(As Prepared for Delivery)

Spectrum Issues Related to Broadband Access

Remarks by

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Before the

2000 Third Annual
International Symposium on Advanced Radio Technologies

Boulder, Colorado
September 6, 2000

Thank you for the kind introduction. I am very gratified to be here at the Boulder Laboratories to speak, because, as it turns out, I started my government career here in this building almost exactly – to the day -- 37 years ago. I had been a ham radio operator since I was in my early teens and interested in such things as meteor-burst and Sporadic E communications. Because I was going to work for what was then called the Central Radio Propagation Laboratory, I thought that I had died and gone to heaven. But that is another story, since we are here today to talk about advanced radio technologies.

I have been asked to address spectrum issues relating to broadband wireless access from a Federal Communications Commission standpoint. I am pleased to do so. But rather than focus on specific issues associated with broadband access -- of which there are many -- I intend to concentrate on the issue of spectrum scarcity. I am going to do so because, without adequate spectrum, all forms of wireless access are at risk.

I have divided the balance of my remarks into four parts. *First*, for those of you who may not be entirely familiar with the organization of the Federal Communications Commission, I will say a few words about the organization and the role of the office I head, the Office of Engineering and Technology. *Second*, from that perspective, I will say a few words about the importance of spectrum management and the challenges we face in meeting the exploding demand for the radio spectrum resource. *Third*, I will discuss some of the initiatives we are taking at the Commission to help meet that growing demand. *Fourth*, and finally, I will offer some concluding thoughts.

Before I continue, however, I need to offer the standard disclaimer that the views I express here this morning are my own and they may not reflect the views of the

Commission itself, any individual Commissioner, or any other Commission staff member.

Role of the Office of Engineering and Technology

As most of you may know, the FCC is organized into Bureaus and Offices. Generally speaking, the bureaus -- the Common Carrier Bureau, the Wireless Telecommunications Bureau, the Mass Media Bureau, the Cable Services Bureau, and the International Bureau -- have the "line" or operating responsibility in terms of the Commission's regulation of particular segments of the telecommunications industry. For example, the Wireless Telecommunications Bureau -- under the excellent leadership of my colleague, Tom Sugrue -- has the responsibility for the terrestrial fixed and mobile wireless access systems that are the subject of much of this conference. In contrast, the offices -- such as the Office of the General Counsel and the Office of Plans and Policy -- provide support and advice to the operating bureaus and to the five member Commission itself.

Reflecting that rough division, the office that I now head, the Office of Engineering and Technology, provides technical advice to the other bureaus and offices and to the Chairman and other Commissioners. In addition, however, our office has the responsibility for administering specific parts of the Commission's rules; namely, Parts 2, 5, 15, and 18. Part 2 of the rules contains the Table of Frequency Allocations. That is, while the individual bureaus have primary responsibility for developing and recommending specific service rules, we, in OET, have the responsibility for general allocation matters relating to non-Federal government use of the spectrum resource. We also issue experimental licenses under Part 5 of the Commission's rules. In addition, we

administer Part 15 of the Commission's rules dealing with unlicensed devices as well as Part 18, which deals with certain industrial, scientific and medical equipment. Finally, we are responsible for the Commission's equipment authorization program. Much of that work is done at our laboratory facilities in Laurel, Maryland.

Importance of Spectrum Management

Given the backgrounds and interests of those of you in the audience here today, there is little or no need for me to stress the importance of spectrum management as a component of telecommunications policy and regulation. As you all know so well, radio spectrum is an increasingly scarce natural resource. The scarcity is being driven by increased demand which, in turn, is being propelled by a host of developments. These developments include:

- the growing shift of our economy towards the service sector,
- the increasing mobility of our workforce,
- the convenience and increased efficiency produced by mobile/portable communications,
- the increasing performance and falling cost of wireless devices,
- the increasing requirements for public safety and for national defense systems, and, perhaps most visibly,
- the dramatically growing interest in accessing the Internet on a wireless basis.

As the office at the Commission that has primary responsibility for spectrum allocation matters, we, in OET, are in a particularly good spot to judge -- first hand -- the increasing demand for spectrum. For our office is generally the first place people stop when they are seeking new spectrum. Hardly a week goes by without someone stopping in my office or filing a petition asking that spectrum be allocated for some new service or

that additional spectrum be allocated to an existing service. I feel the pressure. All of us at the Commission do.

Reflecting this pressure, our Chairman -- FCC Chairman, Bill Kennard -- has recently called attention to the potential for a "spectrum drought," especially in the valuable range below 3 GHz. Under the leadership of the Chairman, and with the solid support of Commissioner Susan Ness – who has always be intensely interested in spectrum issues, we have put forth a number of proposals and undertaken a number of initiatives that are aimed at preventing or alleviating this potential drought.

