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FREEING OUR UNUSED SPECTRUM

Toward a 21st-Century Telecom Policy

TECHNOLOGY CEO COUNCIL

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EXECUTIVE SUMMARY

Every day more than 200 million people use it to stay in touch, do business, or catch up with friends and family. Americans send more than 7 billion written messages over it each month. It supports more than 3.6 million jobs and a rapidly growing share of America's gross domestic product. Soldiers rely on it to do their jobs more precisely, at lower risk to themselves and innocent civilians. Police and firefighters use it to save lives. It helps big businesses become more productive and enables small businesses to compete more effectively against larger players.

There are few more important natural resources than our radio spectrum. An increasingly essential platform for how we work, live, play and learn, radio spectrum may be the most critical infrastructure element of 21st-century economies.

It is also one of the scarcest, thanks in large measure to artificial constraints imposed by public policy. It does not have to be this way. Just as crop rotation and other practices of modern agriculture dramatically improved humans' capacity to feed themselves … as modern air-traffic-control systems made possible 20th-century air travel … and as advancing technologies enable us to find and extract oil and natural gas more efficiently, thus extending the global supply of energy … so too do we have the technology and techniques to significantly expand the use and usability of spectrum. What is needed is permission. A more enlightened and progressive policy approach can dramatically expand America's (and the world's) supply of precious radio spectrum — despite the fact that it is, like any other natural resource, finite.

Indeed, the irony is that our systems of regulating spectrum — based on a recognition of its scarcity — are now, in fact, rendering it much less abundant. This is a classic case of the law of unintended consequences. *Today's spectrum scarcity is very much an artificial product of archaic public policies.* While both technology and the public's need for wireless telecommunications have leapt ahead exponentially over the past two decades, outdated rules and regulations too often don't permit — much less encourage — more productive use and management of this critical resource. *On average, only slightly more than 5 percent of the radio spectrum is used nationally at any given time.*[1]

How we address and manage spectrum scarcity is one of the most important public policy challenges our country faces as we move deeper into the 21st century. Efficient spectrum policy can drive technological innovation and productivity and, thus, our entire economy.[2] Indeed, if our nation manages its spectrum resources well, it will have a competitive advantage in the global market that will benefit all our citizens,[3] concurrently giving the public safety community the resources it needs to take advantage of advanced communications technologies.

The good news is that innovators are constantly creating devices that are capable of using spectrum more robustly and more efficiently. "Cognitive radios," for example, can tell where they are and modify their transmissions to limit interference and to use spectrum that would otherwise lie fallow. By contrast, many older technologies waste valuable spectrum. Policies that encourage spectrum users to retire antiquated systems, and that encourage technological innovation, can greatly increase spectrum efficiency.

As a country we must move quickly to change our approach to the regulation of spectrum and to the use of spectrum by both government and the private sector. We have seen positive proposals recently from the Federal Communications Commission (FCC) Spectrum Task Force Report and President's Spectrum Initiative, but much more is needed. *We need to encourage the use of more efficient technologies, allow greater flexibility in the use and transfer of spectrum, inject free market discipline into spectrum policy, recognize the value of both licensed and unli-*

RECOMMENDATIONS FROM THE TECHNOLOGY CEO COUNCIL

Recommendation 1: The U.S. Congress should instruct both the National Telecommunications and Information Administration (NTIA) and the FCC to conduct a band-by-band analysis of the usage of the spectrum they regulate and to identify any bands that are not being used efficiently. NTIA further should prepare a report on the amount, value and opportunity cost of the spectrum being used by the federal government.

Recommendation 2: For any government band that is not being used efficiently, NTIA should develop mechanisms to encourage more efficient use or consider transferring that spectrum to commercial use or sharing that spectrum with commercial users.

Recommendation 3: For any commercial band that is not being used efficiently, the FCC should consider whether market-based mechanisms — such as two-sided auctions and auction vouchers — could be adopted to encourage more efficient use of the band or the use of advanced technology, or whether reallocation of the band might be necessary.

Recommendation 4: Given the importance to our economy of licensed services, the FCC should reduce service and technological restrictions on wireless licensees, but with clearly defined rights, to promote the most robust possible use of such licenses. The FCC also should consider using combinatorial (package bidding) auctions to facilitate the optimal aggregation or disaggregation of spectrum rights, including the possible creation of underlay and overlay rights in newly cleared spectrum.

Recommendation 5: Congress should give the FCC explicit authority to use two-sided auctions and auction vouchers.

Recommendation 6: Given the importance to our economy of unlicensed services, the FCC should make more unlicensed spectrum available. For example, the FCC should promptly complete its TV white spaces proceeding (docket 04-186) and permit other uses of the spectrum, on a noninterfering basis, in areas where it is not used by television stations.

Recommendation 7: Congress should mandate that the FCC and NTIA contribute 10 MHz of commercial and 10 MHz of government spectrum respectively to be used for experiments on spectrum-sharing solutions — including priority access — between and among industry and local, state and federal government uses.

Recommendation 8: The FCC should review bands where priority access may provide public safety officials with access to spectrum to meet non-mission-critical requirements.

Recommendation 9: Congress should establish an ensured, multiyear funding mechanism to assist public safety organizations and other government agencies in deploying advanced technologies that use spectrum more efficiently and to make their networks interoperable.

Recommendation 10: The United States should urge its trading partners and international organizations to adopt spectrum policies that endorse technological neutrality, flexibility and market-based principles.

censed wireless services, and insist on more collaboration between government and industry. We also should encourage the adoption of similar spectrum policies by the international community.

