

## **New Communications Services -- What does Society Want?**

Robert W. Lucky  
Bellcore  
Red Bank, NJ

Twenty-five years ago the all-powerful Bell System proudly introduced its newly-developed Picturephone to an expectant market in the United States. Shortly thereafter, speaking through the marketplace, society rejected the Picturephone. Later, speaking through the government, society also rejected the Bell System itself. These events have cast their long shadows through time and industry. What, indeed, does society want? It is a deeply important and elusive question.

The history of telecommunications services in recent decades does not fill us with optimism that we know what society wants, or even that we know how to go about finding an answer to this question. It is filled with market failures, like the Picturephone. Even the successes, like the World Wide Web, were unexpected, and many of the applications of technologies, such as in the cases of ISDN and ADSL, turned out to be different than the purposes for which they were designed. Why can't we do a better job of foreseeing the needs and desires of society and constructing solutions that meet these demands?

Perhaps the ultimate truth is that there is no real answer to the question of what society wants. Society itself does not know what it will want in the future. Even determining what society is doing at a given moment is a difficult and contentious matter. The daily newspapers are often filled with surprising stories and analysis of societal trends. For example, it is projected that leisure time will increase. A few years later it is observed to decrease. The population ages in one country, while it becomes more youthful in another. Fads, like the hula hoop and CB radio, blaze into the foreground and quickly recede. It is a fascinating and ever-changing panorama.

Certainly, there are enduring societal needs at a level far below the chaotic fashion layer. War, starvation, illiteracy, and environmental concerns are unfortunately an inevitable part of the human condition. Moreover, there is an additional constancy in the everyday life of ordinary people. Solutions that do little things to save people time, money, and effort are always in demand. I shall return to these themes later in this discussion. First let us review what we have

learned from our mixed bag of experiences with societal acceptance of telecommunications services.

### The Barrier to New Services

In the telecommunications world there are two technology laws that hover over all would-be solutions – Moore’s law of transistor scaling, and Metcalfe’s law of user value scaling. Moore’s law – that chip density doubles every 18 months – guarantees that technologies become obsolete and that economics become overturned at a rate that is incompatible with most infrastructure planning and financing. This law, while really an observation, rather than one derived from physical principles, has held remarkably constant for several decades. While it is well known to all engineers, it is one that is invariably underestimated. It is truly difficult to conceptualize exponential change; nearly everyone has an intuition that is founded upon linear extrapolation.

Moore’s law says, in essence, that whatever you do, it will soon be wrong. Metcalfe’s law, on the other hand, says that a new communications application will probably be stillborn anyway, because the initial value will be so small that no one will have sufficient incentive for purchase. It is based on the observation that the value of a network grows as the square of the number of users. Every new user brings additional value to every one else connected to the network. The overall value of the network to an individual user is small if few other users share that same network or application, while it becomes very large if many users are connected. Thus in the adoption of a new networked service there are two discernible regimes – a sparse regime in which there is little value to anyone and little incentive for new users to join, and a dense regime where there is great value for everyone and large incentive for new users. The huge barrier for any new service is getting from the first regime to the second. It is a barrier that few services have been able to cross.

Picturephone was the most celebrated of a number of casualties of this startup problem. The initial users were asked to pay about \$100 per month for a service that had almost no value, since there was virtually no one who could receive a video call. A mathematical model that was used at the time to predict the market behavior was based on that used for the spread of a disease. The probability of an individual being exposed to a disease grows with the number of people who have contracted the disease. Thus the incidence of the disease shows an exponential increase with time, starting quite slowly and then growing sharply before finally saturating. In the actual introduction of Picturephone only the first phase of this growth was observed, as the economics made it impossible to wait long enough to reach any critical threshold of acceptance.

The startup barrier has been conquered in several ways. The more traditional way is to rely on closed user groups with a high willingness to pay, usually private businesses, and to slowly migrate from these islands of adoption towards a more universal connectivity. A classic example was the adoption of the

facsimile machine. Even though it seemed as if the fax burst like a meteor on the horizon during the early 1980s, it had actually been invented more than a quarter of a century earlier. Both the technology and the societal need were pre-existing, but the pathway to its ultimate adoption was arduous.

