New Challenges and Opportunities for the Global Telecommunications and Information Industries*

Peter F. Cowhey

Introduction

This morning I will do my best to provide a glimpse into the latest discussions in the US telecommunications and information industries. I hope that your questions afterwards will go into issues that I did not raise in my remarks.

Today I will focus on the big picture of changes in the US communication and information technology industries. But first I just wanted to say a word about my current responsibilities as a way of background.

I am the dean of the graduate school of International Relations and Pacific Studies at the University of California, San Diego (UCSD). UCSD is one of the ten leading research universities in the United States. Most significantly for the interests of this group this morning, it is also the home to the California Institute on Telecommunications and Information Technology (CITIT). This is a joint investment by the state of California and Californian industry to the amount of US$ 300 million to create the next set of information infrastructure technologies for the state. My own job at CITIT is to lead the work on policy studies, even while I serve as the dean of the graduate school.

I am especially pleased to be here in Korea this morning because many of the most distinguished graduates of our school are from Korea. As a result while here in Korea I am going to visit many of them. They serve in many of your companies and government institutions. If you see any of my graduates working for you, please make sure to send my personal greetings to them if I do not have the chance to see them.

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Changes in communications and information technology

In San Diego, my office is located within approximately 30 kilometers of 500 communication technology firms, an equal number of information technology firms, and almost an equal number of biotechnology firms. All of them are a result of changes in the American economy since the 1990s.

The 1990s were, of course, a huge boom for communications and information technologies. The successes of the 1990s have led now to a downturn in the communications industry, the dotcom bust, and the collapse of many major communications carriers. Those all trouble the American economy today.

What happens next after the collapse of the American communications and information technology industry at the end of the 1990s? To answer that question—at least for the United States and maybe to offer some lessons for Korea—I want to go back into history and only then look into the future.

Complimentary innovations

The 1990s, with the introduction of competition in the United States, was a period of enormous technology and investment speculation. As a result, we had an explosion in the growth of the American communications and information technology infrastructure. In the US alone, we created the equivalent of five new national backbone networks for high-capacity data transmission. We created a huge legacy of information technology infrastructure for our leading industries.

But this expansion was very much like the expansion of the American railroads in the nineteenth century one hundred years before. At that time, there was huge investment in American railroads. It is now long forgotten, but the majority of American railroads built in the nineteenth century went broke and were bankrupt within fifteen years of their creation.

Out of that investment came the long-term transportation revolution in the

United States. The real benefits of the railroad revolution for the twentieth century American economy came when there were complimentary innovations made to match the railroads.

The classic example of that was the growth of the Armour Meatpacking company. Armour was the company that figured out how to ship beef long distances in refrigerated containers. With the creation of refrigeration for the beef industry, it was possible to ship cattle from one end of the United States to the other, and eventually even from Argentina to the United States.

After Armour's first step, oil tankers were created for railroads by the Standard Oil trust. We found whole new uses of the railroad infrastructure and revolutionized a whole set of complimentary industries. It took almost twenty years after the railroad collapse to invent those complimentary uses for the railroad transportation system. In my view, that is very much what is going on in the United States today.

Regulatory and policy decisions

It took something else for the railroad revolution in the United States to succeed in the long term. It took regulatory and policy decisions to take advantage of that railroad infrastructure. For example, you have all travelled in the United States and you know that in a large continental country we have different time zones. The time in San Francisco is different from the time in New York.

What you may not know is that our system of time zones was invented by the railroads. The reason why the railroads invented the time zones in the United States with the cooperation of the state governments was that it was impossible to run a railroad schedule when there was no common agreement on what time it was from city to city.

In short, it took an agreement on standardizing the time system of the United States to run the railroads efficiently. This too is exactly the challenge we face with the communications and information technology infrastructure. There are

many policy decisions that are necessary in order to take full advantage of the technology.

Today's differences: direction, architecture, network users

The story in the United States is of course different from that in Korea. In many ways, you have done a much more effective job in taking advantage of this infrastructure explosion than has the United States.

But let me concentrate first on the United States. What is different in the year 2002 from the year 1992, or even 1998, the last year of the boom? The first difference today in the United States is the different path, direction and trajectory for technology to network. We are changing from a wired network to a wireless network, from narrowband low-speed data transmission, to broadband high-speed networking.

The second big change is in the architecture of the data networks. Essentially, the period of the 1990s and the growth of the Internet was built around desktop computers operating in enterprises, united through the Internet. The future is going to be built around scalable distributed computing.

The basic goal of the American technology revolution that is being designed now is to unite all computing capacity in the world into a single virtual computer where the resources of all the computers in the world can be combined selectively as needed into a single virtual computing machine.

If you took the fastest supercomputer in the United States one year ago, its intelligence was about equal to that of an insect. Within the next two years, because this notion of a single global computer tied together by software and high-speed networks is slowly beginning to materialize, the supercomputers of the United States will be able to act as a single machine for special tasks. Their intelligence will equal that of a human being. This is a dramatic change in computing capacity.

The third big change today for the United States is a change in who uses the

network. Who is really driving the evolution of the network by their use of it? The big difference in the United States is that in the 1990s it was large corporate users and government users, along with research and development scientists who invented the Internet and advanced it.

Today the major change is the importance of the mass consumer market, such as you have in Korea with the growth of online gaming by your children. Also in Korea, there is a much wider range of business customers than in the US. Particularly, the industry designs technologies and approaches that serve small and medium enterprises. This will be the key to a growing marketplace.

Pro-competition wireless policies

One thing that has not changed from the 1990s, is that the US market is still driven by strong pro-competition policies. You may read that there is a reconsideration of those policies because, one, the growing influence of local telephone companies like Southwestern Bell or Verizon, and two, worries that we have had too much competition in the growth of broadband networks.

