



Opening the Airwaves: Accommodating Third-Generation Wireless Technologies

By

Brent Rowe

North Carolina State University

August 2001

This report was submitted to the Institute of Electrical and Electronics Engineers, Inc. (IEEE) to meet the requirements of the Washington Internships for Students of Engineering (WISE) for the Summer 2001 program.

Table of Contents

About the Author	3
The Wise Program	3
Acknowledgements	3
Introduction	4
Background	5
Definition of Spectrum	5
Spectrum Use	6
Explanation of Spectrum Management	7
Description of Third Generation (3G) Wireless	8
Problem	9
Need for 3G	9
Identifying the Necessary Spectrum for 3G	11
Current Use of ITU Identified Spectrum	12
Models and Examples	13
Interested Parties and Their Positions	15
General Public	16
Federal Communications Commission	17
National Telecommunications and Information Administration	18
Department of Defense	19
Wireless Telecommunications Industry	21
Multichannel Multipoint Distribution Service	23
Instructional Television Fixed Service	24
The world	25
Recent Government Activities	26
Executive Branch	26
Congress	27
Government Agencies	28
Conclusions	29
Recommendations	30
Appendix A	32
Bibliography	33

About the Author

Brent Rowe is double majoring in Electrical Engineering and Economics at North Carolina State University in Raleigh, NC. He plans to graduate in May 2003 with two B.S. degrees. In the summer of 2001, he was sponsored by the Institute for Electrical and Electronics Engineers (IEEE) as part of the Washington Internships for Students of Engineering (WISE) Program. This paper was written with a dual purpose—to educate the student and to provide an in-depth analysis of a particular public policy issue related to the interests of IEEE.

The WISE Program

The Washington Internships for Students of Engineering was started in 1980 through a grant from the National Science Foundation. After acting as a Congressional Fellow, Dr. Barry Hymen founded the WISE program, modeling after his personal experiences in his fellowship. Each summer, up to sixteen engineering students entering their senior year of undergraduate education are brought to Washington, D.C. During the ten week duration of the program, they learn how government officials make decisions on technological issues and how engineers can contribute to legislative and regulatory public policy decision. Additionally each student researches and analyses a particular public policy issue, compiles a paper, and makes a presentation. More information on the program can be found at www.wise-intern.org.

Acknowledgements

Many people were very helpful in the development of my research and in the conclusions to which I came at the end of the summer. I would first like to thank my fellow WISE interns, who provided support and encouragement and pushed me to be better. Thank you also to Ron Hira, the faculty mentor in-residence, who gave me direction and much needed criticism of my work. Chris Brantley and the IEEE office provided amazing guidance and a comfortable place to work throughout the summer. In addition, a special thanks to Dr. Hai Tran, Dr. Saj Duranni, Dr. Jim Mink, Anne Stauffer, Dr. Lionel Sacks, Dr. Jim Kadtke, and Michael Araman.

Introduction

In this day of communications frenzies, mobile telephony services are adding subscribers every minute. These users continue to have new expectations of what their devices should do, and with the impending introduction of third generation (3G) wireless technologies, they might finally be able to get more of the services that they have been imagining.

The third generation of wireless telecommunications systems could allow you to conduct video conferencing, check emails, surf the web, and even call up a map with your location all from your wireless 3G device. You could have the ability to transfer data at rates up to 2 MB/s, although most current estimates put that number at closer to 200 kb/s, still over 20 times faster than the second generation (2G) phones which are being used today.

Unlike using the Internet on a 2G phone, 3G phones will feature an always-on connection so that when your phone is on, you can access Internet features without have to place a call. 3G technologies will allow users to determine their geographic location and use that information for mapping, shopping, dining, or a multitude of other possibilities. A long-range goal for many policy makers and industry enthusiasts is for 3G phones to eventually be able to operate anywhere the world.

So, what's the problem? Why doesn't the wireless industry speed up the introduction of this technology so that we can enjoy it more quickly? Well, in order for 3G services to be offered, providers must obtain a certain amount of bandwidth from the radio frequency spectrum. In the United States, as well as in countries around the world, governments are delving into a process commonly called spectrum management and

trying to figure out how third generation wireless can fit into the picture. The dispersal and regulation of the electromagnetic radio frequency spectrum is an issue which has been a source of debate for many years, however a key factor has changed. There's none left.

I. BACKGROUND

Definition of Spectrum

The radio frequency spectrum (also called the "spectrum") is the portion of the electro magnetic spectrum that carries radio waves and is located between 3kHz and 300 GHz. Specific signals are transmitted over a range of frequencies which determines the bandwidth. So, a signal transmitting between 30 and 50 MHz would have a bandwidth of 20 MHz. Basically, more bandwidth allows for the transmission of more information. Thus, narrowband signals are used for services such as paging and low-speed data transmission, while broadband signals can be used to support communications such a high-speed data and video transmission.

