Statement of Reed E. Hundt

Before the

United States Senate

Committee on Commerce, Science and Transportation

April 28, 2004

Mr. Chairman and Members of the Committee:

Thank you for inviting me to testify today on the future of this country's telecommunications industry. I am grateful for the opportunity to present my views. My testimony today reflects only my personal views, and not the views of any company with which I am associated. (Such associations are in the summary resume attached hereto. See page 25.)

As you know, the only right economic policy for a nation is to seek to obtain a high and rising standard of living. Social policies may be aimed at other goals, but that is the purpose of an economic policy. To do that, productivity gains and full employment are both necessary. The conundrum of telecommunications is that it has contributed more than any other single sector to overall productivity gains, but in the process many of the telecommunications jobs of the past have become unnecessary. At the same time many new jobs, particularly in wireless and Internet companies, have been created.

The challenge for this Committee is how to foster both continued productivity gains and job growth in our whole economy by means of establishing a particular legal regime for the communications sector. Would we have more or less overall productivity gains if we had an unregulated communications monopoly, a rate-regulated communications monopoly, a set of competing firms that shared certain essential facilities, a contribution of public funds to make up for market failures, or a way to capture such externalities as network effects? All these questions must be asked anew very often and we can expect that answers will evolve over time. I honor and thank this

Committee for engaging in this process of continued reassessment of the right answers to these questions, and indeed continued efforts to determine the right questions.

Technology creates potential; in a capitalist society economics is the science by which we describe how the potential of technology is translated into the actuality of the marketplace. But the culture of a country ultimately determines the shape and function of the marketplace's outcomes. That culture is composed of many things, but one key element is the rule of law.

Today we look back at the era of regulated monopoly in telecommunications and conclude that its advantages in terms of efficiency were ultimately outweighed by the cost of regulation and the discouragement of productivity enhancing innovation that was an inevitable corollary of monopoly. For the better part of 30 years the United States, acting often through this committee, has led the world in replacing the paradigm of regulated monopoly with a new framework of competition coupled with certain key elements of legal obligation placed on the owners of bottlenecks or essential facilities. This new framework is the grand outline of the 1996 Telecommunications Act and the 1997 World Trade Organization telecommunications treaty. It is the outline of the rules of law being put in place in more than 90 countries around the world. It is the outline of the rule of law that is helping such huge new economies as China and India take the place that the size and work ethic of their populations should earn them on the global stage, barring such dreadful catastrophes as war or the reversion to communism.

We should take a look at some of the outcomes of this new paradigm here in the United States. The telecommunications industry since 1996 has experienced

unprecedented growth and American consumers and businesses today enjoy the widest array of services at the lowest prices in American history. The industry itself – like its related computer hardware and software industries – consists both of firms that have done better and those that have done worse over the last 8 years. In our system, we do not regard an economic policy as a failure if one or more firms fail in fair marketplace competition. We do regard that policy as a failure if it does not contribute to productivity gains and therefore to a high and rising standard of living for all Americans.

While industry gross revenues are not the only metric by which we should judge the success of a policy, they are relevant. Industry revenues, both overall and by segment (with one exception) have increased tremendously since passage of the 1996 Act. By my current calculations, based on data drawn from several different sources, total sector revenues grew at a compound annual rate of almost 7 percent between 1997 and 2002, increasing from $266 billion to $371 billion. That growth rate substantially exceeds the growth rate of the overall economy for those years. And that revenue growth has come in conjunction with falling prices.

Moreover, these impressive gains are dwarfed by the performance of particularly innovative service segments. Demand for wireless services simply exploded – growing from $30 billion in 1997 to $78 billion in 2002, an annual average compounded rate of more than 20 percent. Mobile services are so cheap on a price per minute basis, because of competition and innovation, that cellular customers here purchase nearly twice as many minutes per month as they do in Europe. The result of the growth of wireless voice is that revenues in this segment will exceed revenues from local wire-based voice in the

next couple of years, even though local voice revenues have gone up about 5 % on a compound annual basis since 1996.

Another tremendous growth story is that Internet access revenues increased annually by more than 25 percent, from a modest $7 billion in 1997 to $24 billion in 2002. E-commerce firms have greatly increased in market capitalization as a result of greater Internet access.

You might also be interested in knowing that contrary to many media reports, returns on dot.com investment have been positive since 1997, averaging about 10% compounded annually, according to a study by Professor Tom Eisenmann of the Harvard Business School. More generally, telecommunications capital expenditure in 2005 will be higher than in 1997, although the trend now is downward unless and until new technologies are deployed. See page 23.

It follows that if revenues are up, then consumer spending by both business and residential consumers on telecommunications services during this period similarly grew strongly. Retail spending by business customers increased from $101 billion in 1997 to $141 billion in 2002 and consumer spending rose from $121 billion in 1997 to $172 billion in 2002. Yet, for almost all communications services the prices have gone steadily down.