I think that is misreading what is going on in the United States. The real emphasis is on bringing competition policies to new areas of wireless communications technology.

In terms of the direction of research and development policy, there are two important trends. The first I have already spoken of: the growth of this idea of a single distributed integrated computing network as the research challenge of the future, and along with that, massive complex and effective databases to take advantage of this computing capacity.

The second trend I want to point out is the growth of what we call "smart sensors": the idea of having miniature cheap radios everywhere to gather data and monitor events. This is important for everything from security policy to basic economic infrastructure and environmental policy. Increasingly, it will be the key to many innovations in medicine.

Finally, of course, a major change from the 1990s is represented by all of you gathered in this room. The leadership of the information technology industry is changing because the market is changing globally. Asia is becoming the center of demand for information and communications technology. The United States will remain still probably the largest single market. But Asia will remain as a whole the center of the market. That means that more and more of the leading technologies will come out of Asia, as represented by the success of your companies.

Also, more and more policy leadership will come out of Asia in the long-term. In the 1990s, the American leadership in technology, in its market position and in its policy innovations, really made the US the center of policy coordination leadership globally.

And the future holds…

So what's next for the US, given those trends? The United States lags Korea on the build-up of a broadband network. You have a higher rate of broadband deployment in Korea than in the United States, much to the credit of your national policies. Perhaps most importantly in that regard, you have a lower price for broadband services to the home than in the United States. If there is one lesson we learned in the United States, driving down the price of data networking is critical to getting innovative use of the network.

We failed to follow our own lessons. Korea has done a better job. This is what is leading to many of your successes as a technological leader today. Among them is also the growth of a new set of mass consumer applications, like gaming over the Internet.

But the US remains the leader in information technology. It still has the biggest and deepest research and development community in the world. A revolution is about to occur in the United States that has deep implications for Korea's choices in the future.

You have all heard various laws about the growth of computing and the

Internet. Let me introduce you to a new law. It's called Cooper's Law, named after Martin Cooper. He is the scientist who made the first call over a cellular telephone.

Martin Cooper suggests that every two and a half years for the last one hundred and five years, the number of calls—voice and data—over the wireless spectrum has doubled. This is illustrated in Table #1. In 1985, there were roughly one trillion conversations or uses of the airwaves of the world. By the year 2005, it will be one hundred trillion. In other words, an explosion in the use of radio communications for voice and data purposes.

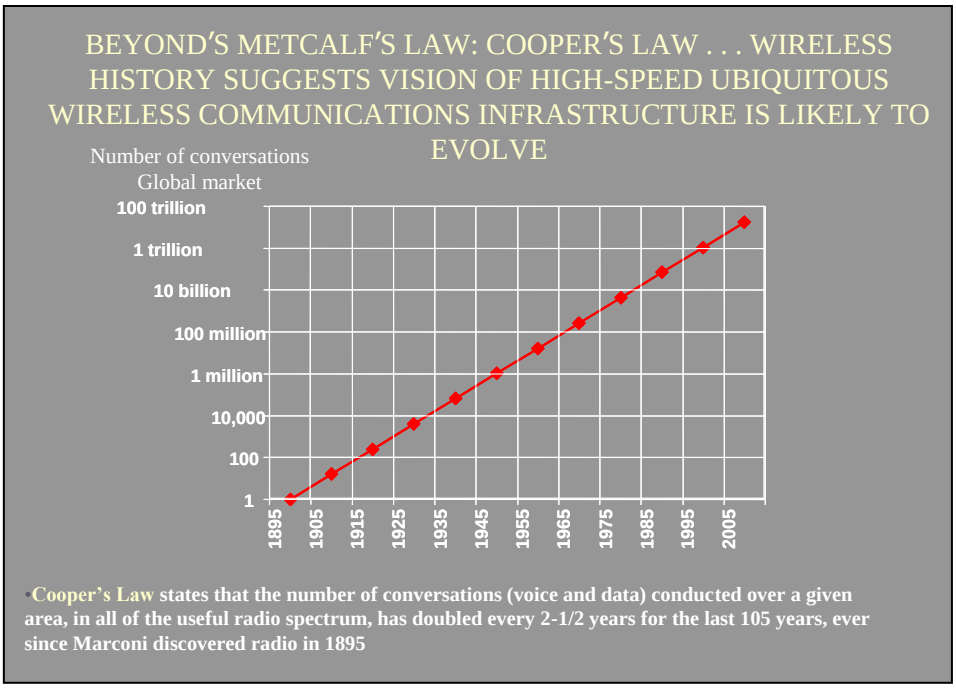

Table #1

In that explosion, there are some constraints that have emerged in the use of wireless communication networks. Table #2 represents an effort by McKinsey, a consultant, to project the amount of money consumers are willing to pay for one megabyte of application, such as short messaging services (SMS). Consumers are willing to pay a lot for a megabyte of SMS. The reason why is that they do not know the actual cost. They pay in very small increments and

do not notice how expensive it is.

