthcare will be able to check a patient's pulse, blood pressure, and heart and lung sounds, all from miles away.

As the Webtone experience evolves, the changes in the way we communicate and exchange information will rearrange the social and political maps of the world, our daily work, and our personal lives. The move to Webtone is on a fast-forward trajectory. The communications industry spent over a century making voice dialtone connections widely available and convenient through a variety of networks. It took less than a decade and a half from the arrival of the PC for almost everyone in business to have computing power on their desktops and to be connected internally and externally through LANs and WANs.

Technology advancements are coming on stream at ever-increasing rates. Even three years ago, audio, video, and telephony over the Internet were fanciful ideas. Today, they are close to becoming a standard part of the media fabric. The rate at which people adopt and adapt to new technologies and applications is even more stunning. It took about two years for the world to go from having access to virtually no Web pages to be able to explore 150 million of them. By the turn of the century, a billion pages will be available.

Bandwidth capacity is expanding all over the world, with undersea optical fibers linking continents and satellite arrays reaching the most remote parts of the planet. Corporate networks are proliferating and almost as many new public networks will be built by 2000 as have been built in the last hundred years. By 2000, the amount of traffic on public and private networks is expected to increase tenfold, with most of the traffic associated with high-speed data, video, and interactive multimedia applications.

As fundamental issues of capacity, reliability, security, and access are resolved, the industry can make great progress in the monumental task of building high-capacity public data networks that are always in service, have global reach, interconnect with a world of networks, and provide secure, high-speed on-ramps to multimedia information.

For Nortel, the shift to Webtone represents a progressive revectoring to a new direction. It gives us an exciting opportunity to once again transform the corporation, much as the shift to digital switching did in the 1970s and the move to wireless did in the 1980s. We are looking forward to the challenge and the fun of building IP networks with the standards we expect for voice and helping create a new industry.

For the communications industry, the move to Webtone represents enormous challenges and equally enormous opportunities. The industry is on a journey that will lead to places we cannot even imagine today. The ultimate value of this journey is that people will have more choices and more opportunities to connect with others and exchange ideas on a grand scale. That is the opportunity all of us face as we complete the historic move from dialtone to Webtone.

Broadband Access Takes to the Air: A Solution to Exploiting the Information Superhighway

William J. Rouhana, Jr.
Chairman of the Board of Directors and Chief Executive Officer
WinStar Communications, Inc.

Often confused with mobile cellular services, the fixed wireless communications powerhouse is the next step in evolving local loop technologies. If all goes according to schedule, in August 1998 a new optical fiber submarine cable called Gemini will be lighted. Its purpose is to reduce Internet traffic congestion between the United States and Europe. Writing in *The European,* Nicholas Moss states that the first Internet submarine cable should make Web pages load faster and e-mail move more efficiently.

Writing in *Forbes,* Howard Banks describes the "Law of the Photon" as tremendous increases in optical fiber transport capacity, allowing high-speed transfer of voice, data, video, and multimedia between users. There is no doubt that optical fiber backbones have supplanted first, copper then successively microwave and satellite services for long-haul high-bandwidth traffic both nationally and internationally. Technology advancements such as wavelength division multiplex are packing more capacity into thinner-than-hair fiber strands. The capacity of the four fiber strands in the Gemini cable, for example, will accommodate 1,500,000 simultaneous telephone conversations—although its purpose is to carry not voice, but Internet traffic.

Meanwhile, other press accounts report on the construction of optical fiber local loops by both incumbent and competitive local access providers. These loops serve, for the most part, high-density commercial areas in the nation's business capitals. Firms operating in buildings served by these loops are "access advantaged" because they can enjoy all the promises of the law of the photon. Chronicles such as these suggest that at least the developed world is rapidly becoming fiberized, and that rapid access to information will be as much taken for granted as electric power. But to thousands of small-to-medium-sized businesses, accessing Web pages and other resources of the information superhighway is like experiencing a brownout. Indeed, the cartoon character Dilbert calculated that all the supposed productivity enhancements of Web access are offset by the time wasted waiting for Web pages to download.

Missing: Ubiquitous On-Ramps

The challenge to full exploitation of the global information superhighway is neither the Internet nor broadband optical fiber backbone networks. It is cached in the words "high-speed local access," otherwise termed the "on ramp." This condition prevails despite the promises of telecom deregulation and the Telecommunications Act of 1996.

The challenge is not indigenous to the United States, and it is not universal. It is faced only by those users—including thousands and thousands of businesses—who are housed in facilities beyond the broadband optical fiber local loops operated by incumbent or competitive local exchange carriers. There is a term for these users—they are "access disadvantaged."

There is no argument that this condition has a negative impact on productivity. Businesses in buildings without broadband interconnection to the superhighway operate at a disadvantage to those in buildings with it. Right now, it is estimated that within the nation's top fifty markets there are between 10,000 and 12,000 office buildings of greater than 100,000 square feet that can be classified as access disadvantaged. Another estimate says that 75 percent of the nation's office buildings depend on outdated copper for access. Lost productivity among those buildings' tenants can be measured in the slow speed with which they can access the resources of the Internet or even their own remote databases. Lost productivity is measured in the frustration factor that rises in direct proportion to the importance of speed in accessing or exchanging data. Or in the inability to participate fully in distance learning or collaborative research.

Owners of access-disadvantaged buildings are at a competitive disadvantage when it comes to attracting tenants demanding an intelligent infrastructure. The challenge is not unrecognized. John Mayo, as president of Bell Labs, commented that the goal of network architecture is to have access to voice, data, and images in any combination anywhere at any time and do it with convenience and economy. John Bernstein, chief technical officer, Telecommunications Intellectual Systems, stated that

the last 1,000 feet is the challenge facing multimedia application. Despite this, however, there is a general ignorance of the challenge on the part of the general populace and the investor community. One reason is the intense media focus on the nation's burgeoning long-haul optical fiber plant.

From the perspective of incumbent local exchange carriers (ILECs), providing universal fiber access is economically prohibitive. With billions invested in what futurist George Gilder estimates as 43 million tons of copper wire in their local loops, they respond by workarounds such as software enhancements and call it digital subscriber lines. They may respond with fiber when competitive local exchange carriers (CLECs) come in and run fiber rings in the commercial centers of large cities.

Both ILECs and CLECs are in a capital-intensive business, acquiring rights of way, digging up streets, and laying the fiber cables. Even with their basic fiber infrastructure in place, it costs an estimated $40,000 and takes sixty days to provide an off-ramp from the fiber ring into a building. Added to the inability or unwillingness of telco service providers to meet the challenge are the broken grand promises of convergence—the melding of telco and cable television networks to deliver multimedia to the doorstep and desktop of America's homes and businesses.

Digital Broadband Fixed Wireless Service: An Alternative Solution

In an address before the International Engineering Consortium's 1996 Executive Council ComForum, George Gilder said, "don't solve problems—pursue opportunities." The opportunity to provide high-capacity local access to buildings off the fiber loop was occasioned by the FCC's granting of licenses to utilize certain portions of the radiofrequency spectrum. Called digital broadband fixed wireless service, the solution uses ultra high frequency–broadband radio, such 38 GHz, to provide direct interconnection between any building and the nearest telco-operated optical fiber ring.

Once digital broadband wireless service providers gain roof rights to place antennas, service can generally be provisioned to that building's occupants within two weeks, and at a fraction of the cost of deploying fiber. As another example of deployment speed, these services were made available in New York City within nine months of the carrier, WinStar Communications, Inc., receiving authorization from city regulators.

Moreover, the solution is being used not only by end users but also by ILECs, CLECs, regional long-distance carriers, and Internet service providers as well. These organizations view it as an economical alternative to deploying fiber plant or as an alternative routing solution to enhance their networks' reliability. Being airborne, connections are not susceptible to severing or damage by backhoes, other construction-related activity, or earthquakes.

The Service Defined

As promising as it is, the technology is frequently misunderstood, a condition stemming from the use of the word wireless. In today's popular frame of reference, the term suggests mobile cellular phones, paging systems, mobile-data-radio-enabled laptops and certain types of plain old telephone service (POTS). Among other segments of the population, it conjures up images of radio or television.

Most wireless services today are cellular in nature, a technology that supports users moving about while continuing to enjoy access. Service providers construct "cells" depicting, if looked at from above, a honeycomb. Each cell is served by a base station that captures airborne signals from the mobile phone, pager, or laptop user and relays them into a terrestrial network to either a fixed or another mobile device. These narrowband services are designed for voice and low-speed data. Connection reliability, while improving, can be sporadic especially in outlying areas.

Wireless local loop services can serve business and residential users. Instead of running copper wire to the users—such as to each house in a residential development—service providers install a base station in the neighborhood to serve all residences. Digital broadband wireless service, in contrast, is at present a line-of-sight, point-to-point service designed for high-speed wideband communications. In this sense, it is similar to optical fiber. Only instead of connecting points through underground conduit, the service takes to the air.

In 1998, new radios will be deployed that support point-to-multipoint service. Among the benefits will be data rates to 1.544 Mbps or three times higher than point-to-point technology, more efficient spectrum utilization, lower user costs, and the availability of bandwidth-on-demand.

Performance: Equal or Better than Fiber

Confusion notwithstanding, the performance of digital broadband wireless service is equal to its promise. Transiting between small-diameter antennas on rooftops, this service is a communications powerhouse that equals and can surpass the performance and reliability of conventional optical fiber paths. In the point-to-point configuration, each 38 GHz channel carries the equivalent of a DS-3 (45 Mbps) circuit with a reliability of 99.999 percent, and a bit error rate (BER) of 10-11.

Initial fears of weather-related outages were allayed as the technology passed severe trials conducted by the largest telecommunications carriers in the country. In terms of capabilities, the technology supports every type of communication and every value-added service available today.

Service providers find themselves in a unique market position. Instead of being embroiled in head-to-head competition between ILECs and other CLECs, for example, they can be an ally of both by serving as a conduit to the thousands of bandwidth-hungry businesses beyond the fiber loop. These busi-

nesses are brought into the loop through rooftop antennas accessing a wireless hub site either co-located with or accessible to the nearest fiber optic access node. From there, the traffic accesses the local phone network, the national long-distance networks or the information superhighway. The process can reverse at the distant end. Furthermore, if a building owner elects not to provide broadband wireless as a service to tenants, it can be accessed on an individual basis by companies within that building.

New Industry, New Assets, New Evaluations

The tremendous churn, position jockeying, and merger and acquisition activity that describes the global telecommunications industry is a result of many factors. One of these is the realization on the part of providers that owning facilities is better than leasing them. Another is that ownership can be faster, easier, and sometimes cheaper through buying than through building. For example, it is much easier for a carrier like WorldCom to gain access to end users by buying a CLEC like MFS (and with it, the customer base that makes the whole thing work) than to invest millions in building its own facilities and compete with entrenched CLECs and ILECs for their customers.

A third reason, only recently coming to light, is that the availability of talented personnel to run today's complex telecommunications infrastructures and Internet access points is not inexhaustible. A solution to acquiring talent is acquiring firms on whose payroll it resides. Conventional service providers, therefore, are measured in terms of their plant, facilities, existing and potential customer base, and their technical prowess in addition to their P&L and P-E ratio and revenue flows.

Digital broadband wireless service providers must measure up in these criteria and others as well. Not the least of these is the fact they are breaking new ground—or more accurately, air—by departing from conventional ways of delivering their services. Air may be free but the licenses to use it are not. Nor are the digital antennas, switching systems, billing systems, network operations centers, customer support services, and other infrastructure that enable air to serve as a communications medium. Airborne rights of way are as much an asset to digital wireless service providers as SP Communications' old railroad rights of way, or WilTel's abandoned long-distance oil pipelines, or TCG's licenses to dig up streets and access buildings. An initial evaluation of a digital wireless service provider can be the number of

FCC licenses it holds in a particular radio frequency such as 38 GHz, and the size of the markets that can be served by those licenses.

A second criterion is how many state public utility commissions have granted the service provider authorization to operate as a competitive local exchange carrier within that state. Authorization to provide local service is not a part of the FCC license to use the radiofrequency spectrum. Licenses are useless unless the service provider has inked interconnection agreements with the various local exchange service providers operating in the states where it has secured authorization to provide service. However, since companies like WinStar are viewed more as a source of additional traffic and revenues than direct competition, interconnection agreements generally follow quickly after PUC authorizations.

Installed and available capacity describe a digital wireless service provider's ability to deliver services. A fifth criterion is the number of roof rights acquired for antenna placements. These are secured from building owners within the authorized service area. They are crucial to reaching the customers that provide the revenues that make the whole thing work. Fortunately, most owners of buildings beyond the fiber loop have come to realize the importance of delivering broadband access to their tenants. Even those not so enlightened may face pressures from tenants—especially the entrepreneurial, fast-growing firms for whom broadband digital access is not a luxury, but a necessity—to get connected. Once a building has been connected, delivering broadband services to all tenants is relatively simple and is not unlike the process employed by any other service provider.

Digital Broadband Wireless: The Answer to Access

Of the technologies available today, only digital wireless data possesses the ability to deliver virtually instantaneous access (at least compared to conventional technologies) to the national optical fiber infrastructure and the information superhighway. For end users, building owners and conventional service providers, it is the solution to bandwidth capacity, reach, and reliability. Other technologies are under development. As they are deployed, they will bring something new to the communications spectrum. But for companies whose bandwidth and access needs are large and now, digital broadband wireless is the most viable solution.

A New World Order: Alternative Microsoft Windows Platforms

W.J. Sanders III

Chairman and Chief Executive Officer
AMD

Just two years ago, Atiq Raza, then chief executive officer of NexGen, and I met secretly in the Polo Lounge at the Beverly Hills Hotel, in booth number three to be precise, and agreed to combine our companies. We had a dream in common: to create a family of microprocessors that could bring the virtues of competition once again to the PC marketplace.

Writing this paper is both personally gratifying and humbling. More importantly, it validates the notion held by a growing number of people that what AMD has accomplished to date, and shows promise of accomplishing in the future, can reshape the world order of Windows® computing. The published title for this paper, "A New World Order," is, upon reflection, embarrassingly pretentious. For this I apologize, and would rather suggest that AMD and its partners can reshape the world order for the greater good for the greatest number over the next several years.

We are currently airing a one-minute television spot in the major markets. This commercial, and its predecessor with the exploding truck sequence, are both intended to convey the message that the AMD-K6™ processor is very fast and using K6-based systems is cool. There is, however, another underlying theme in both: that good behavior is rewarded and bad behavior is punished. While AMD's founding, culture, and behavior are based on this premise, the attitude of the commercial is intended to be tongue-in-cheek, not moralizing. In any event, unlike the TV commercial, it will take more than a minute to change the world order.

Arguably, Microsoft and Intel are the two most important companies in the world today (see *Figure 1*). With each company exhibiting a market capitalization in excess of $150 billion, the marketplace recognizes the reality that standards have been created and those proprietary standards—operating systems on the part of Microsoft, and instruction sets on the part of Intel—have enabled an enormous industry. Again, arguably, the PC business is the most important industry in the world and the driving force behind the Information Age that is powering worldwide economic growth.

We applaud the creation of standards that enable market growth. Accordingly, we are an avid, passionate supporter of Microsoft initiatives and aggressively fight on every front

for the right to compete, cooperate, and coexist with Intel to build instruction-set compatible processors. Yes, even cooperate, as evidenced by our participation with Intel and Motorola in the Extreme Ultraviolet Limited Liability Corporation.

Normally, in the semiconductor industry, standards drive costs down. Standards enable volume, which drives the learning curve, and continuous improvement cost reductions. Only open standards do that. In the absence of open standards and competition, consumers will pay a monopolist's tax.

AMD is here to cut your taxes.

Americans are familiar with the phrase, "Taxation without representation is tyranny," although probably less familiar with James Otis, to whom the phrase is attributed. Conversely, most of us are probably more familiar with Ronald Reagan than with his observation that "Taxation with representation isn't so hot either." While AMD cannot free you entirely from the "technology tax" implicit in aggressively advancing the state of the art, we can definitely ease your burden.

The higher and widening market value and multiple that Microsoft enjoys over Intel is in my view largely a result of the significantly higher capital requirements of the semiconductor business as compared to the software business. It takes a lot more capital to turn ideas into silicon than into software or systems.

The price of admission into the arena of high-volume, high-performance Windows compatible PC platforms is high. The ticket price includes the cost of developing and/or acquiring the intellectual property rights, leading-edge process technology, and state-of-the-art production capacity. AMD is the only player with a realistic opportunity to lead in the development of an alternative PC platform for Microsoft Windows computing.

The heart of a competitive platform is, of course, the processor. A competitive processor is essential for anyone who aspires to be the nucleating force around which other essential players, including providers of motherboards, chipsets,

FIGURE 1

Combined Intel/Microsoft Market Value 1989–1997
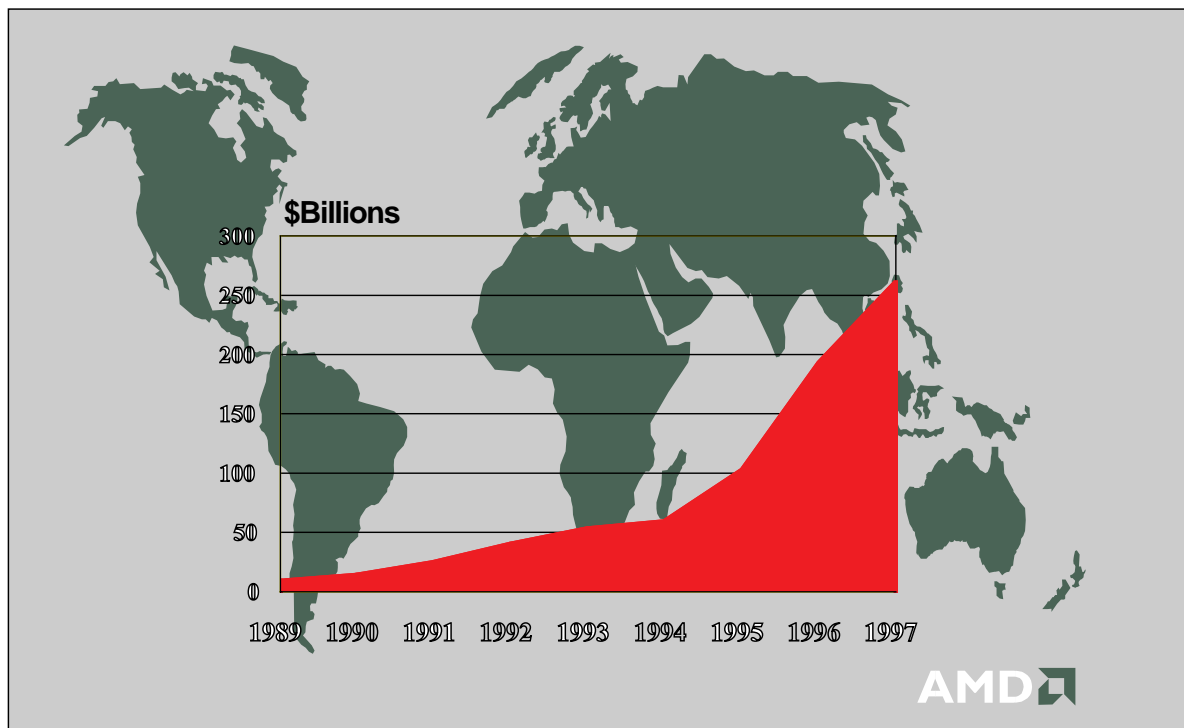
and software, can coalesce to offer an alternative solution. The support of multiple suppliers is essential. In today's environment, at best, a single company can be a nucleating force for a coalition, and that is the role that AMD has chosen to play.

For all of us, the benefits of having an alternative are manifestly evident: competition is good! Competition expands markets, accelerates the pace of innovation, enables consumer choices, and drives down prices. Nowhere are the benefits of competition more evident than in the telecommunications industry, where deregulation and a global competitive environment have accelerated adoption of new technologies, enabled consumers to have an array of choices, and introduced the previously unheard of notion of price competition. In our industry, it is clear that competition from AMD has driven Intel to offer new products and product variations that were not in its original plans or to offer them earlier than planned. To put it another way, the more successful AMD is, the more responsive Intel becomes.

Figure 2 shows the dramatic impact that the availability of competitive alternatives has on processor prices—and the equally dramatic impact of the absence of competition. There is one important piece of information that is not shown on this figure: AMD introduced its AMD-K6 processor family in the second quarter of 1997.

Once AMD had demonstrated volume production capability and begun gathering customer converts, prices came

down more sharply than ever before for a mainstream Intel offering. Competition is good! What are the prospects for achieving a new world order with all of the attendant benefits of competition? As I noted at the outset, it is a daunting challenge. It entails risks. It will require the support of others. It will take courage—not only courage from us, but also from our prospective partners and customers.

Why courage? Intel's dominance is so pervasive that it was hardly a surprise when Intel recently disclosed that the Federal Trade Commission is investigating its business practices. Specifically, we understand the FTC is investigating, among other things, whether:

- Intel uses its dominant position to pressure customers not to work with or buy from Intel competitors;

- Intel attempts to promote and manipulate technical standards that unfairly coerce customers into using Intel chips and components and excluding competitors' products; and

- whether Intel requires customers to sign non-disclosure agreements that are so unduly onerous that they have the effect of excluding competition.

Does Intel do these things? It remains to be seen what the FTC will do. We are not, however, relying on the federal government to provide the alternative platform. We must

FIGURE 2

Intel 1K Pentium Pricing at 200 MHz
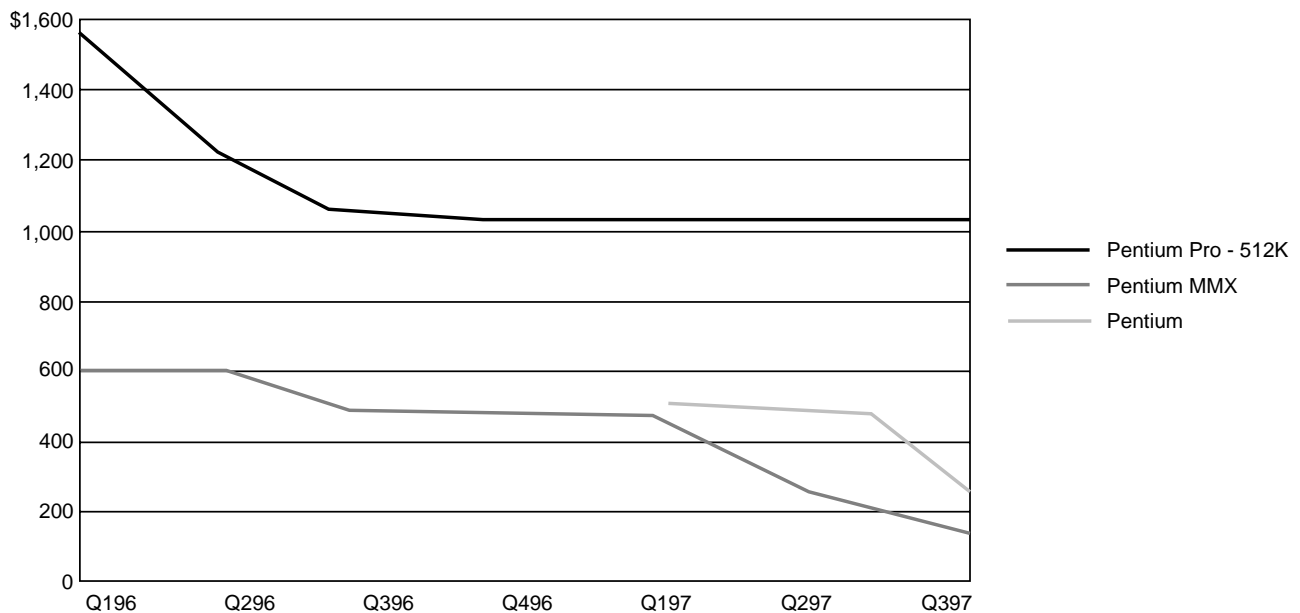
Source: Microprocessor Report

and can bring about a more balanced world order where the industry's profits are distributed more appropriately, based on contribution and not coercion.

But what would comprise a new world order? First and foremost, a new world order means that genuine competition—the availability of alternative platforms—is a permanent, ongoing feature of the competitive landscape in Microsoft Windows computing. To achieve this objective, AMD must establish itself as a solid, number one alternate supplier of processors for Microsoft Windows computing for the mainstream. We must win acceptance from PC manufacturers throughout the world as more than a marginal supplier of processors; we must be in a position to offer an alternative that enables product differentiation and performance advantages and consequently exerts a significant influence on the marketplace. I believe we must achieve a 30 percent unit market share by the year 2001 in order to accomplish these objectives and establish a new, more balanced world order.

While I am an optimist by nature, I am also an engineer who deals with facts and lives in the real world. I recognize that there are many who earnestly desire an alternative platform—and who desire our success nearly as much as I do—who nevertheless are skeptical about our prospects for success. I would like to discuss some of the challenges we face.

Figure 3 shows AMD's actual substantial investment in research and development for the past five years and our projected spending of $450 million for the current year. During this period, approximately half of our research and development spending has been devoted to the development of leading-edge process technology. Our research and development investment has also enriched our patent portfolio. Today AMD holds more than 1,300 active patents, and we are on track to file 1,000 new patent applications this year.

Competitive process technology, closely coupled with design capability, is essential to providing an alternative platform. The mainstream technology in production today is 0.35 micron. We are currently implementing 0.25-micron technology in Fab 25 in Austin, and our next megafab, Fab 30 in Dresden, will be equipped to take us to below 150 nanometers in a time frame of relevance.

For another perspective on the level of investment in research and development necessary to have world-class semiconductor process technology, *Figure 4* compares our expenditures to those of the world's largest personal computer manufacturer, with 1996 sales of $18.1 billion. For most of the period covered, AMD's investment has exceeded that of a systems company—a leading systems company — nearly ten times our size.