Policymakers must make more than piecemeal reforms. They must aggressively adopt a modern spectrum policy that catalyzes increased societal benefits and marketplace efficiencies for consumers and businesses. The Bush Administration is working on just such an initiative, and it must act boldly.[4] As Congress rewrites the telecommunications laws, it should insist upon flexible and efficient management by the spectrum regulators — the FCC and NTIA. And as the FCC implements the laws and continually reviews existing regulations, it must make a priority of maximizing spectrum capacity, thereby addressing the needs of a growing population of Americans whose productivity is inextricably tied to the ubiquitous availability of wireless services. In the 21st century, Congress and expert agencies have a unique opportunity to lead the world in establishing a transformative spectrum policy that continually increases efficiency and embraces future wireless technologies that add economic value and improve our quality of life. Without change, our nation's valuable spectrum resource will be tragically underutilized.

Today's spectrum scarcity is very much an artificial product of archaic public policies.

This paper identifies several emerging wireless technologies that will be central to smart uses of spectrum and efficient management, and recommends concrete, market-based policy initiatives that will allow our nation to maximize its wireless potential.

"Game-changing," Advanced Wireless Technologies

Advanced technologies promise to create ubiquitous, inexpensive broadband wireless networks with the capacity to move high quantities of data, voice and video around the home, the neighborhood, the community and the nation. These networks can be accessible from homes, work, vehicles and just about everywhere else. They will permit the delivery of new services that can improve productivity, educate, enrich personal lives, strengthen public safety and deliver benefits to every sector of society. Such wireless broadband networks will provide access to remote areas that might not be served otherwise. With adequate spectrum intelligently managed, they will supply consumers with much higher data speeds than today's cable modems and/or DSL broadband, which will increase affordability, innovation and consumer choice.[5]

Fortunately, such advanced technologies are emerging. To realize the full potential of these technologies, however, telecommunications policy must encour-

age their use and permit the public to receive the benefits they can provide. Many such technologies are available today and can — under the right regulatory regime — enable much greater value from uses of our spectrum resources:

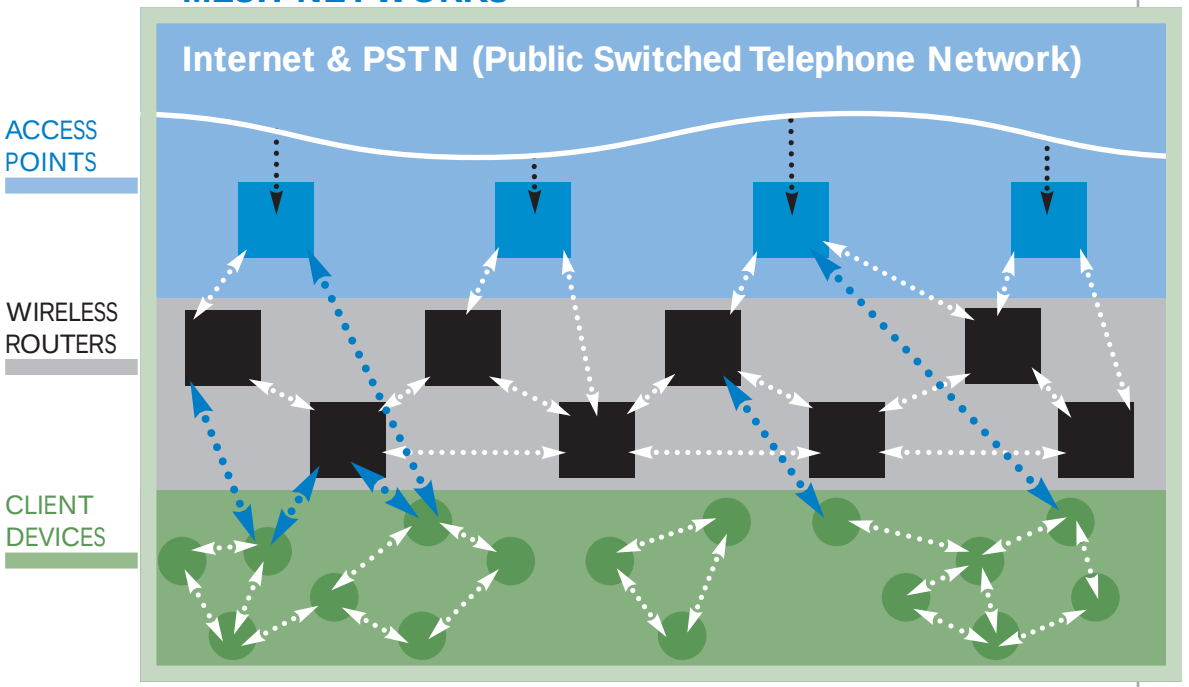
Cognitive Radios. Today cognitive radios can discern spectrum use at their location and modify their frequency and power to operate only in spectrum that is "vacant" at any given time. Because spectrum use varies by time and location, cognitive radios can use vacant spectrum only temporarily and do so without interference to others, maximizing the number of users and services accessing given frequencies. As development of cognitive radios continues and expands to include more frequency bands and sophisticated algorithms, it is expected that they will provide increasing levels of sharing between very different users and services.

Smart Antennas. Smart antennas improve transmission quality and reduce interference by automatically and continuously changing the direction of transmission and reception and matching signal strength to the needs of individual users. They can extend the range and capacity of wireless broadband devices by providing greater reuse of frequencies and more reliable communications by more precisely focusing the radio energy to serve more people at greater distances.

Ultra-Wideband (UWB) Devices. Over short distances UWB transmitters send billions of pulses across a very wide range of frequencies at low power to UWB receivers that decode the pulses into data by listening for a pulse sequence. This allows UWB devices to provide extraordinarily high data rates (enabling multimedia communications) at extremely low power — thus limiting the impact on other spectrum users.