In short, consumers have spent more because they have been offered lower prices for similar services and attractive prices for new services. Whole new markets have been created, especially in wireless and Internet markets.

An exception to this amazing story of economic expansion is the wireline long distance business. Revenues in that industry segment declined, in absolute terms, from $76 billion in 1997 to $55 billion in 2002.

Congress in 1995 was rightfully concerned about the potential for such a downturn in the long distance business. Prices have gone down because of technology innovations that lowered fundamental costs, the actions of the FCC to lower steadily the contribution to cost of the interstate access charge, and the proliferation of competition from both Bells on the fixed line side and the wireless firms offering wireless long distance. Prices have gone down so much that they have outstripped the willingness of consumers to pay more for long distance – elasticity effects did not make up for the price drop and so total revenues are down. The result is that firms depending on long distance revenue have found that it is increasingly difficult to compete in telecommunications. By contrast, those depending chiefly on local voice or cable revenues have had their own challenges, but faced them with a more reliable revenue stream at their disposal.

The Members of this Committee in particular were keenly aware that the traditional long distance carriers like AT&T and MCI would be hard-pressed to offset their losses in toll revenues with revenues from local voice markets. Those carriers, even armed with the market-opening tools Congress provided in the 1996 Act, faced formidable barriers to entering local Bell markets. Generally they have been unable to obtain new revenues in any new market fast enough to overcome the loss of revenues in long distance. This was one of the possible outcomes of the 1996 Act.

I want to step around debate about the troubling role of the extraordinarily prolonged judicial review of the 1996 Act in producing this outcome. Although the judiciary collectively has not acted with clarity or alacrity, competition's benefits have been obtained to a large, if imperfect, degree. Under a competition paradigm the key goals are and ought to be productivity gains, as well as lower prices. These goals necessarily can be achieved only by reducing regulated costs and by promoting innovation. By and large the communications sector has never seen so much in the way of innovation, productivity gains, lower prices and higher revenue as it has seen in the 8 years since the 1996 Act was passed. That is somewhat a function of the wisdom of the law, somewhat a function of technological change and somewhat a function of the effective strategies of various firms.

What then comes next?

As matters now sit, the American telecommunications industry will continue to experience steady growth in wireless, Internet, and traditional voice services, both local and long distance. For the voice business, the pace of growth will not resemble what we have witnessed in the years since passage of the 1996 Act. But the one industry segment that has the potential to re-ignite the engine of economic growth that drove the nation's economy in the late 1990's is broadband services.

This has been and ought to continue to be a subject of Committee attention for three principal reasons. First, measured by the scale of broadband (meaning the percentage of households subscribing), the scope of broadband (meaning the range of bandwidth speeds and proffered services), and the price of broadband, the United States

does worse than important rival nations. Second, broadband has the potential to generate very large new productivity gains, and to create many hundreds of thousands, and ultimately millions, of new jobs here in the United States. Third, we are on the verge of a new technological breakthrough that can be brought more quickly and efficiently into the marketplace if the government takes timely and effective and comparatively minimal action: I refer to wireless broadband and to the wisdom of letting it flourish at frequencies on the spectrum chart that will in any event be vacated soon.

If this Committee now can lay out a path for virtually immediate use of a modest amount of spectrum on the frequency chart below one gigahertz, then wireless broadband will be a much cheaper and easier and more valuable service for accessing the Internet, making a voice call, sending and receiving video, providing health care, education, job training, and universal service. It can be not just a universal service, but a universal solvent that can dissolve many of the roadblocks to innovation and deregulation in communications markets. With an effective spectrum allocation for wireless broadband at the frequencies that permit signals to reach inside buildings, we will in just one or two years be able to commence a step by step process that will achieve fairly soon the complete deregulation of retail prices in communications, among many other long-desired goals of the 96 Act.

Let's start with how the United States lags woefully behind many other countries, especially South Korea, in broadband penetration. See pages 20-22 for charts. Our broadband is Little Broadband, about one megabit per second, whereas in Korea and Japan very large percentages of the population can buy Big Broadband, meaning up to 8 megabits per second. Their services are priced lower: their users get up to 10 times the

bandwidth for the buck. Their household penetration is much higher: South Korea's penetration is about three times higher than America's, measured by percentages of households.

The rapid penetration of broadband in South Korea and other Asian markets is not a coincidence. Particularly in Japan and South Korea, the national governments played key roles in promoting the build-out of a truly broadband network. In Korea, for example, the government provided $1.5 billion in subsidies to finance the build-out of a broadband network backbone and an additional $1 billion in low-interest loans to operators for the construction of last-mile links.

In addition, both South Korea and Japan implemented policies that were designed to foster vibrant competition between providers of broadband services. Japan, for example, required incumbent carriers to make available access to their dark-fiber facilities as well as copper loops. Japan also adopted regulatory directives to prevent the dominant incumbent provider of local voice service from deterring the entry of new providers.