FIGURE 3

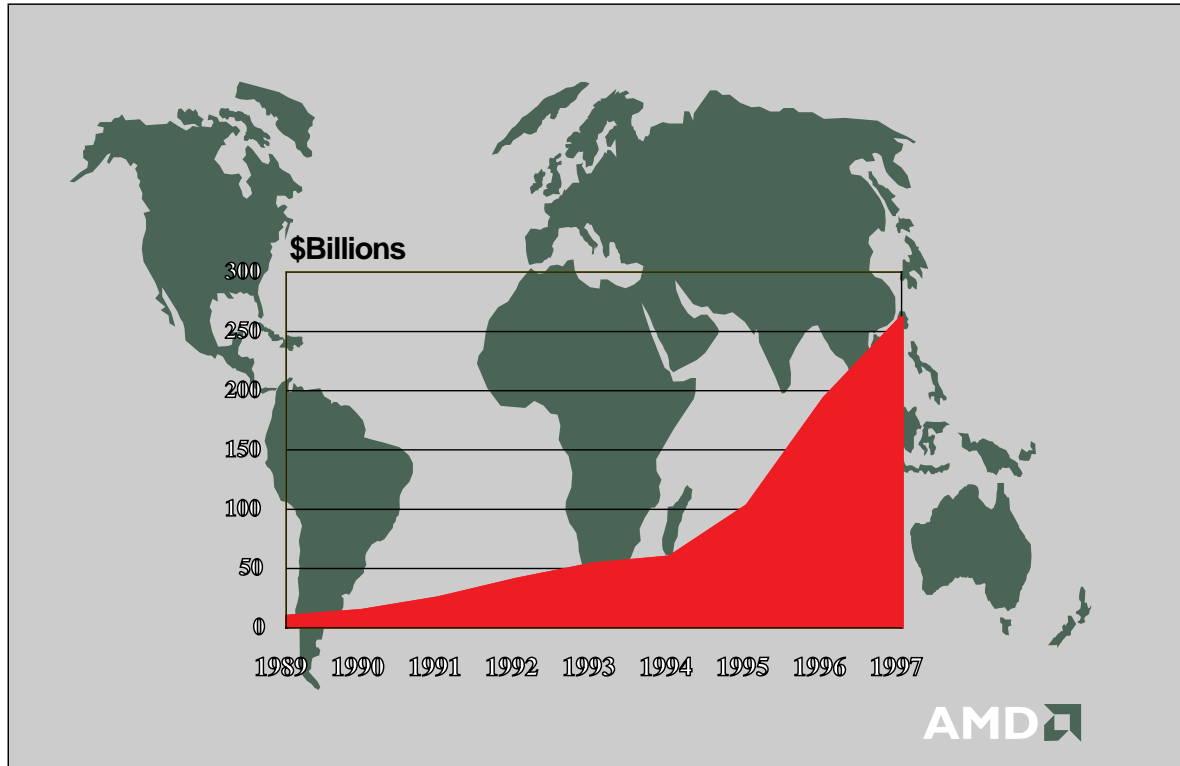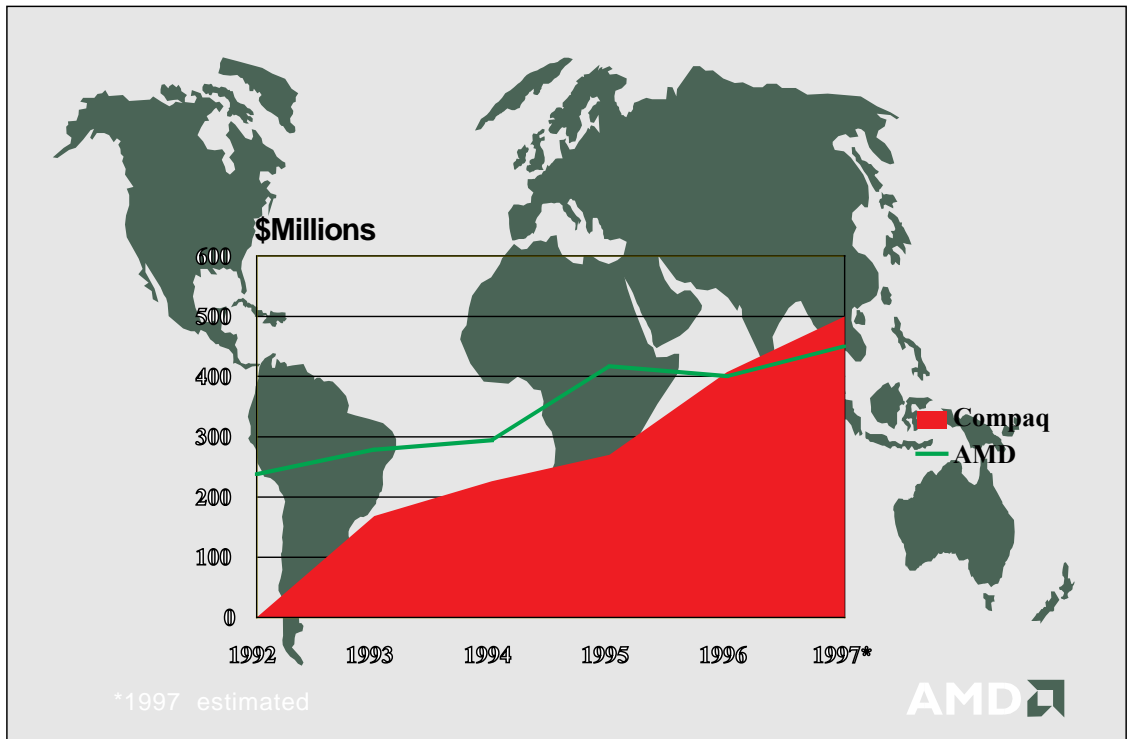**AMD Research and Development Expenditures 1992–1997**

FIGURE 4

AMD and Compaq Research and Development Expenditures 1992–1997

FIGURE 5

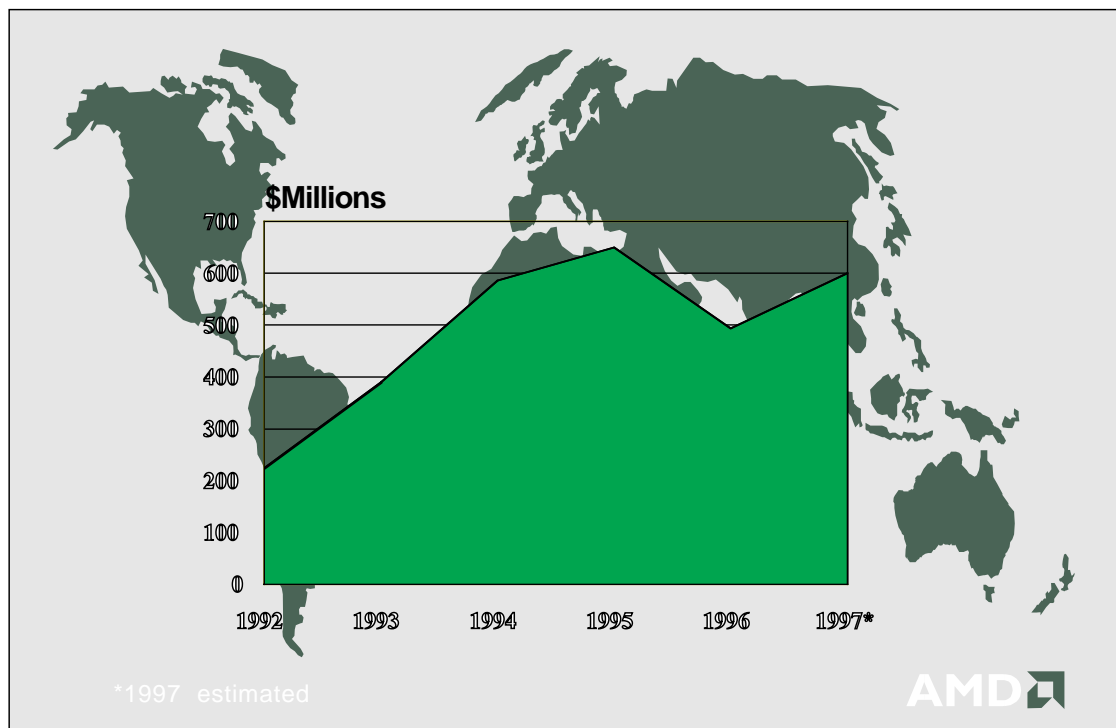**AMD Capital Expenditures 1992–1997**

Figure 5 shows our investment in productive capacity for the same period, the past five years, plus our estimated expenditures for 1997. During this period, our total investment in plant and equipment will amount to nearly $3 billion. This level of investment is essential merely to have an opportunity to compete. Competitive products produced on competitive process technology mean little without the ability to produce them in sufficient volume to affect the competitive environment.

In 1988, during a period of trying times for AMD, ignoring the advice of skeptics, we proceeded with the construction of our principal technology development facility—the Submicron Development Center, in Sunnyvale, California. This facility, which became operational in 1990, has enabled AMD to develop competitive process technology while serving as a pilot line production facility for new products.

We are currently producing AMD-K6 processors in our Austin megafab—Fab 25. We broke ground for Fab 25 in mid-1994, and it became operational approximately eighteen months later. Reflecting the long lead times required to have an opportunity to compete, we began the planning for Fab 30 in Dresden even before we had completed Fab 25.

Construction of Fab 30 has proceeded at a rapid pace. We laid the cornerstone for Fab 30 in May 1997, topped off the structure in September 1997, and we commenced clean-room construction in November 1997 in order to meet our target of starting commercial production in the first half of 1999.

To gain the ultimate perspective on the ante required merely to play in the Windows compatible microprocessor arena, however, you have to look at the combined spending on research and development and additions to plant and equipment. Our cumulative investment in research and development and capital additions from 1992 through the end of 1997 will amount to more than $5 billion (see *Figure 6*). We are making a very big bet that we can compete successfully with an alternative platform for Windows computing.

Figure 7 shows what we are up against. In view of this figure, it probably seems presumptuous that we at AMD believe we can change the world order. Your skepticism is understandable—especially when you look at relative market share. The AMD share of the x86 microprocessor market last peaked in 1992. This was the period when the 386 processor was dominant. The Am386® processor was a very competitive product that was much in demand by customers throughout the world. We also had competitive process technology and sufficient productive capacity to meet the market demand at that time. For AMD, it was a period when we felt we had stepped into El Dorado, the fabled "city of gold." During the past several years, after hacking our way through the courtroom jungles and acquiring the design skills necessary to develop competitive instruction-set compatible processors independently, we once again believe we have an opportunity to return to El Dorado.

Although our unit market share has fallen from about 30 percent in 1992 to an estimated 10 percent in 1997, our dollar

FIGURE 6

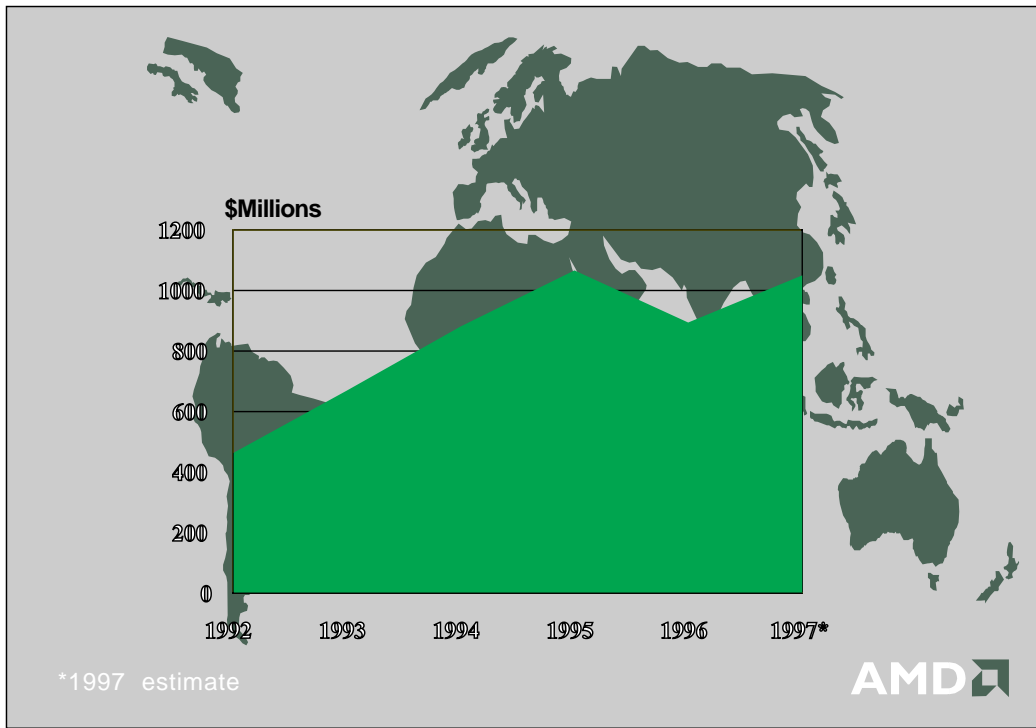**AMD Expenditures for Research and Development and Capital 1992–1997**

*1997 estimate

FIGURE 7

AMD and Intel Expenditures for Research and Capital Additions 1992–1997
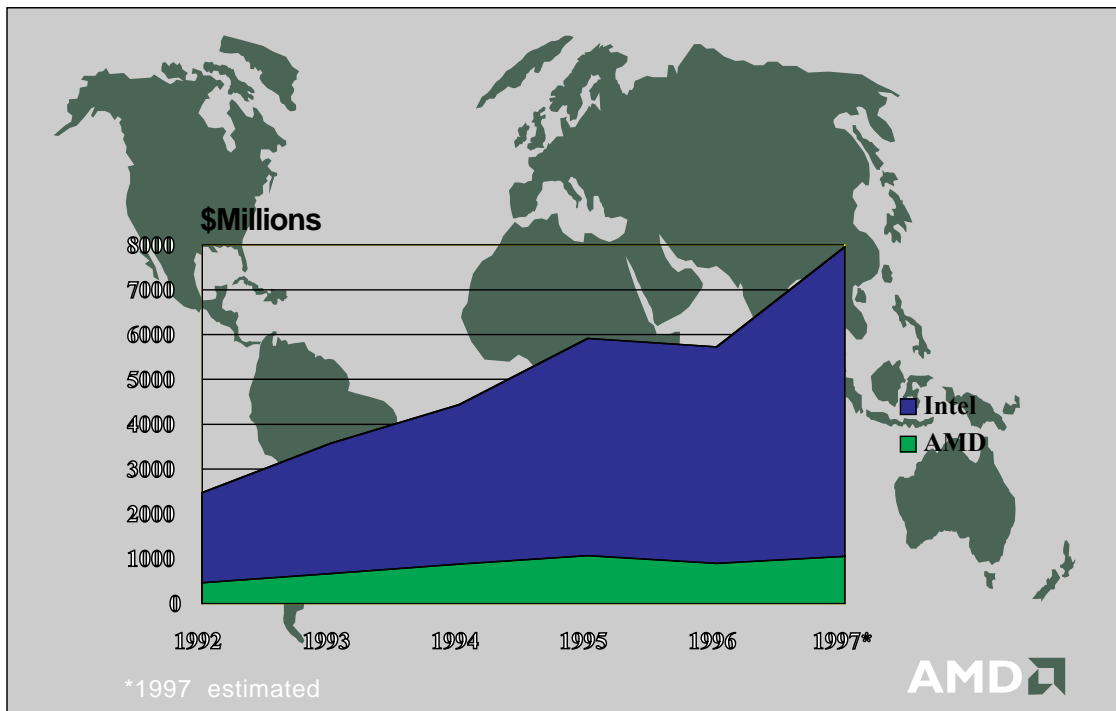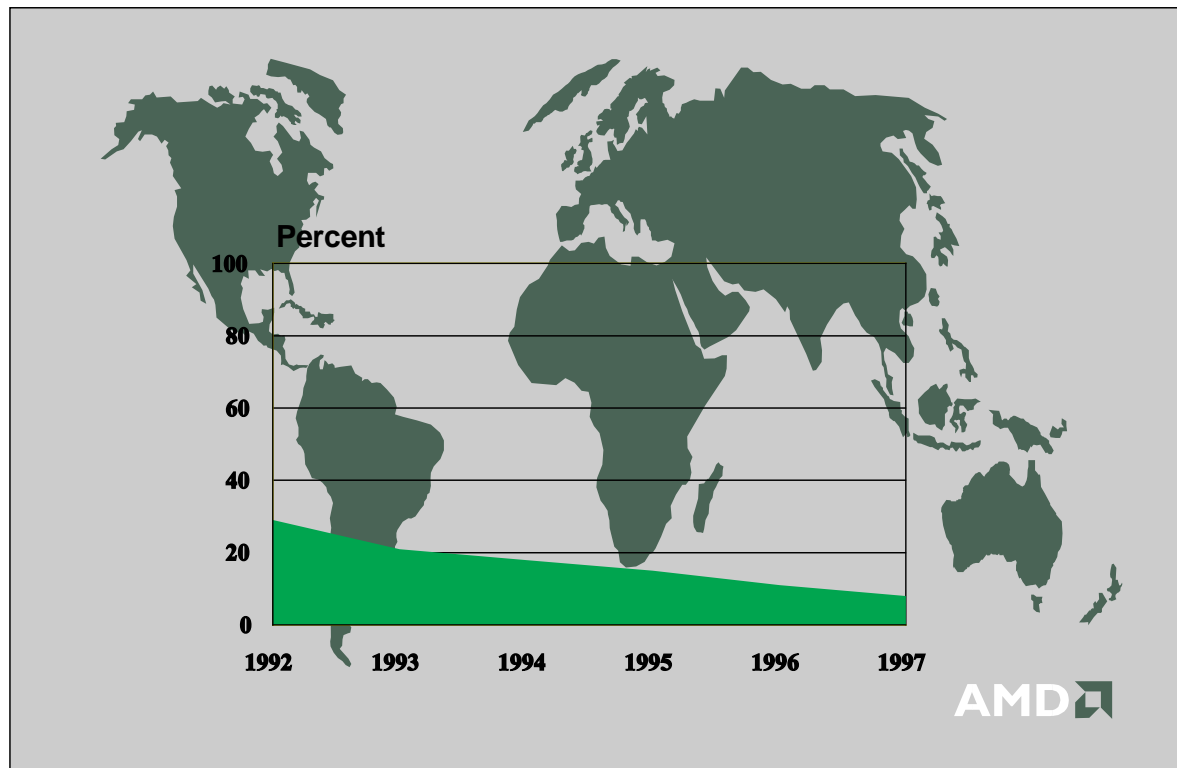

*1997 estimated

FIGURE 8

AMD x86 Microprocessor Unit Market Share 1992–1997

market share will grow this year as a result of a more contemporaneous product offering, which is more than doubling our microprocessor revenues over last year (see *Figure 8*). The AMD-K6 MMX™ enhanced processor has enabled us to offer a compelling value proposition to PC manufacturers and end users in a contemporaneous time frame with Intel for the first time in our history. With a superior value proposition, with the investments we are making in process technology and production capacity, and most of all, with an extremely talented and committed work force, our goal is to be competitive with Intel into the next century.

We recognize that to achieve success in the marketplace and usher in a new world order, we must do so by offering a superior value proposition to customers worldwide. We do. Our strategy is based on offering a better idea. That better idea is the AMD-K6 MMX enhanced processor. We have incorporated better ideas into our K6 processor to offer a better value proposition. These better ideas include a larger level-one cache; local interconnect; C4 flip-chip technology; and shallow trench isolation. These technological innovations enable us to offer more compelling features with a very small die size. Our small die size will enable us to add more capabilities as we go forward.

We have many more good ideas yet to come, which I will describe later in this paper. Unlike the monopolist, whose concern is to defend the monopoly by excluding and vanquishing good ideas that originate elsewhere, our strategy is to unleash and capitalize on the creativity and inno-

vation of an entire industry. No one will ever have a monopoly on good ideas. The continuing success of Silicon Valley start-ups is a testament to that.

In March of 1996, when we commenced shipments of our AMD-K5™ processor, I issued a challenge to the AMD sales force. I told them that we had a window of opportunity of 1,000 days in which to achieve relevance in the PC processor arena. Today, we are approximately halfway through that period. We have less than 500 days remaining. We have a highly desirable product in the AMD-K6 processor today, and we have exciting extensions to that product and the Socket 7 infrastructure coming. Our challenge is to ship 15 million units in 1998. If we achieve that goal, we will be well on the way toward our overarching goals of establishing AMD as a relevant and credible alternative supplier of Microsoft Windows compatible processors and achieving a 30 percent unit market share by 2001.

Here is a snapshot of our planned logic production capacity by technology for the balance of the decade. We are currently in the process of converting production in Fab 25 to 0.25-micron technology, which will dramatically increase production capacity while enabling us to deliver higher-performance products for all members of the AMD-K6 processor family at substantially lower manufacturing costs. We plan to complete this conversion by mid-1998. If we are successful in executing to this schedule, more than 80 percent of our microprocessors in 1998 will be produced on 0.25-micron technology.

With our heavy investments in process technology and production capacity, I believe we can produce enough units to achieve a 30 percent unit market share by 2001, when the total market will be in the range of 140 to 160 million units. AMD has a superior solution for multimedia, which today is the key to gaining market share.

In a recent keynote address at Comdex, Intel's Andy Grove said that "… the platform will continue to evolve from the connected PC of the mid-90s to the visual computing platform of the late-90s." AMD will lead the way with a platform built around forthcoming AMD-K6 3D processors. I believe the consumer platform for both desktop and mobile computing will lead the way to the visual-computing platform of the future. Let me offer a brief overview of our forthcoming extensions to the AMD-K6 processor family and the Socket 7 platform.

First, I would like to discuss how our advanced process technology will enable us to offer higher-performance versions of the AMD-K6 processor while reducing our manufacturing costs. This device is our current version of the AMD-K6 processor on 0.35-micron technology. Operating at 233 MHz, the K6 processor in the Socket 7 infrastructure delivers an unmatched value proposition. Today's Socket 7 platform delivers all of the leading-edge features and performance in a low-cost implementation.

As we move to 0.25-micron technology, the die size shrinks dramatically. This enables us to increase clock speeds to 266 MHz and beyond while reducing power consumption by more than 50 percent, enabling us to meet the power requirements for a compelling mobile computing solution. In addition, with a dramatically smaller die size, we gain an increase in production capacity while reducing manufacturing costs. AMD and our infrastructure partners plan to introduce the first significant enhancement to the Socket 7 platform with the addition of an accelerated graphic port (AGP) capability. This implementation will enable 133-MHz graphics interface.

In 1998, we expect to introduce the AMD-K6 3D MMX enhanced processor with initial clock speeds of 300 MHz and moving to 350 MHz. This processor will deliver a more powerful solution for a superior 3-D multimedia experience compared to any x86 processor on the market in the same time frame. Utilizing new instructions developed by AMD and supported by Microsoft Direct X and leading 3-D game developers, the AMD-K6 3D processor will enable accelerated and enhanced 3-D graphics with full-featured MPEG-2 video and AC-3 sound. We have begun shipping samples of this new chip, code-named "Chompers," to our development partners, and this new set of instructions has had a dramatic impact on Winbench performance by greatly accelerating floating point computations. And, yes, we will license AMD 3D technology to competitors. We believe in open systems and open competition.

Another important feature of the AMD-K6 3D processor will be a 100-MHz, 800-mbps frontside bus. This provides an optimal interface to Super7-based chipsets. In 1998, AMD

and our infrastructure partners plan to introduce another major enhancement to the Socket 7 platform. The addition of a 100-MHz interface to the frontside level-two cache and main system memory speeds up access to the frontside cache and main memory by 50 percent, resulting in a significant system performance increase.

In the second half of 1998, we expect to introduce an even more powerful processor for the visual-computing platform, the AMD-K6+ 3D processor, with clock speeds up to 400 MHz. The AMD-K6+ 3D processor will add 256 kilobytes of on-chip backside L2 cache running at the full speed of the processor while maintaining mechanical Socket 7/Super 7 compatibility. Note that even as we add new performance-enhancing features, the overall die size will remain significantly smaller than our current product.

The advantages of the new Super 7 platform include a 100-MHz local bus; AGP with 133-MHz data transfers; full-speed backside level-two cache for scalable performance; and other performance enhancements—all with the cost advantages of Socket 7. In summary, I believe platforms built on the existing Socket 7 and Super 7 will offer superior performance and better value than competitive offerings through 1998 and into 1999.

Today, the consumer market, with a demand for a richer multimedia experience, is driving the technology for the visual-computing platform. The consumer market is especially attractive to AMD for another reason: given competitive choices, consumers tend to make their purchasing decisions based on value, and this is a criterion that creates a special opportunity for AMD.

With these offerings, AMD intends to establish a beachhead with customers worldwide. If we can establish this beachhead, we will have an opportunity to offer those customers who require even higher performance a solution that takes them to the next level, the AMD-K7™ platform. The AMD-K7 processor will offer industry-leading x86 processor performance. The plan of record at AMD is to deliver the K7 processor in a module mechanically interchangeable with Intel's Slot 1 module. The AMD-K7 processor will enable us to offer products with clock speeds in excess of half a gigahertz, and will feature the ultra-high-performance advanced bus protocol of the Alpha EV-6.

We anticipate volume production of the AMD-K7 processor in 1999. Meanwhile, work has begun on the AMD-K8™ processor. The ultimate success of the AMD-K7, AMD-K8, and future processors will, of course, depend on our success in establishing AMD as a relevant supplier in the PC world with AMD-K6 processors. The products are excellent. We simply must execute.

Our motto for the AMD-K6 processor is, "No matter how much or how little you want to spend, you will get a better PC with higher performance from a K6-based system." With the AMD-K6 family, we have an opportunity to reinvigorate competition in the personal computer industry, with significant benefits for both PC manufacturers and their

FIGURE 9

AMD Microprocessor Shipments
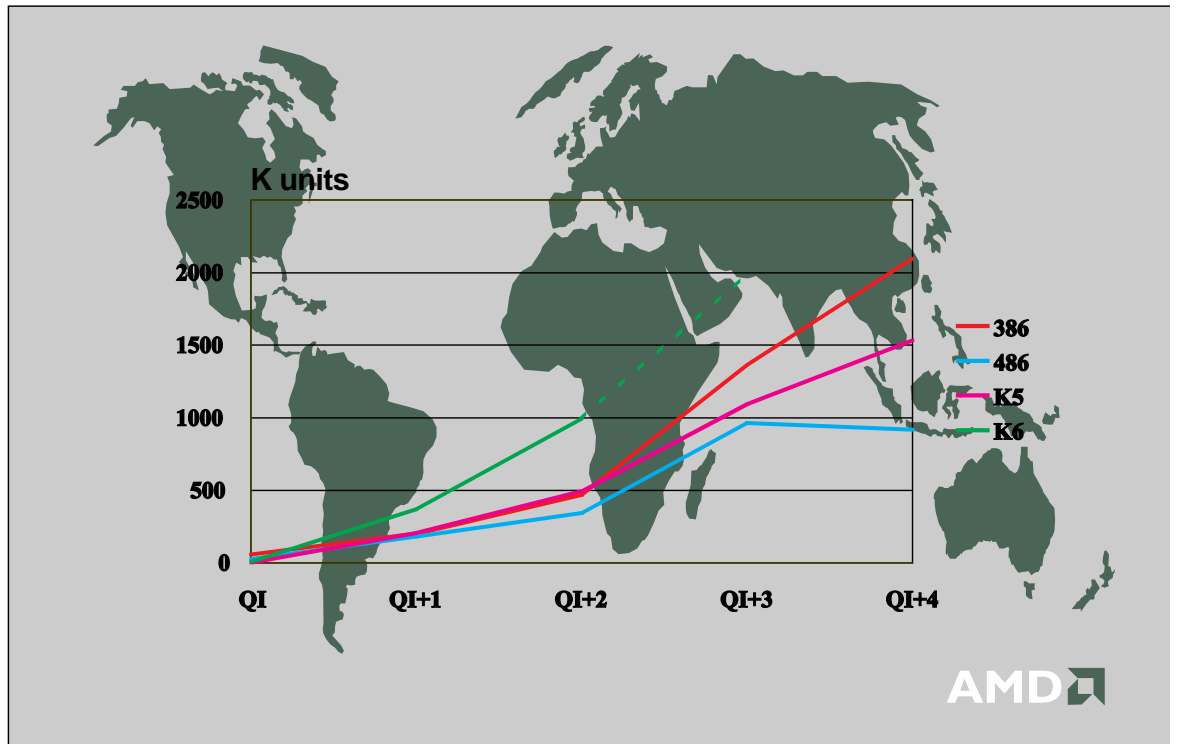
customers. We have once again broadened choices and enabled our customers to offer more value to their customers. AMD 3D technology will give us an opportunity to distinguish ourselves from Intel and lead the way to visual computing platforms that deliver a near-theater-quality experience within the Microsoft Windows standard.

AMD, against all odds, has re-entered the Microsoft Windows computing arena with a better idea. Our customers are yearning for a world where both AMD and Intel compete to offer better ideas, higher performance, and better prices. In that changed world, PC users worldwide will get more choices and more value for their money.

While we are currently struggling to meet demand, *Figure 9* shows that the production ramp for the AMD-K6 processor has to date been the steepest of any microprocessor produc-

tion ramp in AMD history. The second quarter after its introduction, the one million K6 units shipped was twice the number we had ever done in a comparable time frame with any previous microprocessor. All one million K6 processors featured five-layer metal, shallow trench isolation, local interconnect, and flip-chip technology—none of these capabilities was on hand when I first met Greg Favor and the about-to-be K6 design team in January 1996. The level of effort and accomplishment of the combined NexGen and AMD teams in design, process technology development, wafer fabrication, product engineering, and manufacturing services to get us where we are today is a source of the greatest pride for me.