Mesh Networks. Unlike traditional networks, in which many users connect to a central transmitter, mesh networks (below) employ each user device or radio access

MESH NETWORKS



point as a receiver, transmitter and forwarder of information designed to resiliently connect users, reducing the need for costly structured access infrastructure. Mesh networks also are well adapted to survive emergencies where centralized networks are not functional — if one device fails, the network automatically reroutes to another device within range. Mesh networks operating between wireless user devices do so at low power because each device needs only enough power to reach the device "next door," meaning they cause less interference. The capacity of mesh networks also increases with user density and the number of deployed access points. With advances in underlying enabling technologies, wireless mesh networks may be deployed effectively in rural and less populated areas in combination with backhaul wireline infrastructure, such as broadband over power lines (BPL). Mesh networks therefore have significant potential to cost effectively increase usable bandwidth and expand network access, especially as a low-cost alternative to centralized networks.

WiMax. WiFi technologies have proliferated across the nation, enabling high-speed connectivity throughout cities, homes, office buildings, coffee houses, hotels, airports and regional "hot spots." "WiMax," the next generation of these technologies, promises far faster data rates over significantly greater distances. Many analysts consider WiMax networks a leading "third-pipe" challenger to the emerging cable and wireline duopoly.

Radio Frequency Identification (RFID) Tags. Using silicon chips and antennas that can transmit data to a wireless receiver, RFID tags are being used to track products from warehouses to consumers' doorsteps. Unlike bar codes, which need to be scanned manually and read individually, RFID chips do not require line-of-sight reading, so information can be processed significantly faster. RFID is revolutionizing supply chain logistics, cargo security and quality control systems, saving billions of dollars in lost, stolen or wasted products. For example, "smart shelves" in stores will know when a carton of milk or a box of medicine has expired, alerting a store to restock in real time.

New Wireless Technologies Enable Advanced Applications, Changing the Ways We Work, Live, Play and Learn

New wireless technologies are enabling new applications that are transforming how people around the world work, live, play and learn. For example:

Business Applications

Advanced wireless technologies are expanding the broadband-fueled business revolution, enabling ever-more-mobile workforces, productivity-enhancing business process changes and on-the-go commerce. RFID tags are shaving time and costs off global supply chains, improving business understanding of their logistics and customer trends. Trucking and limousine companies are using global positioning systems and wireless communications technologies to optimize drivers' routes, maximize loads and minimize inefficiencies. For example, Boston Coach limo service has begun using a wireless network to track cars, combining the data with customer bookings to better manage its fleet. Since launching the system in the beginning of 2003, Boston Coach has squeezed 20 percent more rides out of its cars, adding $10 million to its $94 million annual sales.[6] Companies continue to improve their wireless e-commerce offerings, with billions of dollars exchanged annually.

Both satellite- and terrestrial-based wireless networks are absolutely essential to the successful work of first responders.

Public Safety

From the Oklahoma City bombing to the 9/11 attacks on New York and the Pentagon to the aftermath of Hurricane Katrina, we are reminded all too frequently about the importance of interoperable wireless communications systems to emergency response and recovery units. Both satellite- and terrestrial-based wireless networks are absolutely essential to the successful work of first responders. Bandwidth — used effectively — saves lives.

For example, the District of Columbia is testing a Wireless Accelerated Responder Network (WARN), which is the first citywide wireless broadband public safety network in the country. The WARN system allows inter-jurisdictional communication via wireless broadband to share voice and video information among first responders in real time, including helicopter and patrol car video, traffic camera integration to manage incidents, and weather radar.[7]

Advanced wireless technologies similarly are helping law enforcement agencies, many of which use laptop computers with wireless connections to quickly obtain vital information such as driving license records, vehicle registrations, mug shots and local crime scene data.[8]

Education

Wireless technologies are transforming learning, from the classroom to the campus to the countryside. Effective use of spectrum creates new ways of learning: rather than using computers only in one classroom, students can connect anywhere in the school, whenever and wherever needed. Teachers likewise can build interactive broadband content into their lesson plans when appropriate.

Texas A&M University–Kingsville, for example, has deployed a wireless network that connects not just the campus itself, but the 235-mile surrounding area. Area high school students can use the network to take advantage of the learning opportunities the university affords. In some cases they earn college credits prior to high school graduation.[9]

The University of New Orleans used wireless broadband connections to stay open after Hurricane Katrina destroyed much of the campus. The university used satellite dishes donated by the Indiana Higher Education Telecommunications System to establish an Internet connection and host an online campus. Weeks after the hurricane struck, classes opened as scheduled, with 6,700 of the college's 17,500 displaced students taking online classes from locations across the country.[10]

Students in rural South Dakota are using wireless broadband to take courses previously available only in large school districts. In towns like Emery, students use laptops and wireless Internet connections to access the statewide Digital Dakota Network and take courses such as advanced calculus. The network brings advanced subjects right to their schools. Similar networks bring qualified teachers to students in more than a dozen other states.[11]

Underserved Communities

Densely populated, higher-income areas often have greater broadband availability than underserved rural and urban areas. More than wired lines or DSL, wireless technologies promise to bridge these divides as a result of their more economical deployment architectures. In the largely duopolistic broadband environment, wireless technologies offer great potential to provide additional competition and deployment to underserved rural and urban areas.