No case study of adoption is a pure example, and there were other factors that enhanced the popularity of fax. An important ingredient here was the agreement upon an international standard for facsimile transmission, and the subsequent embracing of this standard by the industry. Although a standard would seem to be an obvious necessity for spreading a communications service, many services and applications have persevered without the benefit of a single standard – witness, for example, the current situation in wireless telephony. Certainly, the role of standards in any new service is critical, yet that role can be played in many variations, and it is a role that is constantly changing.

Technological and societal factors are also under constant change, and those changes affect the popularity of a new communications service. Generally speaking, technology will make everything less expensive with time, and society will become ever more interconnected with time. Facsimile machines benefited from technology innovations in devices and algorithms that brought the price point to a level compatible with consumer usage. Concurrently, there were changes in society that sharpened the need for such a service. The globalization of business to encompass great differences in language and timezone made the fax an ever more important tool for a society that was increasingly interconnected.

### Another Way to Get Started – The World Wide Web

Because of the barrier posed by the sparse regime of Metcalfe's law, it seems as if any communications service must take a long time to build to universality. But there is a startling counterexample in the recent meteoric emergence of the World Wide Web. In the space of only about two years the Web went from nonexistence to worldwide popularity. How did this come about, and what can we learn from this example?

First, we understand that the ingredients for the Web were already in place before it exploded into existence. Personal computers had penetrated into homes throughout the world, and increasingly they were equipped with modems for interconnectivity. The Internet itself had grown steadily for several decades, and was just reaching a critical threshold of user value based on email and ftp (file transfer protocol). Moreover, standards for document description and transfer, HTML and HTTP, had been adopted. Everything that was needed was there, except for two critical ingredients – a simple user interface and a brilliant service concept.

At this juncture the Mosaic browser came out of the National Center for Supercomputing Applications at the University of Illinois. What had been a network for the computer elite suddenly became easily usable for anyone. A quantum step in usability had been made, and this must serve as one of the lessons we remember from the Web.

As important as the usability was, however, there was another factor that triggered the explosive growth of the Web. The browser was *free*, and could be easily downloaded anywhere in the world. Granted, without any pre-existing material to browse, there was almost no value in having a browser, but the price was right! Thus the way out of the sparse regime of low user value was having a low user price! As soon as a few web sites started putting material on the net, and were suitably advertised by NCSA, the browsers that had been downloaded mostly from curiosity started having incremental value. Suddenly the value was looking much greater than the price, and the explosion occurred – the rest is history.

In retrospect, the concept of value-based pricing seems like the answer to the startup problem. Picturephone might have become popular too, had it been mailed free to a large percentage of the population in the United States. On the other hand, would the Web have taken off if it had been conceived by a commercial company, and the browsers sold for \$199? In an alternative future with these reversed scenarios perhaps today we would all be using Picturephones, and no one would have purchased the shrinkwrapped browsers.

The free-to-start scenario is being copied within the envelope of the Web by a number of other services. Streaming audio and video, security, Java interpreters, and other clients have been given away in hopes of selling server software for these same applications. Ironically, the Picturephone-for-free scenario is likely to happen in the immediate future as more and more PCs are equipped with cameras, standards for videotelephony are promulgated, and application software is distributed freely.

As effective as the free-start service boot is, the problem, of course, is a business model to achieve a return on the investment. In the case of Mosaic, the boot funding was from the government, followed by the commercial venture by Netscape, which depended on sales of server software. It is not clear that there are equivalent business models for introductions that rely on hardware with a per-unit cost. Nor is it clear that value-based pricing could ever be achieved, since raising the price of a service once it is established – even though its value might be increasing – might not be a feasible alternative.

### The “Field of Dreams” Approach

“If we build it, they will come,” was the famous reprise from the movie *Field of Dreams*.

It has since served to codify a philosophy of service introduction, and to represent the core of an old argument. Do services have to be known and quantified before an investment in infrastructure, or will revenue-producing services self-materialize when society is enabled with suitable infrastructure? Engineers often invoke the Field of Dreams scenario, while accountants demand business cases and market analyses.

The World Wide Web was a dramatic exemplification of the Field of Dreams philosophy. Users, not the designers, supplied the content. This was in complete contradiction to the telecommunications industry's previous approach to the provision of similar services. The prevalent idea of the industry in developing what was termed "Home Information Services" was that the industry itself would have to provide the content in centralized servers. Indeed, this was done in a number of trials, and in the initial on-line services, such as Prodigy and CompuServe. Throughout the 1980s there were trials of home information services in many different countries. None of these led to a commercial service, with the notable exception of the French Minitel system, which exemplifies yet another way to break the startup barrier through government mandate and subsidy.