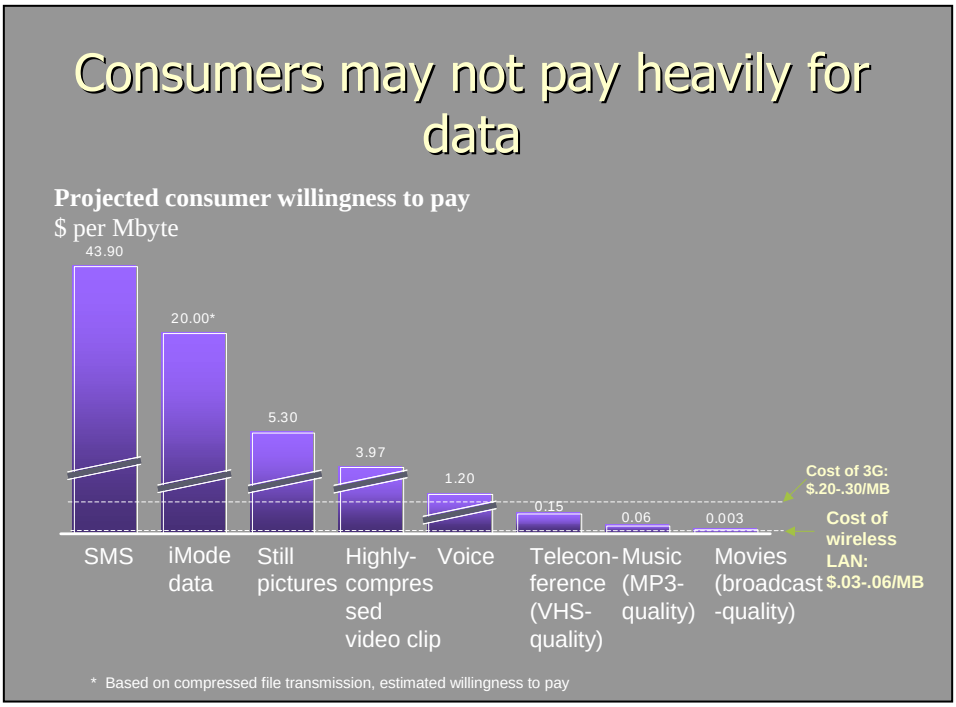

Table #2

If you move across Table #2 toward the right, you see that there is a break point around voice applications where consumers are starting to become more price sensitive. When you get to the cost of a megabyte for teleconferencing, which takes many megabytes to deliver, they start to become acutely price sensitive.

...expensive 3G

The significance of this is that the cost of third generation (3G) wireless communication infrastructure is coming in at about US$ 0.20 to US$ 0.30 per megabyte of information. Nobody knows in the long-term what the precise costs of the transmission will be over 3G. We are still improving the technology.

But if you take that as a rough estimate, it tells us that 3G may be too

expensive to deliver some of the largest bandwidth applications that you can think of—teleconferencing, music, video on demand—at a competitive price.

Wireless solutions

How do you use the wireless infrastructure to deliver really intensive data applications, whether it be movies or massive computing applications? That is why attention is turning very rapidly to wireless local area networks (Wi-Fi) or, to use another term, 802.11 technologies.

These deliver a megabyte of data for roughly three tenths of a cent (US$ 0.003). That is leading to a vision of the future of the communications and information technology infrastructure in the United States.

Policy adjustments

The chairman of the Federal Communications Commission (FCC), Michael Powell, recently made a speech that I would invite all of you who lead technology companies or invest in technology companies to pay careful attention to. In a speech in Colorado he announced the beginning of the next major policy revolution for the communications information industry in the United States.

The purpose of this speech, which was about how the FCC will regulate the use of radio spectrum for communications, was intended to open up a technology and competition revolution. It was a very ambitious speech, carefully planned over the last two years.

The vision in the Powell speech is that wireless communications infrastructure will be available anywhere, at any time in the United States, in high capacity. It will be done by a combination of 3G technology networks, where Korean firms such as LG and Samsung have proven to be leaders in handsets and other devices, and the creation of brand new wireless communications networks using a variety of technologies, but especially using unlicensed radio spectrum. That is spectrum that anyone can use, at any time, with a variety

of new devices that will be fundamentally cheaper than anything that has so far been devised for wireless communications.

The goal of this strategy is to open up broadband networking to homes and small and medium businesses. This strategy will see broadband networking at incredibly low prices for those homes and smaller businesses that are now outside the 15% of large office buildings in the United States that already have cheap networking.

Radio devices everywhere

There is even a deeper revolution beyond this. Anybody can replace copper and fiber with wireless technology. The real goal is to allow the creation of the presence of radio devices everywhere in the infrastructure—in the roads, in the refrigerators, in your bodies—as a whole new basis for organizing the creation of data for new applications.

I could talk about that in the abstract. Instead, I will illustrate what we mean by that. The idea is that everywhere you go there will be radios that cost about US$ 0.01 to produce. These will broadcast on an unlicensed, low-power radio band, and produce data that can then be managed by new applications. This applies to managing environmental issues, like water flow, urban issues, like road traffic, or even security issues.

All those can be monitored because there is a single, large-scale computer network capable of taking on any scale of computational task necessary to work with the data.

Table #3 shows a wireless sensor for the body. Let's say your child goes out to play tomorrow, falls down and gets a large cut. It's a deep cut, and it needs a Band-Aid. The goal one day is that those Band-Aids will have radios in them. The radios will look to see if the cut is becoming infected. It will automatically send a message to the doctor if it is. Does this sound fantastic? The patent is pending and the research is being done at University of California laboratories right now to perfect it.

The further goal is that, as many of us get older, we will have a large scale radio network implanted in our body that feeds data to our doctors, monitors our health and automatically tells the doctor, according to our software profile, when we should see the doctor, instead of relying on our guesses about when we ought to see the doctor. Table #3, as mentioned, shows a thermal patch with the smart Band-Aid, the antenna, the communication chip, the battery, and the sensors.