As we have been saying at AMD for more than 28 years, "People first. Products and profits will follow." Believe it.

Buy Local, Go Global: A New Approach to the International Network

Konnie Schaefer

Chairman and Chief Executive Officer
Swisscom North America

While the world's telecommunications press focused last year on high-profile players in the global alliance churn and on European liberalization on January 1, 1998, the good news for multinationals' telecommunications managers was heralded with much less ink. Many incumbent public network operators (PNOs) abroad are acquiring 214 authorizations in the United States in order to provide service from North America to overseas locations. The benefits to managers? Many.

Last October, the UK-based publication *Communications International* carried an extensive article titled "Europe's event horizon" reporting on the January 1, 1998, "opening" of European markets to full competition. The article focused on the fact that interconnection between new and incumbent public network operators remains—and will remain—a key issue from both technical and economic perspectives.

Last year, especially in the latter half, reporters the world around were kept busy following the courtship of MCI. Perhaps "courtship" is the wrong word, but however it is described, it proves that the global alliance lineup is far from fixed.

These two topics—the struggle toward liberalization and churn in alliances—underscore the continuing challenges faced by telecommunications managers in the multinational corporation. Adding to the challenge is the fact that these events are not confined to "global" alliances. They occur among national, regional, and local carriers—some old-line, some new—within the boundaries of Europe, the United States, and other geographic areas.

While such activity keeps headline writers and stationery printers happy, uncertainty as to who is doing what and with whom wreaks havoc on managers responsible for corporate global networks in the here and now. These same managers may wonder where authority resides within an alliance and, often more difficult to ascertain, where alliance members' interests abide. They also wonder, and with ample justification, when and if the much-touted benefits of complete liberalization will materialize.

Help may be found in new strategies being deployed by public network operators in deregulating countries. To take advantage of these strategies, North American managers need to know where the bulk of their outbound international traffic goes, and from which countries abroad the bulk of their international traffic originates.

A New Approach to International Networking

Until recently, international service depended on structuring at least one, and more likely several, bilateral agreements with the domestic and overseas carriers involved in provisioning the circuits. One-stop shopping notwithstanding, no one entity was completely in charge of the circuit. Now, however, three developments have converged that together can greatly simplify managers' abilities to craft network solutions. They are the Telecommunications Act of 1996, the World Trade Organization (WTO) Telecom Accord and liberalization in Europe. While the word synergism may be overused, in this instance there is no doubt that the whole is greater than the sum of its parts.

Although the Act and the Accord have yet to live up to their promises and it is too early to judge the success of liberalization, the potential of all three developments is recognized and is being exploited. It is found in FCC 214 authorizations allowing foreign carriers to establish points of presence in the United States and provide end-to-end service without traditional reliance on bilateral agreements.

For example, a European public network operator that passes the FCC's Equal Competitive Opportunity (ECO) may establish a network node in the United States to collect traffic and distribute it at the distant end, and vice-versa. The FCC has further decreed that when the WTO Telecom Accord materializes as expected, the ECO test becomes moot.

User Benefits

What is different about this? It helps network managers solve one of their thorniest problems: determining end-to-end accountability. It means that responsibility for the first time resides in a single entity, and with a single point of

contact, for service provisioning and quality to and including the most difficult-to-control portion of the circuit: local access or the local loop at the distant end. This is different because, while U.S. carriers have a presence abroad and can compete with incumbents there, they lack, to date, the ability to provide universal access abroad.

PNOs with 214 authorization may elect to offer services geared to key customer groups. These can include, for example, calling plans, managed bandwidth, trading floor services, IP access, ATM, frame relay and ISDN on an end-to-end basis.

This new method of structuring international services can deliver other benefits to the manager. Capacity ownership on the near end of international circuits should allow the overseas carrier to deliver service faster and at lower cost while providing local support and direct settlement in U.S. currency. Service level agreements and coordinated maintenance windows are easier to structure.

U.S. carriers also can benefit from this new approach to international networking, and extend its benefit to their customers. The 214 authorizations allow both retail (end-user) interconnects and wholesale (carriers' carrier) interconnects to the node. Products available on a wholesale basis include switching services (hubbing, refiling, switched transit), switched international traffic and termination, and wholesale bandwidth services. Either way, these options for the first time allow managers to buy local when going global.

Broadening Overseas Access Through "Home Market Extensions"

While the options do not put an end to multicarrier provisioning, they address many of the traditional problems associated with distant-end provisioning. But few multinationals have requirements confined to a single country. What is deregulation doing to address that issue?

Overseas carriers do not need to limit their strategies to setting up an operating presence in the United States. For example, European public network operators, especially in smaller countries, recognize that they serve a limited geographic area. Their solution is to broaden their market by securing an operating presence in neighboring countries. This is accomplished by investing in service providers licensed to operate in those countries or establishing their own operations center. Swisscom, for example, has acquired a 50% ownership in the German carrier CNS. Communications Network Services, or CNS, was formed by the two largest energy companies in the federal state of Baden-Württemberg. It offers voice, data and multimedia services mainly to companies, local authorities and institutions. An alternative approach for a European PNO is to set up its own subsidiary, which is what Swisscom did in Austria. In addition to enhancing service and performance, these actions reduce costs by eliminating accounting rates. Services are through simple interconnect agreements. Finally, through the mechanism of alliances, PNOs can add

value when their customers' service requirements extend beyond home and neighboring markets.

Every action such as those described above simplifies the job of the U.S. network manager because it extends the concept of true one-stop or single-source provisioning. It enhances service providers' abilities to offer service level guarantees because that service provider owns and controls more of the transport and switching facilities that make up the network. It reduces network managers' costs because lower costs of ownership and fewer accounting rate charges apply.

By the fall of 1997, a relatively small number of European-based overseas carriers had either applied for or received 214 authorizations in the United States as a means of improving customer service to their home markets. They include Swisscom, C&W, PTT Telecom Netherlands, and Telia.

The Impact on Alliances

As overseas PNOs become "domesticized" in the United Sates, what does the trend do to the concept of alliances? First, it will complement them, because few multinationals have requirements confined to a single country. A PNO will seek 214 authorization to better serve those customers who have substantial traffic between the United States and its home market. That same PNO, as a member of an alliance, can help fulfill its customers' networking requirements beyond the home market.

Second, alliances will be supported. While alliances will play a growing role in the makeup of the world's telecommunications infrastructure, incumbent PNOs abroad will continue to be the primary providers of "universal access" or local loop connectivity within their countries. As liberalization proceeds, these PNOs will become more and more competitive in order to retain that business.

Finally, not all alliances serve all countries. A multinational in the United States may elect to do business with a U.S. carrier that is not a member of an alliance that includes the PNO abroad. The U.S. carrier can feed its customer's traffic to that PNO's U.S. node.

Putting Options into Play

The trick for managers to master is using the solution that adds the greatest value, and understanding how alliance members view their membership. To cite an example, U.S.-based Continental Grain states that some 65% of its international voice traffic originates in Geneva. From its perspective, routing this traffic through Swisscom's North American node makes sense. For Continental Grain, Swisscom's presence in neighboring countries results in savings, and its membership in Unisource results in simplifying pan-European network management.

Under the new scenario, a company with high traffic flows to a single country may view that country's primary service provider as its primary service provider. It may view an alliance such as AT&T-Unisource as a means to

augment that service where needed. Rounding out the picture on the U.S. end are domestic interconnects. On the world stage, though, these have not represented major contributors to networking headaches.

Summary

Although deregulation, liberalization, and full competition have yet to be achieved in the field of international telecommunications, some innovative plans are being put into play. If employed correctly, they offer solutions that can greatly ease the task of today's harassed telecommunications manager.

Foreign Carriers in the United States: The FCC, the ECO Test, the WTO Accord and 214 Authorizations

At a customer meeting hosted by Swisscom in September 1997, Scott Blake Harris, former Chief of the FCC's International Bureau and currently Partner and Head of the Communications Practice Group at Gibson, Dunn & Crutcher LLP, provided an interesting commentary on foreign carrier operations in the United States.

Historically, Mr. Harris said, the reason that so few foreign carriers had authorization was that there were no real rules allowing FCC staffers to know when applications should be granted—or denied. With no effective rules to guide their actions, the FCC simply did not rule on these applications.

The remedy to the situation was embodied in the FCC's foreign carrier entry rules, which included the ECO test. Implemented in 1995, it would, without lengthy analysis, allow foreign carriers to serve all routes from the United States except those where they had market power. It allowed carriers to serve routes where they did have market power if U.S. carriers had effective competitive opportunities on those routes.

Despite these actions, most foreign carriers and their governments criticized the ECO proposal, Mr. Harris said. They went as far as to claim that the United States was going backward and predicted that the ECO test would close the U.S. market. Moreover, they complained it was inappropriate for the FCC to impose the ECO test as a unilateral entry rule during the WTO telecom negotiations.

According to Mr. Harris, the Commission responded that the new foreign carrier rules and ECO test was a significant market-opening mechanism, and that the FCC would eliminate the ECO test if the WTO accord materialized as planned. What the Commission did not say was that it also hoped the ECO test would help bring about a WTO deal. It was a promise to open our markets bilaterally and as such, it made a multilateral deal look better to many.

In the meantime, the FCC applied the ECO test as promised and proved its critics wrong. Carriers from several nations in Europe, the Asia-Pacific, and South America have been allowed to enter the U.S. international service market and to invest in wireless licensees above the 25 percent statutory foreign ownership limit.

As the FCC hoped, the WTO accord has been signed. Mr. Harris believes that the ECO test played no small role in bringing that agreement to conclusion. Moreover, he said, the FCC has now proposed to eliminate the ECO test altogether for WTO countries.

While certain foreign carriers and governments have attacked the FCC proposals, claiming the new rules will close the U.S. market and violate the WTO agreement itself, Mr. Harris believes this concern stems from the proposal to evaluate license applications for their ability to distort competition in the U.S. market. This proposal, Mr. Harris said, is consistent under the existing statutory public interest test that applies to all communications licensees in the United States, not just foreign licensees. Nevertheless, the European Commission believes the FCC has created a way to keep foreign carriers out of the U.S. market and implement a protectionist industrial policy.

Mr. Harris believes that this is a difficult concept to accept in view of what the FCC has proposed, namely, to grant international authorizations within 30 to 45 days and allow up to 100 percent indirect foreign ownership of common carrier radio licenses. It would only condition or deny, under the statutory public interest test, market entry applications by carriers from WTO countries based on competition, national security, law enforcement, foreign policy or trade concerns. Under this test, no legitimate foreign carrier will be denied access to the U.S. market, Mr. Harris stated. And no conditions will be imposed that cannot be justified as necessary to protect competition. Nevertheless, he believes that the criticism of the FCC will continue until it begins to rule on authorizations from foreign carriers—and demonstrate again that it keeps its promises. He also believes it will.

The New Face of Networking

Eric Schmidt
Chairman and Chief Executive Officer
Novell, Inc.

Everywhere we look, networks matter. Customers, individuals, and enterprises around the world are using networks to transform every aspect of business. We are seeing the most explosive growth in the largest network of all: the Internet. New forms of Internet-based commerce, from bookstores and boutiques to banking and investment services, have emerged in virtually every country on earth.

No one can dispute that we are entering an era of unprecedented opportunity, both for businesses deploying networks and for vendors delivering solutions and services. The central question for all involved is how to harness networking technology and maximize the opportunity. The task is to make networks smarter, more manageable, easier to use, and more responsive to the information needs of individual users. At Novell, we think of this challenge in the context of what the network looks like to the administrator and the user. We have committed ourselves to the new face of networking.

The new face of the network is not an interface, and it is not even a single face. The new face of networking has a human face, and it has as many faces as there are users on the network today.

Approaching the Time Barrier

When we take a look at everything we have done in the last fifteen years, we have been governed by Moore's Law, and it has been a good law for all of us. The incredible increase in processing power as a function of cost has driven economic growth around the world. We are now moving to a situation where we are governed much more by the limits inherent in the speed of light. But I think that is not the ultimate constraint. I think it is the speed of people's minds that is holding us back and is the ability of organizations to deal with the complexity and creativity that networks bring to them; that solving that problem turns out to be the most important thing we can do; that we need adaptive systems that can work with this set of problems.

The industry that we are in is young. It moves fast. We deal with time compression and globalization; we are very proud of what we have accomplished. But what we are seeing now is a declining significance of Moore's Law, and an increasing significance of the problems that I am going to highlight. They ultimately become the barriers to progress. In other words, the scarcity here is of time—time of the person, time of the customer, time to change these new models; that is the opportunity that is in front of us.

Now, how big is this opportunity? There are a lot of interesting statistics. The size of the Web—there are roughly 71.3 million Web users, according to IDC right now, and 130 million are expected by the year 2000. The compound growth rate of these things yields tremendous numbers. We have often said that at the current growth rate, every human on the planet would have his or her own Web site by the year 2004.

We are witnessing an underlying transition here from static to dynamic systems, and that shift is something that underpins almost everything we do. It is not obvious until you begin to think about its implications, because the Internet and networking technology are bringing forth a whole new set of media. There is a number of examples of what today's dynamic, networked systems make possible for the first time. For example, network computers are capable of creative pattern matching. They can watch what you do. They can figure out what you want, and they can suggest the next thing.

Amazon.com—one of the services that I use on the Net—now remembers your books and then makes a suggestion, based on a perception algorithm, for books that you want to buy. When was the last time your bookstore did that for you? There are many other examples of this. American Airlines has a program that, for a certain category of customers who buy through electronic means, can give you instantaneous price updates so that you can know the marginal price of that middle seat that you didn't want anyway.

Network Effects in the New Economy

We see computers being used not just as substitutes for the physical world that we are used to, but in a very different way. This whole thing is governed by a set of laws around network effects.

If you look back, we can see network effects that were a surprise to us twenty years ago. Most of us spend much of our time traveling around and dealing with the United States airline industry and their hub cities. When the airline industry was deregulated, what was the competitiveness equation? Of course, it was determined by the domination of hubs. That is the network effect. The more people you can get into one hub, the more you can make sure that they stay in your network. The same principle applies to what we do.

Technology adoption is driven by laws of increasing returns. When the first fax machine came out, it was not very useful. But when lots of people had them, all of a sudden, everyone else had to have them. When the first cellular phone came out, the same pattern unfolded.

These mass waves, driven by brands and people, are often confused with the volatility of markets. One year you are a failure, the next year you are a billionaire. Back and forth and back and forth. It happens all the time. You announce a new product, and, in a week, you have a million customers, and, boom, you go public. You have to get the revenue later; ubiquity first, revenue later. That is the true meaning of URL.

The human face of networking is interactive and changing. My essential thesis here is that there are two intertwining issues. One, the network knows you, and, second, the adoption of technology is driven by increasing returns. The two together make our world extraordinarily dynamic and fascinating—and very competitive.

Empowering Individuals

If you follow the new face of networking idea, then every face is different, and everyone's needs for networks are different. Every person on the network has a different perspective. So the world of needs is really about millions of new faces coming onto the Internet. Networks are empowering.

We are delivering solutions today in which every user will have a network identity, a digital persona stored in the network that authenticates and connects that user to all of the appropriate network resources—applications, services, and devices. This digital identity is no longer tied to a particular desktop or a particular domain or workgroup within an organization. Intelligent networks know who you are and how to serve you, no matter which networked PC or access device you choose, and no matter where you happen to be on planet earth when you need information.

The key enabling technologies for smart networks are network services, beginning with the directory. Directory is the master service that provides access, management, and security for all other resources across the enterprise network

and the Web. It is the directory that stores the user's digital identity in the network, and it is the directory that shields the user from the complexities of specific hardware and software components. Network administrators can use directory services to centrally name, store, and manipulate software components or objects, dramatically reducing the cost and complexity of managing the network. Developers can take advantage of directory services, including the LDAP industry standard, to enable new categories of network solutions that are easy to manage and use. These solutions, in turn, are enabling entirely new kinds of business activities.

Intelligent Network Solutions

Intelligent network solutions, enabled by directory services, are today solving customer problems in organizations of every kind and size. A large retailer, for example, is using directory-enabled messaging to automatically deliver a formatted daily sales report covering 1,000 stores into the e-mail inbox of every executive. A U.S. government agency is using a cross-platform directory service to add hundreds of NT servers to its network without hiring hundreds of new administrators to struggle with NT domains. A European government centrally manages and filters the Internet for tens of thousands of school children, all from one location and login! Network managers at a healthcare chain are using directory-enabled software distribution and desktop management to add a new hospital and 500 new PC users to their network—from a central location with the click of a mouse. An Internet Services Provider is renting software applications and computer games to home users by the year, month, week, or hour.

Today's most competitive and innovative organizations are not waiting to deploy intelligent network solutions. Instead, they are putting in place the technology infrastructure needed to support network solutions today and tomorrow. This is a job of managing and integrating diverse resources that no company can do alone, and that cannot be accomplished with products from any single vendor. Choosing the right partners and vendors is the key to putting a new face on the network and staying competitive in an interconnected world.

What Do Users Really Want?

Mack Schwing
Global Managing Director, Networking
Deloitte & Touche Consulting Group

What is a user? Perhaps there is no single answer. Is the user a person on the street trying to use the telephone? Is the user a young person at home trying to use the Internet? Could the user be a chief information officer (CIO) trying to make a decision about corporate voice and data networks? Or is a user a person in the industry trying to build and use solutions? This question and its answer are absolutely fundamental.

Challenges

Telecommunications managers face many challenges in today's fast-moving environment. Technology is evolving rapidly, without a clear success path. Regulations are changing, and development is happening across applications. These new applications demand broad bandwidth to the desktop. There are budgetary pressures urging slower spending, and corporate globalization and business mergers occur daily. Finally, outsourcing is a networking reality. Outsourcing is a focus tool for management, something that every corporate manager is looking at today.

In the midst of these challenges, telecommunications managers are losing sight of the fundamental question: What do users really want? For example, Deloitte & Touche Consulting Group worked with two very large retailers after the companies merged their networks. Each of the firms spent approximately thirty million dollars per year on their networks.

One of the networks was built on a private network technology using a frame relay system. Whenever a customer called for service to a department store, the network would pick up that call and route it to the company's credit department in another city.

The people in the credit department, however, thought that the telephone call quality was terrible. They were not able to provide good customer service. These calls had to pass through five private switches before reaching the credit department, causing them to lose significant sound quality and all customer identification. All this because the calls were routed through a private network rather than a public network. Ultimately, the fundamental question needed consideration: what do users need?

A Global Survey

Deloitte & Touche conducted its first global survey of 1,400 CIOs in mid-1996. This group represented twenty-one countries worldwide. A portion of the survey concerned network needs, but many other topics about technology and information systems were covered.

Private Networks and Legacy Systems
Private networks were rated as critical by 60 percent or more of the respondents, which is an astounding number (see *Figure 1*). In Pacific Rim countries, more than 90 percent of the CIOs rated private networks as important. What does this mean? Communications systems that run on a private network will not have the necessary features or functionality.

And yet another part of the survey indicates that 70 percent of the corporations plan to replace all of their legacy systems within the next two years. Will they continue to use these private networks? Or will they move into the world of client/server systems and network connectivity?

The answer will depend on available features and functions. The study found stunning differences in responses between countries (see *Figure 2*). For example, the South Pacific Rim has a far greater reliance on private networks than other parts of the world. The countries surveyed also had mixed views of technology and how it will grow. Central Europe

FIGURE 1
The Importance of Private Networks

World — 79%
Western Europe — 67%
South Pacific Rim — 95%
North Pacific Rim — 93%
North America — 76%
Central Europe — 61%

FIGURE 2
Current Important Networking Technologies

Legend:
- SM
- Time Division Multiplexing
- Private Frame Relay
- Public Frame Relay
- Ethernet Switching
- ISDN
- ATM

FIGURE 4
Worldwide Networking Management Priorities

- Improve Customer Service — 4.24%
- Improve Network Security and Continuity — 4.01%
- Improve Internal Communications — 3.59%
- Improve Flexibility — 3.56%
- Reduce Network Management Complexity — 3.27%
- Reduce Network Costs — 2.86%

and Asia Pacific rated ATM as the most important future technology. In North America, corporate managers believe Ethernet will be the most important. ISDN and switched Ethernet are of prime importance to Western Europe.

What does this mean for the future of interconnectivity around the world? What does it mean for the ability to use these technologies to make corporate business work effectively?

Expenses

81 percent of the CIOs expected expense increases, with those in North America expecting increases most frequently. These CIOs have already taken management initiatives that will help them figure out how to make this work. As a proportion of IT spending in general, networking was 18.22 percent on a worldwide basis (see *Figure 3*). Again, that number differs significantly according to region. For example, in the South Pacific Rim, that number extends up to 23.5 percent because of the remote locations that must be hooked together and the cost of service there. Networks will become increasingly important, causing the proportion of IT spend-

ing on networks to increase. However, it is likely that the costs of software and hardware will continue to decrease.

Even though 18 percent of the total IT costs was related to the network, only 8 percent of the staffing in an IT department was related to the network. This brings forth a number of interesting issues, because the changes in software and hardware will probably reduce the number of people required to maintain them.

What are the CIO priorities for networking? The network managers are not as worried about costs as they are about customer service (see *Figure 4*). These managers want to ensure that customers are receiving good service and effective use of the network. The second biggest concern is improving network security and continuity—making sure that customers do not experience network outages or fraud.

Vendors

Due to the challenges of dealing with network costs, one management initiative is network service agreements.

FIGURE 3
Network-Related Budget

- World — 18.22%
- Western Europe — 17.04%
- South Pacific Rim — 23.54%
- North Pacific Rim — 13.17%
- North America — 19.35%
- Central Europe — 18.61%

FIGURE 5
Important Technologies for Reengineering

Region	Within Past Year	Within Past Two Years
World	72%	14%
Western Europe	58%	17%
South Pacific Rim	64%	15%
North Pacific Rim	85%	7%
North America	75%	15%
Central Europe	69%	16%

FIGURE 6
Networking Expenditures

Region	Dramatically Increasing	Slowly Increasing
World	21%	60%
Western Europe	25%	55%
South Pacific Rim	22%	55%
North Pacific Rim	17%	67%
North America	28%	58%
Central Europe	9%	67%

☐ Dramatically Increasing
☐ Slowly Increasing

FIGURE 8
Degree of Involvement of Telecommunications in Reengineering Projects

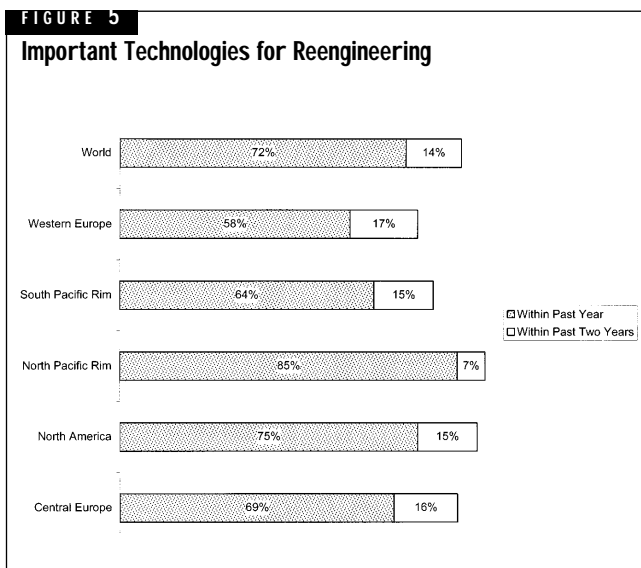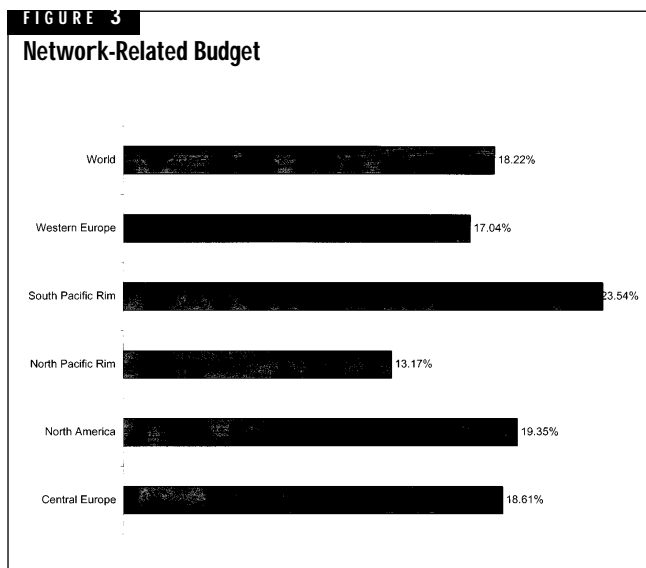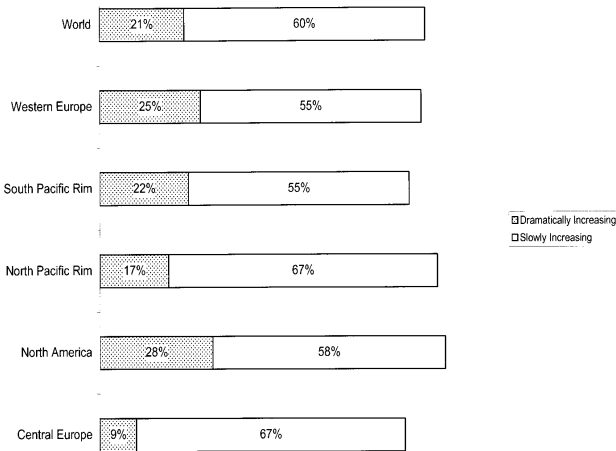|	
None	10%
Peripheral	6%
Limited	58%
Significant-Meaningful	26%

Vendors try very hard to push long-term contracts because they are trying to lock in a customer on a long-term rate. According to the survey, 72 percent of all worldwide network services agreements were negotiated in the past year, while 86 percent were signed within the past two years (see *Figure 5*). In the North Pacific Rim, 85 percent are less than one year old, and in North America 90 percent are less than two years old. These numbers show that vendors are quite open to contract renegotiation at any point in time, which means that there will be a consistently changing cost structure for the industry and a consistently changing pattern of budgets for the people buying these services (see *Figure 6*).

Reengineering
Many companies are going through a reengineering process. Reengineering is a somewhat negative procedure, as it eliminates many jobs. However, the process is not wholly negative—reengineering has brought an entirely new focus on technology. The CIOs surveyed largely said that networking was the most important technology for enabling reengineering (see *Figure 7*). This determination

was compared against client/server, EDI, and packaged and application software. The network is on the cutting edge of what can be done for a client.

Unfortunately, only 26 percent of telecommunications managers were meaningfully involved in the reengineering process (see *Figure 8*). For this reason, the people on these reengineering teams come up with wonderful, creative solutions that have no basis in the reality of how a network works. Network managers are, therefore, trying to solve problems caused by their own corporations.

Outsourcing
With all of these challenges, outsourcing has become a focused tool for these network managers (see *Figure 9*). 95 percent of the global 500 companies outsource a portion of their network services.