By way of example, a 700-square-mile wireless "cloud" in rural eastern Oregon allows farmers to "watch CNN online, play a video game or turn [their] irrigation sprinklers on and off, all from the air-conditioned comfort of [their] truck."[12]

Sioux Valley Wireless offers wireless broadband service over a 35-mile radius at speeds comparable to those provided by cable and DSL providers serving urban areas. The company utilizes both licensed and unlicensed spectrum to reach customers who otherwise would have little chance of receiving broadband services.[13]

Nor are underserved communities in the United States the only ones to benefit from this technology. In Tunisia, a bus has been transformed into a mobile Internet café for rural areas without Internet access. Using satellite technology, the bus gives people access to news, games and employment opportunities throughout the country. Children line up for hours to use the computers for help with schoolwork and to learn about subjects that are not covered in their normal studies.[14]

Health Care

Wireless devices are increasingly important to the information technologies that are improving health care. As detailed in our 2005 report, *A Healthy System*, (http://www.techceocouncil.org/documents/A_Healthy_System_Final.pdf), wireless networks and remote care are helping to transform health care from quantity-based, treatment-centric interactions to a quality-focused, prevention-based system.

For example, electronic monitoring systems allow hospitals to track medications, patients and doctors within hospitals, with RFID tags replacing bar coding to match patients and drugs (ensuring the proper dosage for each patient and reducing errors). Outpatient physicians increasingly are using wireless devices during patient exams to retrieve prior records; access prescription databases and allergy data; and enter new observations and diagnoses in real time into patients' permanent, digital records. More advanced wireless monitoring will allow patients to receive frequent or constant observation and assessment beyond the confines of a hospital bed. Cingular, for example, is working together with PatientKeeper to make critical patient information available to doctors in real time anywhere.[15]

Such advancements are happening all around the world as well. The Uganda Health Information Network, for example, uses wireless devices and the local mobile phone network to expand access to health and medical information and provide time-sensitive diagnoses and treatment options to remote areas of East Africa.[16]

News and Entertainment

Just as news and entertainment content fueled both Internet and broadband adoption, news and entertainment offerings are driving wireless data growth and increasing the need for more bandwidth. Already, streaming video and music services are offered by most of the largest mobile phone companies with programming from the likes of CNN, CNBC, C-SPAN, the Discovery Channel and the Weather Channel.[17] Content is expanding daily for all kinds of devices, and entertainment is changing from one-way broadcasts to two-way interactive applications.[18] Home area networks are proving increasingly essential to connect various

consumer devices to the broadband gateways that reside elsewhere in the house. Rather than rewiring homes with fiber or Ethernet — expensive propositions impossible in many older homes — consumers can purchase inexpensive plug-and-play WiFi networks that handle all voice, video and data applications.

At short distances, UWB technology is starting to be used to connect a wide array of consumer electronics, including computers, printers, digital cameras, flat screen HDTVs and stereo systems, inside the home without wires. Because of its high bandwidth, UWB is well suited for applications like high-definition video or 5.1 audio streaming that require fast data-transmission speeds.[19]

Military

Communications systems are critical to effective military operations, especially as our armed forces embrace "network-centric" warfare. In 2002, Major General Charles E. Croom, then-Vice Director for Command, Control, Communications and Computer Systems for the U.S. Joint Chiefs of Staff, identified the need for more bandwidth as the number one technology challenge facing soldiers in Afghanistan. Whether in the air, at sea or on the battlefield, military communications systems rely on wireless technologies that leverage spectrum assets wherever they are.

The U.S. Department of Defense's Joint Tactical Radio System Initiative has begun to replace military radios with software-defined radios that can communicate on multiple frequencies and technologies to provide interoperability across radio systems used by the armed services. Eventually any unit of the armed forces will be able to communicate easily with any other unit — ending at long last the horror stories about Marines in theater having to call nearby naval vessels via Washington, D.C.

The Defense Advanced Research Projects Agency's XG project is working to develop next-generation smart radio technologies that can find and operate on unused frequencies anywhere in the world. These technologies could increase ten-fold the number of radios that can operate in a given spectrum band and allow the Defense Department to operate wireless networks anywhere in the world without interference from or causing interference to others sharing the bands.

Even more advanced technologies are being developed. But if these technologies are not used, or if there is not enough spectrum for them to operate, their incredible promise will go unrealized. Since useable spectrum — and particularly the most useful spectrum — already is largely allocated and assigned, policymakers need to create an environment that will allow this allocated and assigned spectrum to be used and reused more efficiently and completely to provide new and important services to the American public.

Enlightened Regulatory Policies Can Maximize Spectrum Efficiency, Overcoming Artificial Scarcity

Overly prescriptive regulatory policies stifle innovation and tolerate — or even encourage — inefficient spectrum use by the private sector and the government. Through legislative and regulatory reform, and through collaboration between government and industry, we can foster a system of more flexible, market-based rules that will support technological innovation and efficient use of the spectrum. This will in turn fuel the economy and provide American consumers and industry with more choices.

A. Flexible Licenses

Traditionally, spectrum licenses dictate where, when, how and by whom a specific range of frequencies can be used. A typical television license, for instance, will specify transmitter tower location, height, power levels, channel assignment and broadcast technology.[20] Such rigid specificity may have made perfect sense 40 years ago, but it does not allow sufficient latitude for the new and innovative spectrum opportunities we see today. A television licensee has limited latitude, for example, to use that spectrum for a different but more beneficial purpose, lease its rights to a more efficient user, or even deploy less expensive or more efficient broadcast technology without specific governmental review and permissions. This command-and-control license regime thus suppresses market forces that might otherwise find a way to use this broadcast spectrum more efficiently.