South Korea's approximately 70 percent penetration is the product of a number of different factors, including favorable demographics and strong consumer interest. But, it would be mistaken to understate the importance of government policy in making Korea by far the largest user of broadband services in the world. The South Korean government, for instance, sponsored programs to encourage the purchase of personal computers, including low-interest loans, and to encourage the schools and government to

obtain broadband communications links. It closely regulated Korea Telecom in various respects.

The United States, by contrast, has fallen well behind these other countries. Indeed, today, the United States is not ranked among the top ten countries in the world in terms of broadband penetration. Moreover, our version of broadband is little, versus the Big Broadband that can be found in Korea and Japan and elsewhere in Asia, where speed can be ten to even 50 times faster.

If Big Broadband in America reached 100% of all households at affordable prices, we would see the growth of many new markets. Other countries show us that video games, for instance, produce new revenues for communications carriers. This may not be of much appeal to fumble-fingered formerly youthful people like me, but it's a new market that creates new jobs and new revenue. And it isn't growing in this country as fast as in other countries because our infrastructure is not as well-developed. Moreover, in other countries, where the speed of access tends to be higher, video can be more readily sent over the Internet. Not just entertainment, but education and health care are best delivered in part through video. These social services can be supplied effectively by broadband. We have every reason to worry about burgeoning costs of health care and our shortfall in providing education: broadband is an essential part of obtaining the productivity gains in both health care and education that will help up address our concerns.

However, the good news is that the United States has an opportunity to regain worldwide leadership in telecommunications by taking advantage of a new technology

that is on the verge of deployment. Wireless broadband has the potential to energize our broadband services segment.

When Congress in the early 1990's authorized the FCC to auction radio spectrum, it gave technologists and entrepreneurs the tools needed to use not just Bell, but also Marconi to build an information economy. In the decade since, wireless has emerged as the most important means of voice communications and the Internet has emerged as the most important new medium of pictures and text.

We are now entering the decade of wireless broadband, the era in which airwaves can be used to carry Internet transmissions much more cheaply, with easier access, than mere fixed wire networks can do.

One species of wireless broadband is called Wi-Fi. Many people are familiar with a radio technology called Wi-Fi. If you have a laptop that is Wi-Fi enabled, you know that it connects over the air to a router, which in turn connects to a cable modem or a DSL box. You can walk around the house with the laptop and stay always on the Internet.

Wi-Fi can be found not only in homes but in airports, coffee shops and many other places. These hot spots are places where you can use the laptop today to log on to the Internet using Wi-Fi. Just as the Internet has gone in about a decade from 6 million to about 600 million users globally, in the next 10 years hotspots will proliferate from about 7 million to about 700 million locations. The reach of such hot spots is about 300-1000 feet from an existing wire line Internet connection.

However, in order to do without DSL or cable connections, many cities are contracting with service integrators to deploy antennas that create a mesh of Wi-Fi connectivity over very large radii. These mesh networks are based on principles similar to those on which the Internet is based. Any laptop or other device with Wi-Fi capability can connect to the network of antennas and stay connected even while the owner carries the laptop from place to place. The networks consist of routers with antennas on street lamp poles and telephone poles. Cities with such networks today include Half Moon Bay, San Mateo and Cerritos in California, Baton Rouge and Lafayette in Louisiana, and North Miami Beach, Florida. These are representative illustrations. A large scale example is a recent request for proposals issued by the City of New York. See http://www.nyc.gov/html/miscs/rfp_mobile_wireless_download.shtml.

Another technology on the near-term horizon is called Wi-Max. It also uses open standards negotiated by engineers and private sector firms in the well-recognized IEEE process. Wi-Max also promises to bring inexpensive, high-speed Internet connections to the American home and workplace. Wi-Max is a label used to describe the following: a communications chip in a laptop (or really any other appliance) that sends a signal to an antenna at least several miles away.

Wi-Fi is a synonym for a suite of "802.11" protocols developed by the IEEE for use in unlicensed bands worldwide. Wi-Fi radio technologies are in use today on unlicensed spectrum in the 2.4 GHz and 5.7 GHz bands. Wi-Max is a wireless broadband radio technology specified by the IEEE in its 802.16a protocol. As of now, it also uses unlicensed frequencies fairly high in the spectrum chart. Both are open technology standards that can be used by any wireless broadband provider. Both have been endorsed

by a wide variety of companies. Most interestingly, both these, and other related technologies, can be designed for use on various frequencies, including the far more desirable lower frequencies where radio waves are much longer and more useful for communications.

In addition there are still other flavors of wireless broadband that use related technologies and alternative standards. In general, the technology world assures us that wireless broadband can provide a data rate that will over a short period of time run up to the range of Big Broadband (10 Mbps or higher), and provide a cost-effective alternative to fixed line broadband such as DSL or cable modem, if the government takes the right steps to welcome wireless broadband into the competitive arena. Indeed, the cost for the wireless mesh network might be as low as one tenth – or even lower – than the cost of building new fiber to people's houses. With lower cost, we will at last have an effective efficient way to bring broadband to rural America.