FIGURE 7
Important Technologies for Reengineering

	Central Europe	North America	North Pacific Rim	South Pacific Rim	Western Europe	World
C/S Architecture	58%	55%	70%	41%	51%	55%
Communication and Networking	74%	81%	89%	78%	80%	80%
EDI	59%	37%	43%	31%	31%	40%
Package Application Software	64%	59%			57%	50%

☐ C/S Architecture
☐ Communication and Networking
☐ EDI
☐ Package Application Software

FIGURE 9
The Outsourcing of Telecom Functions

Strategic Planning	16%
Procurement	25%
Internal Operations	28%
International Operations	33%
Billing & Chargebacks	36%
Engineering	38%
Provisioning	44%
Network Management	50%
Help Desk	59%
Network Control & Diagnostic	69%
Tech Support & Maintenance	70%

FIGURE 10

Dominant Technology

Technology	Percentage
Don't Know/Refused	5%
Other	1%
Mobile Computing	34%
Wireless Communications	45%
Multimedia Technologies	46%
E-Mail	47%
Diginet Networks	50%
Electronic Commerce	55%
Intranet	55%
Internet	58%
Knowledge-Based Information Networks	63%

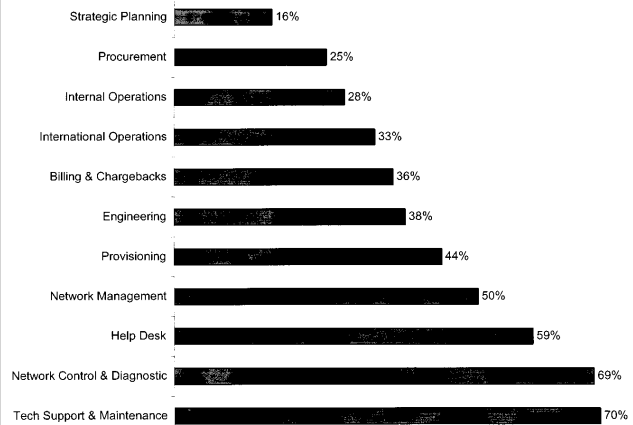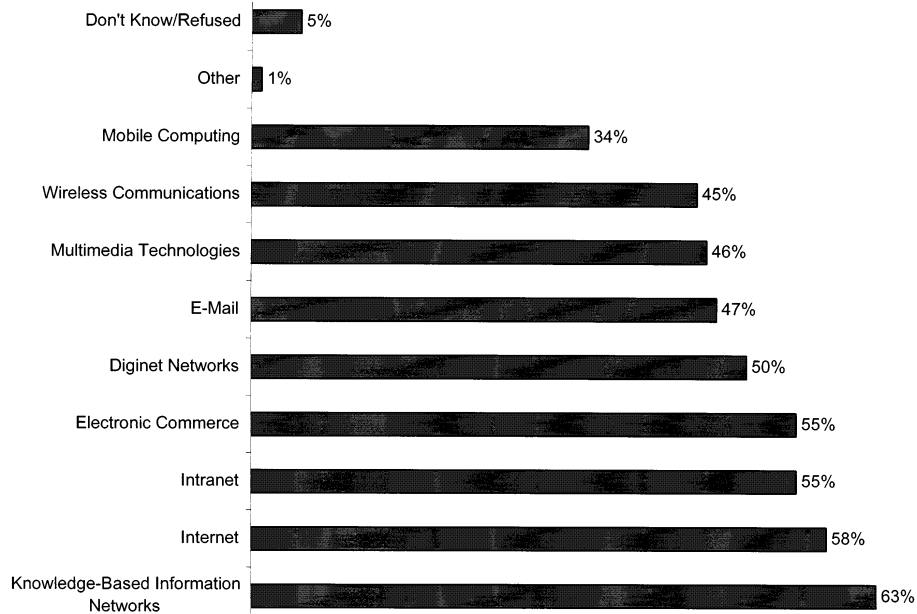## Conclusion

Interestingly, several of the survey respondents said that technology is driving globalization. One senior executive said, "The movement to a global economy requires instantaneous reaction which you can do only with information technology." Many people in the industry have always believed the opposite: that networks were serving these corporations as they globalize. No, these CIOs said, technology is driving globalization—globalization is not driving technology. This is a very important difference. It signifies that their competitors are using technology to compete, and that this competition is what drives them to globalize. These companies do not necessarily want to seek business in other parts of the world, but they must.

The CIOs surveyed all believed that the future of technology would impact their businesses. Each technology that these CIOs believed would be important after the year 2000 relies on the network (see *Figure 10*). That alone is a very important statement about the future of this business.

Using Deregulation and Competition to Impel Investment and Innovation

Ivan Seidenberg

Vice Chairman

Bell Atlantic

In the past, we used to be able to measure technology cycles in decades. Now, they are measured in months. This is not a figure of speech—it is a fact. It took almost eighty years for the landline telephone business to reach 50 million customers. It took almost forty years for radio, fifteen for cellular phones, and ten for cable TV to reach the same milestone. With the Internet, we are in a whole new cycle: 50 million users in five years.

And we are just getting warmed up. Robust demand for high-bandwidth communications attracted record capital flows in 1997, ignited industry consolidation, and pushed stock prices for communications companies to record levels. In 1998, explosive market growth will wind this spring up even tighter—which means that technologies like DSL, cable modems, digital set-tops, and others are just about to burst from the lab into homes and businesses all over America.

Almost all of this innovation is taking place in markets where competition and deregulation prevail, driving down prices and encouraging investment. And at the center of this whirl-wind is the worldwide data customer, whose demand for connectivity is attracting the best efforts of this country's strongest, most sophisticated, most innovative companies—the very same companies that have made America the world leader in the Information Age.

Yet in spite of this burst of entrepreneurial energy and capital formation there are broad stretches of the market that have yet to see the benefits of all this investment and competition. Demand for bandwidth still outstrips supply, by a wide margin. And traditional communications markets—local and long-distance telephone service—are not yet as competitive as the data and business markets.

This does not have to be the case. If we can adopt a market-oriented regulatory model for the whole industry, the next wave of the information revolution—the band-width revolution—will sweep over the entire market, ushering in an era of growth that will drive prosperity well into the next millennium.

So this is an exciting moment—the right moment, in my view—to take a fresh look at how to jump-start this kind of

growth, competition, and investment across the entire industry, including the consumer marketplace. If we listen to what the market is telling us and apply these lessons to all markets and all players, the result will be good for all companies in this industry and, most important, for the American economy.

Let's start by looking at where the growth in communications is occurring and why. In 1997, communications companies and investors signaled their confidence in the future of the connectivity revolution by voting with their pocketbooks. Companies voted by pouring massive amounts of capital into upgrading America's communications infrastructure. The capital markets voted by driving up asset values for crucial "first-mile" network connections—wireline, wireless, and cable. And in every segment of the industry, investment flowed to places where it could be maximized; i.e., the largely deregulated market for high-speed data transport and Internet services.

When you look at what happens when market forces, not regulators, make the rules, the result looks remarkably like what public policy is trying, unsuccessfully, to engineer: multiple providers operating multiple networks, competing fiercely with one another to deliver the most value to customers. For example:

- In the business market, the growing demand for high-bandwidth services has created a whole new kind of phone company and redirected the investment strategies of incumbents.

- First-generation CAPs and CLECs such as Teleport, MFS, and WorldCom continue to invest more than $2 billion per year to deploy digital networks for business customers. The market value of these companies grew more than seventy percent in 1997, and investors poured more than $8 billion into IPOs during the year—an industry record.

- Now, second-generation companies like Qwest, Level 3, and IXC are beginning to pour billions of dollars into new IP-based global networks to accommodate growing data traffic.

- Incumbents are investing to capitalize on this new source of growth, as well. At Bell Atlantic, we are deploying a

sizable portion of our $6 billion capital program to migrate from circuit-switched networks to broadband, packet-switched data technologies.

- There is also tremendous growth in the consumer market, although not in the traditional sense of "plain old telephone service." Rather, growth is occurring in the deregulated portions of the market where risk and investment can be rewarded: new markets, new services, and new customers.

- At Bell Atlantic, virtually all the growth in our residential telecom business is vertical growth, driven by the residential consumer's explosive demand for data and advanced services: 15 percent growth in 2nd lines, most of which are used as Internet hook-ups; 35 percent growth in ISDN, the only widely available mass-market digital service in the market today; close to 20 percent growth in vertical services like Caller ID, which take advantage of our intelligent-network capabilities.

- The cable industry out-paced all other segments of the industry in market appreciation in 1997—a sign that the market believes cable has come of age as an alternative broadband pipe. That is because cable is in the midst of a multi-billion-dollar, multi-year upgrade to two-way, digital capabilities that is expected to reach almost fifty percent of American homes by the end of the year.

- Finally, digital wireless networks—four or five of them, in many markets—are another broadband alternative, representing more than $40 billion worth of investment.

All in all, this represents a tremendous influx of investment from every quarter of the communications industry. From where I sit, the good news about all this competitive activity is that it plays to Bell Atlantic's strength as the premier network company in the world's premier communications market. We've taken the lead in re-inventing the "telephone" business around the needs of the high-bandwidth consumer. And, as we move ahead in the near future, we plan to do everything possible to leverage our strengths to address the data market:

- We create the equivalent of four "Teleports" in our region, every single year. We have revamped our backbone network with 4.2 million fiber miles, almost 2,500 SONET rings, all-digital switching, and, as of 1998, 100 percent ATM-compatibility across our entire region.

- We lead the industry in fast-packet services for business customers, including frame relay, SMDS, FDDI, and ATM.

- We pioneered digital mass-market data services with our early push into ISDN: almost half of all the ISDN lines in the country today are in Bell Atlantic territory.

- The consumer data market is poised to take off in a big way. We have been a big believer in ADSL for some time. We ran the first ADSL trials in the country, both voice and

video. We had the first paying customers for ADSL of any Bell company.

- We are an industry leader in wireless data. Our digital network platform stretches from Boston to South Carolina. We are a major investor in PCS and have invested between $100 million and $200 million in data capabilities for our wireless platforms. We deployed the first large-scale cellular digital packet-data service in 1994, and now offer a full plate of wireless services that feature e-mail, Internet access, packet data transmission, and wireless modems.

- We are a major player in the services and applications that drive off our broadband platform—from our network integration company that helps business customers manage their communications networks; to "Big Yellow," the world's leading electronic directory; to bellatlantic.net—which, although operating under unique regulatory handicaps that no other ISP in the industry faces, gives us an important foothold in the Internet access business.

So when people say that the Telecom Act is not working, that there is no competition, no innovation, or no commitment to invest in the communications marketplace, I say to them: "You're looking in the wrong place." Or maybe, "You're asking the wrong question." Instead of asking what regulation is doing, take a look at what the market is doing. The market is doing exactly what the Telecom Act envisions—stimulating growth, competition, and innovation in communications.

For all of this innovation, however, some frustrating facts remain. The data services market is irrefutably competitive, yet this country's biggest network companies—the Bell companies—are prohibited by regulation from serving key markets. Speed and capacity problems abound on the Internet (hence, the "World Wide Wait,") largely because companies like Bell Atlantic that could solve that problem are prevented by federal policy from making the necessary investments for our customers.

At Bell Atlantic, we find ourselves in the absurd situation of not being able to meet the complex data and networking needs of some of our largest customers, such as universities, the New York Stock Exchange, and the federal government, because of inter-LATA restrictions. Is it because we "dominate" the market for intranets, extranets, Internet backbones, and wide area networks? Because the large business and federal government markets are not competitive? Hardly. It is because rules designed for one market are being applied to another, and everybody loses.

Even more troubling, when we look beyond the data market, the services that American consumers rely on the most—local and long-distance telephone service—have not attracted the same level of competition that has flourished in the data market.

I believe it is time we took at fresh look at how to stimulate growth and investment across all communications markets.

Of course, that is what the Telecom Act of 1996 was supposed to do: introduce competition across the board in the mainstream telephone business. The trouble is, the Act is being implemented according to an over-regulatory approach based on an outmoded view of the industry.

According to this resale-oriented world view, the incumbent phone companies control all communications technologies.

Rather than making the consumer market attractive to investment by allowing it to grow—as is the case in the business market, the wireless market, and most of the Internet market—this world view assumes that the only way to induce competitors into the local telephone business is by making it artificially attractive.

This leads to all sorts of uneconomic pricing, mandated subsidies and discounts, and onerous unbundling rules that force incumbent companies to make potentially profitable technologies available to rivals at fire-sale rates, creating artificial market niches that exist only because of regulatory arbitrage, not true economic opportunity.

This over-reliance on resale and unbundled network elements ignores what smart, entrepreneurial new entrants figured out a long time ago: that you cannot base a long-term entry strategy on using someone else's investment base. Teligent, WorldCom, Teleport, and the other successful CLECs know that the winning game plan for competing in local markets is a facilities-based, investment-based strategy that puts them in control of their own destinies. Resale agreements are important for making sure all the different technology platforms work together, but not as a methodology for subsidizing market entry.

So, at the end of the day, mandating deeper discounts on a low-margin, subsidy-priced, $15-buck-a-month phone line is not the way to attract new investment to the local phone market. Allowing communications companies to profit from delivering new services over that same phone line is.

That is why I believe we need a new model for implementing the Telecom Act, one that recognizes technological diversity and rewards research and development, capital formation, innovation, and efficiency. That is a model which has worked in every other segment of the communications industry, and it is a model that could be adopted today as a way of jump-starting competition in the consumer market.

The FCC has signaled its willingness to take a new, more flexible approach to opening communications markets. In that spirit, here are three things that regulators could do immediately to implement a forward-looking, technology-based business model for regulating the communications industry.

 # 1: Deregulate the Internet now for all players.

It is time to stop applying old regulatory policies to new technologies. Major customers are telling us that there is a critical need for faster end-to-end transmission speeds on Internet backbones, where traffic averages about 40 kbps—less than half the speed of an ISDN connection. But since current regulation considers Internet traffic "inter-LATA" (i.e., long distance) service, Bell Atlantic is prohibited from making the investments in backbone networks that would alleviate these choke points.

The FCC can fix this. Section 706 of the Telecom Act expressly states that, if advanced communications services are not developing fast enough, the Commission "shall take immediate action to accelerate deployment of such capability by removing barriers to infrastructure investment and by promoting competition in the telecommunications market," using whatever deregulatory tools are required.

That is s why Bell Atlantic filed a petition with the FCC, asking the Commission to do two things:

• First, deregulate bandwidth by permitting us to offer high-speed broadband services, including Internet access, without regard to present LATA boundaries. This would encourage our investment in badly needed backbone capacity, alleviate choke points along the data highway, and accelerate the spread of the Internet to the mass market.

• Second, deregulate innovation by permitting us to develop new high-speed services like ADSL free from the pricing, unbundling, and separate-affiliate restrictions designed for voice calls. This would result in faster deployment and lower prices for high-speed technologies in the consumer market. It also would reward us for investment risks and give us the economic incentive to innovate.

These simple steps, which we believe are permissible and, in fact, intended under Section 706 of the Telecom Act, would remove the needless regulatory restrictions that are inhibiting our investment in wide-scale data networks. They in no way supersede our long-distance entry obligations or checklist requirements. More important, they would serve the fundamental Congressional intent of encouraging the rapid deployment of new communications technologies for all Americans.

#2: End the guessing game regarding long-distance entry applications by spelling out the requirements for approval once and for all.

The FCC recently has signaled its willingness to work with local telephone companies and state regulators in preparing 271 applications that can win Commission approval. I believe the acid test for this new approach will be the State of New York, which is arguably the most open, competitive communications market in the United States.

The New York Public Service Commission is currently reviewing our application to provide long-distance service. Our filing documents the extraordinary lengths to which we have gone to open our local network to competitors and provides irrefutable evidence that the local market is open to all comers:

- Our operating systems can handle up to 8,000 orders a day, according to an independent audit.

- We have sold more than 20,000 unbundled loops and resold more than 100,000 lines.

- We exchanged three-quarters of a billion minutes of use with competitors in November 1997 alone—equivalent to all the traffic in Maine and Vermont put together.

- Every single one of the items on the fourteen-point checklist has already been purchased by a competitive carrier in New York, according to a survey conducted by the Public Service Commission.

- We have interconnection agreements with twenty-three facilities-based carriers who are providing service throughout the state.

I am very encouraged to see that representatives from the Department of Justice are working alongside state commissioners in New York in reviewing our filing. I am confident that they will see for themselves that we are ready for full competition with facilities-based competition via open, scalable operating systems and viable resale and interconnection agreements.

We do not believe that the framers of the Telecom Act envisioned that the 271 process would become hopelessly entangled in bureaucratic snafus and inter-agency wrangling. It is time for the FCC, the Department of Justice, and the state commissions to work together to provide us the information required to move this process forward. If the rules are spelled out clearly, there is absolutely no reason that Bell Atlantic cannot file an application with the FCC that can be approved immediately.

#3: Act now to deregulate the business market, which, by any reasonable standard, is already competitive.

Our state regulators are beginning to recognize that there is no justification for continuing to regulate services that are demonstrably and irrevocably competitive, such as business and high-speed data services. Competitors in these markets can provide any service a business customer wants (including local service) with none of the pricing restrictions or cumbersome marketing rules we face.

We intend to change that:

- In New Jersey, the Commission recently found all high-speed data services to be "competitive," including frame relay, SMDS, virtual private networks, and digital data services.

- In Pennsylvania, Bell Atlantic has a comprehensive filing on the table right now that would free all the services we offer business customers from earnings regulation. This means we would be able to do everything our competitors can do today, from bundling and packaging services to custom-pricing in response to market needs.

We think our business customers will benefit from Bell Atlantic's ability to bundle, price, and tailor service packages to their particular needs. And we believe the public interest will be served by regulatory policies that provide incentives for investment and reward competitiveness and customer responsiveness.

That is my proposal for moving the industry forward just as fast as possible by using deregulation and competition to impel investment and innovation. I am very optimistic that policy-makers—from the FCC to the U.S. Congress to state regulators—are ready to take a fresh look at how to regulate this vital industry. We look forward to working with the new FCC to take advantage of the huge opportunity we now have to expand the technology investment, innovation, and competition we have seen in parts of the communications marketplace across all segments of the industry.

After all, my very business depends on it.

The merger of Bell Atlantic and NYNEX came about because of our belief in the value of "first-mile" connections, almost 40 million of them in the richest markets in the world. Our future lies in delivering as much innovation, value, and connectivity over that link to customers as possible. We have shown that wherever Bell Atlantic has had the opportunity to compete and invest, we can lead the way— and the entire marketplace can benefit.

It is time for us to show that we believe in the competitive, technology-driven, market-based approach that has made America the world leader in information-age technologies. The reward will be continued U.S. leadership in the most critical industry in the global economy and a new cycle of investment, innovation, and growth.

Let's get on with it.

The Key to Local Competition: Public Policy Should Follow the Money

Raymond W. Smith

Chairman
Bell Atlantic

There was a time not so long ago when human technological progress was measured in decades. Now, it is measured in months.

It took almost eighty years for the wireline telephone business to reach 50 million customers. Radio did it in about forty years, cellular phones in fifteen, cable TV in ten. With the Internet, we are in a whole new cycle: 50 million users in just five years.

And we are just getting warmed up. Robust demand for Internet access and data services is igniting investment in high-bandwidth communications services. Everywhere you look, new high-speed networks are under construction, and technologies like DSL, cable modems, and digital set-tops are bursting forth from the lab into homes and businesses all across the United States. Meeting record demand—data traffic is growing twice as fast as voice—has given rise to a burst of entrepreneurial energy and capital formation, attracting record capital flows, prompting industry consolidation, and pushing stock prices for communications companies to record levels.

Almost all of this innovation is taking place in markets where competition and deregulation prevail, driving down prices and encouraging investment. At the center of this whirlwind is the worldwide data customer, whose demand for connectivity is attracting the best efforts of this country's strongest, most sophisticated and most innovative companies.

But there are still broad stretches of the market that have yet to see the full benefits of investment and competition. Demand for bandwidth still outstrips supply by a wide margin, and traditional communications markets—local and long-distance phone service—are not yet as competitive as data and business markets.

What is going on? There is marked disparity between markets driven by the regulatory model—which attempts to encourage competition through artificial incentives, like arbitrary discounts for resellers—and those driven by the competitive model, which encourages investment, innovation, and genuine competition to profitably meet customer needs.

In 1997, communications companies and investors signaled their confidence in the future of the connectivity revolution by voting with their pocketbooks—pouring massive amounts of capital into upgrading America's communications infrastructure. Capital markets drove up asset values for "first-mile/last-mile" connections: wireline, wireless, and cable.

When you look at what happens where market forces—not regulators—make the rules, the results look remarkably like what public policy is trying unsuccessfully to engineer: multiple providers operating multiple networks competing fiercely with one another to deliver the greatest value to customers. In the business market, the growing demand for high-bandwidth services has created a whole new kind of phone company and redirected the investment strategies of incumbents like Bell Atlantic.

First generation competitive access providers (CAPs) and competitive local exchange carriers (CLECs) like Teleport, MFS, and Brooks Fiber are investing more than $2 billion a year to deploy digital networks for business customers. The market value of these companies grew more than 70 percent in 1997, and investors poured more than $8 billion into initial public offerings during the year—an industry record. Second generation companies like Qwest, Level 3, and IXC are spending billions of dollars on new, IP-based global networks to accommodate growing data traffic.

Incumbents are investing billions to capitalize on this new source of growth, as well. At Bell Atlantic, for example, we are deploying a sizable portion of our annual $6 billion capital program to migrate our network from circuit-switched, voice-friendly technology to a broadband, packet-switched, data-friendly technology.

There is tremendous growth in consumer markets as well, though not in the traditional sense of plain old telephone service. Growth is occurring primarily in the deregulated portions of the market, where risk and investment can be rewarded. At Bell Atlantic, virtually all the residential growth is vertical, driven by demand for data and advanced services: 15 percent growth in second lines, mostly for Internet hook-ups; 35 percent growth in ISDN, the only widely available, mass-market digital service in the market today; nearly 20 percent growth in vertical services such as Caller ID, which take advantage of intelligent-network capabilities.

The cable TV industry outpaced all other segments in market appreciation in 1997—a sure sign the financial market believes cable has come of age as an alternative broadband pipe. That is because cable is in the midst of a multibillion dollar, multiyear upgrade to two-way, digital capabilities that is expected to reach almost half of American homes by year-end 1998.

Digital wireless networks—four our five of them in many markets—are another broadband alternative, representing more than $40 billion of investment. Many believe 1998 is the year in which digital wireless pricing will reach the point where customers begin to replace their primary wireline-based phone service with wireless.

When people say the Telecom Act is not working—there is no competition, no innovation, and no commitment to invest in the communications marketplace—they are looking in the wrong place. Or, perhaps, asking the wrong question. Instead of asking what regulation is doing, take a look at what the market is doing. Because the market is doing exactly what the Telecom Act envisioned: stimulating growth, competition, and innovation.

Regulation, however, has turned the Telecom Act on its head through policies that discourage long-term investment in a well-intentioned but off-the-mark attempt to jump-start competition in local markets. According to the regulatory, resale-oriented view, incumbent phone companies control all communications technologies. Rather than making the consumer market attractive to investment by allowing it to grow (as with business, wireless, and most of the Internet markets), this view assumes the only way to induce competitors into the local telephone business is to make it artificially attractive.

This leads to uneconomic pricing, mandated subsidies and discounts, as well as onerous unbundling rules that force incumbent phone companies to make promising new technologies available at fire-sale prices—creating artificial market niches that exist only because of regulatory arbitrage, not true economic opportunity. This approach ignores what smart entrepreneurs figured out long ago: you cannot base a long-term strategy on someone else's investment base. Teligent, WorldCom, Teleport, and other successful LECs know that the winning game plan for competing in local markets is a facilities-based, investment-based strategy that puts them in control of their own destinies.

Resale agreements are important for making sure all the different technology platforms work together and as fill-in for coverage voids, but not as a way to subsidize market entry. Mandating deeper discounts on a low-margin, subsidy-priced, $15-a-month phone line is not the way to attract new investment to the local phone market.

We need a new model for implementing the Telecom Act—one that recognizes technological diversity and rewards research and development, capital formation, innovation, and efficiency. That is the model that has worked in every other segment of the communications

industry, and it could jump-start competition in the consumer telecommunications market.

Charting a new course will take time—and willingness on the part of regulators and all players to let market forces do their job. That will not be easy in an industry where almost every regulatory action is greeted by contention. Indeed, it will be many months before challenges to existing regulatory schemes are resolved.

Meanwhile, there are things regulators could do now:

First, deregulate the Internet now for all players. It is time to stop applying old regulatory policies to new technologies. There is a critical need for faster end-to-end transmission speeds on Internet backbones, where traffic averages about 40 kbps—less than half the speed of an ISDN connection. But since current regulation considers Internet traffic interLATA (i.e., long distance), Bell Atlantic is prohibited from making investments in backbone networks to expand capacity and improve service.

The Federal Communications Commission (FCC) can fix this. If communications services are not developing fast enough, Section 706 of the Telecom Act directs the FCC to "take immediate action to accelerate deployment of such capability by removing barriers to infrastructure investment by promoting competition in the telecommunications market."

That is why we have asked the FCC to deregulate bandwidth by permitting us to offer high-speed, broadband services, including Internet access, without regard to LATA boundaries. This would spur investment in badly needed backbone capacity and accelerate the spread of the Internet to the mass market.

We have also asked the FCC to free new, high-speed services like ADSL from the pricing, unbundling, and separate affiliate restrictions designed for the voice business. This would result in faster deployment and lower prices for high-speed technologies in the consumer market.

These simple steps would remove the needless regulatory restrictions that are inhibiting our investment in wide-scale data networks and encourage the rapid deployment of new communications technologies.

Second, act now to deregulate the business market, which, by any reasonable standard, is already competitive. State regulators are beginning to recognize that there is no justification for continuing to regulate services that are demonstrably and irrevocably competitive, such as business and high-speed data services. Competitors in these markets can provide any service a business customer wants, including local service, with none of the pricing restrictions or cumbersome marketing rules faced by incumbents such as Bell Atlantic.

In New Jersey, state regulators recently found all high-speed data services to be competitive, including frame relay, SMDS, virtual private networks, and digital data services.

Throughout 1998, we will be filing in other states to free all business services from earnings regulation. If our petitions are granted, business customers will benefit from our being able to bundle, price, and tailor service packages to their particular needs—in real time.

While those initiatives play out in 1998, I am hopeful that we will see more immediate benefit from yet a third step that, more than any other, could spur competition in local and long distance: ending the guessing game on long distance–entry applications by spelling out the requirements for approval once and for all. Though regional Bell long-distance applications are being greeted with a new sense of cooperation by the FCC and U.S. Department of Justice, a common, plain language set of rules has yet to be explicitly stated. Indeed, the 14-point checklist enumerated in the Telecom Act has grown in practice to many scores of rules that vary with the agency doing the interpreting. Once the rules are made clear—and regulators see for themselves that

our local markets are competitive, that we offer competitors open, scalable operating systems, and that viable resale and interconnection agreements are in place—we can quickly move forward to inject new competitive vigor into the long-distance market.

Taken together, these three proposals will move the industry rapidly forward by using deregulation and competition to impel investment and innovation. I am optimistic that policy-makers—from the FCC to the U.S. Congress to state regulators—are ready to take a fresh look at regulation that will speed investment and competition in this vital industry. It is time for the United States to show that we believe in the competitive, technology-driven, market-based approach that has made our nation the world leader in information age technologies. The reward will be continued U.S. leadership in the most critical industry in the global economy and a new cycle of investment, innovation, and growth.

Global Wireless Communications: The New Era of Telecommunications

Edward F. Staiano
Vice Chairman and Chief Executive Officer
Iridium LLC

A new era in telecommunications is just around the corner.

Less than five months from now—147 days to be exact—Iridium will begin commercial service as the first company to offer something known as global mobile personal communications by satellite (GMPCS).

This revolutionary new technology is the next giant step into the future for telephone services. The process, of course, began 122 years ago when Alexander Graham Bell made the first telephone call on his new invention. Following that first call—which traveled from one room to another in Bell's laboratory—the telephone quickly became a vital communications tool.