Licensees need greater flexibility. In most instances licenses should not prescribe any particular type of service or technology. Regulatory bodies should allow licensees to assign, lease or transfer spectrum rights to others whenever economically or technologically desirable. This will allow industry to determine for itself the most efficient use of any particular spectrum license.[21] Greater flexibility also will allow market forces to play a more significant role in ensuring that spectrum is used efficiently and for its highest and best purpose.

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The track record for such flexible licenses is encouraging. In 1994, the FCC wisely chose to issue licenses for second-generation mobile phone services — called Personal Communications Services (PCS) — that were less prescriptive than traditional licenses. PCS licensees were given significant freedom to provide the type of services they wanted to provide and to use the technologies they wanted to use.

Interference in the PCS band was primarily regulated through output limits specified at geographic and frequency boundaries, not through detailed technology requirements. Thus, licensees are able to resolve interference issues among themselves. As a result, PCS licensees continually have introduced new broadband services and more advanced equipment, without the inherent delay caused by the need for regulatory intervention.

One of the keys to the success of flexible licenses is to define interference controls in objective, but technology-neutral, technical terms. So, while the PCS band needs a set of technically defined interference standards that are conducive to PCS, they should be crafted so that if a licensee wants to offer a new service (such as broadcast mobile television) in the band, and meets the interference requirements, it can do so without the delay caused by a need for regulatory action. Ideally, the license holder should be permitted to provide broadcast mobile television service — or lease the spectrum to others for that purpose — with no FCC intervention whatsoever.[22] Moreover, licensees should be free to negotiate interference rights with each other. The FCC (and NTIA) should provide oversight only to make certain that all parties that may be subject to increased interference from any such negotiation — and only these parties — consent to any changes.

Increased flexibility in licensing processes will encourage vigorous secondary markets. The FCC already has begun to implement and streamline rules and procedures for leasing, assigning or otherwise transferring spectrum licenses with certain restrictions.[23] Prescriptive licenses, however, limit the value of secondary transfer rights. Just as a home buyer would be less likely to purchase and maintain a house if renovations or improvements were barred, potential spectrum license buyers are less likely to maximize the potential of a license that limits the permissible services and technologies. Thus, creating licenses and band rules that combine flexibility with well-defined, objective interference rules will encourage a robust secondary market.[24]

In conjunction with reducing regulatory barriers to flexibility and transferability, the FCC and NTIA should inventory and evaluate spectrum usage on a band-by-band basis, with an eye toward improving efficiency in bands that are used intensely but inefficiently or bands that are used only modestly. The review should look at changes in use over time to help identify bands where technological implementation or efficiency has been stagnant or in decline and encourage licensees to transfer their spectrum rights to users who will boost the economy through more efficient use of the spectrum.

Where spectrum is not being used efficiently, the FCC and NTIA should find ways — market-based ways wherever possible — to ensure that it is put to more efficient use. Sometimes, simply encouraging market participants to collaborate to develop their own solutions can help solve the problem. Not long ago, licensees in what was then known as the MMDS band (now called the Broadband Radio Service or "BRS" band) recognized that this valuable spectrum was being seriously underutilized because of how the band was licensed and use was restricted. The licensees presented the FCC with a series of suggestions, many of which the FCC adopted, to transform the use of the

band and allow market forces to assist in using the spectrum more robustly.

But more aggressive action is needed. To this end, Congress should give the FCC explicit authority to use auctions to encourage incumbents to transfer underutilized spectrum. Although "[t]he FCC has pioneered innovative auction formats to assign rights to use radio spectrum," the "assignments to date have generally been for bands of spectrum where either there were no significant incumbents or there were clear rules for removing the incumbents."[25] In other words, auctions have not been fully utilized in a way that would allow market forces to encourage inefficient spectrum users to give up the spectrum to those who would use it more efficiently or for more important purposes. Congress should give the FCC explicit authority to use so-called "two-sided auctions" and "auction vouchers" as possible means of reducing transaction costs and encouraging incumbents to relinquish their spectrum to those who can provide more valuable services to the public.[26]

B. Unlicensed Use

Over the past few years, unlicensed (or license-exempt) broadband networks have generated substantial economic and social benefits. License-exempt wireless radios and devices have been used to create broadband networks in homes, offices and schools, and at public facilities such as airports and hotels, that now can offer access points to the Internet. These standardized, low-powered devices are easy to buy and use. They are inexpensive and often can simply be plugged in and turned on to provide broadband connectivity.

Unlicensed wireless networks crafted from radios and devices have been successful because they have improved productivity in commercial enterprises and universities, allowed inexpensive networking in schools, and provided convenient Internet access to millions of individuals both inside and outside their homes. The flexible rules governing unlicensed spectrum use also allow deployment of non-standardized technologies that are optimized for certain applications, such as rural broadband, creating an environment ripe for technology and service innovation.

Unlicensed wireless networks, however, would not exist without FCC decisions allowing unlicensed equipment to operate at higher power in certain bands. Wireless broadband devices built to the IEEE's 802.11 standard (WiFi), for example, are a direct result of the FCC's decision in 1997 to allow spectrum to be used for unlicensed high-speed data devices. Similarly, over the past five years the Bush Administration (NTIA) and the FCC, working together, have more than doubled the amount of unlicensed spectrum available for such devices and uses, while seeking greater global harmonization to achieve economies of scale for device manufacture and application adoption.

Other unlicensed technologies are likely to prove equally beneficial. UWB, for example, is an extremely low-power use that is intended to limit interference with incumbent users. Because UWB devices operate across wide swaths of spectrum, the high transaction costs of negotiating access to all of the bands necessary likely would be a practical bar to the development of UWB technologies other than as unlicensed devices.