Wireless broadband can also help keep the United States at the forefront of the technology revolution, creating new jobs and giving a much-needed stimulus to our economy.

To be clear, what I'm talking about is not the so-called third generation of cellular, also known as 3g. That term describes advances in cellular phones to carry data along with voice calls. The acronyms for 3g are: EVDO, UMTS, WCDMA, and EDGE. These technologies enable handheld devices to send and receive data to mobile users in amounts ranging up to several hundreds of kbps. This service is sufficient for

applications such as short mp3 downloads, limited Internet browsing, ring tones, email, low-resolution pictures, and video clips.

These 3g technologies are the evolution path for the technologies used today by the mobile carriers and can be installed as an add-on to their network infrastructure. They are important and are being deployed now in the United States and worldwide.

But for higher speed, affordable broadband – and certainly Big Broadband at a rate of 10 megabits or more per second – a user must look to a wire-based connection or the new wireless broadband technologies.

Wireless broadband is not a new technology, by any means. The industry has been around for 15 years. Indeed, the nation's leading experts on high speed wireless have been working on wireless broadband, learning lessons from years of trials, and their relentless efforts are now coming to fruition with the deployment of techniques such as Orthogonal Frequency Division Modulation, beam forming for antenna reception, and, of course, IP as the way to deliver the bits. What is now possible is ubiquitous, metropolitan area wireless broadband coverage.

Wireless broadband can eliminate the need for per node wiring. The technology enables a self-organizing system, just like today's Internet, allowing nodes to be added or subtracted as needed, a feature that remedies defaults in wireline backhaul that may arise or interference that may be encountered. Advances in software claim to provide the reliability, security, and redundancy/diversity that are the foundation of public safety and other government communications systems, which are even more critical in this era of heightened national and local security.

Implementing this technology does not require digging up the streets. It does not require installing a vast infrastructure. There are no zoning ordinance encroachments. It requires no new towers. The entire infrastructure does not have to be completed before it can commence. Significantly, it can be modified to meet changes in requirements very cheaply.

But there are potential barriers that could delay or frustrate the entry of wireless broadband providers. One potential barrier is spectrum access. Wireless broadband today uses "unlicensed" spectrum. As the name suggests, unlicensed spectrum users do not need a license from the FCC to transmit over the airwaves. This is in contrast to licensed users of the spectrum like Verizon Wireless, Cingular; or T-Mobile; these companies hold FCC licenses that give them the exclusive right to use a particular set of electromagnetic frequencies in a particular geographic area. Unlicensed operators, on the other hand, do not have exclusive use of the spectrum they use. They must also use equipment that complies with various technical requirements that minimize the amount of signal interference they cause to other spectrum users.

The FCC has set aside some spectrum for unlicensed devices. These devices include cordless telephones, garage door openers, and wireless broadband. But there two problems with relegating wireless broadband to the unlicensed spectrum at and above 2 GGHz.

First, many of the current unlicensed spectrum bands are already too congested with other devices – there are a lot of cordless telephones and garage door openers out there.

Second, the current unlicensed spectrum allocations are at regrettably high frequencies. Waves at lower frequencies are longer in length. Longer length waves hold their energy over longer distances and also bounce around physical objects such as buildings. As a result, longer wave lengths are ideal for broadcast television – they can travel miles from a tower and find their way inside living rooms. These are the ideal wave lengths for wireless broadband, just as they were ideal 60 years ago for the original allocation to broadcast television. Another similarity is that broadcast television waves carry tremendous amounts of information (for example, digital TV waves will carry up 20 megabits per second.) Correspondingly, wireless broadband can deliver very high bit rates at lower cost and greater equality if it also uses the lower frequencies of broadcast television.

Of course, it is possible to relegate wireless broadband to higher frequencies. Those frequencies are useful for garage door openers – after all we do not want garage door opener to send signals over long distances, since the user wants to be opening his or her own garage and not the neighbor's. But to treat wireless broadband the same way as garage door openers would be to lower the value and raise the cost of this new technology.

Of course any frequency can be used for any kind of wireless business, if you ignore the cost. For example, the shortcoming of higher frequencies for PCS has led cellular firms to build more base stations to retransmit signals. But that has cost more money, hurt industry return on capital, and embedded additional costs for consumers for decades.

Engineers today for the most part agree that the cost of wireless broadband internet access in the 700 MHz or 800 MHz bands is likely to be about 50% lower than if the technology is consigned to the unlicensed spectrum bands at or above around 2 GHz. See chart on page 24. The consequence of higher costs is higher prices for the consumer. If we want truly high speed Big Broadband internet access for all Americans we need to help lower costs for the technologies being invented. This is a particularly important goal for rural America, where costs are inevitably going to be higher due to reduced density of customers, and for emerging markets, where higher costs take the prices of service beyond the reach of populations with much lower national incomes per capita than in the developed world.