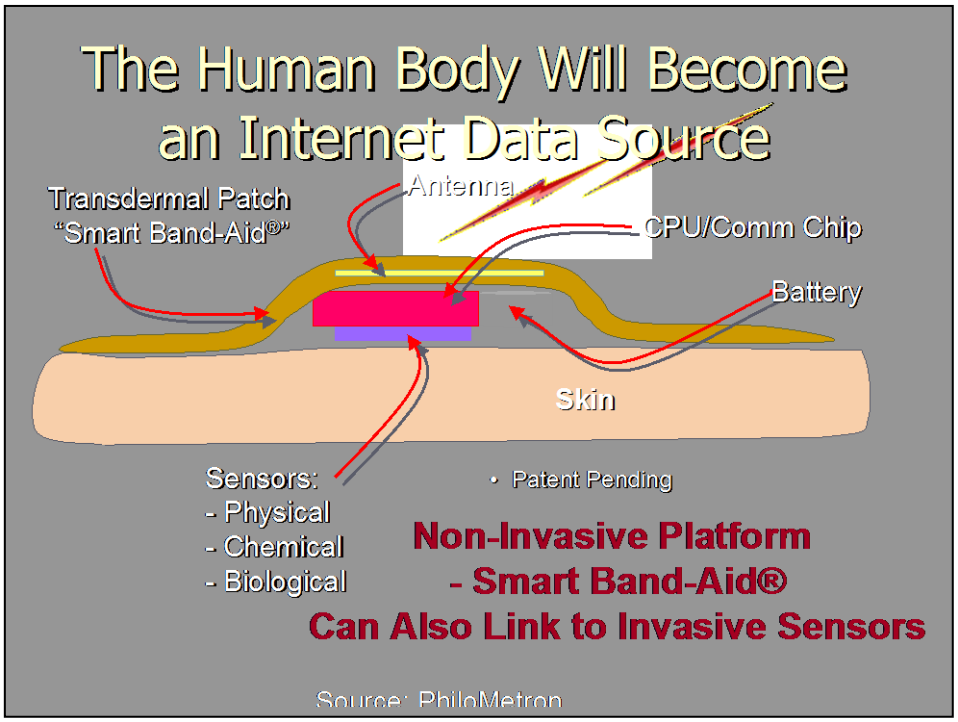

Table #3

I talked earlier about the change in the computing revolution. Table #4 is a picture of a scalable computer grid for the future done by a small software company, Entropia. Entropia launched its system in November 1997. In nineteen months, by linking together desktop computers, it has achieved an approximate processing capability of 1 teraflop. That is essentially one trillion calculations per second, a standard benchmark for super computing. This was all done with a scalable software system.

The Internet is achieving a level of penetration in the United States per

person that exceeds newspapers as a source of media information. It is another benchmark by which we are going to judge our success with broadband. We want to be moving the Internet closer to the levels of television.

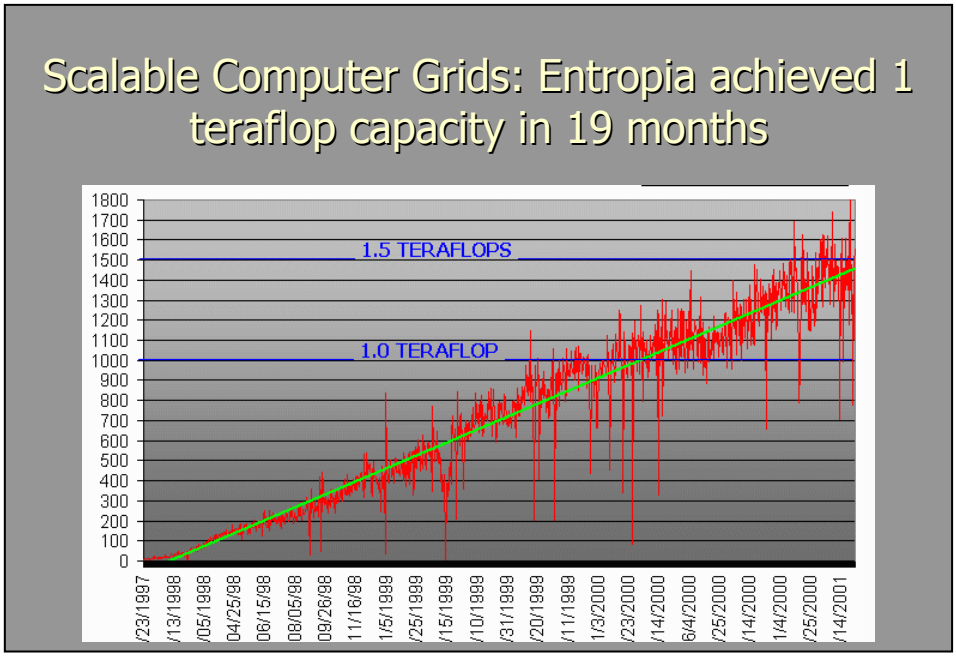

Table #4

Wireless infrastructure

Let me talk about the communications infrastructure on wireless. Table #5 shows the growth of wireless local area networks. It shows, in thousands—so at the top that's actually 30 million—the number of interface cards being shipped to wireless local areas in US computers each year.

Wireless local area networks are becoming a standard part of computing capability in the United States. The prices are dramatically dropping, and wireless local area networks operate on radio spectrum that is not licensed. Nobody gets a license to use it, anybody can use it, there is no price charged for its use, and it is capable of carrying high data flows on the order of 11 megabits per second today, going up to 54 megabits per second in the next twelve months. This means that wireless local area networks are growing

from the bottom up in the United States, taking over university campuses.

For example, in our classrooms at the University of California, San Diego, we no longer are going to wire classrooms. Remember how the United States said that every classroom will be wired? We are getting rid of the wires now. Wireless local area networks are going to deliver the data at 54 megabits per second. When our students walk across the campus, they can go into the local wireless area network and find out where every other student who has a computer or an information device is located on the campus. That way, they can figure out where they want to go next if they want to find their friends.