There is, of course, always a risk that high-power, unlicensed spectrum use may be susceptible to "tragedy of the commons" problems, with attendant over-use and debilitating interference. In most locations, this problem has not yet occurred with the use of low-power devices having limited range. It is now clear that unlicensed use can be an important complement to licensed allocations and lead to more efficient spectrum usage.

Despite our support for unlicensed devices, regulators should weigh carefully any decision to allocate cleared bands exclusively to unlicensed devices because of the high opportunity cost of foreclosing flexible exclusive licenses. Regulators should allocate cleared bands to unlicensed use only where the benefits of such use are demonstrably greater than the licensed alternatives. Regulators also might structure combinatorial (package bidding) auctions to include a right to operate devices that avoid interfering with specific rights granted to the new licensees (by operating at power levels so low or with sophisticated new technologies that operate in ways intended to avoid causing interference). In this way private bidders or governments could create licensed bands in which traditionally "unlicensed" devices also can be used.

C. Government and Public Safety Use

Both federal and nonfederal governments use large amounts of the spectrum. NTIA regulates federal spectrum use, while the FCC regulates state and local government spectrum use. Given the large amount of spectrum reserved exclusively for government use, or shared between government and private use, it is critical that efforts to improve the efficient use of spectrum include government users. For a variety of reasons, including funding problems, efforts to improve efficiencies have been limited. Indeed, no one seems to know even the value of the spectrum used by the government, let alone how much economic benefit could be gained by using it more efficiently. This situation must change.

Creation of a trust fund to finance government user relocation with auction proceeds was a positive first step and good model for future action.[27] Policymakers must ensure that government entities have incentives not only to maximize spectrum efficiency, but also to share their spectrum with private users when possible. Likewise, government users should have access to commercial spectrum when appropriate or necessary. This will require collaborative solutions and innovative funding sources.

Regulators should allocate cleared bands to unlicensed use only where the benefits of such use are demonstrably greater than the licensed alternatives.

Transitioning spectrum from government use can benefit the U.S. Treasury and the economy. For example, NTIA recently estimated the cost of relocating government users of the Advanced Wireless Services (AWS) band (1710-1755 MHz) at just under $1 billion, while many experts predict auction of these unencumbered bands could fetch up to $10 billion.

Congress should direct NTIA to inventory all federal government spectrum use, determine the value and opportunity costs of government uses, and identify any spectrum bands that are used inefficiently.

Then, as the FCC must do for the private sector, NTIA must develop policies designed to use the bands more efficiently,[28] provide greater sharing with the private sector or even transfer the bands to commercial use.

To its credit, NTIA already has recommended setting aside 10 MHz of government spectrum and 10 MHz of commercial spectrum for experiments designed to establish best methods and policies for spectrum sharing. With Congressional help if necessary, both NTIA and the FCC should move ahead quickly to set this spectrum aside for such experiments. Collaborative experiments that encompass both commercial and government spectrum sharing could pave the way to far fuller use of spectrum resources.

The extraordinary joint solution reached in 2005 — regarding the use of the 5 GHz band — powerfully demonstrated the public benefits gained when government and commercial spectrum users collaborate to adopt innovative technological approaches to spectrum sharing. Recognizing the benefits of wireless broadband networks at 5 GHz, the FCC worked with NTIA, the Defense Department (by far the largest user of government spectrum) and the private sector to allow sophisticated unlicensed devices to share use of 5 GHz spectrum with sensitive military and government systems. Thus, through collaboration, the private sector was provided with promising new possibilities and a new platform on which to innovate without interfering with critical military needs.

Public safety communications also are undergoing changes as the need for greater interoperability becomes apparent, with images, video and data increasingly being used to provide the level of information necessary for homeland defense. Public safety needs access to spectrum and dedicated, multiyear funds to meet its modern communications capacity and technology requirements.

We must be creative if we are to ensure access to sufficient resources to meet tomorrow's needs.

While public safety traditionally has built systems using dedicated spectrum, we must be creative if we are to ensure access to sufficient resources to meet tomorrow's needs. Congress should direct the FCC to investigate ways to provide public safety with access to additional spectrum to meet non-mission-critical communications needs through greater use of cooperative, priority pre-emption agreements with commercial carriers or with users whose communications needs during emergencies would be low. Such agreements not only could provide communications capacity during times of major crises when public safety needs are greatest, but could enhance day-to-day enforcement activities. If priority pre-emption techniques prove sufficiently reliable, consideration could be given to extending the model to additional bands.

Federal, state and local government spectrum users also should have access to the most advanced wireless technologies and solutions possible to meet their operational requirements. Most importantly, these technologies will allow them to carry out their missions more effectively and safely. Almost as important, it will allow more intensive use of the spectrum for both governmental and non-governmental purposes.

Advanced, standards-based equipment using technologies developed through an open-standards process — that is, technical standards that any manufacturer is permitted to use under fair and reasonable terms — can foster interoperability and allow first responders from multiple jurisdictions to communicate at the scene of a major incident. Cognitive radio technology can help provide access to additional spectrum and flexibility to use the most

appropriate spectrum. Mesh networking can help restore emergency communications quickly, provide localized broadband access and greatly enhance access to information during emergencies. Wide-area broadband can provide information — including video, data and images — that are becoming a critical part of everyday public safety operations. In addition, satellite capacity can provide coverage in very remote areas or where communication infrastructure has been lost.