Quite literally, the lower the frequencies assigned for wireless broadband, the more millions of people in rural America will be able to afford Big Broadband Internet access, the more hundreds of millions of people in the world will be able to afford joining the Internet community.

Fortunately, in the United States new spectrum will become available in the 700 MHz band. This is ideal spectrum for wireless broadband. It has excellent propagation characteristics that will allow the build out of an inexpensive and ubiquitous wireless broadband network.

This spectrum is currently being used by TV stations operating on UHF Channels. The broadcast industry is converting from analog technology to digital technology, and during this conversion process every TV station in the country has been given two TV channels – one analog and one digital.

However, under the law, these stations must turn in their analog channel. This will clear UHF TV Channels 52-69 for other uses, including wireless telecommunications services. That spectrum covers from 698 to 806 MHz in the spectrum band, a total of 108 MHz. That spectrum should be the fit and proper home of wireless broadband.

So once again the tough job for Congress and the FCC is to push the recalcitrant and incentivize the willing participants in the private sector to promote innovation, productivity gains, and new job creation. The current chapter in this ongoing story of facilitating the creative innovation of capitalism will be written if Congress and the FCC can find ways to let businesses use the best spectrum physics can find for us not for analog UHF TV but rather for wireless broadband. This transformation of the use of that spectrum means for the economy literally hundreds of billions of dollars of extra growth and hundreds of thousands, if not ultimately millions, of new jobs – provided it were done quickly.

The first step I suggest is for Congress to urge the FCC to read correctly the meaning of legislation passed by Congress in 1997. That legislation requires broadcasters to turn in their analog channels at the end of 2006, or when 85% of the TV audience is capable of receiving a digital television signal – whichever occurs later. As mentioned recently by the FCC staff, all households that get their TV through cable or satellite services should be counted in order to determine whether we have reached 85% penetration of digital television.

This certainly makes sense: anyone with cable or satellite is obviously no longer dependent on over the air broadcast for the television consumption, and so those are the

households that should be counted to determine whether we have crossed the 85% threshold for the relinquishment of the UHF analog spectrum. Moreover, cable and satellite can either deliver a HDTV broadcast signal to a digital TV set in the consumer's home, or permit the consumer to convert such a signal through a set top box into an analog TV set. By simply telling the FCC to count wisely the 85%, Congress can make available the spectrum most useful for wireless broadband.

Next, Congress should take steps to allocate part of the 700 MHz spectrum for unlicensed use by broadband wireless services. In 1997, Congress directed the FCC to allocate 24 MHz of the 700 MHz band for public safety communications, and to allocate 36 MHz of the band for commercial use to be assigned through spectrum auctions. In order to facilitate wireless broadband in this spectrum, Congress could amend this 1997 law to allocate 30 MHz of this commercial spectrum for unlicensed services that would not be subject to an auction. In this way, Congress would have provided for wireless broadband public safety, licensed spectrum for wireless broadband, and unlicensed spectrum for wireless broadband: this perfectly wise trio of actions can produce millions of new jobs and billions of dollars of economic growth.

Congress should also instruct the FCC to resolve quickly a notice of inquiry it opened in December 2003. In that NOI the FCC asked about the feasibility of allowing unlicensed devices to operate in the TV broadcast spectrum at locations and at times when this spectrum is not being used. The FCC should quickly adopt a rule embodying that proposal. Then wireless broadband services could use UHF TV spectrum provided they do not cause interference to full-service television stations. This would be especially important in rural areas where there tend to be far fewer television stations,

and thus vacant UHF TV spectrum. Furthermore the wireless broadband technologies that are deployed in rural America will prove to be ideal in developing markets where there also are relatively few broadcast television stations and much unused spectrum in the 700 MHz range.

The Congress should ask the FCC to take still other steps to facilitate the growth of wireless broadband. Wireless broadband requires the deployment of antennas in small boxes, small enough that they can be attached to a streetlamp pole or a utility pole. Due to the fundamental physical characteristics of wireless signal propagation, delivering the higher speeds enabled by wireless broadband requires a higher density of smaller cells as compared with traditional cellular networks. Therefore, wireless broadband needs access to these platforms so that its service is available ubiquitously. The FCC can and should ensure that no one exercise control over these platforms so as to prevent the deployment of wireless broadband services.