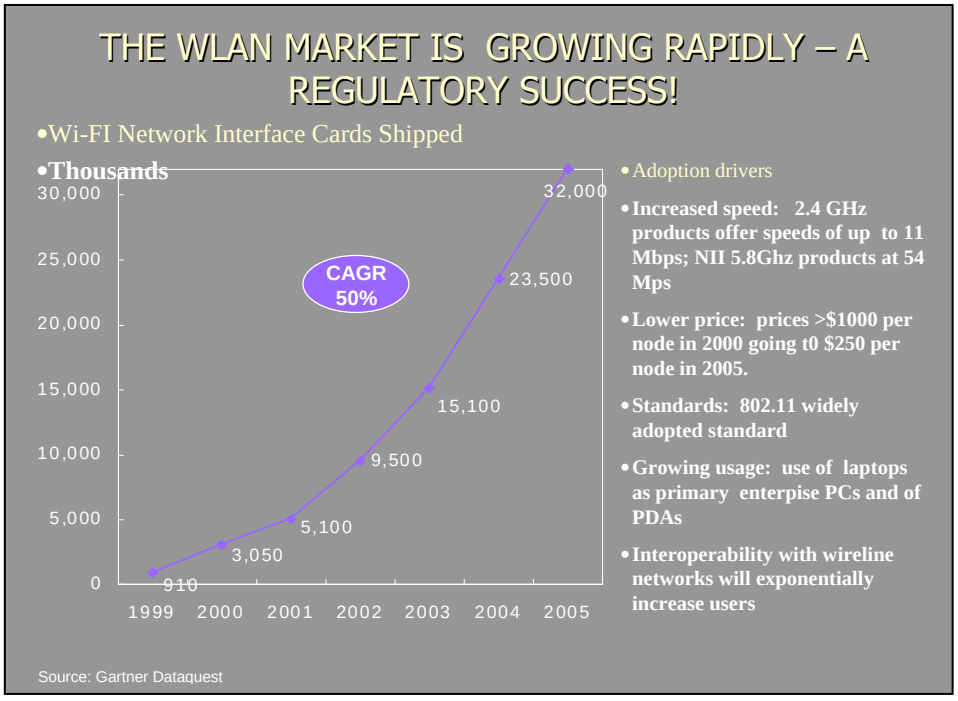

Table #5

This is going to produce cheap, very high capacity data networking everywhere in the United States. 3G will then serve as the long distance back bone connecting it.

New world, new policy

With that breakthrough, and other types of similar technologies, the United

States will be in a position to experiment with computing capacity on a distributive basis, tied together by networks that cost very little to use, in a way that no one has imagined before.

The issues facing US policy in this area are many fold. First of all, there is the issue of interconnection. When we build a network at UCSD that combines all our students at no charge into one high-speed access, they have to eventually be connected to the national network via various fiber optic carriers. Will those students be allowed to do that? What will be the charge from the fiber optic carriers to the university for using the national fiber network?

My home has a wireless local area network. By having a wireless local area network, I can allow the next five homes around me to be able to use my cable modem wirelessly. Once I build my network using a cable modem for high-speed access, everybody can use that network, unless I exclude them by imposing a security barrier. Does the provider of cable high-speed services to my home accuse me of illegally sharing their network with my neighbors? This is the type of question that is arising around the United States. It poses a major question for competition policy and investment.

If you deliver data at 54 megabits per second for almost nothing on a university campus using voice-over-Internet protocol technology, it can become a substitute for the telephone. This will make telephone traffic disappear from the public telephone network and move toward various wireless networks.

In the United States, as in many other countries, there are very elaborate subsidies built into the pricing of telephone services in order to make sure that farms and other rural areas get telephone service. What happens if traffic disappears off the traditional telephone network and those subsidies disappear?

If we are truly to have a global data network that is everywhere, very high speed, and very cheap, how do we deal with a fundamental economic problem for telephone companies that run wireless cellular networks today? Those

companies make a significant part of their profit from what is called international roaming charges.

I know many of you come to the United States. If you then use your Korean telephone in the United States, you pay something like US$ 0.50 per minute. The cost of delivering that service to you in the United States is more like US$ 0.03. It is not US$ 0.54 per minute. This is pure profit margin for the telephone companies. It is one that people accept nowadays as a luxury, a useful service. But if you truly have a world where people are living on a global wireless high-speed infrastructure, what happens to telephone companies if they keep trying to charge those prices?

You will recall that not more than fifteen years ago it used to cost some US$ 0.75 per minute to call the United States long-distance, when the true cost of that call was something more like US$ 0.02 per minute. There has been a price revolution that has brought down those prices in Korea. A similar issue is going to be faced soon in regard to international wireless networks.

19th Century policy meets 21st Century technology

Finally, let me point out one last issue. The spectrum for radio that enables the wireless infrastructure is one of the last examples of central government rules and regulations governing a high-technology industry. When I was at the FCC, I was writing regulations that told technology companies how much power they could use in their devices, and precisely how they could engineer their networks for wireless applications. We did not allow interference among the devices and uses of radio waves.

I think that I am a fairly clever person. I think the engineers working for me were very hard working engineers. But it is crazy for me to tell the Samsungs and Ciscos of the world how to engineer their technologies in detail for the next stage of the wireless revolution. It does not make any sense. The government cannot be that smart no matter how hard it tries.

The next challenge in front of us is to invent rules about the architecture of

wireless networks that gets government out of the business of writing technical details. That is what Chairman Powell was proposing in his speech in Colorado six weeks ago: that the government invent a whole new way of regulating wireless networks so as to allow companies much more freedom in devising how they create technology for the networks.