By 1915, telephone wires spanned a continent. In 1927, undersea cables allowed telephone service to cross an ocean. More recently, cellular technology has given people the freedom to carry their phones with them—but not very far.

That is, until now.

The new GMPCS systems will revolutionize the way people communicate. Subscribers to these new services will have enormous freedom to travel great distances—to cities around the world, and even to the most desolate areas—and always be in touch with their colleagues and their families. People living and working in remote regions of the world—where telephones do not now exist—will be able to connect into the world's telecommunications system, without the exorbitant costs associated with building terrestrial infrastructure.

In other words, the new GMPCS systems are poised to bring global telecommunications into the 21st Century. On our first day of commercial service—September 23rd, 1998—Iridium customers will be able to send and receive calls anywhere in the world from their own hand-held, wireless telephones. As you no doubt are aware, cellular standards differ from country to country. Today's cellphones cannot roam across these standards. If you purchase or rent multiple cellphones for the places you travel, you have to have separate phone numbers for each one—and you receive separate bills, usually not in a single currency.

Meanwhile, a vast portion of the Earth's surface—some 90 percent of it—has no cellular coverage at all. In many places, the local wireline systems are unreliable and difficult to use—or simply non-existent. This can be an enormous headache for the international business traveler people who go from country to country, people who need to stay in touch with their home offices and their families, people who want to make calls from wherever they are, and who need to be reached at all times, no matter where they go.

Iridium customers will have one telephone that they can use anywhere in the world. They will have one phone number where they can be reached—whether they are in Europe, Asia, Africa, South America, here in the United States, or somewhere in between. And, for all the calls they make, they will receive one monthly invoice in their own language and currency.

We will do it by combining terrestrial cellular roaming with a constellation of sixty-six low earth orbiting satellites. Using multi-mode wireless phones, Iridium customers will "roam" across previously incompatible cellular systems. When no cellular coverage is available, the phones will communicate directly with the satellites, which function as cellular towers in the sky. The launch of five satellites on board a Boeing Delta II rocket on May 15 1998 completed the Iridium constellation. The entire constellation—sixty-six satellites plus spares—was put into orbit in slightly more than one year's time.

There were many who said it could not be done. But, time after time over the past ten years, the Iridium project has continually proved the naysayers wrong. It was initially said that we would never raise the money to build this system. But, in fact, we have raised more than $5 billion—about half of it from our equity investors and the other half through bank financing and high-yield bonds. We are fully funded through our commercial activation and beyond.

Building our extensive ground infrastructure has been another challenge—and one that we are meeting successfully. Our Satellite and Network Operations Center, located near Leesburg, Virginia, is up and running and has installed the final version of the software that controls the satellites in their orbits. Our backup control center in Italy is fully opera-

tional, as are the four Telemetry Tracking and Control Facilities that are used to communicate with the satellites.

Physical construction has been completed on all twelve of our gateway ground stations—located around the world—where telephone calls are switched between the satellites and the public-switched telephone networks. Equipment has been installed in eleven of those twelve facilities, and they are now undergoing testing.

We have fifteen gateway business offices associated with these ground stations. Business systems hardware and software has been installed in thirteen of them. Production equipment and software for the Iridium clearinghouse in Reston, Virginia, have been installed and are operational, enabling worldwide call processing and settlement.

Our roaming partners and service providers are a vital part of our distribution strategy. Service providers are the national or local retail presence for the Iridium system. Roaming partners will offer their customers the convenience of keeping their existing cellular phone numbers and invoices, while offering them the global reach of the Iridium system as a service enhancement. In other words, Iridium will enable its cellular network partners to expand their cellular service coverage to the entire planet.

Thus far, we have signed up more than 190 service providers and roaming partners around the world. Together, these operators already service some 56 million cellular customers. There are now more than eighty countries in which Iridium will have at least 75 percent market access.

We are making excellent progress on licensing our system in countries around the world. We have secured licenses to operate in more than fifty markets worldwide, representing two-thirds of our anticipated market. Our efforts are continuing, and we fully expect to have 100 licenses by the time we go into commercial service.

Together, these milestones add up to a truly remarkable set of achievements. We are on the verge of completing a massive system that has been ten years in the making. And, in the 147 days between now and our commercial activation, we will be working very hard—installing software, testing the network, integrating our distribution partners, and, finally, bringing it all together to ensure that Iridium provides the highest quality services to our customers on September 23.

Let me tell you a little about those services. As I often point out, Iridium is not really a satellite company. We are a global wireless telephone company that happens to use satellites as a means of extending our reach to all corners of the Earth. Our global roaming capability will enable international travelers to carry their wireless phone and phone number with them wherever they go. If they are in an area with cellular coverage, such as a large city, their phone will work with the local cellular system. When they travel outside the reach of cellular towers, they will always be in line of sight with an Iridium satellite flying above. Their call will go directly to the satellite, and then the signal will be carried satellite-to-satellite and brought back to Earth at one of our twelve gateway ground stations. From there it goes into the public telephone system and to its destination.

Iridium will also offer a global, alphanumeric paging system—capable of getting messages to our customers anywhere on Earth. This belt-worn pager uses a double-A battery that lasts thirty days and has enough signal strength to penetrate areas where cellular and satellite signals might not otherwise reach—such as deep within the interior of a concrete-and-steel skyscraper. We envision that a large number of our customers will use the Iridium pager to receive word that somebody is trying to reach them and then use their Iridium phone to contact that person.

In addition, we plan to sell our services to industrial users—for example, in oil and mineral extraction, cargo shipping, construction, and to your colleagues in the media—who often operate in areas where there are no wireline or cellular services. Many of these industrial users have an urgent need for the instant telephone service that Iridium will deliver to their most remote locations.

We are working in partnership with dozens of developing countries to use this technology to expand telecommunications coverage—and do it much less expensively than building land-based telephone systems. Through a program we call NOMAD, we are offering governments an opportunity to share ownership in our system, as well as subsidized rates to help them deliver phone service in underserved areas. We are also providing governments with free phones and airtime for use in emergency communications and disaster relief.

But our primary target market is going to be the increasingly mobile worldwide business traveler. We believe that, in this age of rapidly expanding global commerce, there is a large and growing number of people who will see a tremendous benefit in a wireless phone they can take with them from country to country and will enable them to make and receive calls, at a single phone number, from virtually anywhere they go.

Our extensive market research indicates that, four years from now, the market for global mobile personal communications services will be about 12.5 million users. We are excited about that potential market. Come September, Iridium is going to lead the way with this new technology. At that time, I will be proud to be the first to welcome you to a new era of global wireless communications—one offering the freedom to communicate anytime, anywhere.

Intelligent Networking in Mobile Communications Systems

Peter Stanforth

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Phoenix Wireless Group Inc.

Introduction

Sophisticated applications are rapidly being rolled into telecommunications networks and are vital to the support of nomadic users. The demand is accelerating and the traditional architectures are ill suited for and hard pressed to keep up with this demand. Intelligent network standardization is complex and not necessarily adequate. This paper discusses the limitations of current architectures and a model for an alternate one employed in the Phoenician™ system. This will serve as an example of how computing-based systems and standards are adequate for telecommunications needs. Finally, the paper will look to how computer technology and standards can help solve IN application issues.

The Rationale for Computer-based Switching Systems

The majority of wireline and wireless switching systems deployed today can be traced to technologies, concepts, and architectures of the late 1970s. In the intervening time period the computer hardware and software industries have reinvented themselves several times over. While telephone switches are required to perform more and more computing-like applications their ancestry makes this extremely difficult to accomplish. Migrating to off-board systems or adjuncts that do not fully exploit computing technologies only partially solves the problem. Wireless adds a level of complexity to the problem not inherent in wireline switches, such as dealing with the abstract concepts of mobility management and the requirement to route calls to a user rather than a geographic port location. This can be quantified by looking at the way a 100,000-user wireline switch is scaled back to wireless users due to the increased demand on call processing.

The early switches had very limited memory (as little as 64kb) and slow processors that required that every low-level machine instruction be hand crafted and evaluated for execution critical timing. As such, many compromises were made in the architecture and behavior of these systems. These compromises are becoming increasingly unwieldy as the requirements for applications grow. Traditional systems have no operating systems, no backup storage, and no support services to speak of. Any capability that a commercial operating system would provide to support applications is therefore proprietary and custom built, which involves a

great deal of time and expense. Today these switches have evolved to proprietary procedural programming language (PP) paradigms that are rooted in the late 1960's attempts to solve the "Software Crisis." PP is inadequate for today's switching systems. It has high comprehension requirements, and therefore low manageability, lack of reuse mechanisms, and specifications tightly coupled to implementations that resist change and do not closely model the real world. Finally, the complexity of these systems has grown to the point that a single engineer cannot grasp the full extent of the changes, which results in large development organizations and up to two year lead times for feature development. Much of the effort is in the integration and regression stages as the lack of tools and support for the proprietary environments means modification is like trying to do open heart surgery with a knife and fork—very slowly and carefully.

Abstract Call Models and Object-oriented Telephony Architectures

As stated above, procedural programming is not ideally suited to the design of communications systems. Object-oriented paradigms resolve the inadequacies of the PP methods and, in addition, make it easier for a service designer to model a new service and resolve conflicts with existing services. Objects in the system have well bounded and defined behavior that does not change when new services are added. Therefore, the impacts of adding new services are not propagated through the system.

The genesis of the object-oriented architecture exemplified here in the Phoenician system came from a number of desires. The primary desire was a belief that it would be simpler to teach a commercial computer to run a telecommunications service than to teach a telephone switch to behave like a commercial computer. Secondary was a desire to leverage 1990s computer technology and the advances that came with it in the art of software engineering. The goal of the latter was to ensure that the development of the system would accommodate the reality that whatever was built today would have to change or grow tomorrow. Finally, the aim was to treat the hardware as a commodity so all the basic components should be standard, commercial-off-the-shelf (COTS) components to leverage the scale of production and support of commercial systems.

Object-oriented, Distributed Object Model
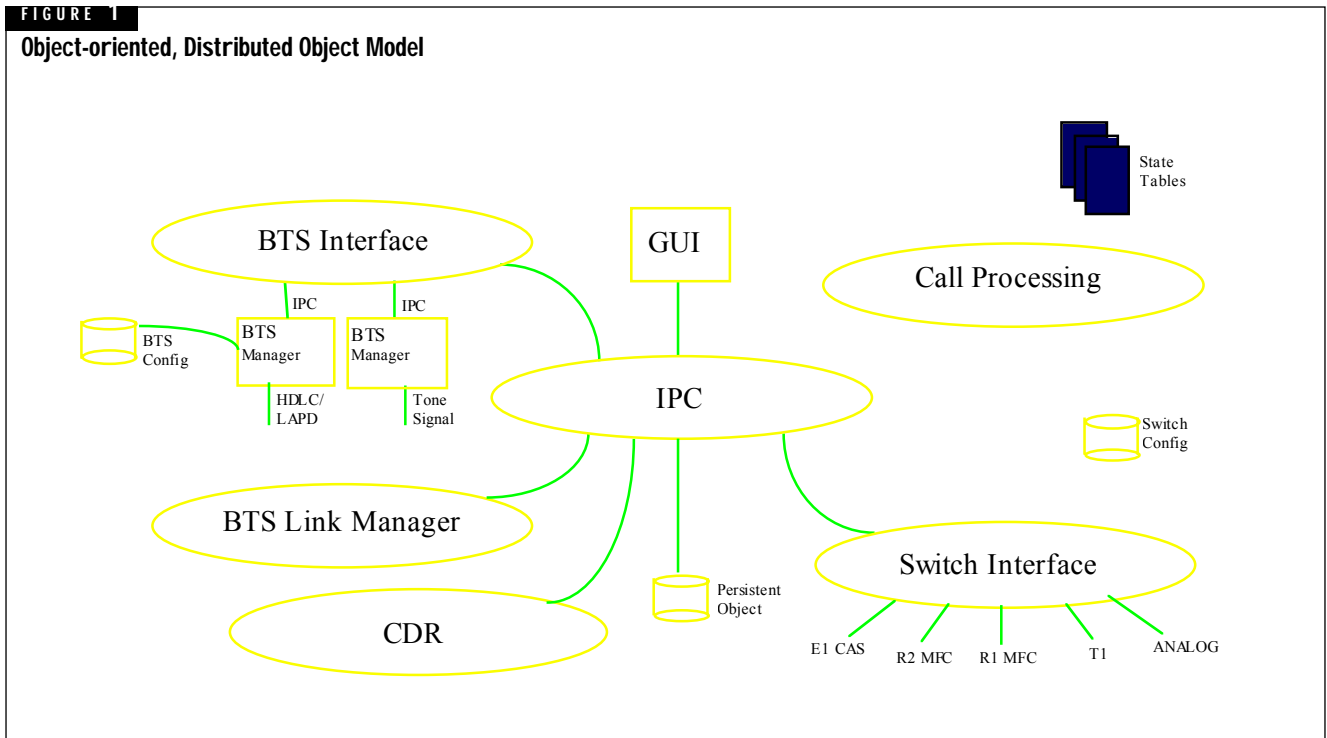
There are a number of key components of this software model, shown in *Figure 1.* Those that are applicable to a broader market, and therefore, appropriate to any number of open applications are the graphical user interfaces, the object- oriented call model, and the inter-process communication (IPC) scheme. All of these are built on a POSIX-compliant operating system base to allow portability and replication on a number of different hardware platforms.

The use of graphical user interfaces (GUIs) was intended to allow the operations and maintenance of the systems to be significantly simplified compared to traditional systems. While some of this capability is possible on a traditional system by some form of wrapper, or application program interface (API), around the existing interfaces, the real power is the close integration with the rest of the system. This has resulted in an interface more suited to greenfield and new operator applications than integration with legacy systems. In the case of legacy systems, the functionality is degraded to the lowest common denominator when a gateway function is applied to the Phoenician application management system. The ramifications of this trade-off are discussed below.

The object-oriented call model, shown in *Figure 2,* is believed to be unique in the industry and has proved to be a very viable model for future switching systems. It is possible to view this as an extension of the IN basic call model and SLP concepts implemented in a rigorous software environment. The call model is actually a text file that describes the state-event coupling and the individual objects that make up the call control model. A state machine exists for each originating port type (currently 3 types: wireline subscriber, wireless subscriber, and trunk), which identifies the unique properties of the abstract port type. This means

that all trunk signaling types are abstracted to a common trunk port type and all wireless common air interfaces are abstracted to a common wireless port type. The state machines are compiled into the system at start-up to circumvent the inefficient operation of an interpretive system and a port model is instantiated for each port origination. The text-based call model allows very fast and effective evolution and enhancement. Moving objects around in the table to change the behavior of the state machine and adding objects for new services does not impact the call processing software or the software of the individual objects. This results in maximizing the advantages of the object-oriented paradigm defined above.

The final critical piece of the puzzle is the inter-process communications (IPC). Each individual object and process in the system is uncoupled from all others and communicates only with the IPC. The IPC determines which objects and processes the messages are delivered to and resolves the physical addressing. The IPC is common object request broker architecture (CORBA) based but because the objects in the system are generally sustained indefinitely, the model is adapted to a "consumer-producer' relationship. This is to bypass the inefficiencies of the current object brokering mechanisms and message handling capabilities of CORBA. The consumer-producer model has each object and process register for the messages it wishes to receive. Each object posts messages to the IPC, which will then deliver them to all registered consumers. The IPC allows for a great deal of flexibility to be built into the architecture without impacting the basic software of the objects and processes that use it. The software is processor independent; thus the processing requirements can be scaled from a single machine to multiple machines transparently. The IPC handles multicast functions so the system gains geographic

FIGURE 2

Object-oriented Call Model Example

start state		event				next state		action(s)		
----------		-----				----------		---------		
idle		ORIGINATE				validating		(Counter:30 Validate)		
validating		VALID				waitRecCnct		(IsSpecialDial)		
validating		INVALID				idle		(Close Counter:31 CallCleanUp)		
waitRecCnct		FAIL				validateThreshold	(CheckThreshold)			
validateThreshold	SUCCESS					calling		(BeginBilling MakeCall)		
validateThreshold	FAIL					waitRecCnct		(Counter:33 DivertAnncmt:2)		
calling		OPENED				calling		(NoOp)		
calling		FREE				waitConnect		(Counter:32 Connect)		
calling		BUSY				waitTone		(Counter:32 Counter:37 DivertBusy)		
calling		TONEFREE				waitRinging		(Counter:32 CallProcEvent DivertRingBack)		
calling		TONEBUSY				waitTone		(Counter:32 Counter:37 DivertBusy)		
calling		NETWORK_CONGESTION				waitTone		(Counter:32 Counter:38 DivertReorder)		
calling		CALLFWD_BUSY				calling		(Counter:32 Counter:40 Counter:30 PostEvent:2 MakeC		
calling		CALLFWD_NOANSWER				calling		(Counter:32 Counter:41 Counter:30 PostEvent:2 MakeC		
calling		CALLFWD_ALL				calling		(Counter:32 Counter:42 Counter:30 PostEvent:2 MakeC		
waitTone		CNCT_TONE_SUCCESS				cnctTone		(NoOp)		
waitRinging		CNCT_TONE_SUCCESS				cnctTone		(Counter:35)		
cnctTone		ANSWERED				waitToneDisCnct		(DisConnectTone)		
cnctTone		CALLWAITING_ANSWER				waitToneDisCnct		(NextPort DisConnectTone)		
cnctTone		CALLFWD_NOANSWER				calling		(Counter:44 Counter:30 PostEvent:2 DisConnectTone		
waitToneDisCnct		DISCNCT_TONE_SUCCESS				waitSpeech		(Connect)		
waitToneDisCnct		CONNECT				speech		(Speech)		
waitSpeech		CONNECT				speech		(Speech)		
waitConnect		CONNECT				waitAnswer		(Counter:35)		
waitAnswer		ANSWERED				speech		(Speech)		

replication and distributed redundancy as an implicit benefit of the architecture. Finally, these capabilities can be leveraged for remote management and maintenance—communication between processors can be over the Internet! The system operator can decide the speed/bandwidth required based on cost and the demands of the application.

Advantages over Traditional Call Models

While a traditional switching system may have hundreds of engineers working on development and maintenance, this is insignificant compared to the tens of thousands of engineers working on commercial computing platforms. Adding in the reuse, isolation, and flexibility of object-oriented paradigms, there are a number of key benefits.

Engineering Practices
The commercial environment has learned much over the last 20 years regarding what is possible to do to change software development from an art into an engineering discipline. Using commercial platforms allows the resulting communications systems to take advantage of all the methodologies, design techniques and programming and test philosophies to the utmost. Many of these practices are the basis of the software structures that provide isolation, reuse, and flexibility in the systems evolution.

Tools
In the commercial environment the availability of third-party tools is vast and varied. The tools include complex

capabilities to manage the design development and operational aspects of the program. These include:

• object-oriented design and development packages

• software test tools that evaluate code coverage under test, code utilization (timing), and identifying un-initialized, poorly referenced, and lost code

• source code control and release control

Test tools that are software based allow the test plans, test cases, and test results to be incorporated into the source and release control mechanisms allowing regression to a software load and testing of the load to be automated. The testing activity is contained in that once an object is tested it is unlikely that it will need to be retested in the future.

Software Packages
Class libraries, specific applications like graphing tools and database systems or protocol stacks, and enabling technologies are freely available or bought to maximize the reuse and leverage existing investment. All are available to be abstracted and integrated into a commercial platform. No one would consider trying to develop a word processor package when a multibillion dollar investment such as Microsoft Word' is available for a few hundred dollars. To this end, the time and resources invested are in the telecommunications applications and the basic building blocks are acquired as part of the operating system package or from third-party vendors. The end result is the ability to produce

complex switching systems and the intelligent applications required by today's users in significantly less time using significantly fewer human resources.

Real-World Experience with the Architecture

The architecture example mentioned above has been deployed in a number of countries around the world over the last three years and has proven to be stable and resilient to change. Today the development environment is ObjectCenter and the resulting code is all C++ running on a Sun SPARC platform (SOLARIS 2.5).

The system consists of approximately 20,000,000 lines of code of which about 5,000,000 were custom development by Phoenix Wireless. The balance is made up of commercial packages, the operating system and its support utilities, and, in some cases, customer specific packages.

Upgrades and enhancements have been easily accomplished. The first set of custom calling features, call forwarding variants, and call waiting, took less than a month to integrate into the call model. Subsequent feature development has been similarly quick. Country-specific trunk signaling protocols use a combination of the call model and a procedural programming language that handles the ITU SDL constructs. In most countries the specific protocols have been developed in a matter of a few weeks. Final integration is typically done by an engineer in an Orlando, CA facility running call processing remotely over the Internet to verify the signaling and control sequences of the field installation.

The system is capable of running 50,000+ BHCC. Presently the bottlenecks are in the switch matrix, not the control processor. The control has been simulated at well over 100,000 BHCC in a single processor. As the architecture allows for a distributed multiprocessor environment, the actual limit is significantly higher.

The first-generation systems that were deployed in mid-1993 used a PC computing platform. This was not acceptable in a real -world telecommunications environment for a number of reasons. During 1994, the system migrated to a Sun Workstation platform which has proved to be an excep-

tionally stable environment and a significant improvement over the PC platforms. The major problems with the PC platforms centered around the lack of rigorous standards for the components and interfaces and the resulting lack of consistency and quality of the components.

Cost savings provided by the architecture's flexibility have been substantial. The best example of this is using PPP or the Internet to provide internode communication for roaming at speeds from 14.4 kbps to 100 Mbps for the price of a modem or an Ethernet cable instead of the costs associated with SS7 signaling links.

Feature and Service Evolution

Generally speaking, the requirements for intelligence in communications networks continue to grow and most of the new capabilities are outside the domain of the traditional switching systems. The telecommunications model is migrating to calling people not places. Traditional switching systems have relied on a step-by-step digit translation to a physical geographic location. This is no longer valid in a wireless environment and will not be valid in a wireline environment with number portability. There is strong consumer interest, as shown in *Figure 3,* in such features as a means of simplifying the way the world communicates with them.

Number portability is best considered as a component of a "one number" service. Many such one-number services exist today but most are crude requiring either complex management by the served subscriber or long delays to the calling user while the network hunts for the called party.

The Costs Associated with Running a Telephone Network
In terms of the overall costs of network operations the equipment costs are a small fraction, in the order of 20%,[2] as shown in *Figure 4.* The major cost structures are in operations and services. Intelligence in the network that is capable of bringing operational costs under control will have significant benefit to the operators.

The definition of the cost breakdown in this model is as follows:

FIGURE 3

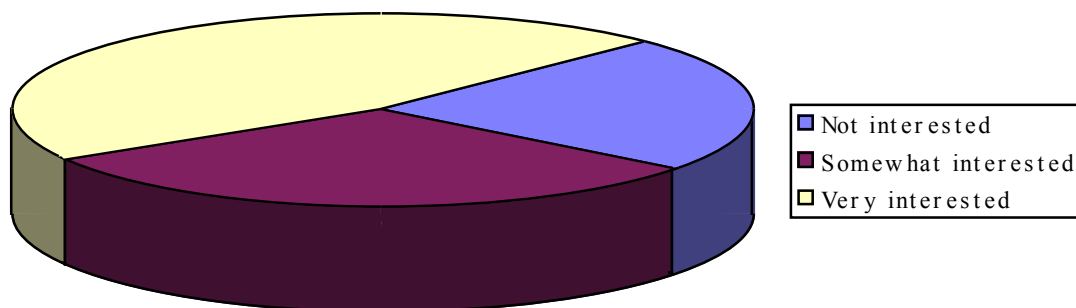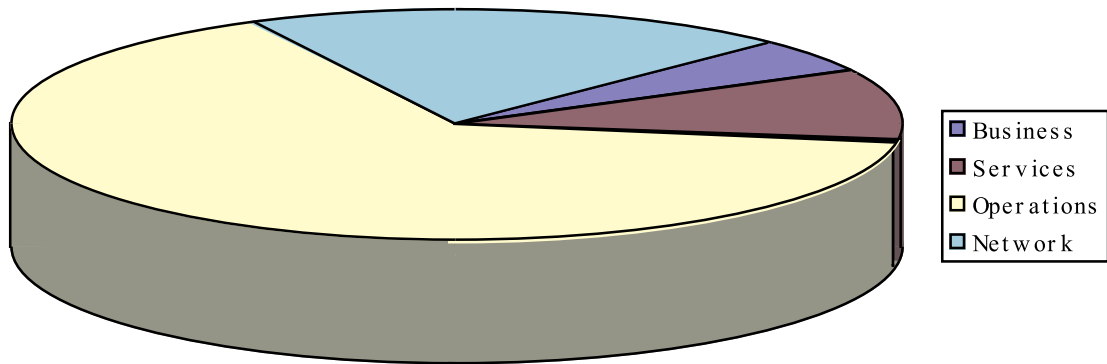**Level of Interest in 1-Number Service[1]**

Legend:
- Not interested
- Somewhat interested
- Very interested

FIGURE 4
Wireline Operational Costs

Legend: Business, Services, Operations, Network

- "Business" includes billing, administration, planning, and customer care.

- "Services" is the value-added services to retrain customers (such as voice mail).

- "Operations" includes network operations, provisioning, and network planning.

- "Network" includes the actual hardware cost of the switches and OSP.

This model looks fairly typical for a regulated monopoly. As the only game in town, not much needs to be spent on customer care or service differentiation. In a competitive environment, like the cellular industry, these numbers should be much higher.

By comparison, *Figure 5* provides the costs for a GSM system in Germany.[3] There are two competitive carriers in the German market. Here the infrastructure cost is 30%, which is indicative of the extra cost of a mobile system.

There are two trends that go beyond the basic comparison:

1. The cost of the infrastructure is (worst case) less than a third of the overall operating cost, yet most commercial tenders are awarded on the lowest cost per line/trunk or user.

2. The costs for marketing and services are going to become more and more critical in the evolution to a deregulated environment. As such, the models shown will still have the same cost associated with the infrastructure. This means an additional cost burden for customer service and features.

There are also significant differences in the way that IN services are deployed today to capture revenue for the operator. IN services today are currently deployed by wireless carriers to increase airtime use. This is due to the differences in the regulated rate structure/revenue capabilities of wireline and wireless. Bell operating companies (BOCs) charge customers for call waiting, call forwarding, and other such features, as their use does not generate much additional revenue. Wireless operators, on the other hand, are giving away voice mail, call waiting, and other services because their revenue is maximized by additional use of revenue-generating airtime.

The capability of the users of networks to use technology to achieve their goals or circumvent what they see as unrea-

FIGURE 5
GSM Mobile System Operating Costs

Legend: Marketing, System, Personnel, Interconnect, Other
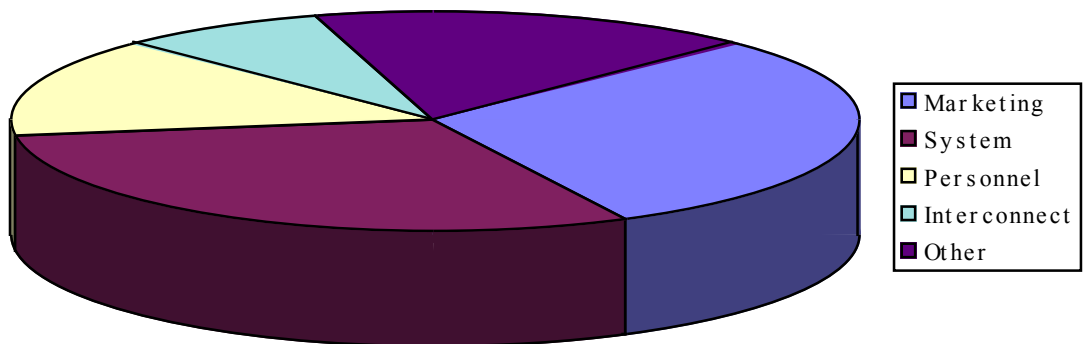
sonable is growing daily; carrier complacency will result in consumers flocking to or creating alternatives. Examples of the current crop of creative solutions include international call back systems to get better pricing, Internet Fax store and forwarding, and Internet voice. All of these can be achieved with relatively little, inexpensive technology.