In a few moments, I will describe some of the specific things we are doing at the Commission to prevent or alleviate this potential drought. I will also talk specifically about the role that advanced radio technologies can play in that effort. But, before I do so, I would like to stress the importance of spectrum management by making three points:

First, we cannot – indeed, we must not – allow spectrum scarcity to constrain competition among Commercial Mobile Radio Service providers. Nor must we allow it to constrain competition between wireless providers and wireline providers in the provision of fixed, broadband access to the network. As I have emphasized on other occasions, if the Nation is to enjoy the full pro-competitive, deregulatory benefits envisioned by the passage of the Telecommunications Act of 1996, we need *wireless* systems as full-fledged competitors in the provision of local telecommunications services.

Second, we cannot – indeed, we must not – allow spectrum scarcity to limit productivity gains in the economy as a whole. Many economists attribute much of our

recent prosperity to economic efficiency gains associated with the Internet and e-commerce. The increased mobility of our workforce suggests that there may be significant additional productivity gains that can be achieved by extending high-speed data services – the Internet – to mobile and portable devices and systems.

Third, and more fundamentally, we cannot – indeed we must not – allow spectrum scarcity to (a) compromise the efforts of public safety officials in protecting our lives and property or (b) to compromise our national defense, our national security.

Techniques for Avoiding the Spectrum Drought

With that background on the importance of spectrum management, I would like discuss -- in general terms -- techniques for heading off the potential spectrum drought that the Chairman identified early this year. As I see it, there are three basic techniques for reducing spectrum scarcity: (1) increasing the technical efficiency with which we use the spectrum resource just as we have improved the efficiency of motor vehicles to reduce our dependency on fossil fuels, (2) increasing the amount of sharing among users of the scarce resource and (3) extending the upper-most range of the useable spectrum through improvements in devices and systems.

Before I address each of these three techniques in more detail, I want to emphasize that I did *not* mention reallocation as a technique for alleviating scarcity. The reason I did not mention reallocation is that it is becoming increasingly difficult to find a new home for licensees/users displaced as a result of involuntary reallocation. Long-term reallocation works when there are large blocks of under-utilized spectrum, but those are no longer easy to find. While there may well be some remaining outright reallocations that are economically and socially beneficial, we can not count on them for solving the

spectrum scarcity problem in the long term. That leaves the three techniques I mentioned a moment ago.

Of the three techniques I mentioned, the first -- increasing the technical efficiency with which we use the spectrum resource -- is perhaps the most relevant to this conference. I am talking, of course, about improving wireless networks so that they are able handle more telephone calls or data communications sessions per megahertz in densely populated areas. I am talking about carrying more bits per second per Hertz per square kilometer or whatever measure of efficiency you want to use.

As exemplified by second generation cellular systems and terrestrial and satellite delivered digital television systems, we are making important strides in terms of improved efficiency. Most of you here in this room are very aware of the more efficient modulation methods, improved compression algorithms, greater spacial reuse, and other techniques that have led to these improvements in spectral efficiency. Indeed, many of you as individuals -- and the industrial, academic, and governmental research institutions you represent -- have played a key role in these advances.

But we need to do even more. How do I know that? Well, we now have hard evidence. The $35 billion bid in the recent Third Generation Cellular auctions in the United Kingdom and the $45 billion bid in the even more recent auctions in Germany provides very clear evidence of the increasing value of spectrum. Whether or not you believe that auctions are the best way of assigning scarce spectrum among competing applicants – and, personally, I strongly believe that they are – the auctions are sending us technologists an extremely important message. They are indicating to us what the potential economic value is of additional spectrum capacity that is produced through

efficiency gains. If, for example, a cellular or Personal Communications Service (PCS) carrier with 25 or 30 MHz of spectrum in most major urban areas can double the amount of information that can be transmitted in that amount of bandwidth, the additional spectrum is worth – literally – tens of billions of dollars. The auction results are a strong signal to our industrial, university, and governmental laboratories to redouble their efforts to find ways of squeezing more capacity out of the limited spectrum resource.

The second of the three techniques I mentioned for reducing spectrum scarcity is increasing the amount of sharing among users of the resource. Spectrum sharing is not a new concept and it has been widely used in the past. For example, terrestrial, point-to-point microwave services have successfully been able to share spectrum with the fixed satellite service. There are two broad approaches to increased sharing. For convenience, I will label one the traditional regulatory approach and the second the economic or market approach.

In the traditional regulatory approach, groups petition us to allow additional spectrum sharing -- or, on our own motion, we propose additional sharing -- in a particular portion of the spectrum. Typically, the proponents or advocates of additional sharing -- often, new entrants -- submit engineering studies demonstrating that the proposed sharing *can* be accomplished economically and without causing harmful interference to the incumbents. And, predictably, the incumbents submit engineering studies demonstrating that additional sharing *cannot* be accomplished economically and without causing harmful interference.

Sorting through competing engineering studies has always been difficult and it is getting even more difficult as spectrum congestion grows, the systems involved and the

sharing techniques grow more complex, and the inherent value of the underlying spectrum becomes more apparent. Because of the billions of dollars at stake, it is predictable that the process will not only become more contentious but more politicized as well. While we, as stewards of the spectrum resource, have little choice but to continue to search for increased sharing opportunities and to squarely address the rival engineering and economic claims of the proponents, I am concerned about the inevitable delays that will result given the value of the resource involved.