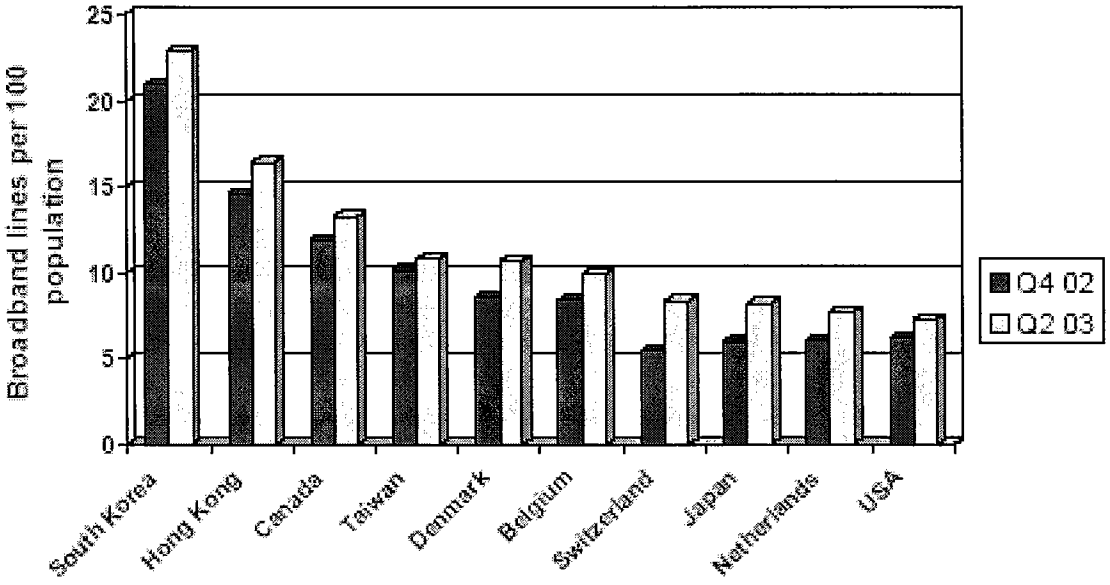
We are on the verge of being able to unleash a revolutionary broadband technology. This Congress and the FCC have a chance to take certain steps that will deliver tremendous cost savings to the emerging wireless broadband technology firms. We can save billions of dollars in cost, and thereby make wireless broadband available more efficiently to millions more people, without a significant expenditure of public funds on a subsidy program. We need only to allocate the optimal spectrum to the future of communication instead of to its past, and to remove other impediments to the rolling out over the airwaves of this new way to connect everyone to each other and to all the knowledge in the world.

KOREA IS STILL WORLD LEADER IN BROADBAND PENETRATION WITH OVER 75% OF HOUSEHOLDS SERVED

2003 broadband penetration

Broadband lines per 100 population

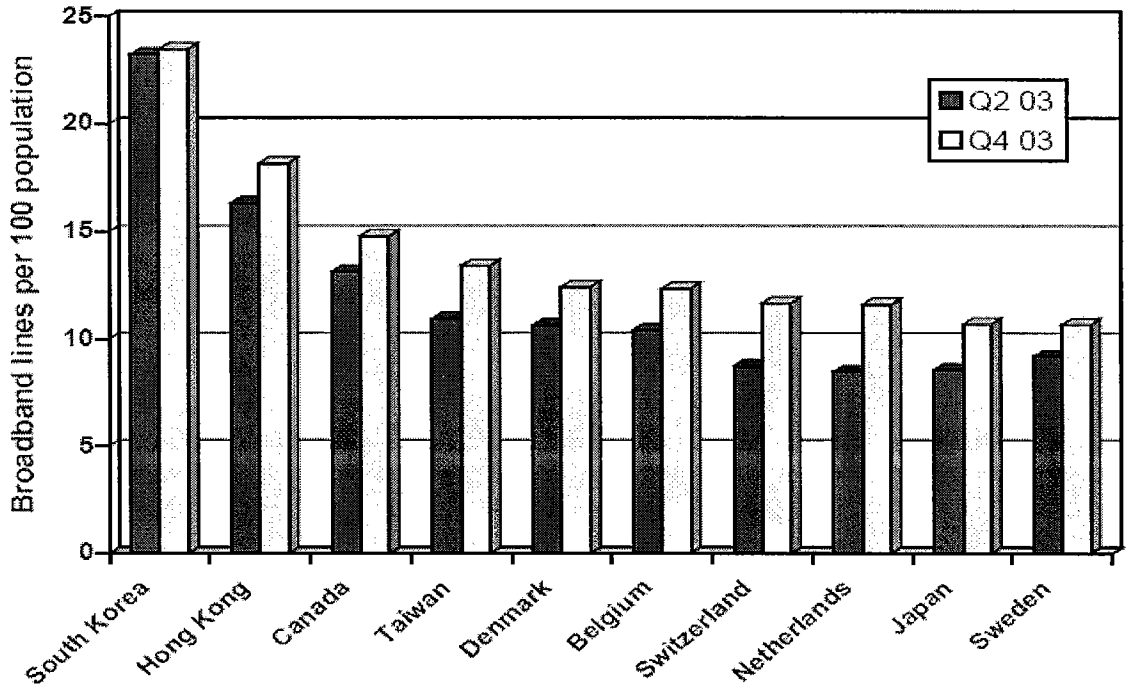
Figure 6 Top Ten broadband countries by penetration