If it succeeds, this revolution will require a fundamental change, not just in how the US regulates wireless networks, but how Korea and every Asian nation does so as well.

I am pointing to a revolution in wireless networking that will fuel a communications network change and allow a whole new vision of computing and services. But I am also saying that this opens the way to electronics companies that have proven to be leaders in innovative radio network engineering.

This is very good news for Korea. This vision of the future is basically one where Korea can leverage and compliment its 3G engineering successes, providing the US$ 0.01 radio sensors under Band-Aids comes to fruition. This will allow Korea to get involved in making many of the components of the optical electronics revolution that will come along. It will open a whole new set of markets for Korea and, I believe, benefits for consumers around the world.

Questions & Answers

Question #1: What is your view on the privatization of KT? It has been privatized and they are faced with not only the process of fully privatizing the organization, but also adapting to the new IT environment you have described. Do you have any advice for them? How can they redefine themselves? Can they sustain themselves?

Answer #2: The challenge to KT is not so different from the challenge to almost every other major telephone company in the world. You know KT's challenges better than I do. But let me make a point about restructuring any

telephone company, anywhere in the world.

If you took a look at the economics of Verizon, France Telecom, or KT, you would find a common theme: the wireless communication divisions have a much more effective cost infrastructure than the wired divisions. It is the same company, but very different cost structure. Why is that? The wireless parts of the companies grew up in a competitive market. They were created in a more competitive world and so created a more competitive cost structure.

In every one of the big telephone companies in the world, there is a tension between the wireless operations and the traditional wire line operations in their cost structure. The big issue is how these companies manage these two cost structures. Right now, the companies really struggle to maintain the higher cost structure for the wired line division. In the long-term, the technology trends I am talking about make that impossible. What happens when they finally reach the point where it is impossible?

Up until now, whether it is Korea or the United States, government has stepped in to use regulatory powers to force KT or Verizon to share their network at a low price level with their competitors as efficiently as they can through an interconnection policy. In the long-term, if these companies were really succeeding with their cost reduction policies, they would want to share their networks at low cost. It would be a profitable wholesale business. And they will do so if they can restructure their costs.

This is really a labor and cost adjustment policy issue, and the growth of the wireless market is going to force a restructuring sometime in the next ten years.

Question #2: Your point on regulation of competition and pricing is very valid. But in North America we are also conscious of personal privacy and the privacy of personal information. I may not necessarily want my doctor to know everything that is wrong with me. There are certain things that I may want to keep away from those US$ 0.01 radio sensors. How do you see this issue being addressed in the context of this new wireless revolution?

Answer #2: I think you made a fundamental and very important point. We are going to face a situation where the protection of privacy is one of the most important issues in the wireless world. The current rules of privacy are probably inadequate for these challenges.

In the case of your doctor, I expect it will be pretty much of a model of what we are going to see in many industries. Medical associations in each country will adopt whole new codes concerning patient privacy in order to allow the technology to be used in confidence by their patients.

Even today in the US, for example, many people will not take certain medical problems to their usual physician. They do not want it to go onto their insurance record. They will pay cash out of hand to avoid that.

We understand there are fundamental issues here. I do not want to pretend there is a single solution. No one privacy law will cover this. It will be a series of case-by-case codes as we enact new capabilities. That is part of the policy challenge of this information technology revolution.

Question #3: I have a political question. The Clinton Administration started to set up a national information infrastructure and ended up with the Y2K problem. Lots of money was put into the IT and service industries. But the Bush Administration is not favorably supporting the IT industry. Do you think this wireless single market problem under the Bush Administration can be effectively implemented?

Answer #3: As someone who worked for the Clinton Administration, I should be very careful of my words, especially since the Bush Administration just asked me to serve as their representative to the International Telecommunication Union (ITU) for certain expert work. So I want to be very bipartisan here.

My feeling is that the Bush Administration came into office at a time when the market was collapsing. The Republican party has traditionally been closer to

the local bell telephone companies than the Democrats. The bell telephone companies took this as a signal that they could weaken the rules of competition in wired networks. Whether that was right or wrong, the economic downturn in the United States led many Democrats to no longer want to fight about this either.

In my view, wire line competition policy is less vigorous today than it was when I was in the US government. But the Bush Administration, to its credit, recognized that the next big round of technology innovations would still require a competitive market. The FCC has been putting all of its real attention on developing a package of policies that will let this type of wireless market revolution take place.

Let me try to explain how big this policy proposal of Chairman Powell really is. In the United States today we have a few megahertz of spectrum that is set aside for what is called unlicensed use, like the wireless local area networks that I was describing. The Bush Administration is saying that in the future we will have a very large part of all spectrum—all the radio spectrum in the United States—made available for unlicensed use. Every major incumbent on that radio spectrum, every telephone company that owns spectrum, every specialized holder of a radio license in the United States is going to fight this proposal. The Bush Administration is trying to take them on and produce this breakthrough.

I believe they will get bipartisan support from the Democrats. There is a growing recognition that this is what will likely trigger the next technology revolution in the US. The Bush Administration is in favor of competition, but they are focusing on the wireless area in the way I have described.

Question #4: You mentioned in your presentation that after the railroad bust, it took fifteen years to see complimentary innovations. It also required an appropriate regulatory infrastructure. We had an IT bust recently. Investment is still not picking up, and wireless technology and many other areas need investment. How long will it take until the IT industry comes back and sees investment again? Do you see a big wave coming soon?

Answer #4: Yes, I do see a big wave coming soon. I would join my friends in the Korean stock market here if I knew exactly the precise time. I would buy a lot of companies.