Given the increasing difficulties with the traditional regulatory approach, I am convinced that we also need to encourage the economic or market approach to sharing. This brings us to the idea of a secondary market in spectrum. In his speech at the CTIA convention early this year, the Chairman suggested that secondary markets in spectrum might facilitate greater use of the spectrum resource. Under this notion, the primary market is represented by the initial distribution of a block of spectrum through auctions, for example. In contrast to the primary market, the secondary -- or after-market -- is represented by the exchange or trading of spectrum after the initial distribution. The exchanges could be facilitated using brokers and dealers as intermediaries. This idea arose, in part, because we observed the emergence of "bandwidth brokers" in the wired telecommunications market.

One interesting variation of this idea of a secondary market in spectrum is the potential "lease" of under-utilized spectrum on a temporary basis to meet short or medium term demand for a particular service. For example, a licensee, holding commercial or private mobile radio spectrum or fixed wireless access spectrum in anticipation of its own growth, might lease spectrum to another entity to allow the latter

to meet some spike in demand. The spike in demand might be produced by the presence of a major public event in the area such as national political convention or the Olympic Games. Even more dynamic – or shorter term – exchanges have been suggested.

It is easy to see how arrangements such as these could produce a "win-win" situation for everyone involved. The lessor could gain revenues while maintaining control of spectrum that they feel they need to meet their long term strategic objectives while the lessee would be able to make a profit by providing service to otherwise under-served customers. Consumers would benefit from the availability of the service and manufacturers would potentially benefit by the sale of more product. We, as regulators representing the public, would benefit from the greater and more efficient use of the spectrum resource that we have been charged with managing in the public interest.

Earlier this year, on May 31, the FCC convened a public forum to gain insight into why there has not been more active secondary trading in spectrum and how the FCC could facilitate such trading. At the public forum, several panelists addressed possible rule changes that would facilitate the further development of secondary markets. In addition, since the public forum, several groups have come forward with specific examples of situations where a licensee would like to lease spectrum to another entity, but was being frustrated in doing so by our rules. We are currently reviewing the results of the forum and gathering additional information and ideas. We are also actively reviewing our existing rules to determine whether adjustments might be possible and desirable. Depending upon the outcome of that review, I would expect us to move on to a more formal proceeding such as a Notice of Inquiry or Notice of Proposed Rulemaking in the fairly near future.

Before I leave the topic of increased spectrum sharing and secondary markets, I want to stress that advanced radio techniques have a strong role to play in them as well. For example, from our discussions and deliberations, it is clear that, for longer-term leases of the spectrum, the lessee would have the opportunity to recover the cost of the necessary equipment -- including specialized equipment that might be required to provide a particular service in an other-than-normal allocation. With shorter-term leases, however, the lessee may not be able recover the cost of such specialized equipment -- or even interest a manufacturer in producing it. That is where Software Defined Radio (SDR) technology could play a major role by reducing the cost (and time) of deploying radio equipment on temporarily under-utilized spectrum. By providing the needed flexibility in equipment, SDR can help enable secondary market applications.

It is even possible to imagine a radio that could adapt its characteristics to fit the interference environment and user needs on a more-or-less real time basis. For example, the radio could maximize its use of bandwidth in areas where the spectrum is not congested while conserving bandwidth or going to more robust modulation in areas where interference is heavy and/or propagation conditions are particularly difficult. In other words, SDR and other advanced radio techniques can facilitate the more dynamic – or shorter term – exchanges of spectrum capacity I touched upon a moment ago.

Because of these and other potential advantages of Software Defined Radios, the Commission initiated a Notice of Inquiry on the topic last March and comments and reply comments have been received. I expect the Commission to take further action on the topic this fall.

In terms of the third technique for reducing spectrum scarcity – extending the upper-most range of the useable spectrum – we are especially dependent upon technological developments taking place in various research institutions. Once again, many of those private, academic and governmental institutions are represented here today. At the Commission we monitor these developments and, for example, in 1997 we raised the upper limit of frequencies available for non-experimental use by the private sector from 40 GHz to 77 GHz. In mid-July, we organized a one-half day forum devoted to the possible use of frequencies in the 90 GHz area. We were encouraged by what we heard at the forum and we are looking forward to working with our colleagues at the National Telecommunications and Information Administration (NTIA) in developing a mutual consensus about how the band might be made available for civilian use.

Concluding Thoughts

Well my time has now run out so I need to wrap up. There is a lot more that I could talk about including the Spectrum Policy Statement we issued last November, the current proceeding we have underway dealing with Ultrawideband Systems, the situation regarding Third Generation (3G) Cellular spectrum, and the status of various upcoming auctions. Important as they are, they will have to be left for another time. The main point that I want to leave you with is that, through your interest in advanced radio technologies, you and the institutions you represent have a major role in helping this Nation – in fact, all Nations – avoid the consequences of the potential spectrum drought. I am looking forward to attending the balance of the symposium. Thank you for your attention.