Because of the nature of electromagnetic waves, certain characteristics help to define how the radio frequency spectrum can be used. The spectrum is transmitted and received using antennas which can send signals in all directions or aimed at one receiver. However, in order to reduce *interference*, more than one signal is not usually transmitted in the same frequency range, in the same geographic area, and at the same time.

The spectrum can be used up, or occupied, in an area, but it is never destroyed, unlike most natural resources. And as soon as a transmission ceases over a certain

frequency, that frequency can be used for another purpose. So, the spectrum is scarce, but can be very easily reused.¹

Spectrum Usage

The spectrum is used for a variety of wireless communications services, which are categories such as fixed or mobile voice/data services or broadcast services. Both private and public organizations are given the rights to specific portion of the spectrum. As described by the Office of Spectrum Management under the National Telecommunications and Information Administration (NTIA),

“The vast majority of spectrum use for both the private sector and the Federal government is below 30,000 MHz (or 30 GHz). From an allocation point of view in the 0 to 30,000 MHz range, the government exclusive allocation is 7% (2271 MHz), non-government users have 30% (8961 MHz), and the remainder (63%) (18768 MHz) is shared.”²

Within the Federal Communication Commission’s (FCC) domain, the commercial uses range from radio, television, wire, satellite, and cable services. In order for the FCC to be effective, they must continually monitor services and their effective use of the spectrum. Requests are made daily for pieces of the spectrum which might be available, and each one must be addressed.

¹ Kruger, Lennard G. “Radiofrequency Spectrum Management: Background, Status, and Current Issues.” p. 1-3, Congressional Research Service, Updated April 10, 2001.

² Office of Spectrum Management, National Telecommunications and Information Administration homepage. <<http://www.ntia.doc.gov/ntiahome/myths.html>>.

Explanation of Spectrum Management

The radio frequency spectrum, which is defined as ranging from 3kHz to 300 GHz, has been allocated to numerous groups, public and private, through a predetermined process. The NTIA, under the Department of Commerce, is responsible for allocating frequencies for Federal use, but they are also in charge of developing domestic and international telecommunications policy. The FCC, created under the Communications Act of 1934, manages all non-federal spectrum use. The NTIA and the FCC work together to keep the spectrum in order and to promote the public good as best possible.³

More specifically, the FCC has used several different methods in the past to determine who actually receives portions of the commercial portions of the spectrum. Some groups in the past were part of so-called “beauty contests,” in which an FCC panel evaluated the candidates for a particular section of the spectrum, and one was deemed able to make best use of it. After that practice ended, lotteries were used to make the allocation fairer; however, this soon proved to not result in the most efficient use of the spectrum. Some groups would acquire a particular piece, and then squander it away.

The most recent allocation tool has been the auction. Beginning in 1993, the FCC has used auctions in an effort to allow for market competition to determine the most competent and eager participants to acquire pieces of the spectrum. There have been successes and failures, but the FCC has made many changes along the way as to how the auctions were run. Unfortunately, the process is not perfect, and there are many skeptics who are unsure whether a 3G auction will be deemed successful.

³ Office of Spectrum Management, National Telecommunications and Information Administration homepage. < <http://www.ntia.doc.gov/osmhome/primer.html>>.

Description of Third Generation Wireless (3G)

“3G is videoconferencing in a taxi. 3G is watching clips from your favorite soap in the train. 3G is sending images straight from the field to headquarters for analysis. 3G is sharing your Moroccan vacation with your friends—from Morocco. 3G is the future of everyday communications” or so says Nokia’s website on third generation wireless technologies.⁴

The first generation (1G) of mobile telecommunications was realized by analog cellular phones which became increasingly popular in the early 1990s. The introduction of digital phones represented the second generation (2G) of wireless telephony. At this point, the majority of mobile communications in the world is over 2G digital networks. One of the problems with 2G service is that several different technologies (i.e. CDMA, GSM, TDMA) are used in the U.S. With the advent of 3G, systems would be established with worldwide interoperability and roaming abilities, based off of mainly GSM technology.

The key features which are associated with third generation wireless include data transmission rates up to 2 Mb/s and global positioning capability (for use by the network and by the user).⁵ Although many people predict that data speeds won’t reach higher than 200 Kb/s, surfing the web would be much more feasible than it is today on 2G networks.⁶ Also, this Internet access would be an always-on connection, unlike current phones where the user must dial-up the mobile operator.

As a result of the locational potential and the increased speeds, 3G could enable mobile commerce (“m-commerce”) to become a huge market. Mobile users walking

⁴ Nokia’s website on 3G technologies, <<http://www.nokia.com/3g/whatis.html>>

⁵ FCC’s homepage on 3G technologies, <<http://www.fcc.gov/3G/>>

⁶ Most current networks allow their users to connect to the Internet at speeds of about 9 Kb/s.

down a street could pull up a map of the area on their 3G devices as well as receive information from restaurants, movie theaters, or banks that are nearby.