The World Wide Web had no central server providing the information and entertainment content that users would need. Instead it was up to the users to provide their own content – and this they did. In the beginning they provided the content not for commercial gain, but through amateur enthusiasm, and for that ultimate amateur payback – attention and fame. Because the amateurs jump-started the content, commercial enterprises were able to piggyback on the increasing viability of the user population. Today the Web seems to be transitioning to a commercial endeavor, largely supported by advertising, and increasingly dominated by professional and commercial sites.

In retrospect it is difficult to fault industry for pushing the central server, closed system approach that typified the home information system era. It is hard to imagine selling a business case to investors based on giving away free browsers and depending on the users themselves to build the content. Even today with the tremendous success of the Web so evident it is difficult to understand and quantify the business cases for many of the services being proposed and implemented on its economically-fragile base. Much of the enthusiasm for investment lies in the prospect of exponential growth and the rewards that would be promised for any endeavor that could ride the course of the explosion.

The Field of Dreams proposition continues to be debated. What about broadband services? If the infrastructure is upgraded to video capability, will services grow to fill the bandwidth? If so, how quickly will that happen? These questions are not mere philosophical whimsies, but serious matters of national economics. The dilemma for the infrastructure provider is whether the enormous investment required to upgrade the bandwidth can be justified on the basis of

return. This is exacerbated in an unbundled environment characterized by tumultuous competition and by the timescale required to recoup an investment in infrastructure. Unforeseen technological alternatives could result in large stranded investment – the great fear of all carriers. It is hard to blame corporation executives and national policy makers who fear to rely on the Field of Dreams proposition.

There is a catch-22 in such arguments, however. The Field of Dreams proposition also has a corollary – if we don't build it, they surely can't come. As stated in a report of the National Research Council, "The market cannot explore a space that technology has excluded." If no one invests in a broadband network, then surely we will not develop broadband services. Moreover, we would probably not know what we were missing.

The discussion over the applicability of the Field of Dreams proposition to broadband is somewhat muted today, since many backbone providers are having trouble positioning adequate capacity even for today's needs. This is in contrast to the early days of Internet, when the National Science Foundation used the Field of Dreams approach, as perhaps only a government can, in the aggressive deployment of over-capacity in the net. This over-capacity enabled experimentation, and stimulated the growth of new services. This approach is no longer possible in the commercial backbone of today, but the US government is currently attempting a reprise of the earlier success with a program called Next Generation Internet, with a capacity of 100 to 1000 times that of today's Internet. What will users do with the gigabit stream promised by the new system? No one knows, but the mantra that gets repeated is: "If we build it, they will come."

### Predicting Societal Acceptance

For all the surprising insights that a retrospective view of the World Wide Web provides, none is more remarkable to me than the realization that no one seems to have predicted it. Moreover, in the perfect vision of hindsight, the World Wide Web now seems perfectly obvious. While it might be argued that glimpses of the Web were evident in science fiction writings – most particularly in William Gibson's *Neuromancer* – there seems to be no trace of the Web in serious professional writings. It is a troubling admission of a failure in the vision of the industry.

What, instead, has the industry foreseen? For decades it has been videotelephony. It seems that nearly every article, book, movie, executive speech, or television commercial that has tried to portray the future of telecommunications has told of people using videotelephones. However, that future has not yet happened. Perhaps it will, but if there is a statute of limitations that applies to future predictions, it has surely been exceeded in the case of videotelephony.

A more recent industry vision has been video-on-demand. This vision was engendered by the surprising success of video rental stores. Here was a commercial model, with quantifiable economics, of an application that would support the deployment of a broadband communications infrastructure. Based on this vision, the telecommunications industry planned for fiber-to-the-home, or some variation of it. Subsequent trials and advertisements were focused on the concept of providing consumers a choice of any movie at any time. ADSL (asymmetric digital subscriber line) was invented to carry digital television to the home over copper pairs. The computer industry began the development of centralized video servers.

Again, video-on-demand may indeed be the future, but it remains to be seen. Today the trials of this service are quietly being dropped, server development is no longer being advertised, and the fiber and ADSL systems are being adapted for broadband Internet access. How can we be so consistently wrong in these visions? How do we, in fact, discover what society will want?