Competitive markets require strategies to create customer loyalty. Some companies are capable of doing that today but telecommunications companies have a long way to go. The strategies of the successful companies typically include a level of integration of a variety of voice and data technologies to provide value added services. Customer-focused companies consistently outperform financial market averages, so utilizing IN to create and sustain such services will become critical to competitive success.

Implications for IN Architectures

The systems deployed today are woefully inadequate to address the issues of a deregulated competitive market and operators are ill equipped to determine how the systems will help them solve the issues they face. The computing environments are evolving too fast and the tidal wave is likely to swamp current telecommunications capabilities as the change accelerates. The ponderous standards of telecommunications management network (TMN), integrated services digital network (ISDN), and SS7 in use today are no match for the communications capabilities of the computer world in terms of flexibility, bandwidth, or cost.

The telecommunications standardization processes are draconian and work at a snail's pace. Much of the computer and consumer technology we take for granted today was never standardized, or it achieved standardization in a fraction of the time it takes to standardize a telecommunications concept. While Internet telephony is crude today it has the potential to rapidly erode the higher-margin telecommunications markets such as long-distance and international calling.

Within the rapid evolution of new services are the increased potential for fraud and the complexities of billing systems. Billing must be taken out of the switching systems and network elements and placed into an intelligent computing environment. In this way heuristics can be brought to bear on real-time data to detect patterns of fraud and billing abuse, even to the extent of individual consumers going beyond their credit limit. This is no longer as simple as call minutes but must be aggregated with all the features and services utilized by the customer outside the basic call switching fabric. When the potential for two local access providers, one long-distance provider, and one or more enhanced service provider to be involved in a single call, all expecting to earn revenue from it, the complexity mounts rapidly. Within data networks it is common for users to pay for bandwidth or packets, but this is currently challenging in the current SS7 networks that provide the backbone for the intelligent network.

Operators cannot wait for standardization in a deregulated and competitive market. Operators are not far from offering

service via the Internet. Soon customers will be able to access their account and billing information via a Web browser such as Netscape . As an applet language like Java as well as Internet concepts invade the intranet, corporate users will have the means to configure their virtual private networks (VPNs) and users via the same Web browsers and tools used on the Internet today.

Management and operation of the network is under extreme pressure. TMN is the current darling of the industry. However, although TMN was created with a view toward distributed management, it was long before the impact of remote access, telecommuting, Internets, and intranets was even vaguely understood. In addition, network operators in deregulated environments are required to provide access to operations support systems (OSSs) for competitors who intend to provide network services. The cumbersome TMN systems are seen as unfair and confusing to these new operators and appear to keep control in the hands of the incumbent operators. TMN also needs to be radically opened to endorse computing concepts and CORBA-like integration to allow information exchange and interconnection.

IN Role in Competitive Wireless Markets

Beyond the basic mobility provided by home location register (HLR) and visitor location register (VLR) components of a wireless market there are a multitude of application levels and convergence levels where an IN provides the glue that cements the pieces together. This ranges from managing public and private mobility, called cordless terminal mobility (CTM) inside ETSI, through convergence of wireline and wireless networks including voice and data, to a range of applications and services that enhance the mobile capabilities. Such mobile enhancing capabilities include integrating paging, radio trunking, and global positioning system (GPS) location services.

The ETSI CAMEL initiative migrates the basic HLR and VLR concepts into a CS-2 advanced intelligent network (AIN) architecture that is focused on GSM and CTM integration with IN. This is not enough. The focus is still too much on voice-centric applications. The value-added services will come from support of nomadic users who will be armed with a phone and a personal digital assistant (PDA) or notebook computer. These nomadic users are primarily business users today who demand the latest stock market quotes, e-mail, document exchange, and, eventually, multimedia applications. If user demand is projected forward five years, many of these will be expected by residential users. These residential users already have calling line identity, personal computers, fax machines, and Internet access at home so their comfort level with using these in a nomadic environment is very realistic.

Unfortunately for the wireless industry the current common air interfaces are somewhat restrictive and have low data transfer rates, therefore the IN applications will have to be creative to deal with these limitations. In order to preserve the integrity of the links, the best applications will be client-server based in concept and applications will probably be

best suited to running on the PDA or notebook computer using the phone as a data transport device.

Wireless network operators are in a highly competitive market. The current U.S. marketplace can have as many as seven wireless service providers in a city, with two traditional cellular carriers and three or more personal communications service (PCS) band carriers as well as enhanced specialized mobile radio (SMR) systems such as iDEN™ (time division multiple access) and Geotek™ (FHMA). The end result today is customer confusion and lack of market differentiators. Their only attempt to date has been to try to leverage the different technologies, but most consumers could not care less about the technical details.

A key cost factor in the competitive wireless market is churn—users who jump from one provider to another based on the latest marketing promotion. This phenomenon is already apparent in the cellular markets and the competitive long-distance market in the United States. It will undoubtedly become a factor in the wireline industry as it is deregulated. Churn is a very expensive proposition to the carriers and directly affects profitability, as it is difficult to administer and manage and even more difficult to control. Anything that an operator can do to reduce churn and the costs associated with it will be of tremendous benefit. Intelligence in the network can assist. First, reducing the costs of administering users will reduce the cost of churn. Also, the ability to create an environment where a user will not want to jump ship will
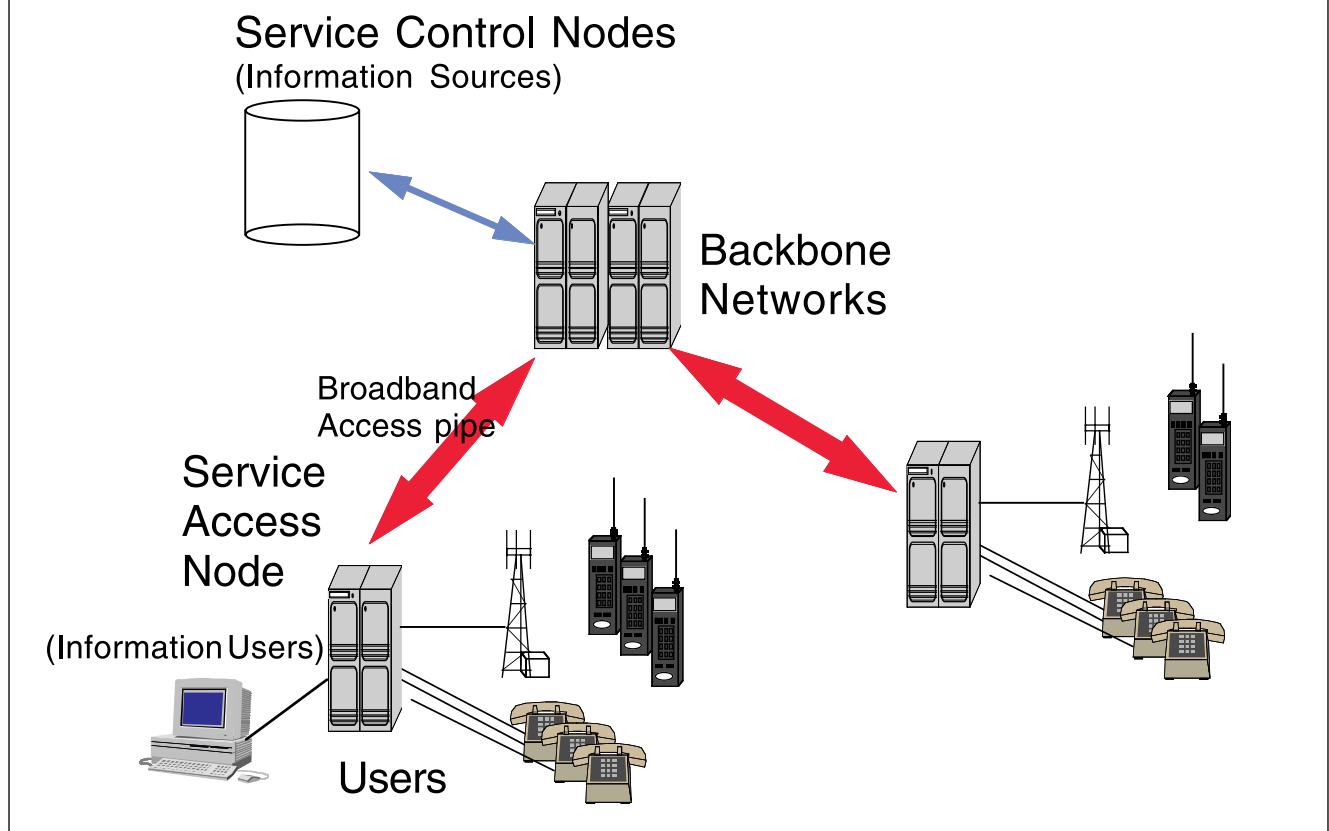
clearly control churn. Intelligence in the network is the answer, providing the user with incentive to stay in the form of unique features and services that are worth more to the user than the cost savings and inconvenience of changing carriers. Brand loyalty helps, but bundled services and perceived value and service will be the key. In order to target ever-smaller groups, possibly down to individual subscribers, the software defined architectures described above are critical. Custom services must be created at almost no cost to the carrier to be profitable for small user populations. Object-oriented call models have been demonstrated to meet this requirement.

Given a clean sheet of paper, where would an IN that supports mobility be today? If the architecture were to take advantage of the concepts of distributed computing systems instead of centralized mainframe systems? If the concepts of CORBA- and Java-like applications were incorporated? Specifically, not something that stretches the bounds of possibility but uses technology available today.

It is not too difficult to extrapolate from today's centralized switching environment to a radically different model without the requirement for technology that does not currently exist. The days of the large central office are surely numbered in a deregulated market. With several operators in a single market, the need for a 100,000-user switch will be relegated to the small number of very large urban markets. There is no requirement for features and services to be

FIGURE 6

An Alternative Intelligent Network

Service Control Nodes
(Information Sources)

Backbone Networks

Broadband Access pipe

Service Access Node

(Information Users)

Users

rolled out, at huge expense, across a network of class 5 local access switches when the target markets are much smaller. It is possible to consider small access nodes, where small could be anywhere from a few hundred to a few thousand users. These access nodes provide network access to a variety of wireline and wireless circuit switched and connectionless devices, as shown in *Figure 6.* They may well be based on a small asynchronous transfer mode (ATM) access device instead of a circuit switched device. A service request from a particular user will result in a query of a network repository that will download the service profile, account information and even possibly the call processing model for the user. While an interpreted scheme like Java may not be optimal for such an architecture, something similar will be.

This kind of architecture will leverage as much commercial technology as possible instead of inventing new and complex standards, and focus on geographic redundancy and heuristic healing as opposed to centralized hardware fault tolerance. This kind of architecture allows for custom features and services on a per user basis and the network only knows how to understand the service commands it is given. There are a number of prototype systems currently defined for network agents or proxies to fulfill pieces of this model. In such an architecture there can be a number of service providers. The access node, the backbone networks, and the service control node can all be operated by separate service providers.

Conclusions

This paper has attempted to identify the need for a shift in the IN paradigm to a commercial computing-based architecture, with a corresponding shift in the way that the basic telecommunications network will support the IN. It is proposed that the rapid evolution in computing standards and technologies will mandate this shift or more and more

of the traditional telecommunications role will become absorbed in the computing arena. Systems like the Phoenician have proven that open architectures and object-oriented concepts can work in the real world of telecommunications.

The implication of convergence of wireline and wireless means that it is unreasonable to consider a wireless market in isolation as mobility is more than a function of the access device. The call a user not a place concept implies mobility inside a wireline network, between an office and home, inside a wireless network, between wireline and wireless networks and between public and private networks. The reality is that today's wireless operators are faced with addressing the challenges sooner than the wireline industry because of the mode of access of the users and the competitive environment in which they have always operated.

The wireless industry is in a position to exploit these changes more easily than the wireline industries as they are used to a competitive environment and do not suffer from as many legacy systems, practices and procedures as the wireline operators. The single piece of the puzzle that will either accelerate or impede the potential is the way that the operators are regulated. Much of the difference in the last 20 years evolution is due to regulatory restraint on the telephone operators rather than a lack of desire or competence in the telecommunications industry. As regulation is eased, telephone companies will become much more creative but will demand that standardization processes become much more rapid and responsive.

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When the Detour Becomes the Highway: The Future of Alternative Routing

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Abstract

Alternative telecommunications carriers have undermined the traditional bilateral operating agreements and accounting rates regime by offering consumers less expensive options. The resulting liberalization of telecommunications was inevitable. Although long-established large players are now adopting alternative calling procedures themselves, small, independent alternative firms will continue to be able to compete because business success in current telecommunications depends on factors that have little to do with sheer size. Governments that recognize the continuing advantages of liberalization and deregulation will deliver maximum benefits to their citizens and economies. One area that can benefit especially is the establishment of investment capital markets in emerging economies.

During the Middle Ages, Flemish merchants wanting to buy or sell goods in Milan had to traverse a narrow pathway along the northern shore of Lake Geneva. They paid a tidy sum for this privilege, however, thanks to the Chateau de Chillon, a shoreside fiefdom controlled by the Duke of Savoy. If a goods-laden caravan tried to brush past the Chateau's toll collector, a troop of armed riders would pursue it and quite effectively exact the toll.

Comparing this to the traditional telecommunications system may exaggerate matters, but not beyond recognition. Traditional PTTs and PTOs can be said to have carved up the telecommunications realm like feudal lords dividing up territories. In the absence of alternative routes, they could levy maximum tolls and generally have.

Admittedly, one could argue that the motivations of the medieval fiefdoms were overtly mercenary, while those of the PTTs involved the more complex ideas of the natural monopoly, cross-subsidization, and universal service. For now, let us simply mention the well-known tendency of monopolies to overcharge and underserve their customers and add that both tendencies have been amply present in telecommunications regimes. On the old highway of half circuits and correspondent relationships, the monopolists faced no competitive pressures forcing them to reduce overhead and other costs or to improve service. When one possesses the primary route between Flanders and Milan, one finds oneself thinking of good reasons for charging higher tolls, just as one finds little incentive to repair potholes.

Various forces could undo such a monopoly, but the most obvious would be the development of less expensive alternate routes. If merchants could fly their goods to Milan or ship them by truck, boat, or railroad, then any Chateau that exacted a high toll on passers-by would soon have no passers-by.

Here the analogy becomes more obvious. For over a century, the old bilateral operating agreement/accounting rate regime offered the only route available for termination of international traffic. But what telecommunications "ships" is information, and information is, increasingly, packaged in such a way that it resists attempts to contain its transmission. It is becoming ever easier to find clever ways around PTT control of bottleneck facilities. When strategies such as callback, refile, and bypass came along, it was inevitable that someone would notice that they offered an inexpensive alternate route to the old monopolistic highway, and it was inevitable that consumers would climb aboard. In 1993, for example, the first Japanese consumers of callback were faced with the choice of paying incumbent operators ¥200+ a minute to place a call to the United States versus paying callback operators ¥75 for the same call. This was not a difficult choice to make.

The majority of monopolistic regimes and their regulatory accomplices have only recently begun to respond to the forces of market liberalization and technological revolution. PTTs have, after all, enjoyed a monopoly for over a century. A recent study by Frost and Sullivan estimated that AT&T alone could lose $350 million a year worth of international revenue to Internet telephony by 2001, and updates to this study are increasing that figure across the industry. But most agree that the trend cannot be stopped, any more than contemporary travel from Bruges to Milan could be restricted to a narrow pathway traversing the gates of the Chateau de Chillon. While significant opposition to liberalization remains, it is increasingly acknowledged that this amounts to futile rear-guard action. In the artificially inflated market of international long-distance telecommunication, alternative carriers were an inevitability and so was their success.

Skeptics have wondered just how long that success will last. Don't the large, established players have the resources to trounce the upstarts at their own game? This question arose with the advent of callback. Low-cost digital switching, plus competition in liberalized markets (notably the United States and United Kingdom), had led inevitably to the export of low-cost dialtone. Callback was, in essence, the exporting of competition to noncompetitive markets. It was bound to succeed for the simple reason that it gave consumers and businesses extraordinary price advantages. The result was, inevitably, a downward pressure on the incumbents' collection rates. For example, in Kenya, the cost of a call to the USA fell from the 1993 rate of US$6 per minute—with a three-minute minimum length—to today's rate of $3 per minute. The cost of sending a one-page fax to the United States fell from $18 to $3—attributable, primarily, to the competitive pressures introduced by callback.

Why Alternative Carriers Are Here to Stay

But could this change the roster of major players for more than a brief moment? Until the spring of 1996, *The Wall Street Journal* assumed that it would not. Once collection rates were adjusted downward, it reasoned, the arbitrage advantage of callback would disappear. And so, *The Journal* assumed, would callback firms.

By 1996, however, *The Wall Street Journal* began to realize that while callback itself may disappear, callback firms themselves would outlast the technology responsible for their birth. Let us consider several reasons why. One factor, necessary but not sufficient, is the continuing emergence of new technological tricks from up the independents' sleeves. Alternative carriers have, for example, gone into refile and by-pass. Today, if a call from Southeast Asia to the United Kingdom costs US$.005 per minute less when routed through the United States on an ISR route than it does when placed directly at settlement rates, then the traffic is more likely to flow through the United States than to take the direct route.

The reason this is not sufficient to keep alternative firms competitive is, of course, that the arbitrage advantage represented by refile will again disappear. An estimated 50 percent of the world's telcos are refiling traffic. Moreover, in some markets, over 20 percent of customers are using callback. AT&T itself now offers callback. Internet telephony will follow the same pattern. The detours, in short, have now become the highway. Couldn't the independents, again, be hoisted by their own competitive petards?

For several reasons, I don't believe so. For one thing, as *The Wall Street Journal* noted in 1996, callback offers a strategy by which alternative carriers can enter a previously monopolistic market, build a sales force, develop a customer base, gain brand recognition, and form strategic alliances. With these advantages, successful callback companies can migrate to private-line resale and full, facilities-based competition.

More basically, technological advances have changed what constitutes key competitive advantages in our business. To understand this, consider first that advances in fiber-optic technology have dramatically decreased the cost of transmission. William Carter of Submarine Systems, Inc., one of the leading researchers in fiber-optic technology, has said that his R&D engineers see "no end in sight" to the increasing bandwidth and transmission capacity of each new generation of submarine fiber-optic cable. Another factor reducing the limitations of bandwidth is asynchronous transmission. Between these two technologies, supply of bandwidth is no longer a limiting factor.

What this means is that technology is reversing the traditional cost structure of the industry: the cost of transmission is now becoming lower even than the cost of switching. In a competitive environment, transmission becomes virtually free. Under the old monopoly-based paradigm, telecommunications services were treated like platinum—an expensive, rare commodity. Under the new paradigm of alternative calling procedures, telecom services become as abundant as water. The new generation of telcos, with access to cost-based transmission, is increasingly passing these benefits along to customers in the form of low-price, high-quality service.

With transmission a minor cost of doing business, telcos will now be competing on bases that have little to do with sheer size. They will compete on the basis of their sales ability, their customer service, and their efficiency—their ability to keep general and administrative expenses at a minimum. Those who can attain the lowest overhead without sacrificing quality will succeed.

Here is where a hidden advantage of the alternative carriers lies. Surprisingly, it is often the small, independent telcos that can maintain the most favorable ratio of employees to volume of traffic. Without a tradition of bureaucracy, the independents have from the start been oriented toward maximal leanness and meanness. However, much the majors try to downsize, some will never be able to surpass the independents in these efficiencies.

For all these reasons, then, the competitive landscape of international telecommunications has been permanently altered. The example of Sprint and MCI is relevant: when the U.S. market was liberalized, these firms were unknown, but today they are major forces. Moreover, now that telecommunications is becoming affordable to so many people, the sheer size of the telecommunication market is becoming so huge that capturing even a small slice of it is enough to make an independent company very healthy.

Ahead of the Power Curve

For these and other reasons, trying to prevent the transition from a monopolistic to competitive paradigm is like jamming one's finger in the dike when water is already pouring over the top. The more far-seeing regulatory authorities already understand this. A case study illustrates the direction they are taking. In April 1997, USA Global

Link President Larry Chroman visited Japan and announced the introduction of its Global InterNetworkSM system, which will provide voice telephony services that work from telephone to telephone but are carried via the Internet. The Japanese media was enthusiastic about the idea, but Japan's Ministry of Post and Telecommunications (MPT) was not; it informed Global Link that Internet telephony was illegal in Japan.

However, the MPT thought further about the implications of the new technology, and as a result, reversed its initial ruling. In July of 1997, the MPT announced that as of August 1, Internet telephony would be fully legal in Japan. What was perhaps most interesting about its announcement was that simultaneous with its sanctioning of Internet telephony, the MPT announced that Japan would open the door to international simple resale (ISR). Like Internet telephony, ISR allows traffic to flow between countries while staying outside the traditional accounting rate system, so that the only costs involved are the costs of transmission and the cost of ingress and egress from the public switched telephone network (PSTN) at either end. These costs are generally minimal.

In short, the MPT realized that both these technologies represent a de facto convergence of voice and data, with all the implications this entails for the pricing of voice-telephony services. Whether we like it or not, the convergence of voice and data is unstoppable. We can choose to position ourselves behind the power curve or ahead of it. The Ministry of Post and Telecommunications in Japan made a wise choice. The situation illustrates an observation from the report of the ITU's Sixth Regulatory Colloquium on The Changing Role of Government in an Era of Telecom Deregulation: "It is apparent that the impact of convergence upon regulation will be greater than the impact of regulation upon convergence."

In contrast to Japan's enlightened decision, current attempts to plug the crumbling dike of monopolistic restrictions are failing; the water is indeed coming in over the top. The most forward-thinking PTTs and PTOs realize this and are learning to surf the new wave.

Convergence and Emerging Markets

Surfing these waves has many benefits to offer to the countries the PTTs serve. I have written elsewhere about ways in which the new paradigm of telecommunications offers economic benefits to emerging societies around the world. I would like to point out one other such benefit. When telecommunications and transportation infrastructures are undeveloped, businesses must be in close proximity if they want to communicate with each other. This is the origin of crowded commercial centers such as Wall Street, the Ginza, or downtown Bombay. But with the development of the global information economy, people will be able to live anywhere and still work together. They will be able to commute instantaneously. They will be able to know anything known anywhere to anyone else instantaneously, at virtually no cost. The implications for global commerce

and global financial services are obvious, and this holds special promise for emerging nations seeking investment capital, export markets, and relief from the overcrowding of capital cities. Convergence, therefore, not only involves data, fax, voice, video and multimedia services, but also the convergence of telecommunications with information technology, finance, and commerce.

All of this is going to come to exist on the world's new fiber highways. How can the Asia Pacific region maximize its access to this highway? The region is characterized by national economies that range from those that are advanced economically and technologically—e.g., Japan, Singapore, and South Korea—to those at the other end of the spectrum, e.g., Myanmar and Mongolia. The highly developed are in a position to enjoy the benefits of the new free-market paradigm immediately, since they already have a telecommunications infrastructure to take advantage of this change. All that needs to be done is to open it up to competition. The less-developed economies are similarly in a position to open their doors to competition in the form of new market entrants eager to deploy the latest technology. This will allow less-developed countries to leapfrog to the latest technology rather than continuing to rely on inefficient monopolies for improvement that may never come. Thus, whether a country is poor or wealthy from a telecommunications perspective, the main factor inhibiting its leap into the 21st century is antiquated regulations and restrictions on competition, and the main gateway to taking maximum advantage of the telecommunications revolution now underway is removing these same restrictions to competition.

That gateway is opening, either as it is being pried open effectively from without or advisedly from within. Indeed, traditional PTTs and PTOs are actually entering into alliances with aggressive independents like USA Global Link, to take advantage of the numerous opportunities inherent in a time of rapid change. Thus, not only is the detour becoming the highway; those who blazed the detour trails are among the new highway's chief engineers.

The story of Chateau de Chillon contains the seed of one more relevant principle. The companies that will thrive in the coming era will not be those that try to shore up their defenses and restrict access, but rather those whose innovation and efficiency enable them to contribute maximum value to their customers and shareholders. As future technologies unfold greater and more powerful possibilities, much will change, but I am certain that success will remain contingent on an aggressive pursuit of innovative solutions and increased efficiency in their deployment. This principle will determine the fate of individual corporations as well as nations in the next millenium.

Creating the Engineer of Tomorrow

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Introduction

These years leading into the 21st century are a time of contradiction. They are a time of sustained economic prosperity, with high employment and low inflation. But it is also a time in which there is a critical shortage of engineering talent—especially software engineers. It certainly is a great time to be entering the profession. The competition for talent has never been greater, and the rewards have never been as attractive.

At the same time, these shortages reveal weaknesses in the economic system and the way engineers are educated. These problems threaten to undermine the nation's competitiveness and unravel prosperity upon the dawn of a new decade, century and millennium. There is a need to figure out how to improve the talent pool and fill the skills gap—the problem that seems to attract the most attention. But there is also a need to examine productivity—how to make the best use of information technology and engineering resources. As part of this process, redefining the role of the engineer within the organization and within society becomes a necessity. This may involve turning a few assumptions upside down and erasing a few stereotypes. More than clickers and draggers, there is a need for creators and designers.

The Skills Gap

First of all, what about the skills gap? Many people have been talking about the year 2000 problem—the need to reprogram computer systems to avoid a colossal crash on January 1, 2000. The stories in the media highlight a problem about which those in industry have known about for a long time: there is a shortage of approximately 300,000 people in the information technology industry in the United States. There simply are not enough software engineers. People who never thought they had any interest in math or science are taking six-month courses to become programmers. Retirees are going back to work. Yet the gap still cannot be filled.

How did this problem arise? First, the demand side. When the transistor was invented fifty years ago, few could foresee the impact it would have on society. Microcontrollers are embedded in just about everything these days, and the explosion of applications makes it impossible for software developers to keep up.

What about the supply side? As a nation, the United States cannot produce enough people who aspire to careers in science and technology. Problems in our elementary and secondary public schools have been identified and will require systemic reform if schools are to provide students with the math and reading skills needed for tomorrow's jobs.

In addition, we must step up efforts to encourage women and minorities to pursue careers in science and technology. At the university level, some stellar schools attract science students from all over the world. But, quite frequently, these students either prefer to work in their home countries or are forced to leave the United States as a result of strict immigration regulations. As foreign universities improve, more top students will remain in their home countries to go to school. Global companies based in the United States are doing more research and development in the international communities they serve in order to provide better customer service as well as to tap the supply of engineering talent throughout the world.

The national talent pool was one of the fundamental issues explored at MIT in March 1998 during an Innovation Summit sponsored by the Council on Competitiveness. Some questions and observations that were raised are as follows:

- Has the potential for vocational schools to create more software talent been underestimated?

- The semiconductor industry's effort to develop technically oriented workers in junior colleges has started to pay some dividends.

- Many liberal arts majors have the aptitude to develop software skills. Have they been encouraged to pursue careers in that arena?

- What about distance learning or education over the Internet? Carnegie-Mellon University, for example, offers an engineering certificate program over the Internet that is being expanded into a master's in software engineering. Making education available at home and at the desktop is a promising development.

- How should the shortage of professors be rectified? Can retired engineers be lured back into the classroom? Can they stimulate interest in science in elementary and secondary schools?