II. THE PROBLEM

Need for 3G

Why do we need 3G? If you ask this question to the general public, they would probably have no idea what you're talking about, but if you ask a diverse group of ten members from industry, government, and other such segments of the public policy arena, you could get ten different answers. If you asked Motorola or some other wireless telecommunications industry member, they would tell you that without 3G technology, our economy will fail. If you ask Adam Thierer, a telecom analyst from the Cato Institute, he would tell you that he doesn't know if the rollout of 3G will be profitable in the U.S.⁷ So, let's look at some more specific pros and cons of 3G technology.

Pros:

In a letter to the President, members of the executive management of the Cellular Telecommunications & Internet Association⁸ wrote,

“Without Presidential leadership, U.S. national security interests will face mounting interference in spectrum around the globe, the U.S. wireless industry will lag further and further behind its European and Asian competitors, capital and investment dollars will continue to flow from the U.S. to foreign wireless markets, and U.S. consumers will lose as much as \$1 trillion in potential value over the next decade.”

⁷ Peacock, Steve. “3G Legislation Said to Ensure DoD Spectrum Migration Funds.” Comm Daily, 18 June, 2001.

⁸ CTIA is a trade group which represents many U.S. wireless telecommunications providers.

This is a pretty powerful statement, but one which is agreed upon by wireless industry members and by many others in the policy playing field.

In a document released by the NTIA, our worldwide market status is challenged by the prospects of 3G technology. “Already Asia and Europe are leading the world when it comes to wireless Internet,” states the document. The argument continues that we are in a race for the future, and 3G is the future. Over 80 percent of wireless Internet users in the world are in Asia.⁹ To summarize this position, we are currently losing this battle, but if we don’t act quickly we will lose the war.

More than just worldwide worries, there are other factors which support the development of 3G services in the U.S. In a report written by President Clinton’s Council of Economic Advisors in October 2000, it is asserted that even looking past the benefits to mobile carriers and consumer users, introducing a new technology such as third generation wireless could result in the fostering of many secondary innovations in specialized applications and content. The next Silicon Valley could develop as a result of 3G companies.¹⁰

Cons:

At this point, many people are questioning if it is logical for us to push forward into a market which we do not really need. The United States has a much more established fixed-wire national telephony infrastructure than do Japan or many European nations. Thus, 3G might not be as necessary for us as it is for their countries.

⁹ “Wireless Internet: What the 3G Challenge Means for U.S. Competitiveness,” NTIA’s 3G webpage, <<http://www.ntia.doc.gov/ntiahome/threeg/3gintro.htm>>

¹⁰ Baily, Martin N. Statement concerning “The Economic Impact of Third-Generation Wireless Technology.” The White House Council of Economic Advisors, October 13, 2000.

Also, following certain auctions, many European wireless companies are having major problems because they don't have any money left to build an infrastructure. They are having to share their networks and borrow capital in order to remain in the game.

Despite its several obvious problems, I am going to assume that third generation wireless communication is a viable technology. Unfortunately, it is impossible to prove whether a decision such as this will positively affect our society and our economy in the future. There is quantitative and qualitative data which could support or reject such an assertion, some of which has been offered in this paper. However, I believe that the integration of 3G into our society will have a positive impact.

Identifying the Necessary Spectrum for 3G

At the 2000 World Radiocommunications Conference (WRC-2000) held in Istanbul, the International Telecommunications Union (ITU) focused on the introduction of third generation wireless systems, based on the ITU's International Mobile Telecommunications (IMT-2000) standard. In order for the technology to be implemented effectively, additional spectrum would need to be allocated. The ITU referenced three main considerations, which are as follows:

“The number of users which is expected to reach an estimated 2 billion mobile users worldwide by 2010 and the rapid growth of mobile data services, mobile e-commerce, wireless internet access and mobile video-based services and the need to secure common spectrum worldwide for global roaming and cheaper handsets.”¹¹

The WRC-2000 identified three additional frequency bands to be used by third generation wireless systems. After careful consideration to protect existing services (i.e.

¹¹ “World Radiocommunications Conference 2000,” <www.itu.int/br/conf/wrc-2000/docs/index.html>.

such as television and radio broadcasting, radio navigational services, meteorological radars), the agreement was that one band would be below 1 GHz (806 - 960MHz), another at 1.7 GHz (1710 - 1885 MHz) where most 2G systems operate, and the third band in the 2.5 GHz range (2500 - 2690 MHz). Since these designations, however, many more concerns have been raised related to the future deployment of 3G equipment, and the ITU is working through these.¹²

In the United States, these pieces were already taken and thus it would be a tedious and extremely expensive process to free some of the spectrum up to be available to 3G service providers. In both of the major bands identified by the ITU (1.7 GHz and 2.5 GHz), government and non-government parties are currently using the spectrum. The government, mainly the Department of Defense, is occupying the spectrum in the 1.7GHz area, while several private organizations, such as the Multichannel Multipoint Distribution Service (MMDS) and Instructional Television Fixed Service (ITFS), are using the band of the spectrum around 2.5 GHz. Thus, these groups are very adamantly trying to dissuade the FCC and NTIA from taking their spectrum away from them.