The traditional approaches to market forecasting rely on surveys, focus groups, expert opinions, and trials. None of these approaches has been historically successful, yet they continue to be used, and large investments are often made on their outcomes. They are easy targets for criticism, but perhaps worth a few words of observation here.

User surveys seem to be nearly useless, if not misleading, for predicting future acceptance. To begin, the survey authors are confined to inadequate and wrong scenarios for the future on which to base their questions. Moreover, the questions themselves, unless unusually skillful, determine the answers. Finally, the people surveyed have no idea themselves what they would like in the future. "It depends," is really the only possible answer to most questions.

"How would you like to have a videotelephone?"

"Well, since you ask, that sounds just great!"

But even those few of us who have lived with videotelephones aren't so sure. There is a delicate psychology about them that cannot be described. Their usefulness would depend a lot on who else had them and how well society had adapted to their use. We have forgotten now, but society even had to learn to use the telephone in the early part of this century. The truth is that users themselves do not know how well they would like a particular service, because society as a whole will make this decision in the future. Moreover, such decisions seem to be made in a way that bears a resemblance to chaos theory, as trends crystallize out of the social fabric. We don't even know what we like until the rest of society tells us.

Focus groups, on the other hand, are useful for tuning an existing product to greater usability. Seeing how people actually use something, and hearing them discuss it, can bring surprising and useful revelations. For predicting the future, however, the same limits that applied to surveys pertain. Imagine, for example, showing the first Web browser to a focus group. Without the content, how is anyone to understand its usefulness? And without the wide acceptance of the browser, there is no content – nor is it ever feasible to provide enough dummy content to give a real feel for what the service would be like. Furthermore, as we now know, the browser was an incredibly successful idea. Few visions of the future are ever in this class.

Experts aren't much better at foreseeing the future or predicting the societal acceptance of new services. They may be worse, actually. Gordon Bell recently made a comment on expert predictions that I would like to popularize as the "Bell Test." He said, "If you are going to predict what the average person is going to do, then you had better be sure that you're an average person." The Bell Test is one that most of us in the industry often fail without even realizing that it needs to be applied. Today, for example, Internet appliances like WebTV are being marketed. Will they succeed? Don't ask an expert – WebTVs are not intended for the experts.

Finally, there are concept trials. These are often expensive and showy. In recent years there have been many trials of home information systems, video on demand, and broadband services. On the surface it does not seem like many have led to actual service deployments. Why are trials undertaken, and what do we learn from them?

In the early 1980s, AT&T conducted a trial of home information services in Coral Gables, Florida. Early adopter households were chosen, given an extra television set, an extra telephone line, and free information services for a period of time. Then they were asked how well they liked the service and how much they would be willing to pay for such a service. I thought at the time that there was no way that accurate predictions of market success could come from such a methodology. When I accosted the program manager with this opinion, he told me that I simply didn't understand – that the purpose of the trial was "not to fail."

Although at the time I thought this was a facetious response to my question, I have come to reconsider this statement. Perhaps, after all, this is the real reason for many market trials. It is probably unrealistic to believe that quantitative market data can result from a trial in which the content and users are underpopulated. It is a market test necessarily conducted in the sparse regime of Metcalfe's law, and not indicative of the behavior in a mature network or application. The sociology will be in the infant stage.

Nonetheless, trials must serve a real purpose, or they wouldn't continue to be funded. (At least we assume so!) Partly this purpose is to develop the

technology, understand the economics, and discover the difficulties. However, increasingly, it appears that the real reason for trials is as a political statement. A trial serves as a well-publicized stake in the ground. "We're in this business," it says. This perception can have real impact with shareholders, analysts, regulators, policymakers, customers, and employees.

It really is easy to be critical of all the methodologies used to predict societal acceptance of new services or products. What is hard is to propose a better approach. I have no proposal of my own to advocate, but a persistent belief that the question itself is unanswerable. There is no way to predict societal acceptance, because it depends on social dynamics that do not yet exist, and which will only later coalesce from some complex phase change in the social state.

In the United States, in particular, we have an engine in venture firms to explore the market space. Market successes and market failures inch the line of progress forward. While this is an energetic way to uncover societal desires, it has practical financial limitations. A venture firm can promulgate a web application or put a relay balloon over a city, but it cannot rewire the nation. How are these national investment decisions to be made? Given the uncertainty about what is desirable, and the trends to deregulation and smaller government, the probable answer is that there will be no national decisions on infrastructure. We will get what the market will give us.