• What about the immigration policy? Canada welcomes scientists and engineers with enthusiasm, but in the United States, it is difficult to get talented, educated individuals into the country.

Talent and Productivity

To get an idea of how this shortage threatens the nation's competitiveness, productivity needs to be examined. Observe the impact on prices. Today, people do not seem to worry about inflation, because they are discovering what those in the semiconductor business have known for decades—as the cost of memory and computing power goes down, each new generation of products delivers greater functionality for less money.

These innovations cause more productivity, and that means successful competition. But the competition keeps getting tougher. Within the past year, currency devaluations in certain Asian countries may have appeared to be good news to the U.S. consumer, but they have had a significant impact on the competitive position of American manufacturers. That is just one factor. For survival, there is a call to innovate and improve productivity across all sectors of the economy—goods and services alike. The challenge for tomorrow's engineers is to make it happen.

I have mentioned some of the reasons for the shortage of software talent, but I have not mentioned an obvious one: writing software is an extremely manual process. Writing code is tedious and time consuming. In the last three or four years, productivity, as measured by lines of code per day per person, has remained about the same. This does not bode well for the information technology industry in the United States. Without an increase in productivity, the countries with the largest manpower resources will win. We can infer that the United States will not be one of them.

Some of the less glamorous industries like steel and automobiles have made far better progress. They have automated their operations and strengthened their competitive position. In the consumer electronics industry in the 1960s, workers placed a few hundred components an hour on circuit boards. Today, with advanced automation tools, the figure is 15,000 to 25,000 per hour.

Can something be done about software productivity? As a nation, there is a need for government-funded research in tools for capturing requirements, designing optimal software architectures, and generating system specifications. This in turn can lead to automated code generation, testing, and verification, all of which is done almost manually today. There is the talent to achieve this in the national labs as well as in the universities. Building on cooperative efforts among government, industry, and the universities can make this happen.

These standard architectures and tools promise to make a career in engineering far more exciting, as well as closing the skills gap. Mechanical engineers use advanced computer-aided design tools to eliminate tedious, repetitive operations. Likewise, an engineer in the semiconductor industry can draw on libraries of standard software to design specific customer applications. The software engineer writes the macrocode that assembles the building blocks that create the solution. This is a far more productive use of the engineer's talent than writing endless lines of microcode.

The Role of the Engineer

Today, redefining the role of the engineer, and the way engineers are educated is crucial. William A. Wulf, president of the National Academy of Engineering, defines the profession as "design under constraint"—constrained by nature, cost, safety concerns, reliability, environmental impact, manufacturability, and maintainability. But Wulf believes that engineering education "has not kept up with this changing environment. I think it is only a slight exaggeration to say that our students are being prepared to practice engineering in a world that existed when we were trained a generation or two ago. They are not being prepared for the 21st century."

The stereotype of an engineer is a lonely inventor who sits at a workbench and tinkers with electrical equipment. That image has been replaced by another one of an engineer as person who sits alone at a keyboard and desktop computer all day, keystroking and clicking and dragging. I think it is about time to get rid of that stereotype, too.

Tomorrow's engineer will concentrate on design and creativity as part of a team that anticipates the needs of a customer and knows the technology that will be available to solve the customer's problems. These skills do not rely on computer programming. They require creativity rather than dexterity on the keyboard. The engineer needs to be able to work with people, research and analyze markets, and understand the expectations of the average consumer as well as the needs of the business customer. In the global marketplace, the engineer must be aware of, and sensitive to, differences in cultures and ergonomics.

This is a type of relationship with a customer that does not fit the stereotype of the engineer. It is a relationship that requires exceptional communications skills, both speaking and writing, combined with technical knowledge. It requires the ability to persuade and negotiate. It requires the imagination to be able to sell the customer on the idea of what is possible. These skills are all within the domain of tomorrow's engineer. As computer tools advance, engineers need to resist the temptation to spend all their time in isolation with these tools.

These new skills are not often associated with today's engineers. Motorola invests $185 million a year on training and much of it on engineers who need to improve their ability to work in teams. Going through a Motorola University catalogue will reveal courses in marketing and communications. Visiting Motorola offers the opportunity to observe engineers taking these courses. It used to be true that the half-life of the knowledge of an engineer was about five years. That

means that five years out of college, half of what he or she learned was obsolete. Today, that half-life is between 18 months and three years. Indeed, most of the life-long training that Motorola engineers receive is to keep up with advances in technology. Motorola has always been able to attract and retain talent, but it has become an ongoing challenge.

William Wulf notes that the notion of lifelong learning has not been part of the engineering culture, either among individual engineers or at engineering schools. This must change. What about the present curriculum? He asserts that the modern engineer "must design under constraints that include global cultural and business contexts at a deep level. We can't just add these new elements to a curriculum that's already too full, especially if we claim that the baccalaureate is a professional degree." Wulf suggests that tomorrow's engineer will need more than a bachelor's degree. He also points out that engineering faculty need to practice their profession, like performance-oriented professions such as law or medicine. Unfortunately, he says, at most engineering schools, it is hard to bring someone onto the faculty who has spent their entire career in industry, even though such people would be extremely valuable to the students. It is even difficult to get recognition for a sabbatical in industry.

Companies are often described as having an engineering culture or a marketing culture. This is a distinction that may disappear in the future. Engineers traditionally focus on designing a specific product. Marketers focus on the needs and expectations of the consumer. Watching any of the TV commercials from Motorola's new "Wings" campaign will show that it is quite a departure for the ultimate engineering-driven company. It does not focus on a product. It defines Motorola as the company that enables consumers to take their worlds with them. It offers them personal autonomy and the promise of freedom through wireless communications.

Does this fall within the domain of the engineer? Absolutely. Motorola wants engineers who can be on the team that satisfies the customer. This takes imagination. But what does it mean in terms of closing the skill gap that I talked about earlier? I think the job I have described appeals to a wide range of personalities. Liberal arts majors might be turned off by the nerdy stereotype of the computer programmer, but might embrace the new image of the creative industry professional. Kids in elementary school might nurture their natural curiosity and aspire to careers in engineering.

Would there be a surplus of engineers if so many of their present tasks were automated? Or to put it another way, what will happen to all those year 2000 experts on January 1, 2000? I don't think there is cause for worry. Partly because of the shortage of technical people, the potential applications that combine communications and computing have not begun to be harnessed. Innovation creates new opportunities.

Can an information-based economy keep growing? Here's a view from Peter Schwartz, author of *The Art of the Long View,* writing in *Wired*: "We have entered a period of sustained growth that could eventually double the world's

economy every dozen years and bring increasing prosperity for—quite literally—billions of people on the planet." From the birth of the networked economy, Schwartz builds on the implications of computing power doubling every eighteen months, along with events like the launching of the Iridium global wireless communications system and the completion of the human genome project. He envisions sensors that can enter a person's bloodstream and bring back information about its composition and vehicles powered by alternative forms of energy, such as hydrogen fuel cells.

Schwartz sees a "learning society" where "a dramatic reduction in the number of unskilled jobs makes clear that education is a matter of survival." This underlines the need to achieve greater diversity in engineering, and yet, as William Wulf points out, less than 20 percent of entering first-year students are women and the percentage of minorities is in the single digits. There is danger of becoming a bipolar society—those who understand technology and those who do not. To serve a diversity of markets, there is a need to appeal to a diversity of people. I am on the board of trustees of Morehouse College, the only traditionally all-male African-American college in the United States. Morehouse and Spelman College, a women's school, provide 25 percent of the technically trained people and 20 percent of the engineers from African-American schools. The three-two program with Georgia Tech is providing most of the African-American graduate engineering talent. Build on programs like these and reforming engineering education will make better use of information technology, along with a broadened curriculum.

Conclusions

That is a good recipe for closing the skills gap and solving the productivity problem. Will the United States lead the revolution? It will if it makes the investment, and the time to start investing is now. Now is the time to transform the engineering profession, to attract the people needed, and to help them develop the skills to lead in the next century. After all, who will create that long wave of global prosperity? The engineers, that is who.

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Past Lessons and Future Directions: The Context of the Current Telecommunications Era in Australia

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In considering what might be the future direction of our industry, it is important to know what our starting point is for the new telecommunications era and to understand how we got here. Also while the lessons learned along the way will guide us in these future directions, we must avoid the temptation of walking backwards into the future. This paper seeks to present a balance between these considerations.

From a broad perspective of change in the industry, we can consider a number of separate phases as follows:

• pre 1989, with three government-owned carriers, but with competition only in OPE and certain VAS services;

• 1989–91, which saw the creation of an independent regulatory body, AUSTEL, the introduction of a price cap era for Telstra, and a fundamental review of service provision;

• 1991–98, the current era, featuring a limited number of competing carriers, unrestricted resale, and the opportunity for competition in all service areas;

• 1998–2000, which will see reviews of the price cap arrangements and the need (if any) for industry specific regulation of anticompetitive conduct together with two major public floats; and

• beyond 2000, when we might expect a maturing in the development of competition following a decade of change.

Returning now to the change at hand, there are, in my view, five key features that characterize this evolution. These factors are the removal of a number of competitive barriers; an integration of telecommunications law with general competition law; the maintenance of the industry's social obligations (in particular the USO); enhanced provisions for consumer protection; and greater industry self-regulation.

The remainder of my paper focuses on the two competition issues in this list of five key features. In terms of the past lessons of competition, while the outcomes in overseas regulatory eras are of interest, all of our directly relevant experiences to date relate to the current Australian regulatory era. So what are these experiences and what are the lessons to be learned?

Let's start by looking at the five broad end-user market groupings used by AUSTEL in its recent competition work, vis-a-vis, local, national long distance, international long distance, mobile, and others. Let's examine the changes within these broad markets since 1991 and the outcomes now being delivered to end users.

First, in the area of mobiles, Australia currently has one of the highest per capita penetrations in the world, with current growth rates continuing to be the envy of every other industry. Barriers to entry for consumers are low, and there is a diversity of choice among networks, service providers, service plans, and customer equipment. Telstra's market share of users is down from that of a monopoly to around 60 percent, and, as reported by AUSTEL, quality of service on all networks is acceptable. Perhaps the only disappointment is that air-time charges have not come down, but this could be explained by the roll out of the GSM networks and the need to support a rapidly growing customer base.

In international services, competition is also strong, with end users having an extensive choice of service supplier and prices continuing to decline. Telstra's market share of end-user paid minutes is now below 60 percent, clearly demonstrating the rate of change in this market sector. In national long-distance services, there are also numerous competitors, and prices have also declined significantly. Telstra's market share has not been eroded to the same extent. While all these changes clearly demonstrate the benefits of competition, unfortunately quality of service as measured by a number of considerations (in particular, billing) has not met the expectations or requirements of many end users.

With respect to local service, while residential penetration remains high and the USO scheme has worked well to

support the industry's social obligations, there have been few changes and, hence, few end-user benefits to date from competition. Product innovation has been limited to timed local calls for a small number of business users, pricing has changed little, and choice of supplier is limited. Furthermore, according to certain well-established commentators, charges for local calls in Australia remain high by world standards.

Within the remaining market grouping of "other," and excluding any consideration of pay TV, change has extended from evolutionary (e.g., radiopaging) up to revolutionary (e.g., Internet service provision). However, more importantly, the range of these so-called "other" services has expanded dramatically, driven in part by the emergence of specialist service providers.

Let me now turn to the five key competition elements of the current regulatory era that have shaped these market outcomes and identify the past lessons from each of these elements.

Resale and Service Providers
There is no doubting the significant contribution of these two activities to the market outcomes I have described. Quite obviously, the policy intention for these activities was correct, but major problems such as access arrangements, billing, and customer and network information have arisen in the implementation of this policy. These problems have been reported by AUSTEL in its two reports on the service provider industry, and they can be directly traced back to the two tier era of carriers and service providers. This lesson has been well understood in shaping the post-'98 legislation.

Tariff Filings
Carriers are required to file their tariffs for basic carriage services (BCS) with AUSTEL, but tariffs for higher level services need not be filed. This immediately raises the issue of what is a BCS and what is not—an issue that has never been resolved to the industry's satisfaction. Furthermore, while tariff filings by the nondominant carriers serve little purpose and only result in an administrative burden for AUSTEL, there were over 200 tariff filings by Telstra in 1995–96, and Telstra's filings for 1996–97 seem to have run at about the same rate. Consequently, under the time constraints imposed by the current legislation, ex-ante evaluation by AUSTEL of Telstra's tariffs has become burdensome and difficult. As a result, AUSTEL has increasingly turned to ex-post evaluation for any consideration of anticompetitive effect. There are two lessons from this experience: first, drawing lines in the sand is difficult and often of little value, and, second, a simpler approach is required to any requirement for tariff filings.

Market Dominance and Anticompetitive Conduct
Under the current era, a carrier in a position to dominate a market is subject to restrictions on price discrimination and to regulation of its tariffs for anticompetitive effect. These provisions have contributed positively to the outcomes described earlier and, hence, constraints on the market power of the incumbent are an essential requirement of any

successful transition from monopoly to competition. However, the implementation of these constraints is complex and contentious; the lessons from the past suggest that this necessary feature of the ongoing transition to competitive markets will remain difficult.

Access and Interconnection
As is generally known, access arrangements are central to the success of competition. The access era in Australia, insofar as it applies between carriers, has been highly successful, particularly by comparison with arrangements in a number of overseas countries (e.g., United States, United Kingdom, and New Zealand). Experience to date has proven the value of access arrangements being subject to a number of prerequisites (e.g., mandatory interconnection and separation out of the USO) plus certain desirable features such as pricing principles, a preference for commercially negotiated outcomes, and final arbitration by the regulator, if required. Furthermore, the outcomes from the current carrier access and interconnection agreements have led to end-user benefits and have been accompanied by ongoing (if not increasing) investment in infrastructure. In contrast, interconnection arrangements for service providers have been a constant source of contention that result in vastly inferior outcomes. Quite simply, the carrier arrangements are a demonstration of what to do, and the service provider arrangements are a demonstration of what not to do.

Numbering
While not wholly a competition issue, numbering does have consequences for the successful development and maintenance of competitive outcomes. In particular, issues such as number allocation, number portability, and network conditioning all impact upon the competitive process. Experience to date is that each of these matters must be managed in a competitively neutral fashion to ensure successful numbering arrangements.

Having discussed the competition outcomes from the current regulatory era, together with the key competition elements that have shaped these market outcomes, let me quickly summarize the past lessons:

- competition to date in Australia has worked and has delivered end-user benefits, particularly in choice and price—the only disappointing feature being quality of service (including billing performance) where much remains to be achieved;

- the transition from monopoly to competition does require management, with the key matters for resolution being market power and anticompetitive conduct together with access and interconnection arrangements; and

- artificial constructs within a regulatory era inevitably lead to complexity, contention, and sub-optimum outcomes.

As a final point on past lessons, let me comment briefly on the resolution of conflict. Experience to date has clearly demonstrated the benefits of administrative outcomes to such conflict both in terms of efficiency and effectiveness. While the court system, quite correctly, has an ultimate role

to play in any resolution of legal issues, the fact that so few matters have had to be resolved by the courts has, in my opinion, contributed to the marketplace outcomes achieved.

Having talked about past lessons, I now wish to turn to future directions and to the post-'98 era. At the outset, let me state that I shall concentrate on the period 1998–2000 discussed earlier (after all anything beyond 2000 is at best a guess) and that the views I shall be expressing are entirely my own and not necessarily those of AUSTEL or any third party.

First, as a general comment, if we accept that competition remains as the most appropriate model to deliver end-user benefits with respect to product, price, and performance, then it is clear that the post-'98 regulatory era has the necessary attributes to meet this objective. Turning now to specifics, and, in particular, to the broad market groupings identified earlier, my assessment of future directions in these markets is as follows.

In mobiles, we will continue to see rapid change, including convergence with local service. The forthcoming auction of spectrum in the 800-MHz and 1.8-GHz bands will be a significant milestone in the development and evolution of this market. Given the essential nature of spectrum for both mobiles and wireless local loop services and the scarcity of this resource, it will be essential to ensure that appropriate ex-ante auction rules are in place if competition in this market is to deliver better products, prices, and performance.

In international services, competition will continue to evolve; the range of choices available to end users are expected to expand, and recent trends in growth and prices are expected to continue. This area will remain good news for end users, particularly the more sophisticated customers as represented within ATUG. Likewise, with national long-distance services, we can expect recent trends to continue. Again, however, I refer to my earlier concerns on quality of service and hope that major advances in this area can be made in the period ahead.

As for local service, I believe that we all look forward to significant changes in this market sector under the new liberalized telecommunications era. Indeed, as competition has evolved in the other market sectors discussed, the realization among end users of the need for and benefits of competition in local service has become more apparent. In this regard, both the achievements to date and current developments in the United Kingdom and the United States provide important benchmarks on what might be achieved during this forthcoming phase of telecommunications liberalization in Australia.

Returning now to the five competition elements of the current regulatory era that I discussed earlier, it is my view that all of these will continue to underlie the post-'98 era and that they are either directly or indirectly addressed in Parts XIB and XIC of the telecommunications amendments to the Trade Practices Act. Let me now make some specific comments on future directions of the two most important of these five elements, and these are as follows.

Market Power and Anticompetitive Conduct

Past lessons in Australia, supported by experience in other competitive eras, clearly indicate the need for industry-specific regulation of market power to curb any potential for, or practice of, anticompetitive conduct. Since one such source of market power is the provision of local service, then it can be expected that such market power will remain while there is little competition in this market sector. Even with greater competition, it is still likely that there will be residual market power arising from control of the local loop, much as a gatekeeper has a level of control over both incoming and outgoing traffic. Technological change that increasingly leads to services being delivered on a common technology platform also opens up opportunities for predatory pricing, anticompetitive cross subsidies, and anticompetitive bundling. These opportunities are made even greater within an environment of vertical integration. Therefore, let there be no doubt that the regulation of anticompetitive conduct will be important to the successful evolution of this next phase in competition. However, it should also be noted that based on these future directions just described, such regulation will be both complex and contentious.

Access and Interconnection

Earlier, I stressed the importance of successful access arrangements to the competitive outcomes achieved to date. Under the post-'98 era of unrestricted market entry, where carriers will now be the primary suppliers of facilities (and not services as at present), the need for successful access arrangements is even more crucial. The new Part XIC of the Trade Practices Act sets out clear objects for the access era, with paramount importance given to promoting the long-term interests of end users. Past lessons demonstrate that the successful conclusion of access negotiations is as much an art as a science, with the need for a strong regulatory framework and regulatory participation to assist in dispute resolution. With unrestricted market entry, increasing competition, and the market attributes discussed earlier in relation to anticompetitive conduct, it is clear that the future direction of access arrangements is also that of growing complexity and contention.

These two key issues of anticompetitive conduct and access arrangements are not just the concern of the post-'98 era here in Australia, but are also recognized in other jurisdictions as the key to the successful development of competition in any telecommunications market. To demonstrate this, I would like to quote from a February 1997 report by Salomon Brothers on U.S. telecommunications services in light of the 1996 legislation, as follows:

We believe that the intent of the telecom legislation, which continues to be updated and to significantly impact the industry, is to deconsolidate market power and increase competition, in particular the local exchange market, creating thriving new entrants. We believe that the game will be fair and there will be no ability to cheat, that the letter and the spirit of the law is such that anybody who wants access to anybody's

network will get that access in a fair economic manner. Thus, ownership of commodity transport assets will be irrelevant. Rather, ownership and applications of value-added assets, such as relational databases, support systems and flexible billing will be the hard assets representing the keys to success. Furthermore, if a given carrier can market and merchandise, provide customer service and execute better than others, that carrier will be a net winner regardless if it is a local exchange carrier or an interexchange carrier.

As we move into the next phase of the evolution of competition in Australia, these views represent a timely reminder of what we are seeking to achieve with the future direction of our industry.

Among the past lessons we should recognize are those relating to the way in which the industry works together. In a regulated industry such as ours, where carriers and carriage service providers are necessarily bound together by connectivity, there is a need to ensure both strong competition at

the end-user level and cooperation at the wholesale and facilities level, subject to compliance at all times with the requirements of the law.

While these objectives may conflict, cooperation at the wholesale and facilities level is essential in promoting the long-term interests of end users. Much has been achieved in this area in recent years and the development of the ACIF is an encouraging step in ensuring that this cooperation continues. As with so many other matters in our daily commercial life, constructive communication will be the key to success.

In conclusion, let me acknowledge the contribution of AUSTEL staff to the achievements of the current telecommunications era. Past lessons are that the commitment and skills of such regulatory staff are an important contributor to successful outcomes, and this will continue to be the case under the new era for the ACA, the ACCO, and also for the ACIF.

Telecommuting: Drivers, Issues, and Challenges

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Digital subscriber line (DSL) technology was not initially developed with telecommuting applications in mind, but this is the application that truly will launch the service. Telecommuting has become an essential part of corporate culture. For the telecommuter, a key advantage is that the time and effort otherwise spent traveling can be spent working in the comfort of one's home. From a corporate perspective, the corporation can get productivity out of telecommuters. The growth rate of telecommuting largely will be a function of the effectiveness of the home environment compared to being in the office tied directly to the corporate local area network (LAN). The more the telecommuting experience becomes a virtual LAN-direct connection, the more people will accept the role of and become effective telecommuters.

Wireline Technologies and Challenges

Voice Band (Dial) Modems
The dominant means of telecommuting today is via voice band (dial-up) modem access to corporate LANs. While that technology is ubiquitous and improving in speed, it is still not fast enough. For many telecommuters, the dial-line experience is not very satisfying.

ISDN
The integrated services digital network (ISDN) has enjoyed substantial growth over the past few years, both for telecommuting and largely for access to the Internet. The higher speed associated with it has dramatically improved the LAN-like experience. However, it still is not fast enough for some current applications, and it is not sufficient in throughput for some emerging applications. It is a circuit-switched service, and its cost is based on usage. It also requires ISDN service at all communicating locations.

Cable Modems
Cable modems are increasing in popularity and press accounts. There are advantages and disadvantages to cable modems, as there are with every technology. Effective symmetric communication — not only downloading information but sending information — requires the cable network to implement major network upgrades to support the upstream communications. In North America today, roughly 95% of the existing cable plant will need to be upgraded before symmetric transmission can be supported over the coax network.

Some cable modems are available that provide a 28.8 kbps dial modem return channel. While it is indeed a return channel, the transmission control protocol/Internet protocol (TCP/IP) has a 10:1 or 12:1 ratio of downstream versus upstream channel. Even though the cable modem supports a very high-speed downstream channel, the effective throughput on cable modems will be substantially limited as long as the reverse channel into the corporate LAN is limited to 28.8 kbps throughput.

In addition, the shared bus architecture that is inherent in the implementation of cable modems will have an effect on the quality of service. This will not be a crucial issue for residential Internet access, but for the types of applications envisioned for the telecommuter, it will be a very limiting factor in acceptance of cable modems for telecommuting. Also, because the entire network must be upgraded to support symmetric service for just one user, it will have somewhat limited availability.

DSL
DSL technology has existed for a number of years and has gained tremendous market momentum in the past year, particularly in the areas of data transmission and telecommuting applications. The way DSL is being implemented today is as a line extension, which may be to a telecommuter, a branch office, or the Internet. DSL is not without its challenges, but it is rich in opportunity and potential.

Historic Telephone Network Model

In the historic telecommunications network depicted in *Figure 1,* bandwidth has not been an issue. In the backbone from central office (CO) to central office, fiber is used extensively. The challenge is to get the high-speed services to the customer over the local loop, over the twisted pair of copper wire. The perception has always been that the local loop is limited to dial–modem transmissions. That is not quite accurate. The limitation of dial-modem communication over the local loop is not a function of the copper itself, but a function of the implementation of the public switched telephone network (PSTN). The phone operates at less than four kHz frequency. It goes into a pulse code modulation (PCM) termination, which is an industry-defined interface that only recognizes 4 kHz or less. The modem speeds today

FIGURE 1

Historic Telephone Network Paradigm

"High Bandwidth To The Network Edge"
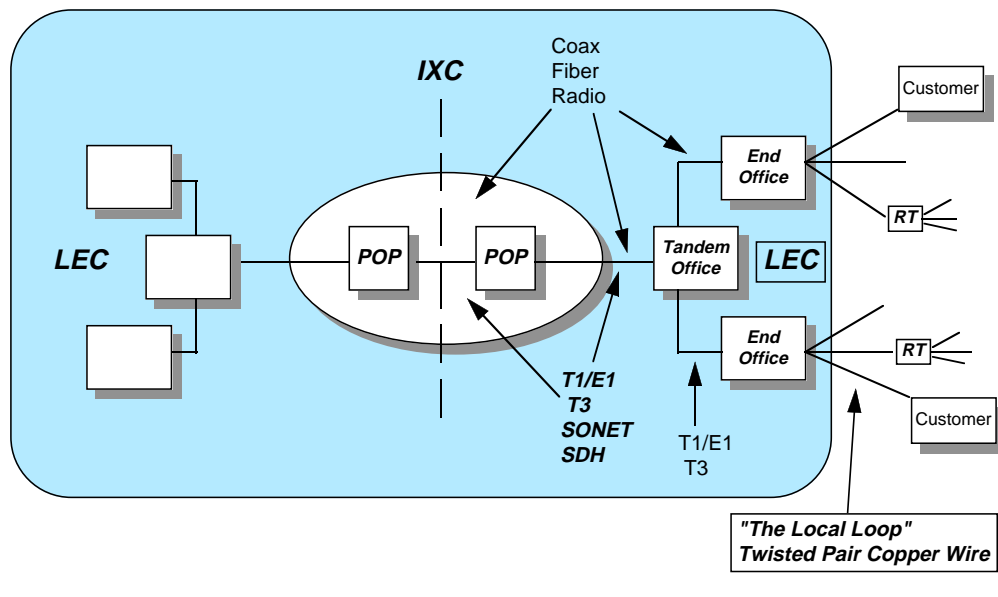
are data rates that are achieved by transmitting analog wave forms within this relatively limited range of frequencies. This allows one to transmit through the existing PSTN and establish communication with a remote end without the need for any special circuits.

DSL Exploits Local Loop Capacity

In reality, the copper wire itself supports much higher frequencies than four kHz transmission of voice. With DSL, the copper can support those high-speed transmissions, which is shown in *Figure 2.* Once this happens, it is no longer compatible with the switched port in the PSTN. A DSL device is needed both at the customer premises and on the network edge—on the other end of the copper wire loop—to terminate the data that are transmitted in a much higher range of frequencies, and then to pull that off the local loop and interface it into any of the wide area network (WAN) services that exist in the home environment.

One obvious question is that if the copper wire always supported high-speed transmission, why is it just now being deployed in the market? This is because technology is changing the rules. One of the original implementations of high-speed services over twisted pair of copper was time division multiplexed carrier 1 (T1) service, which is 1.544 Mbps. The modulation encoding technique to transmit T1 service used a scheme called alternate mark inversion (AMI). That transmitted one bit of information per baud. Transmitting 1.5 Mbps requires transmitting over a range of frequencies up to 1.5 megahertz (MHz). As one goes higher in frequency over the copper wire loop, signal attenuation increases. Signals get weaker faster, and they cannot traverse as long a distance as lower-frequency signals. As a result, repeaters were placed on the copper wire loop to regenerate and reamplify the

signal and send it on to the next stage of the local loop. T1 service has been in use for a number of years, but because of the very simplistic encoding technique that was used to transmit the data, it did not operate in the presence of bridge taps. It has a maximum distance of 6,000 feet between repeaters and more typically 2-3 kHz, and there has to be a repeater within 3,000 feet of the end point, either at the network edge or the customer premises. This is possible to do, but the equipment has to be physically located on the loop and it has to be maintained, which presents a problem. That is one of the reasons there has been a premium service charge for T1 services historically.