Current Usage of ITU Identified Spectrum

Within the ITU identified spectrum, fourteen Federal agencies operate within the 1755-1850 MHz band using it for both fixed and mobile services. The specific use can be categorized into several classes:

1. Tracking, telemetry, and commanding for Federal space systems
2. Medium-capacity, conventional fixed microwave communications systems

¹² The ITU is looking at the effects on incumbent systems, equipment design factors, the possibility of worldwide roaming, and backward compatibility with first and second-generation systems. Although at WRC-2000 the ITU attempted to identify bands which could be used globally, the vast number of differing opinions prevented this from happening.

3. Military tactical radio relay (TRR) systems
4. Air combat training systems (ACTS)
5. Precision guided munitions (PGMs)
6. High resolution airborne video data links, and various other aeronautical mobile applications
7. Land mobile video functions such as robotics, surveillance, etc.”¹³

The rest of the ITU identified spectrum which the U.S. has honed in on, the 1.7 GHz band, is occupied currently by MMDS and ITFS systems.

Models and Examples

We discussed the process by which the radio frequency spectrum has been allocated and managed, but it is essential to look at the successes and failures during this process, in order to treat this situation with as much importance as possible. It is also very important look at how the issue has been addressed around the world, particularly in European and Japanese governments, so that we can better understand our own system and its limitations. However, we must realize that there are certain distinctions between our cultures and economies that make the situations very different. What’s been good and what’s been bad?

Europe

The European Union banded together and assigned several bands for 3G services, as chosen by ITU at WRC-2000. These bands included 155 MHz located in the 1900-1989 MHz, 2010-2025 MHz , and 2110-2170 MHz bands to be used for terrestrial-based 3G operations. An additional 75 MHz were made available for satellite-based 3G

¹³ Slye, Russel W., et. al. “Final Report on the Potential for Accommodating Third Generation Mobile Systems in the 1710-1850 MHz Band: Federal Operations, Relocations Costs, and Operational Impacts.” p.xiv, NTIA, March 2001.

services. In March 1999, Finland, the world's most mobile-friendly country, became the first in Europe to issue 3G licenses.¹⁴

Even though they are moving much faster than in the United States, 3G operators in Europe have not had an easy ride. After shelling out approximately \$125 billion for 3G spectrum licenses, they are looking at costs of between \$90 and \$160 billion to build a network infrastructure, plus an additional \$90 million in marketing.

As a result, many Europe wireless companies are asking for help from their governments, in the form of reduced regulations. They want to be able share facilities, such as base stations and antenna towers, which usually make up the largest mobile networks expenses.¹⁵ According to Lionel Sacks, from the University College of London¹⁶, "(In Europe) telcos are, in my opinion, saying that the 3G licenses are too expensive as an excuse to pressure the regulators to let them share infrastructure."¹⁷ As an example of this trend, in Early June, the German telecom regulator announced it would permit certain sites and towers to be shared.

As would be expected, some people don't agree with *any* sharing of infrastructure, claiming that it would decrease competition and show technological innovation. Lars Godell, an analyst at the London office of Forrester Research Inc., believes that increased flexibility will "punish those who behaved responsibly and weren't stupid enough to spend billions on licenses and gamble their futures." Such opinions remind us that nothing in this game comes easily or without opposition.

¹⁴ Third Generation Mobile Phone Licensing in Europe," Telecommunications Industry Association, May 9, 2001; <<http://www.tiaonline.org/international/regional/nis/licensing.cfm>>

¹⁵ Blau, John. "Europe's Cellulars To Share Infrastructure," *IEEE Spectrum*, July 2001, p.20-21.

¹⁶ Lionel Sacks in a Lecturer at UCL, in the Department of Electronic and Electrical Engineering, working on Telecom Systems issue. He has done many studies on European 3G companies (British Telecom in particular).

¹⁷ Email correspondence with Lionel Sacks, with University College of London, on July 3, 2001; Re: Help Requested – Spectrum issues.

Japan

The single fastest growing mobile communications market in the world is Japan, especially in the mobile Internet category. Just recently, the percentage of Japanese households who have access to the net via their cell phone (61%) surpassed those using PCs (59.1%). Although the major usage of cellular Internet usage is for email and SMS (like instant messages), the speed at which the Internet spread across mobile phones is quite astonishing.

DoCoMo Inc., a Japanese company and the world's largest mobile phone company, has secured over 24 million subscribers to its I-mode mobile Internet service.¹⁸ By entering the market in May 2001, DoCoMo assured themselves the number one spot in the third-generation wireless marketplace, at least for now. But, just like everyone else, they too are having problems. In order to keep the prices cheap enough to interest people, DoCoMo is barely making money with its 3G services.