### Fulfilling Ancient Dreams

Arthur C. Clarke has observed that modern technology is not easily discernible from magic. People have become so accustomed to the miracle of the silicon chip that they will believe anything is possible. In conceiving new communications services technology is seldom the root problem. I sometimes pose to myself: If I were a modern Merlin empowered with magic, what communications would I like? It troubles me that I am not able to provide an answer to my own question.

Descending deeply into the human psyche, I consider the furthest aspirations that we might harbor. What have we dreamed of for these long ages? I put together a short list of ancient dreams that we might aspire to fulfill with the modern magic of telecommunications.

*We want to be somewhere we are not.*

I have an image in my mind of the store window of a travel agency in London on a cold, dark, and blustery day. The pictures in the window are of smiling people on sunny, far away beaches. It seems that in everyday life we are seldom where we would like to be. Our dreams take us to other places -- can telecommunications do the same?

The telephone projects our voice and hearing to another place. It's a start. The videophone projects our eyes. Sensors, actuators, and robotics can project movement and feel. It is quite conceivable that other sensors could project smell and taste. With the five senses technically achievable, telepresence seems within our grasp. Ultimately, with virtual reality there might be no perceptual clues as to where your physical body was actually located.

But is telepresence a dream or a nightmare? Many future communications scenarios that I imagine are Janus-like, with two opposite heads, depending on whether the service is seen from your perspective, or the perspective of other users. For example, I always wanted a Dick Tracey wristwatch telephone so I could call anyone in the world at any time – until I realized that anyone in the world could call *me* at any time. You can't have one without the other. In the case of telepresence, I like the idea of attending a meeting using my remote robot. But I don't like the reciprocal idea of attending the meeting in person, only to find that other people at the table are represented by their telepresence robots.

Through the years, videotelephony has been advertised as a way to cut transportation costs. However, there seems to be no evidence that this has actually happened. Travel continues to increase, even in organizations that champion video conferences. One explanation of this trend is that the increased human connections made because of the videotelephony ultimately result in greater travel among participants.

A government official, discussing what was wrong with videoconferencing, reached out and embraced me, saying, "I need to *smell* the person I am dealing with." Although at the time I was embarrassed, I later realized that "smell" was a metaphor for some human contact that was missing from the electronic image. No matter how high the resolution of the image or how good the audio, there is something sterile about the electronic representation. My own opinion is that videoconferencing will grow, made easy by the Internet, but that it will not supplant face-to-face conferencing on any wide scale. Travel will inevitably increase at the same time.

*We want to be sometime we are not.*

Another ancient dream – time travel. We want to relive today, or hurry the day by. We want it to be last year or next week. Of course, not even the miracle of silicon technology can promise real time travel, but time displacement and choice have become of central importance. It is said that we increasingly live asynchronous lives, whereas the telephone was originally designed to be synchronous -- I call you, you answer, we talk. That doesn't work anymore; no one is at home when you call them.

I often see demonstrations of conferencing and groupware products in which canned scenarios are acted out that involve multiple participants. "Let's add Bob in Seattle, and Jane in Austin." Smiling people begin working together around a virtual whiteboard. I always think to myself: Bob isn't going to be there, and neither is Jane! Moreover, both the project they seem to be doing and the way they are doing it usually ring false – but that is another story!

Today we rely on the voice answer machine, email, fax, pagers, and other messaging media that allow us to communicate asynchronously. Indeed, the case can be made that the primary business communications medium has now become email, rather than voice telephony. Clearly, the ability to displace time is an important attribute of any new communications service.

*We want to be someone we are not.*

The best selling computer games for young boys are adventure and action games involving superheroes. But today they are far outsold by a dress design program for young girls that lets them imagine they are beauty queens or graceful brides. The most successful magazine in decades is *People*, and the television airwaves are filled with entertainment news, gossip, and personality shows. Everyone wants to be like Mike (Michael Jordan). The world is captivated by adulation of the famous. Whether this is desirable is not the issue; it is just something that exists at this time on this earth.

Vicariously sharing the experiences of others is an important element of life, both for entertainment and education. Services that enable us to put ourselves in the shoes of others will always be in demand. Whether it is Shakespeare or James Bond, the need to leave our own existences temporarily, to see things through the eyes of another, endures. We can be sure that entertainment television will continue to exist, or will be reincarnated in a similar format in another medium.