Take San Diego. San Diego now has the largest concentration of telecommunications technologies firms in the United States. As I said in my opening remarks, we have about 500 within 30 kilometers of my office.

Those firms, by and large, are spending their money on technology development. They are not trying to take the technology to market. The investment community is just investing in technology development right now, and putting together the teams of people for this work. They are waiting to see some sign of an upturn in the market before they actually spend the money on product marketing. We have the development of a large inventory of new technology waiting for the first signs that the market will sustain it.

Equally important, we are starting to see the deployment of prototypes of these technologies at universities and communities around the United States. There are maps of major US cities that show the growth of the "wireless local area network bubble". People are linking together these wireless local area networks in larger and larger groups. These will not replace the telephone companies. But they will change how we deliver broadband data in the United States.

That investment is going on as we speak. Every single personal computer sold in the United States now usually comes with a wireless local area network card. The cost of deploying a wireless local area network in my house was US$ 200. That's cheaper than getting a cable modem. It is starting to happen, but we haven't seen it hit the mass market yet.

You read primarily about the problems of the telephone companies, and things like 3G deployment in the United States. What you do not really see is what happens beyond that. 3G will happen in the United States. But it will happen while this other explosion goes on around it. It is the interaction of 3G with

these other new technologies, both in computing and communications, that will really define where the next revolution occurs.

Question #5: What exactly does 3G, and 1G and 2G mean?

Answer #5: First generation (1G) was analog cellular telephones. Second generation (2G) is the type of telephone that most of you have carried for the last several years, a digital cellular telephone. Third generation (3G) is the area where Korea has led the world in deployment: a medium- to high-speed wireless communications infrastructure using CDMA technology. That allows for speeds that range from 50 kilobits per second up to 1 megabit or more per second over wireless infrastructure. That is using standard telephone wireless networks.

Question #6: Recently, *The Economist* carried an article about a trend where the PC is becoming a telephone and the telephone is becoming a PC. They are coming from different directions, but toward one goal. Does this new trend have something to do with this kind of competition between 3G and wireless area networks? How will it effect the whole future of the IT industry?

Answer #6: If you wanted to take a picture of the United States in terms of its technology and industrial policy for the last thirty years, across many administrations the clear trend in US policy was to make the computer industry dominant in information networking. The telephone companies wanted to dominate that industry for information networking.

Basically what the US did was create a competition policy that put the computer companies in charge of the information network. We did that because we thought computer companies were better at making the required technological changes. Also, the customers who actually used the information networks basically supported the computer companies over the telephone companies. The decision to use competition policy to break up AT&T, introduce competition in telephone services, and introduce competition in data networking were all done so that the computer industry would dominate the telephone industry.

In the future will the telephone companies and their equipment suppliers become a large part of the story with a larger role? That is what *The Economist* article was asking. My view is probably not. The telephone companies will continue to have a large and prosperous market because the provision of basic infrastructure on cost effective terms is a good business in which to be. The business will keep growing because the infrastructure needs to keep growing.

But I think the revolution we saw in the 1990s, and the one I am describing today, is going to lead to even more radical innovation in the way we define a communications network company. It will be a market with combinations between specialized providers of these wireless local area networks, often funded by the equipment companies like Cisco, and the telephone companies. They will join together in whole new ways no one has yet thought of.

If you want one good example of this, Microsoft, AT&T, Cisco and Intel have a joint venture called Project Rainbow. In the next six months, it will probably announce a massive deployment of wireless local area networks around the US as a joint business venture. The purpose is, of course, to drive the use of data in the US in whole new ways so that Cisco can sell more routers, Microsoft can have a pick-up in the computer industry, and Intel can sell chips. They are going to deploy the wireless local area networks entirely at their own expense to drive demand for their core products in the future. The negotiations are going on right now.

Question #7: If Nokia is designing a telephone that is like a computer and Microsoft is designing a computer that is like a telephone who will win?

Answer #7: The European technology industries see the cellular telephone as a great opportunity to take on Microsoft and Intel in their dominance of information technology. This is a very real tension between the United States and Europe. Information technology in the future is going to be very diverse in its applications. But I generally feel it will be closer to its computing roots than to its telephone roots.

So if I had to chose between Nokia and Microsoft, I would chose Microsoft. But let it be said that the revolution in information technology devices is so large that it will likely be neither one. It could be somebody else. The growth of alternative software architecture may lead to something that is totally different.

I gave a talk in Korea in 1984 on the future of the information technology industry. The question was, would IBM or AT&T dominate the future of the network. I was posed that question in a room much like this. My answer then was, I'm not sure either one will win. This nearly led me to lose the job I was negotiating for at AT&T. So I would say to you, that between Nokia and Microsoft, maybe neither one will win. Probably something completely different will be developed.

Question #8: I have a two part question. There has been a lot of criticism on the growth from 2G to 2.5G, just because a lot of the broadband growth has been based on online games. What is your opinion on that?

Second, going from 2.5G to 3G the issue will be on profit sharing between the content providers and the carriers. What is your opinion on this?

Answer #8: For those of you who are not technology specialists, as we go from a standard cellular telephone service to a general data service, called 3G, there is a transitional step called 2.5G. That is used for online gaming here in Korea today.

My belief is 3G technology is still evolving in how it will be used. We will see a general 3G infrastructure world wide because, for a reliable medium-speed mobility application, 3G is the best we have on the drawing boards. It will be rolled out.

But many of the uses of 3G technology may not be in ways that we anticipate. Where are the big growth markets outside economies like Korea, or Germany or the US? In the long-term, the development of networks will be in countries

like India and elsewhere.