One of the things that has changed is dial modem technology. Dial modems originally were 300 baud modems that transmitted 300 bits per second, one byte of information per baud. With advancements in modulation techniques, they are now up to 33.6 and 56 kbps of information operating within a four kHz channel. This means that multiple bits of information are transmitted per baud. That same concept is being applied in DSL, but it is no longer limited to the four kHz channel. Although wave forms can be transmitted over a broader range of frequency, if more information is put into them, the same amount of information can be sent in a much smaller range of frequencies. By operating in a lower range of frequency, that signal can go over a much longer loop without the need for repeaters. That is the principle of DSL.
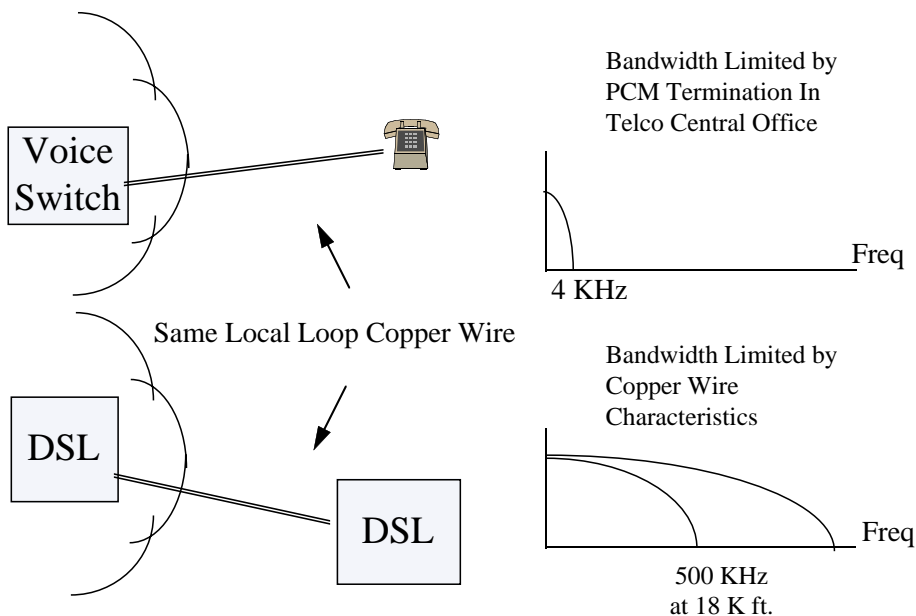
Changing Transceiver Technology

Modulation techniques are being developed to support carrierless amplitude and phase (CAP) modulation, which is a variation of quadrature amplitude modulation (QAM), the modem modulation that has existed for 20 years. Discrete multi-tone (DMT) also was developed over 20 years ago, but

FIGURE 2

DSL Exploits Local Loop Capacity

it was never implemented because of its complexity. It needed very powerful signal processors that are now available and make it more practical to implement, which is illustrated in *Figure 3.*

Two binary one quaternary (2B1Q) is a line code that is supporting the high bit rate digital subscriber line (HDSL) and ISDN very extensively today. 2B1Q is a baseband modulation technique as o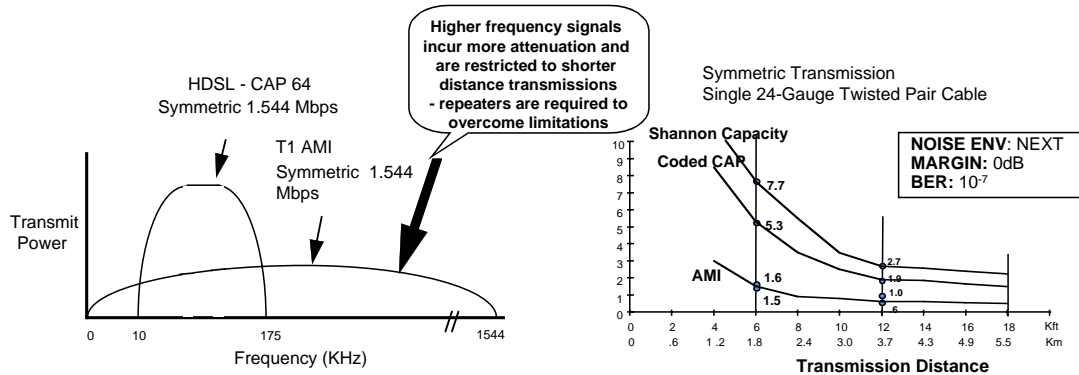pposed to a passband. This means that the baseband starts at 0 Hz and operates in the same range of frequencies that voice would operate on, versus the passband nature of CAP or DMT. Passband allows the signal to be placed in a different range or frequency so it does not overlap and interfere with plain old telephone service (POTS).

While is it important to get more information in a smaller range of frequencies, this also increases the probability that the data will be corrupted because of the complex algo-

FIGURE 3

What Changed—Transceiver Technology

- **Carrierless Amplitude & Phase Modulation (CAP)**
- **Discrete Multi Tone (DMT)**
  - **Transmit Multiple Bits Of Data Per Baud**
    - » **Transmission of high-speed data in a lower range of frequencies than traditional schemes which transmit one or even a few bits of data per signal pulse**
  - **Advanced Error Correction Techniques - Reliable Transmission Over Traditional Twisted Pair Copper Wire Phone Lines**
  - **Passband Characteristic Allows Multiple Independent Channels To Operate Concurrently Over A Single Telephone Line**

rithms that represent multiple bits of information per baud. As a result, another substantial technology breakthrough was an error-correction technique to assure that the information could be sent reliably and error-free. The passband characteristics are an important attribute desired by the t&commuter.

Multiple Concurrent Services

With passband services, the analog POTS channel can operate in a four-kHz range, and one or more channels can operate in other frequency ranges on the same physical twisted pair of wire. Different services can run concurrently and independently over a single twisted pair of phone line. Figure 4 shows the wave form associated with the asymmetric digital subscriber line (ADSL). In ADSL there is a relatively lower-speed signal going back into the network and a very high-speed wider range of frequency signals coming into the customer premises. Those signals allow the POTS to operate with no change required for implementation_ It is still a line-powered service just as it has always been, which is important for line services. If a power outage occurs, the ISDN capability is lost. 2B1Q could augment POTS by digitizing the voice and transmitting it in the digital wave form. The problem is that it is now no longer lifeline powered but locally powered, and when power is lost at that endpoint, the phone service is lost as well.
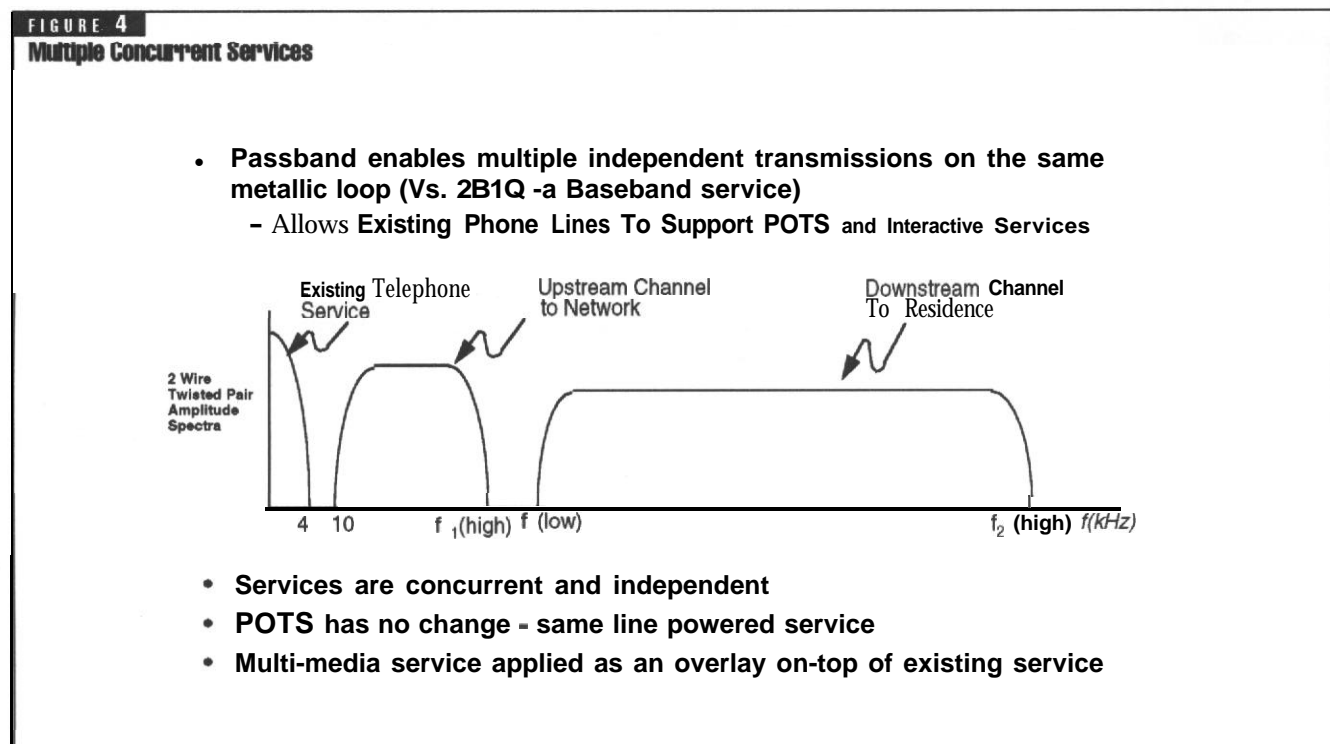
DSL Variations

HDSL
With recent breakthroughs in technology, there have been many variations of DSL, which is shown in Figure 5. The original implementation of HDSL was largely an extension of ISDN. The 2B1Q modulation technique that applied to

ISDN was extended to operate over a higher range of frequencies to support higher-speed services. The higher the frequency, the shorter the loop reach. In order to support the 1.5 Mbps services of HDSL in both directions, the signal was split to operate over two wire pairs. Therefore, 784 kbps was operating on one wire pair, and 784 kbps on the other. HDSL is multiplexed, presented at the network, and the customer interface becomes 1.5 Mbps. HDSL by definition today is a two-wire-pair service that provides symmetric transmission (that is, equal in both directions). It isprimarily used for T1 and El service provisioning. The key benefits and compelling reasons to utilize HDSL consist of the following attributes.
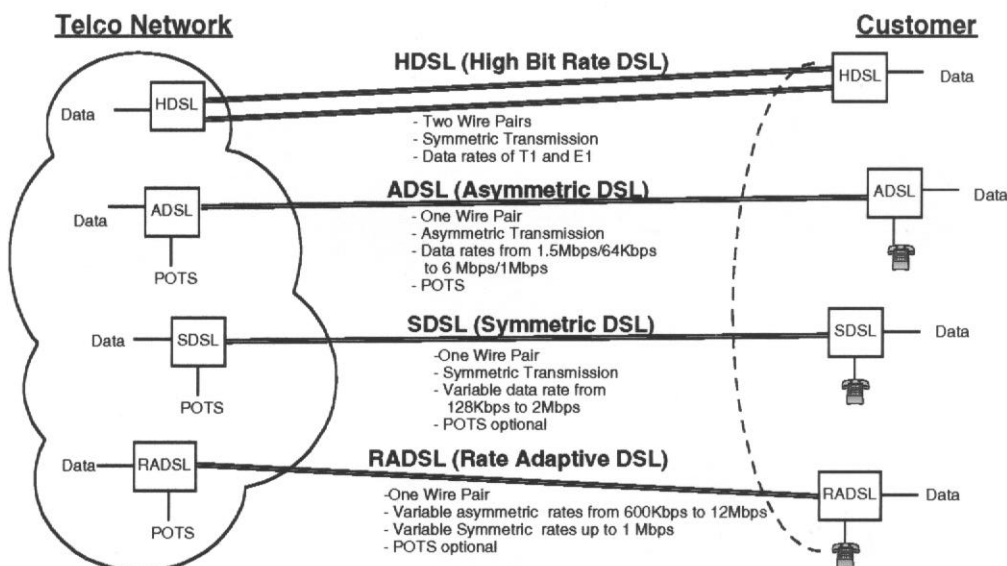
- It operates cm unconditioned loops.

- It operates in the presence of bridge taps.

- It does not require special circuit engineering, with the exception of loading coils.

- It eliminates the need for repeaters.

DSL fundamentally does not work well with loading coils. Fortunately, less than 20% of the loops in North America have loading coils, and those can be removed. It may be an impediment for broad-scale deployment, but it is not a major factor.

The HDSL specifications typically run over the range of CSA loops. CSA loop specifications are 12,000 feet on 24 gauge wire or 9,000 feet on 26 gauge wire. The same concept of HDSL was extended with ADSL. Bellcore, Paradyne, and a number of other companies began work on ADSL (which again was a derivative of HDSL) early in 1992. ADSL was

FIGURE 4
Multiple Concurrent Services

- **Passband enables multiple independent transmissions on the same metallic loop (Vs. 2B1Q -a Baseband service)**
  - Allows **Existing Phone Lines To Support POTS** and **Interactive Services**

- **Services are concurrent and independent**
- **POTS has no change - same line powered service**
- **Multi-media service applied as an overlay on-top of existing service**

FIGURE 5
DSL Variations

intended originally to be a residential service. Because most residences do not have two wire pairs coming in, it was designed to operate over a single wire pair. Because POTS would be on the line, it was designed to operate over POTS. One interesting phenomenon of the network is the noise model. Each of these loops transmits electrical energy on the wire, and all of them generate energy that interferes with each other. A CO may have 2,000 or 50,000 lines all coming into a building, all emitting electromagnetic energy and interfering with one another. Data transmitted into the phone company CO experiences a noisier environment, which means a high-speed service cannot get through reliably. It may need to be slowed down or the loop shortened so the signal maintains a level of intensity to accurately receive and decode data. Conversely, on the customer premises side, far fewer phone lines come into the customer, so there is far less noise. Over a given cooper wire loop, a much higher-speed signal can be sent from the CO to the end user than in the opposite direction. Fortunately, many applications are asymmetric in nature. They can operate with high-speed service in one direction while running slower on the other.

ADSL

The first envisioned application for asymmetric DSL (ADSL) was video dial tone services. It was designed with a fixed speed, because video services required digitized compressed video to be transmitted over the line. To work ubiquitously, the DSL line always had to run at a very specific data rate. There was an American National Standards Institute (ANSI) standard for ADSL that designated specific data rates and specific attributes of ADSL, which were optimized for video applications.

SDSL

Symmetric digital subscriber line (SDSL) is a hybrid of HDSL and ADSL. Like ADSL, it operates over one wire pair concurrently in some implementations with POTS, but like HDSL, it is symmetric in nature and designed to be configurable for different rates. As speed is reduced, it can go over longer distances. The speed could be adjusted based on the loop length and provide different levels of service. If the loop were short enough, one could install one piece of equipment and, depending on how much a customer pays, configure it for different rates.

RADSL

Rate-adaptive digital subscriber line (RADSL), a variation of all the DSL services described, is a relatively new industry DSL offering. It has the asymmetric attributes of ADSL, but it also has the symmetric attributes of SDSL, up to 1 Mbps. RADSL was developed with data applications in mind, whereas the initial application for ADSL was video. Video to the personal computer (PC) or TV will employ motion picture experts group 1 (MPEG-1) or MPEG-2 video, and it, by definition, requires a specific line speed to support the application without errors. In the case of data, particularly LAN services, it makes no difference to the LAN whether the DSL link is running at 384 kbps, 1 Mbps, or 6 Mbps. The nature of the packet traffic across the LAN can accommodate any of a wide range of speeds. RADSL was therefore designed particularly for data application, and the objective was to ensure that service could be provided to the customer. If the particular loop is too long to support 6 Mbps, then it will automatically lower the speed to 4 Mbps or 3 Mbps or even 1.5 Mbps; whatever the highest achievable speed is on that loop. Much like dial modems, it will adapt the rate to the highest level that can be sustained on that

FIGURE 6
Targeted Applications

Videos On Demand / Interactive TV

Video Conferencing / Web TV

Multimedia

CD Quality Audio

Home Shopping

Distance Learning

Interactive Games

Online / Interactive Services

Medical Services

loop. Once it installed, the noise model does not change significantly, so a rate adaptation would not be expected to occur on an installed circuit, but it simplifies the installation process and ensures that service can be provided. In addition to the auto rate option, RADSL systems can be manually configured for any of a number of data rates, giving service providers flexibility in pricing the different services.

Applications of DSL

Considering the applications of DSL, clearly video dial tone can be supported as well as videoconferencing. Paradyne and other companies have demonstrated video-conferencing running at 384 kbps and remote LAN access running at 384 kbps on SDSL as well as RADSL in order to show the impact these services have on the experience of connecting to the LAN at different speeds. Web TV is an ideal application to connect to the Internet with DSL. The phenomena of both the Internet and the whole range of applications that can be supported over LANs expand the opportunities of DSL. Some examples of the applications are shown in Figure 6.

Why Did ADSL Video Dial Tone Fail?

The initial application for ADSL was video dial tone services, introduced in 1993 and 1994 with substantial fanfare. It was envisioned to be one of the great initiatives for the phone companies to compete with cable companies. Unfortunately, the video dial tone initiative that went far beyond DSL and into cable largely failed, with a few exceptions. There are a number of reasons for that, not the least of which is the rationale and justification for video dial tone in general, independent of the physical means for delivery of the service.

- discretionary spending of residential consumers-The service had to be offered at a relatively low price or the service-adoption rates would not justify deploying this on a broad scale.

- lack of accessible content-Video over DSL requires compressed digitized video, which means all the movies in the world need to be compressed, digitized, and stored on a video server. That could not be done quickly enough nor stored to provide significant content options.

- numerous technology challenges and expenses-DSL was a new technology, as was the compression technology, the set-top box, and the video-server technology was new. Too many new elements were needed at one time to successfully execute the plan.

- the mindset that to deploy a new network to support a service, it should have the capability to support every application one will want to do over the next 20 years-While that paradigm is desirable in a monopolistic environment where it is possible to force the service subscribers to pay, it is difficult to implement in a competitive deregulated environment.

ADSL itself also was limited initially because it could not provide sufficient bandwidth to support concurrent real time, bit synchronous video sessions to multiple TVs in a house. Additionally, every TV had to have a $300 or $400 set-top box. These issues worked against video dial tone with ADSL.

Why Will DSL Succeed for Multimedia?

DSL will succeed for multimedia and particularly for business t&commuting applications for numerous reasons. First, in business there is a compelling need for higher-speed and lower-cost services, which DSL can provide. The initial subscriber to the service is the business customer, not the residential consumer. Businesses are very pragmatic. If the technology is a good investment that will make them more successful and provide a return, they will spend the money. They are not constrained by a discretionary entertainment budget as residential customers are.

The lack of content is no longer an issue, because the Internet is rich in content and drives demand for higher-speed services to that content. In addition, the LAN itself—the corporate environment-provides the content that creates the need for the t&commuter.

The packet nature of LAN extension services will minimize the backbone requirements associated with this service deployment. It leverages existing LAN protocol and Internet protocol (II') for both remote LAN access and the Internet, and can be supported over a range of WAN services. With bit-synchronous video dial tone, the concept was a full-service network using asynchronous transfer mode (ATM) end-to-end that required ATM at every point of presence on the network edge as well as over the DSL link. While that is an eventuality, it is not practical to execute in the near term. Conversely, the LAN-based protocols today run very cost effectively over existing time division multiplex (TDM) and frame relay services.

The nature of DSL allows service to be deployed on a customer-by-customer basis. It does not require ubiquitous deployment for a customer to use it, and the whole network does not have to be upgraded just to provide service to one customer. DSL equipment is deployed on a subscriber line and connected to the backbone of an existing WAN service.
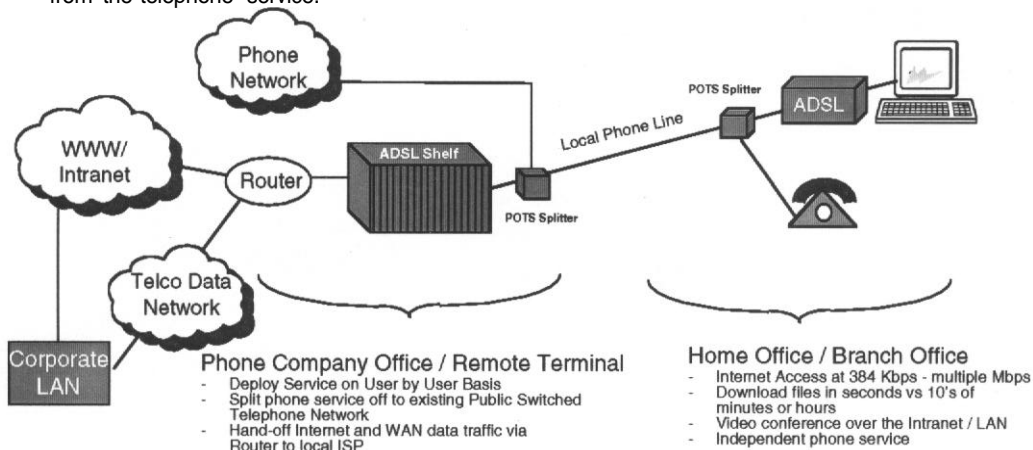
One of the limitations of ISDN was that it was a circuit-switched WAN or LAN service. Two ISDN devices were needed, one at either end. Conversely, DSL is simply a local-access technology, not a WAN technology. IP service may run over DSL to individual t&commuters, across the WAN via frame relay, then back to corporate headquarters via digital service, level 3 (DS-3). For the t&commuter application, it is an access device: once it comes in contact with the network edge, it interfaces with either frame relay or any of a number of existing WAN services. ADSL could be provided to one house, 56 kbps to another house, full T1 to yet another, and all of them could be aggregated at a corporate headquarters over DS-3 or ATM. It is inherently a local access technology, and the terminating end of DSL is on the other end of the copper wire loop. Once that terminates, it does not matter where it goes, so ubiquitous deployment is not a requirement.

Some vendors' DSL implementations such as Paradyne's HotWire will support a range of applications over the IP LAN extension service. Not only will these services support high-speed remote LAN access and Internet access, but also videoconferencing and additional voice and fax lines that can be transmitted over IP. Some companies are developing the ability to send voice over IP. The quality is excellent (unlike voice over the Internet, which has considerable limitations). Voice over IP has about a 40 millisecond delay, and one cannot tell that it is not on a circuit-switched voice service. These are applications that can be utilized directly and do not require any new invention or standards. One can just take advantage of what already exists.

FIGURE 7

Work-at-Home/Telecommuter Access

Description: The upgrading of the local loop telephone lines to support digital overlay services which provide high speed data connectivity to one or more Internet Service Providers (Internet I Intranet) and corporate LANs. This service is optimized to support more symmetric applications such as video conferencing and large file uploads to a remote LAN. While these services share the same physical local phone line. they operate separate and independently from the telephone service.

Phone Network

WWW/ Intranet

Router

ADSL Shelf

POTS Splitter

Local Phone Line

POTS Splitter

ADSL

Telco Data Network

Corporate LAN

Phone Company Office / Remote Terminal
- Deploy Service on User by User Basis
- Split phone service off to existing Public Switched Telephone Network
- Hand-off Internet and WAN data traffic via Router to local ISP

Home Office / Branch Office
- Internet Access at 384 Kbps - multiple Mbps
- Download files in seconds vs 10's of minutes or hours
- Video conference over the Intranet / LAN
- Independent phone service

Finally, the RADSL assures that high-speed service can be provided over virtually any loop. The loops that have loading coils will have to be modified, but that will affect a relatively small percentage of the customers.

Work-at-Home Telecommuter Access

In the diagram shown in *Figure 7,* the customer premises have an xDSL device that connects to the customer premises equipment and overlays the existing twisted pair phone line. This overlays a high-speed digital service and runs across the local line. The POTS is filtered off and the high-speed digital service goes into an ADSL terminating unit in the CO. These are aggregated for multiple remote locations, and the output signal goes to a router that can interface with ATM, frame relay, T1, etc. Data leaves the CO and enters the wide area network. How it connects back to another subscriber or to a corporate LAN is immaterial. The technology does not require DSL at all points in the network.

The POTS splitters, although not given much attention, are an important part of this technology. POTS splitters are a fundamental part of certain DSLs. As the technology matures, more equipment vendors will begin to realize that the POTS splitter materially affects the voice quality. Thus, it will affect user acceptance of the service. The role of the POTS splitter is to filter off all of the DSL energy, so that the phone receives the same phone POTS signal it has always received. The effectiveness of this device determines how much background noise is heard on the DSL line.

DSL Issues for Multimedia Applications

Video dial tone was the initial application driver for ADSL and initiated the ANSI standard for DMT. ANSI specification does not adequately cover today's xDSL application. There is some confusion over the line code itself. In the spring of 1993, the T1E1.4 standards body selected a line DMT as a line code for DSL-80, a cell standard. That work has continued. At that time, Paradyne had developed CAP modulation technique, an alternative line code that did the same thing. For a number of reasons, the decision was made to adopt DMT, but the reality today is that CAP is supported. Some 30,000 lines of ADSL have been deployed globally, and virtually all are based on CAP, whereas there are only few hundred lines using DMT. As the DMT technology improves the level of integration and performance of the DMT chips and reduces the power consumption associated with its use, more equipment and service providers will adopt and deploy DMT. The market, not a standards group, will decide the de facto standard, and it will become a non-issue.

DSL is not an end-to-end communication like dial modems. A dial modem has to connect with another dial modem across the world; it is a point-to-point leased line. The point-to-point leased line-like deployment for DSL will allow multiple DSL technologies to operate independently within a network. CAP could be running on one line, 2B1Q on another, DMT on the next one: it does not matter, as long as they are matched on a point-to-point basis. Line codes must match on a local access circuit basis only.

As previously mentioned, the loading coils must be removed. This disadvantage has limited impact and is primarily a function of very long loops that may not be good candidates for DSL. These loops can be modified, and no other circuit engineering is required. Lastly, lower price points will increase adoption rates.

Summary

DSL operates over the existing copper wire phone lines concurrent with and independent of basic telephone service. The video dial tone trials around the world clearly demonstrated that this technology works. One desirable attribute is that it is deployable on a user-by-user basis versus requiring a whole network upgrade. Therefore, it does not require ubiquitous service deployment. It does require equipment both on the customer premises and on the telecommunications-provider end of the copper wire loop. DSL on one end is connected to remote serviced by T1, T3, etc. There must be a coordination of services.

Some of the challenges that existed with ISDN will exist with DSL. The service will have to be coordinated with the telecommunications providers. DSL supports higher-speed transmissions from network to residence than from residence to network. This attribute will work well in some applications, but may be limiting in others. Currently with RADSL, the reverse channel support is up to 1 Mbps, so at a minimum it can support up to one 1 Mbps symmetric services, as well as higher-speed service down to the customer premises.

For the next few years, not many telecommuters or other users will require much more than 1 Mbps back into the network, and equipment prices will fall. The equipment is still relatively expensive because it is new: vendors are spending millions of dollars developing it and selling only a few lines at a time for trials. As deployment increases, the technology matures, and cost-reduction programs are implemented, the price per line will drop substantially. In 1996, the average price was $1,500-$2,600 per line, and the 1998-1999 prices are projected at $500 per line.

The pricing of DSL requires one to look at the total network cost. Discussion about cable modems specifies only the end-point cost. The cost of upgrading the entire network must be accounted for as well, and that adds substantially to the price. A fallacy of cable companies is to state the cost to upgrade the network involves the cost per home passed.

The cable network might pass 10,000 homes, but if only 2 percent of those homes subscribe to the service, the cost must be spread across that small percentage of subscribers, not across 10,000 homes. Thus, the cost per subscriber becomes substantially more.