Someday in the future it will undoubtedly be possible to live entirely vicarious lives through electronic or biological means. Perhaps this is the endpoint in the evolution of movies towards ever a greater reality. The prospect of fulfillment of such a dream is inevitably tinged with sadness for humanity that our own private lives are seen as less significant or desirable as compared with the lives of the rich and famous. However, the capability of extending our experiences beyond the limits of everyday life has a potential for the betterment of mankind.

*We want to be something we are not.*

We strive to be more than ourselves, seeking out community and inclusion in a greater consciousness. Whether it is the clubs and gangs of youth, the regiment of the military, the cloistered life of the monastic, the fanaticism of a cult, or simply the membership in a political party or a golf club, we seek an augmentation of ourselves through association with kindred fellows.

I am reminded of a meeting a few years ago in which there had been extended discussion about finding information on the net. A young graduate student derailed the ongoing discussion, saying, "You people don't get it – this (the net) isn't about information; it's about community." She had a good point. While the focus of the business community has been on commerce and information, the amateurs, and particularly the youth, are adapting the net to enhance the idea of community.

The telephone enabled greater community, but was limited in this ability by being essentially one-to-one. Moreover, it is necessary to know someone by name (and number) before they can be called. You can't simply place a call to "someone who is interested in model trains." But with the Internet you can do exactly this.

Esther Dyson is credited with observing that on the Internet it is difficult to conduct propaganda, but easy to do conspiracy. Propaganda thrives on broadcast, which is difficult (though not impossible) in the current Internet model. Conspiracy, on the other hand, involves finding people with common beliefs, and this is where the Internet excels.

In fact, the current Internet may be too good at putting together people with like opinions. I heard a politician complain recently that there was too little learned argument on the net, inasmuch as people naturally gravitate to discussion groups that favor their own opinions. I think there is some truth to that. However, "conspiracy" is a pejorative term, whereas most gatherings of like-minded people achieve a desirable social objective. Nearly everyone has some hobby or individual interest that they would like to share with others of similar inclination. Before the Net this was relatively difficult, since the mass market broadcast model reduces everyone to a common taste, and the constraints of geography often preclude the local assembly of a critical mass of people of similar interests.

It is even possible to create community mechanistically on the net. Collaborative filtering is a process whereby an algorithm is used to discover people with statistically similar interests. For example, you can be grouped with people who have in the past exhibited similar likes and dislikes in movies, books, restaurants, or music. One outcome of such groupings is their predictive value – with high probability you will like a movie that you have not yet seen, but that was liked by people judged to have tastes similar to yours. Such techniques could be used in the future to extend the notions and strengths of community through a kind of group intelligence.

### The Needs of Society

So much for the dreams and aspirations of society – what does society really need from telecommunications? We need it to help with world problems, such as

war, crime, education, transportation, and the environment, and we need it to help with everyday life in such things as business, commerce, and leisure time activities.

Telecommunications has the demonstrated potential to alleviate a number of world problems. It has been given credit in recent years for being a major factor in ending the cold war. The opening up of the world because of ubiquitous communications has had a profound effect on the politics of the late 20<sup>th</sup> century world. Satellite communications, CNN, video tapes, and the Internet have truly created Marshall McLuhan's dream of a global village. People everywhere have been empowered with information, and hardly an event transpires in the world today that is not captured by some amateur or professional video camera.

The openness of the world is certain to increase because of the growing interconnection of Internet. Today there are already tens of thousands of cameras connected to the network that can provide realtime pictures of locations throughout the earth. In the future it may come about that virtually every square meter of the earth is observable on the net. The Gulf war was marked by being the first large scale conflict seen realtime on global television. Future conflicts may be observable on a much more personal and intimate scale.

Generally, technology is thought of as a neutral force that can be applied for good or for evil. Communications, however, does have a kind of one-way arrow - like the second law of thermodynamics -- that points in the direction of ever increasing openness. This openness helps society by promoting human rights, making it hard for totalitarian governments to conceal their activities from the watching world. However, it would be unrealistic to believe that increased visibility and connectedness of the world will result in fewer conflicts. The increased knowledge and visibility may only serve to highlight the great disparities that already exist in the world between nations and between peoples of these nations. There will always be people who want what other people have that they themselves lack.