WHILE THE U.S. IS NO LONGER IN THE TOP TEN

2003 broadband penetration
Broadband lines per 100 population

Figure 6 'Top ten' broadband countries by penetration

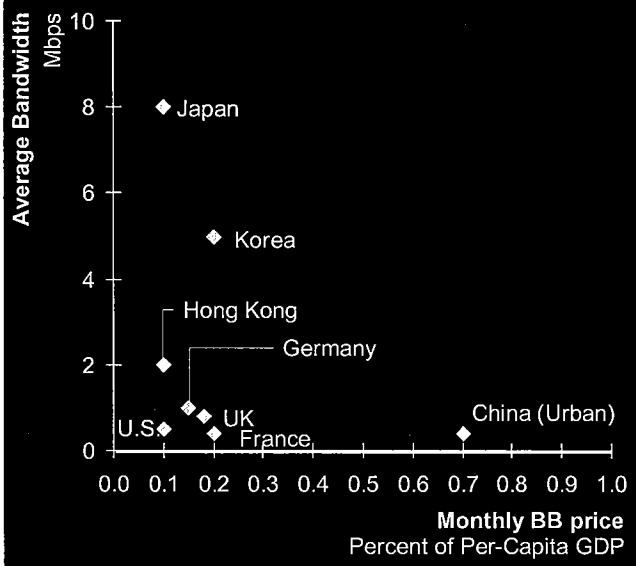


ASIAN SUBSCRIBERS GET MORE BANG FOR THE BUCK

2003

PRELIMINARY

Value for customers in ADSL service



Penetration by connection type

Percent of all households

	U.S.*1	Sweden*2	Japan*3	Korea*4
Narrowband (dial-up)	34	52	40	4
Middleband (up to 2Mbps)	24	9	5	65
Broadband (More than 2Mbps)	<1	6	19	8

Official "broadband" penetration figures can be misleading

*1 Estimate from the number of overall DSL subscribers and speed/price offerings

*2 Broadband users are comprised of only B2's 10Mbps service subscribers

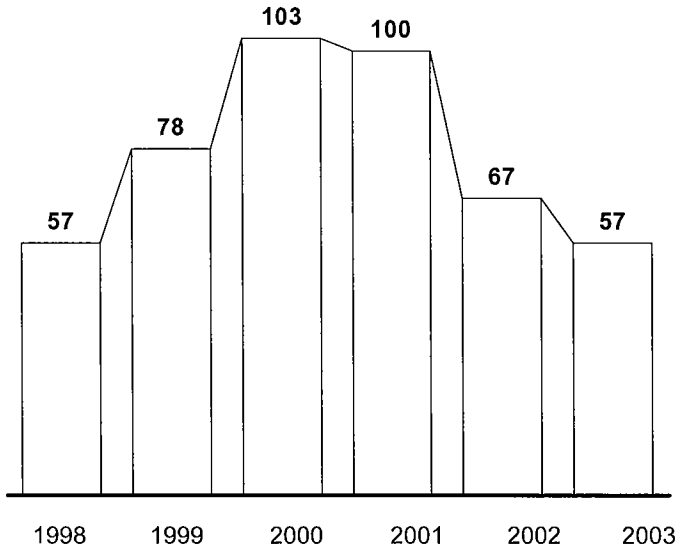
*3 Based on the Internet user survey by NTT-X, Broadband penetration is high in Japan owing to negligible price difference between middleband and broadband services

*4 Broadband users are comprised of only those of KT and Hanaro Telecom. More than 25% price premium exists for broadband service