Interested Parties and Their Positions

As you might imagine there are many groups, each with a different opinion about how this situation should be handled, each trying to explain why their idea is the correct one. So, here we're going to look at several groups which have a large stake in the issue of 3G spectrum allocation in the U.S.

¹⁸ Messer, Ian. "Cell Phones Overtake PCs as Most Popular Way to Log on in Japan," Bloomberg.com, June 25, 2001; <<http://quote.bloomberg.com/>>

1. General Public (U.S.)

Many economists and especially wireless enthusiasts discuss the need for spectrum as a need for our country, in order for our economy to survive. Seemly in order to spur immediate action from the FCC and NTIA, the President's Council of Economic Advisors (CEA) released a report in October of 2000, in which Chairman Baily gave quantitative evidence to support the need to make spectrum available for 3G. He said,

“The telecommunications sector represented 3 percent of GDP in 1998, having growth at a 7 percent annual rate over the previous 10 years. Wireless carriers employ over 150,000 people in the United States and generate \$44 billion in annual revenue. At the end of 1999, the United States had 86 million wireless subscribers; today that number exceeds 100 million. By year-end 2000 there will be over 600 million wireless subscribers worldwide.”¹⁹

With the many promises of third generation wireless, the general public is left to determine how the technology will progress. Should industry members deliver all their promises, the prices could be so high that no one will be willing to pay. Advertising on 3G phones could become increasingly overbearing, causing frequent frustration and complaints.

The general public as a whole has always had a desire for things to be made easier and cheaper. 3G technology has the capability to do both, but will it. Thus, whether to allocate spectrum to 3G operators (as it relates to the general public) is a question that cannot logically be answered.

¹⁹ Baily, Martin N. Statement concerning “The Economic Impact of Third-Generation Wireless Technology.” The White House Council of Economic Advisors, October 13, 2000.

2. Federal Communications Commission (FCC)

The FCC's role as manager of the commercial radiofrequency spectrum, which has been previously discussed, is not intended to be swayed toward any particular technology or group. By staying unbiased, the FCC can do their best to serve the *public good*. The separation of the group has allowed it to be segregated from outside influences of government, however, with five politically appointed commissioners, is it possible for the Commission to be objective and remain completely out of the reach of members of industry, labor unions, and Congress? There is no concrete answer to this.

On the issue of 3G technologies, the Executive Branch has determined their role thus far. In his Executive Order, President Clinton ordered the FCC and NTIA to evaluate certain sections of the spectrum. The FCC wrote an interim report in November 2000 in response to the President's order, noting its goals of evaluating the spectrum band between 2500 and 2690 MHz. They then put out a Notice of Proposed Rulemaking (NPRM) and Order in January, and finally released a *Final Report* in March.

According to the FCC's *Final Report* analyzing this spectrum band, "these systems offer a significant opportunity for further competition with cable and digital subscriber line (DSL) services in the provision of broadband services in urban and rural areas." Additionally, the FCC report notes that this band provides video services to schools, health care centers, and a variety of other institutions.

The FCC report concluded that MMDS and ITFS should not be asked to vacate their spectrum because of the services they provide, the lack of an alternate acceptable

frequency band, and the money involved in such a move. A study offered in the report suggests that the total cost to move MDS and ITFS systems could be up to \$19 billion.²⁰

The FCC is working to make 3G spectrum available. At the same time, they are being bombarded by the wireless industry, incumbent spectrum holders, Congress, and many others to come to some decision. They are generally trying to serve the public good, but unfortunately that means different things to different people.

3. National Telecommunications and Information Administration (NTIA)

Under the Department of Commerce, the NTIA has as its mission to oversee the use of the entire radiofrequency spectrum, but to specifically manage that which is used by government entities. In regard to 3G, the role of the NTIA has been to direct the analysis of several possible spectrum sections and to produce a report on the federal government's use of the 1710-1850 MHz band.

In this *Final Report*, the NTIA looked at how the band is currently being used and how it might be made to accommodate 3G service providers. The 1761-1842 MHz band is used for federal space command, control, and range and range-rate systems for earth station transmission. The DoD uses the 1755-1850 section for a wide-variety of communications—Satellite TT&C, Point-to-Point Microwave, Air Combat Training Systems, Tactical Comm, and Tactical Data Links.

To summarize the report, the NTIA basically determined that they believe the spectrum band between 1710 and 1850 MHz could be used for 3G technologies; however, the time, effort, and money involved would be significant. Under no

²⁰ Matisse, Geraldine, et. al. "Final Report for the Spectrum Study of the 2500-2690 MHz Band: The Potential for Accommodating Third Generation Mobile Systems." Federal Communications Commission, March 30, 2001.

circumstances would the DoD be asked to compromise national security, thus special considerations would have to be taken into account with any relocation procedures. The NTIA is dedicated to determining the best way to accommodate 3G providers and maintain public safety and the public good by working with incumbent spectrum users.