In warfare itself, of course, information operations can be applied offensively as well as defensively. Society will demand both capabilities, and both will be honed to great levels. Networks will be extremely robust against failure and attack, but they will be such lucrative targets that they will also be highly vulnerable to sophisticated assaults. The only thing that is certain is that the centrality and importance of information networks will increase with time.

### Crime, Education, and Transportation

While the avoidance of war seems to be an impossible objective for technology, the prevention of criminal activity might be more achievable. At least here we would have the overwhelming agreement on the goal, if not the means. Certainly there are ways in which communications and networking can be used to deter

crime. For example, public surveillance cameras in high crime areas are beginning to be used. Early results appear to show effectiveness, and public acceptance generally favorable.

Unfortunately, in the prevention of crime there are the inevitable tradeoffs with privacy and individual freedom. As yet there is no societal consensus on these issues, and it is unlikely that there ever will be one, for on some level they are irreconcilable. The question of individual privacy versus the needs of society has come to a stark division in the current worldwide argument over the control of cryptography. Shall individuals be permitted to use unbreakable codes to protect their privacy, or shall governments have authority to read all communications for the greater good of society? Thus far it has not been possible to find an effective compromise on this issue.

The situation with respect to the applications of communications to education and transportation is quite different. Here we have general agreement on goals, and the tradeoffs are not so onerous -- the questions lie in the effectiveness. Schools are now being wired to the Internet, as are libraries and public access points. Government takes the principle of universal access as a first priority, and however that might be defined, we can be assured that it will happen.

Granted that every school child has access to the Internet and all its information and community. Does that necessarily mean a more highly educated populace? What is the role of the traditional teacher and of the library? For the moment, and perhaps wisely, those questions are being put aside in favor of a "Field of Dreams" approach to school networking. Wire the schools, and good things will happen.

Like the educational system, the transportation system is considered to be in crisis. Traffic is growing faster than the capacity of the traditional highways. Here also communications can be an enabler, but is probably incapable of being the answer in itself. As in most things, more information networked to more people and places provides a framework for solution.

### Everyday Life

When I think about the most important breakthroughs in telecommunications of the last quarter of a century, most of them have had little to do with technology. Perhaps the single innovation that has made the most difference in everyday use of the telephone has been the ability to make credit card calls. Next I might list the concept of 800-number calling, and perhaps after that touchtone dialing -- little things that made big differences.

It puts some perspective on telecommunications to realize that the great majority of the people in the world have never made a telephone call. The fact that a large percentage of the population in many countries is very young partially

accounts for this startling observation. However, it is sobering to observe that the telephone density (percentage with telephones) in many emerging nations hovers around 1%. While many of us in technology focus on advanced data networking, the majority of the world has much more simple and basic needs.

I have on occasion held the momentary belief that a telephone would offer little improvement in the life of a starving person in a rural area of an emerging nation. But I have been disabused of this notion. For example, it has been observed that poor rural farmers raise their standard of living after getting access to a telephone, for the simple reason that they are then able to find new customers and to discover for perhaps the first time the true market value of their products.

Wireless technology now offers the possibility of creating instant infrastructure for the unwired world. Bringing the telephone to the world at large would be a great feat in itself, but now of course we have the Internet overhanging telephony. At the current growth rate of doubling annually, Internet use is expected to exceed that of the telephone sometime in the years 2001-2003. Conceivably, new users might be connected to the Internet before they have telephones. They could then, of course, use the Internet for voice telephony, as will many users in developed countries in this time frame. In fact, the paradigm may shift from today's Internet-over-telephony to tomorrow's telephony-over-Internet.

Tomorrow's successful communications services will bridge the gap between work and home, and will forge a support web for business nomads. Technology will push on the sociology of work, and sociology will push back. Telecommuting has not spread as fast as has been predicted, and it is not necessarily good that everyone is in continuous communications with their work environment.

In our homes many of us will have broadband communications access and home local area networks. Services that aid us in electronic commerce, that bring us entertainment, that save us time, and that create small conveniences will be among those that survive.

### Conclusion

The theme of this essay has been that in spite of a fundamental inability to predict what society will want, truly remarkable progress has happened, and the future is fertile with the potential of societal improvement through telecommunications. Corporations and governments agonize over strategic planning, economics, regulation, and legalities. Few of these daunting questions being considering seem to have answers. Somehow, though, it will work out. There are mechanisms in the free market, in the march of technology, and in the interplay of social forces that will shape a future in which telecommunications will build a better world, of that I am convinced.