3G used for stationary communication purposes—not for roaming and telephone in cars, but for services to office buildings—may be one of the cheapest and most effective ways of providing data networking in those countries. This represents a huge market opportunity. It is higher speed and cost effective for those countries. That is one potential surprise in 3G. There may be others.

What about sharing money for online gaming between telephone companies and content providers? There is a basic rule of thumb here that every government policy maker should follow. Government policy should always favor experiments by users of the networks. They should always be in favor of people who find new ways of using the network, and reward them instead of the people who supply the network.

Why is that? The real innovations in data networking come from users inventing ways of using the networks, not from the vision of the people who design the network. I make the point about policy because I want to come to the conclusion: government policy should allow the market place to experiment with various revenue sharing schemes. We have seen many different models in the market place. Government policy should be designed to stop the telephone companies from controlling content on the networks and how it is deployed.

The biggest surprise in information technology constantly comes from the people applying the technology, not from the designers. All government communication ministers in the world must let the telephone companies experiment with any sharing of revenues they want. If it comes to the point where the telephone companies actually and effectively control who gets to put what content on the network in a way that puts them in charge, step in and say that this will not be permitted. That is the key policy conclusion.

Question #9: What would be the best policy for Korea if it wants to take advantage of this forthcoming new set of markets in information technology?

Answer #9: National policy in Korea faces two main questions. Will Korea do exactly what it did so successfully in the 1990s and continue competition policies that make the network inexpensive and widely available at high speed to the economy? That will take continual strong pro-competition policies.

Second, in addition to keeping some good policies from the 1990s, can the Korean government also innovate the required new policies to face the information technology revolution? There is going to be an entire policy revolution necessary in the management of radio spectrum. Radio spectrum is going to be key to the development of the next generation of communications and information infrastructure.

Korea, the United States, Europe and Japan have old fashioned nineteenth century spectrum policies. Our policies were designed around the idea that the government will design and manage the way in which radio spectrum is used. Then, we hand out licenses to companies—two, three, four at a time—saying now that we have designed how to use the radio spectrum, go ahead and offer your service.

Can you imagine if we built the computer industry around the government saying, here are the next four uses of the semiconductor, we have approved these uses of the semiconductor, and this design, and that is what you are to do? I can predict what would have happened: today we would still have computers that operate at the level of a 1984 computer.

Government cannot design policies fast enough or effective enough to allow this technological revolution. The US hopes to design a whole new way of regulating radio spectrum. I do not know if we will succeed.

For example, instead of having a rule that says your radios can only operate within a certain power level and with certain technical designs to it, there will simply be a rule that says all radios have to look to find the highest spectrum available at the moment. The higher the spectrum, the less crowded the spectrum. You can simply put a smart chip in a radio and tell it to find the

least crowded spectrum, and use that for communication. If it needs to use a slightly more crowded spectrum, then it will.

This is going to require a whole new way of regulating. Anyone who has been involved in this knows that companies that design radios are completely caught up in the tradition of a lot of government regulation. One of the hardest problems to revolutionize this market will be to change the people in the industry that are used to the old way of doing things. You have to change their mindset, not just change policy. That is going to be a big challenge.

Korea has one of the greatest electronics industries in the world. If Korea manages this policy revolution, it could become one of the key specialized suppliers for the oncoming information technology revolution.

Question #10: There are many participants here today from KOSDAQ and small- and medium-sized businesses. They face many difficulties. Could you say something more positive for such small players?

Answer #10: I do not know if you would want my advice. If you took a look at my personal stock portfolio for the last four years, I had too many KOSDAQ and NASDAQ companies in it. But I am reinvesting in the companies now. I believe small to medium companies are going to do extremely well in this environment.

There is going to be a major shift in how we do computing and how we deliver communication services. Many of the key suppliers for these technologies are small and medium companies. Why is that? Large suppliers are designed for, and have cost structures for, large established market bases. But this is all new stuff. It is a totally different way of organizing technology. While many of these companies will end up being bought out by larger firms, the small and medium suppliers will in fact lead the marketplace.

The distributed computing firm, Entropia, that saw the rapid growth to 1 teraflop computing is a small start up. It is one of the leaders of distributed computing in the United States. If you took a look at the specialized

components for the sorts of radio sensors I was talking about, most of the specialized components are being designed by small and medium companies. A principal leader in chips for 802.11 systems is Intersil, a relatively small company.

The message of this lecture is good news for KOSDAQ's companies. Although nobody would want me to manage their investment portfolio, a good financial manager could make a great deal of money by picking a careful portfolio of some of Korea's promising technology start ups.

Question #11: Will China be a factor in this IT revolution? It is such a big market and developing so fast.

Answer #11: Yes. First, China Unicom, the second largest communications carrier in China, just had its first board of directors meeting outside of China. They held it in San Diego. Much of their wireless infrastructure is being developed from technology out of San Diego.

I was very impressed by their investment plans. Clearly any country that has such a rapid growth in investment and spending on technology is going to influence the market. I have no doubt that China will be a major factor in information technology, simply because its fast rate of spending will make it into a major supplier in the long term.

Secondly, the important question for Korea is not what I have been talking about. The major question for Korea is electronic commerce. Electronic commerce is going to continue to grow in importance in the world economy. We are going to see China try to become the dominant center for electronic commerce design and operations in East Asia using the major scale of its market to help it get there. That means that China will be significantly involved in the growth of information technology design for electronic commerce platforms.

That challenge poses a major question for Korea. How does the growth of electronic commerce in Korea relate to the growth of electronic commerce in

China? Are you rivals or is this all compatible? If you are rivals, how do you make sure that Korean suppliers have a major voice in the design of Chinese electronics commerce technology platforms? This is a very big question, and one that is one of the hidden challenges of the next generation.