4. Department of Defense (DoD)

The DoD has a very large stake in this issue. They currently use the spectrum between 1755 and 1850 MHz, and do not want to give this up. However, this section of spectrum is one of the major ones which is being looked at by the FCC and NTIA. The NTIA's report covered this area and agreed with the DoD that its use should be avoided at all costs. However, mobile telecommunications operators have stated that the 1.7 GHz section of spectrum would be most easily adaptable for their use.²¹

The DoD has been advocating a better spectrum management policy for years, but now they have been put in the spotlight again.²² In response to the recent issue, the DoD released a 328-page report in February 2001 assessing the feasibility of accommodating 3G services in their spectrum between 1755 and 1850 MHz. Estimates given in the DoD report put the necessary time required to move well beyond the timelines proposed for the study. Most DoD non-space systems could be moved by around 2010, however many of the legacy space systems would take at least until 2017. Some satellite systems might not be completely moved until 2030.

²¹ Salomon, Kenneth D. and Gray, Todd D. "Reply Comments of the Education Community of the United States," Instructional Television Fixed Service, March 9, 2001.

²² Back in 1996, Emmett Paige Jr., Assistant Secretary of Defense for Command, Control, Communications and Intelligence, spoke to the Armed Forces Communications Electronics Association Spectrum Management Symposium about this need. He urged a better spectrum management policy to be established; one in which more sharing occurs between federal and non-federal users. This has continued to be the policy which is advocated by the DoD over the years.

Additionally, the financial costs, which they would incur, would be very large. The DoD has estimated that to move all of their communications equipment to another frequency range, it would take about \$4.3 TY billion (in “Then-Year” dollars), without any sharing occurring. They also noted that there is no other frequency which would be fully compatible with their telecommunications equipment.²³

In order to address the issue of possible sharing²⁴, the report looked at the feasibility of sharing bands between the DoD and IMT-2000 (or 3G) networks. The DoD’s assessment states,

“Predicted interference to both IMT-2000 and DoD systems would preclude compatible operation at a large number of metropolitan areas and over large geographic areas of the country. Unacceptable operational restrictions would be required to migrate the interference with IMT-2000 systems. *Therefore, full band sharing is not possible.*”²⁵

The report did, however, suggest three possible options, should some type of accommodation be deemed necessary. In Table 1, it can be seen that if DoD gave up the band between 1805 and 1850 MHz, it would cost them \$2.8 TY billion, while if they lost the 1755 to 1790 MHz piece, it would cost them \$3.9 TY billion. Lastly, if the DoD were to lose all of the spectrum between 1755 to 1850 MHz, they estimate that \$4.3 TY billion would be necessary to move their equipment to another piece of spectrum deemed fit for their use.

²³ Slye, Russel W., et. al. “Final Report on the Potential for Accommodating Third Generation Mobile Systems in the 1710-1850 MHz Band: Federal Operations, Relocations Costs, and Operational Impacts.” p.xv,xix; NTIA, March 2001.

²⁴ “Our definition of sharing is using technology and coordination to enable disparate users to exploit the same spectrum; multiple users of the same frequencies whose individual uses are technically compatible; multiple reuse of the same frequencies through physical separation of users.”- Emmett

²⁵ “Investigation of the Feasibility of Accommodating the International Mobile Telecommunications (IMT) 2000 Within the 1755-1850 MHz Band,” Department of Defense, February 9, 2001.

Table 1: DoD Cost Summary (TY\$B)²⁶

Full Band Sharing (Option 1)	Band Segmentation DoD gives up 1805-1850 MHz (Option 2)	Band Segmentation DoD gives up 1755-1790 MHz (Option 3)	Total Band Loss (Option 4)
Not applicable	\$2.8	\$3.9	\$4.3

5. Wireless Telecommunications Industry

Across the U.S., wireless telecoms are working to promote 3G as the next wave of technology which will take the country by storm. That is once they get adequate spectrum. Representing many of these companies, the Cellular Telecommunications and Internet Association (CTIA) is the major industry group pushing the interests of mobile telecommunications operators. Within the past few years, they have been a large participant in every step of the process to get standards set up and spectrum allocated for third generation wireless technologies.

On May 10, 2001, CTIA President/CEO Tom Wheeler along with CTIA Board Chairman John Stanton and Vice Chairman Richard Ekstrand sent a letter to the White House urging action on spectrum allocation for 3G. The letter noted the current lack of a sound spectrum policy and stated that,

“Urgent action is needed to protect critical national security and public safety interests, to protect America’s high-tech economic edge, to encourage competition, and to protect taxpayers and consumers.”²⁷

The letter continued by referring to Japan and Europe as places where third generation wireless has taken off. Each of these countries, the letter states, has made

²⁶ “Investigation of the Feasibility of Accommodating the International Mobile Telecommunications (IMT) 2000 Within the 1755-1850 MHz Band,” Department of Defense, February 9, 2001.