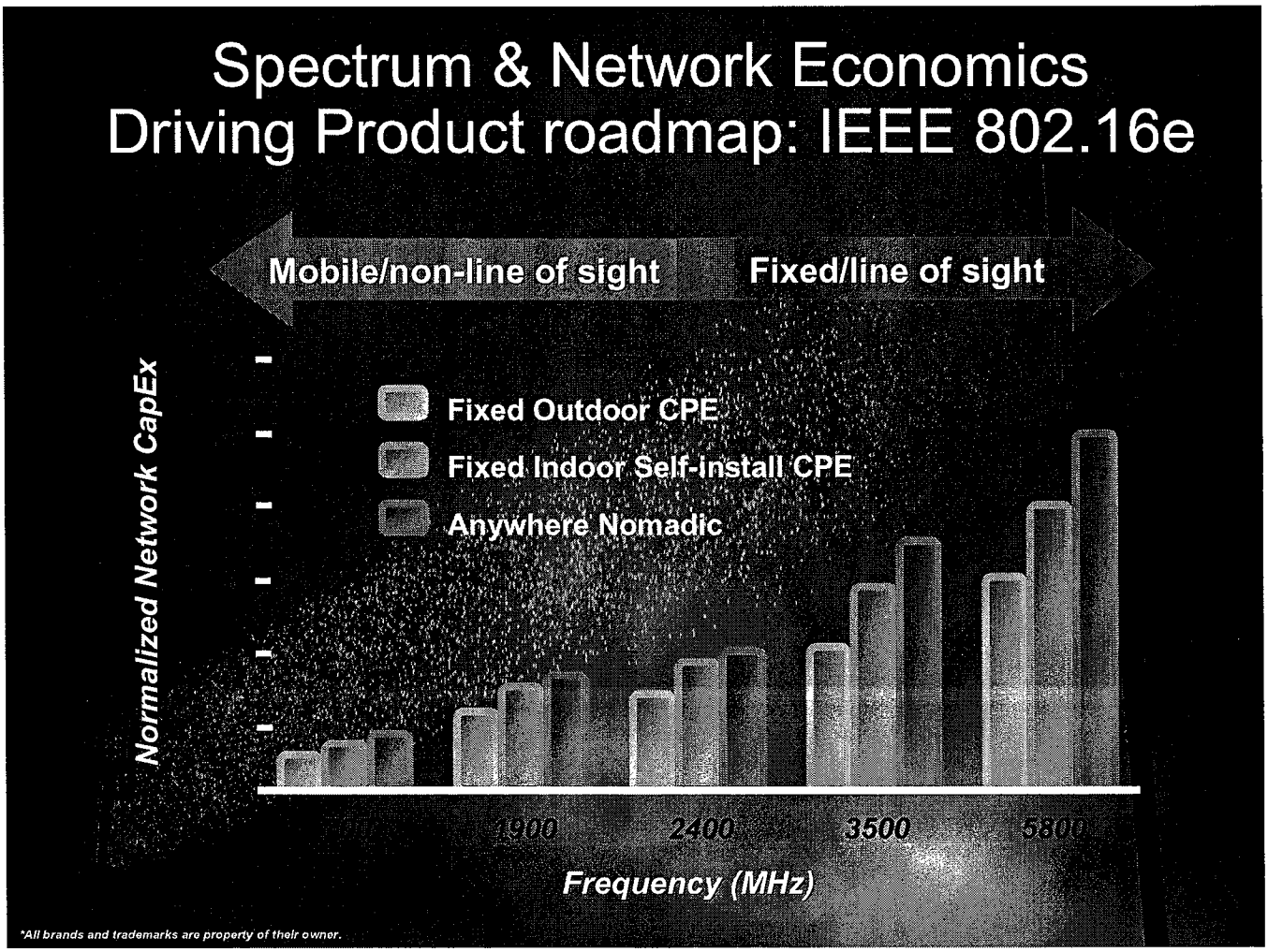
Source: Pyramid Research; Forrester; NTT-X; MIC; KT; Hanaro Telecom; Broadband Dashboard, 2003 Texas Instruments report; KT, Acca Networks; NTT

CAPEX HAS FALLEN BACK TO HISTORIC LEVELS

$ Billions



Source: Goldman Sachs, JP Morgan, Company reports


Spectrum & Network Economics
Driving Product roadmap: IEEE 802.16e
Mobile/non-line of sight
Fixed/line of sight
Normalized Network CapEx
Fixed Outdoor CPE
Fixed Indoor Self-install CPE
Anywhere Nomadic
1900
2400
3500
5800
Frequency (MHz)
*All brands and trademarks are property of their owner.

Reed E. Hundt

Reed E. Hundt is a senior advisor on information industries to McKinsey & Company, a worldwide management consulting firm. His work with McKinsey has focused on helping senior management and boards address a wide range of strategic and other leadership challenges.

Mr. Hundt serves on the board of directors of Intel, Pronto Networks, Tropos Networks, Polyserve, Megisto, and Entrisphere. He is a special advisor to Blackstone Group, a New York-based private equity firm. He serves as a member of the advisory committee at the Yale School of Management,

Mr. Hundt served four years as Chairman of the Federal Communications Commission (FCC), from 1993 to 1997.

Mr. Hundt is the author of, "You Say You Want A Revolution: A Story of Information Age Politics." (Yale University Press, 2000). He is Co-Chairman of The Forum on Communications and Society at The Aspen Institute.

Mr. Hundt is a *magna cum laude* graduate of Yale College, earning a Bachelor of Arts with Exceptional Distinction in History (1969). He is also a graduate of Yale Law School (1974) where he was a member of the executive board of the Yale Law Journal. He clerked for the late Chief Judge Harrison L. Winter of the U.S. Court of Appeals for the Fourth Circuit, and is a member of the District of Columbia, Maryland, and California bars. Prior to his position as Chairman of the FCC, Mr. Hundt was a partner in the Washington, DC office of Latham & Watkins, a national and international law firm.

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