Of course, allowing government users access to the most advanced radio technology requires money. But providing the highest level of interoperability with advanced, spectrum-efficient systems will be well worth the cost. Public safety users need a dedicated, multiyear funding mechanism to replace the current base of non-interoperable communications systems. Unfortunately, there is no such mechanism in place. Congress should work with federal agencies, including the FCC, NTIA and the U.S. Department of Homeland Security, as well as the private sector, to develop a mechanism to allow critical government functions to use the spectrum fully and efficiently.

Conclusion

We have the technology and we know the techniques to make more efficient use of radio spectrum. We simply need the permission. This requires policymakers to rethink the often archaic rules in spectrum allocation, management and usage, looking for new and market-based approaches. Over the past few years, the FCC and leaders in the Administration have made hopeful progress in this direction. The President's Spectrum Initiative is considering many of the right steps. But much more action is needed. Animated by a common vision and working together, we are confident that industry and government will prove able to gain far more from our spectrum resources and maximize the benefit of this critical infrastructure for all our citizens.

Recommendations from the Technology CEO Council

Recommendation 1: The U.S. Congress should instruct both NTIA and the FCC to conduct a band-by-band analysis of the usage of the spectrum they regulate and to identify any bands that are not being used efficiently. NTIA further should prepare a report on the amount, value and opportunity cost of the spectrum being used by the federal government.

Recommendation 2: For any government band that is not being used efficiently, NTIA should develop mechanisms to encourage more efficient use or consider transferring that spectrum to commercial use or sharing that spectrum with commercial users.

Recommendation 3: For any commercial band that is not being used efficiently, the FCC should consider whether market-based mechanisms — such as two-sided auctions and auction vouchers — could be adopted to encourage more efficient use of the band or the use of advanced technology, or whether reallocation of the band might be necessary.

Recommendation 4: Given the importance to our economy of licensed services, the FCC should reduce service and technological restrictions on wireless licensees, but with clearly defined rights, to promote the most robust possible use of such licenses. The FCC also should consider using combinatorial (package bidding) auctions to facilitate the optimal aggregation or disaggregation of spectrum rights, including the possible creation of underlay and overlay rights in newly cleared spectrum.

Recommendation 5: Congress should give the FCC explicit authority to use two-sided auctions and auction vouchers.

Recommendation 6: Given the importance to our economy of unlicensed services, the FCC should make more unlicensed spectrum available. For example, the FCC should promptly complete its TV white spaces proceeding (docket 04-186) and permit other uses of the spectrum, on a noninterfering basis, in areas where it is not used by television stations.

Recommendation 7: Congress should mandate that the FCC and NTIA contribute 10 MHz of commercial and 10 MHz of government spectrum respectively to be used for experiments on spectrum-sharing solutions — including priority access — between and among industry, and local, state and federal government uses.

Recommendation 8: The FCC should review bands where priority access may provide public safety officials with access to spectrum to meet non-mission-critical requirements.

Recommendation 9: Congress should establish an ensured, multiyear funding mechanism to assist public safety organizations and other government agencies in deploying advanced technologies that use spectrum more efficiently and to make their networks interoperable.

Recommendation 10: The United States should urge its trading partners and international organizations to adopt spectrum policies that endorse technological neutrality, flexibility and market-based principles.

Endnotes

1 McHenry, Mark A. NSF Spectrum Occupancy Measurements Project Summary. Vienna, Va.: Shared Spectrum Company, 15 Aug. 2005. From January 2004 to August 2005 the Shared Spectrum Company measured spectrum occupancy for the National Science Foundation under a subcontract from the University of Kansas. The project measured 30 MHz to 3 GHz in six locations and found an average occupancy over all locations of 5.2 percent, with a maximum of 13.1 percent in New York City. The results, of course, vary with time, place and frequency but the point remains the same. <http://www.sharedspectrum.com/inc/content/measurements/nsf/NSF_Project_Summary.pdf>

2 The spectrum powers a $750 billion economy. Calabrese, Michael, and Snider, J.H., "Up in the Air," The Atlantic Monthly, September 2003

3 The wireless telecom industry is expected to become a larger sector of the U.S. economy than the agriculture and automobile sectors within five years, based on the wireless industry's current 15 percent annual growth rate. Entner, Roger, and Lewin, David, Impact of the U.S. Wireless Telecom Industry on the U.S. Economy. Ovum, September 2005 <http://www.heartland.org/pdf/18141.pdf>

4 See Memorandum for the Heads of Executive Departments and Agencies, Spectrum Policy for the 21st Century, 69 Fed. Reg. 1569, 9 Jan. 2004. For U.S. Department of Commerce implementing reports and recommendations, see <http://www.ntia.doc.gov/reports/specpolini/presspecpolini_report1_06242004.pdf> and <http://www.ntia.doc.gov/reports/specpolini/presspecpolini_report2_06242004.pdf>

5 The FCC concluded as long as three years ago that "broadband deployment will bring valuable new services to customers, stimulate economic activity, improve national productivity, and advance economic opportunity for the American public." The Appropriate Framework for Broadband Access to the Internet Over Wireline Facilities, 17 FCC Rcd. 3019, 3020, 2002. Indeed, the FCC itself has offered WiFi at its headquarters since 2003. See, for example, <http://zdnet.com.com/2100-1103-5060099.html>

6 Arner, Faith, "The Web Smart 50 — Management: Boston Coach," Business Week Online, 24 Nov. 2003 <www.businessweek.com/magazine/content/03_47/b3859642.htm>

7 <http://www.spectrumcoalition.dc.gov/html/home.html>

8 See Connected & On the Go: Broadband Goes Wireless, Report by the Wireless Broadband Access Task Force, Federal Communications Commission, February 2005, pp. 38–39, <http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-257247A1.pdf>