²⁷ Letter to President Bush from CTIA President/CEO Tom Wheeler, CTIA Board Chairman John Stanton, and Vice Chairman Richard Ekstrand, dated May 10, 2001, regarding third-generation wireless spectrum allocation.

more than 300 MHz of spectrum available, while the U.S. has less than 190 MHz.

Lastly, the letter urges the President to take a stance on the issue so that the U.S. will remain a player in the 3G market.²⁸

In addition to this call for action, a similar letter was sent to the Honorable Michael K. Powell, Chairman of the FCC, on July 4th, asking the Commission to delay making a hasty decision on allocating spectrum for 3G. The letter states that “while the industry’s need for additional spectrum is urgent, its need for harmonized additional spectrum is even greater.” Thus, they suggest that the target deadline of July 2001 is too soon, and more time is needed for analysis of the spectrum management policy.²⁹ The spectrum policy offered by the United States government is well below par, CTIA remarks, when compared to those of other countries around the world, and it needs to be rewritten.³⁰

Furthermore, the letter to Chairman Powell comments that the spectrum occupied by the DoD is the same spectrum being used around the world for mobile telephony applications. This is a very powerful statement, acknowledging that the wireless telecom industry would be helped if the 1.7 GHz spectrum section were used for 3G. Comments released by Cingular Wireless, AT&T Wireless Services, Motorola Inc., Verizon Wireless, and Ericsson all remarked that the 1.7 GHz band would be preferable for their

²⁸ Letter to President Bush from CTIA President/CEO Tom Wheeler, CTIA Board Chairman John Stanton, and Vice Chairman Richard Ekstrand, dated May 10, 2001, regarding third-generation wireless spectrum allocation.

²⁹ Letter to Michael K. Powell, Chairman of the FCC, from CTIA President/CEO Tom Wheeler, CTIA Board Chairman John Stanton, and Vice Chairman Richard Ekstrand, dated June 4, 2001, regarding third-generation wireless spectrum allocation.

³⁰ In a paper entitled, “The Battle Over Spectrum: 3G and the Wireless Internet,” they state that U.S. spectrum policy is much more similar to budget policy. The Administration and Congress, the paper asserts, use spectrum auctions to raise more money when they need it. The CTIA further degrades the U.S. spectrum policies by looking at FCC “spectrum cap” policies which prevent providers from using more than 45 MHz per market. In the United Kingdom the cap is 90 MHz, while in the Japan DoCoMo was allowed to use 86 MHz. With these spectrum caps, CTIA asserts, the U.S. will not be able to reach the potential of other countries.

service offerings, citing “great harmonization potential and greater synergies for equipment manufacturers.”³¹

The wireless industry and groups such as the CTIA are working to secure spectrum and bring 3G services to the U.S., however, some wireless companies have said they will not need extra spectrum. “Both Sprint PCS, the nation’s No. 4 wireless company, and a joint venture between BellSouth Corp. and SBC Communications Inc. said they plan to sue their existing 1900 MHz spectrum to roll out advanced mobile services.”³² So, yet again, while the majority can be heard promoting one viewpoint, additional spectrum, it is not a unanimous opinion.

6. Multichannel Multipoint Distribution Service (MMDS)

Currently the 2500 to 2690 MHz band is licensed to MMDS and ITFS. The MMDS industry, specifically, has invested several billion dollars in developing broadband fixed wireless data communications systems.³³ They provide wireless cable services, giving competition to wireline cable and direct broadcast satellite systems.

In response to the FCC’s *Final Report* concerning 3G spectrum allocation, the Wireless Communications Association International Inc. submitted a letter generally applauding the Commission for its analysis of the 2.5 GHz spectrum occupied by MMDS. They did note, however, concern they have about some of the safeguards which need to be put into place if 3G systems are to be established even in nearby spectrum.

³¹ Salomon, Kenneth D. and Gray, Todd D. “Reply Comments of the Education Community of the United States,” Instructional Television Fixed Service, March 9, 2001.

³² Pelofsky, Jeremy. “Lawmakers to Propose Deal for More 3G Spectrum,” Yahoo! News, June 14, 2001. <http://dailynews.yahoo.com/hix/nm/20010614/pl/congress_spectrum_dc_1.html>

³³ Matisse, Geraldine, et. al. “Final Report for the Spectrum Study of the 2500-2690 MHz Band: The Potential for Accommodating Third Generation Mobile Systems.” Federal Communications Commission, March 30, 2001.