9 Hoskins, Robert, "Texas A&M's State-of-the-Art Wireless Network Sets Bar for Distance Learning Programs," Broadband Wireless Exchange Magazine, June 2004 <http://www.bbwexchange.com/publications/newswires/page546-939808.asp>

10 Carnevale, Dan, "Technology Experts Help Colleges in Gulf Region Get Back Online," The Chronicle of Higher Education, 21 Oct. 2005 <http://chronicle.com/temp/reprint.php?id=01olmycsxxfmspjrej52a7vyhjkphagh>

11 Kingsbury, Alex, "Rural Schools Around the Nation are Expanding Students' Options with E-classes," U.S. News & World Report, 18 Oct. 2004 <http://www.usnews.com/usnews/edu/elearning/articles/04rural.htm>

12 Callimachi, Rukmini, "Biggest Wi-Fi Cloud Is in Rural Oregon," Associated Press, 16 Oct. 2005 <http://www.breitbart.com/news/2005/10/16/D8D9FN780.html>

13 See Connected & On the Go, Broadband Goes Wireless, 2005, Appendix C, p. 6

14 Inside Africa, CNN, 27 Aug. 2005 <http://transcripts.cnn.com/TRANSCRIPTS/0508/27/i_if.0.html>

15 Entner and Lewin, 2005, p. 43

16 Technical Report, Uganda Health Information Network, 10 Dec. 2004 <http://pda.healthnet.org>

17 See Connected & on the Go, Broadband Goes Wireless, pp. 37–38

18 Gonsalves, Antone, "Cingular To Offer HBO 'Sopranos' On Mobile Phones," Internet Week, 16 Dec. 2005 <http://internetweek.cmp.com/175004712>

19 Gain, Bruce, "Ultrawideband's Macworld Twirl," Wired News, 11 Jan. 2006 <http://www.wired.com/news/technology /0,699900.html?tw=wn_tophead_10>

20 Rothkopf, Michael, and Bazelon, Coleman, "Interlicense Competition: Spectrum Deregulation Without Confiscation or Giveaways," New America Foundation, August 2003 <http://www.newamerica.net/Download_Docs/pdfs/Pub_File_1329_1.pdf>

21 In some cases, the FCC may need to restructure band and channel plans or use overlay licenses to make it feasible for licensees to exercise their flexibility.

22 The FCC's Spectrum Policy Task Force has recognized as much: "Interference standards based on outputs provide desired flexibility while protecting the reasonable expectations of licensed and authorized service providers and the public," Report of the Spectrum Rights and Responsibilities Working Group, Federal Communications Commission Spectrum Policy Task Force, 15 Nov. 2002, p. 29 <http://www.fcc.gov/sptf/files/SRRWGFinalReport.pdf>

23 See, for example, Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets, Second Report & Order, Order on Reconsideration, and Second Further Notice of Proposed Rulemaking, FCC 04-167, WT Docket 00-230, (released 2 Sept. 2004, expanding the availability of spectrum leasing to more wireless services and devices and streamlining the processing of lease, assignment and transfer applications)

24 In a comment filed with the FCC, a group of scholars calling themselves "37 Concerned Economists" recommended the FCC allow secondary license markets to promote efficiency in spectrum allocation. The group, which included a Nobel Laureate, two former members of the President's Council of Economic Advisors, six former Chief Economists and Deputy Chief Economists to the Commission, and 10 former Deputy Assistant Attorneys General in the Antitrust Division, noted that policies that facilitate market transactions can create a more efficient allocation of spectrum and promote innovation. Comments of 37 Concerned Economists, WT Docket No. 00-230, 7 Feb. 2001

25 Rothkopf and Bazelon, 2003, p. 2

26 In two-sided auctions, spectrum voluntarily offered by incumbents is auctioned together with any unassigned spectrum. Bidders can efficiently aggregate spectrum that is currently highly fragmented by making all-or-nothing bids on packages of assigned and unassigned licenses. In voucher auctions, incumbents are given auction vouchers in exchange for turning back their licenses. The value of vouchers is determined in an auction of the returned spectrum and unassigned spectrum held by the government. See Kwerel, Evan, Spectrum Exchanges and Incumbent Clearing, presentation at SIEPR and AEI/Brookings Joint Center Conference on Communications Policy, 9 Oct. 2004. See also Strong Support for Extending FCC's Auction Authority Exists, But Little Agreement on Other Options to Improve Efficient Use of Spectrum Telecommunications, Government Accountability Office, Report to Congressional Committees, December 2005

27 On Dec. 23, 2004, President Bush signed into law the Commercial Spectrum Enhancement Act, which provides a funding mechanism through which federal agencies can recover the costs associated with relocating their radio communications systems from certain bands to be auctioned for commercial purposes. See Pub. L. No. 108-494, 118 Stat. 3986, 3991-97, 2004

28 Some proposals that have been discussed are charging spectrum fees, similar to what is being done in the United Kingdom, or allowing federal agencies to lease spectrum. Each approach has drawbacks but is worthy of discussion.

About the Technology CEO Council

The Technology CEO Council is the information technology industry's public policy advocacy organization comprising chief executive officers from America's leading information technology companies.

Founded in 1989, and formerly known as the Computer Systems Policy Project (CSSP), the Technology CEO Council is dedicated to advancing policies that ensure and promote U.S. competitiveness through technology leadership. The CEOs regularly visit Washington to meet with policymakers about issues of importance to the high-tech industry and offer recommendations through reports and white papers on issues having a transformative impact on society.

Currently, the Technology CEO Council is focused on public policy initiatives related to health care information technology, telecommunications, international trade, innovation, digital rights management, export and knowledge controls, and privacy.

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