The letter concludes by suggesting that the FCC's *Final Report* should "lead the Commission to promptly withdraw the MDS/ITFS spectrum from consideration for 3G usage."³⁴

7. Instructional Television Fixed Service (ITFS)

As stated above, the ITFS band is occupied jointly with the MMDS community, who shared the spectrum and often work together in providing services. As compared to the MMDS organizations, a greater response has been generated by the U.S. educational community, which has come together to prevent their spectrum from being taken away. In the FCC's *Final Report*, the findings were obviously indicating that ITFS should not be removed from its portion of the spectrum, for a variety of reasons.

Still, the ITFS community felt it was necessary to send a response to the FCC regarding its NPRM & Order released in January 2001. The letter states, "The Commission should not do anything to endanger the current and future uses of this spectrum, particularly at a time when improving the quality and reach of education is such a high national priority." Among the 107 partners represented in the comments are representatives from basically all areas of the educational process—public and private schools, groups representing teacher and administrators, K-12 and higher education, and public television stations.

In working with MMDS, their commercial counterpart, the ITFS community has developed a mutually beneficial relationship. "Neither party is truly able to make the most of its spectrum without the help and support of the other." Additionally, using the

³⁴ "Comments on FCC Final Report," The Wireless Communications Association International, Inc., April 16, 2001.

combined efforts of both parties, ITFS claims that broadband services will soon be taken to many rural and urban communities for the first time and will give competition to cable modem and DSL services around the country.³⁵

According to Rodney Small, an FCC economist working on spectrum allocation issues, multiply meetings with members of the MMDS and ITFS communities have resulted in this spectrum almost being taken off the table.³⁶ But, nothing has been publicly reported as such.

8. The world

Currently, countries around the world are working to allocate spectrum so that they can create national 3G networks. They are also looking at the progress of the United States for several reasons—to keep up with our development, to help promote worldwide harmonization, and to avail another location for companies to market their devices. Countries around the world recognize the United States as a leader in telecommunications technology, and they often use our progress as a basis for their own.

Additionally, with the development of 3G technologies comes the possibility of a phone which can be used all over the world. The only possibility for this is by countries using the same spectrum for development, and because of the efforts of the ITU, several sections for pinpointed for use. In particular, many countries have identified the 1.7GHz piece as the one which they intend to use.

³⁵ Salomon, Kenneth D. and Gray, Todd D. “Reply Comments of the Education Community of the United States,” Instructional Television Fixed Service, March 9, 2001.

³⁶ Interview with Rodney Small, an FCC economist working on 3G spectrum allocation issues.

Recent and Current Government Activities

Executive Branch

President Clinton put out an executive memorandum on October 13, 2000 asking the FCC and the NTIA to work quickly to determine how they could allocate the necessary frequency. He asked for a decision by July 2001, so that an auction could be held by September 30, 2002.³⁷

The FCC was asked to perform tests on the 2500-2690 MHz band, while the NTIA looked at the 1710-1850 MHz band. Their tasks were to determine how the pieces of spectrum were being used, to analyze their effectiveness, and to make recommendations on how they should be used in the future. When performing these studies, they did so with the understanding that 3G rollout had become an Executive initiative. Thus, they attempted to provide objective summaries of their findings.

Recently, third generation wireless issues have begun to cause a much greater stir around the White House. Rep. Chip Pickering (R-Miss.) told reporters on July 10th that the Bush administration will probably propose delaying the upcoming sale of pieces of the spectrum for 3G until a better structure has been established for allocating the spectrum. Recently the FCC asked the President to push back the auction scheduled for September 30, 2002, and “high-level White House officials” have been discussing the issue with members from the Department of Defense, Office of Management and Budget, the National Security Council, and the Treasury Department.³⁸

³⁷ Clinton, President William. “Memorandum for the Heads of the Executive Departments and Agencies: Advanced Mobile Communications/Third Generation Wireless Systems.” Office of the Press Secretary of The White House, October 13, 2000.

³⁸ “Bush administration to delay airwaves sale,” CNET.com from Reuters, July 10, 2001; <http://news.cnet.com/news/0-1004-200-6536483.html?tag=cd_mh>

Although the Executive Branch has not made any statements concerning its position on this issue, there are several factors which help to indicate the expected response. According to Wired News, “the Bush Administration has already included projected proceeds from the auction in its budget.”³⁹

Congress

Within the U.S. House of Representatives, Rep. Pickering (R-Miss.) and House Telecommunications Subcommittee Chairman Upton (R-Mich.) are reviewing a draft of a 3G bill which would migrate DoD spectrum to the private sector for 3G network deployment.

“The most fundamental part of the (proposed) legislation is establishing a new structure in which we can make spectrum decisions and dedicate the funds, the proceeds to relocate and compensate all the entities involved in allocation decisions,” Rep. Pickering said.⁴⁰

At the core of this bill are provisions that ensure the government will compensate the Pentagon completely for the relocation expenses incurred. Through use of a trust fund, the money collected in an auction of the DoD spectrum would go directly to aid their transition.⁴¹ The FCC would not be allowed to close the auction until a certain minimum price is reached, such that the DoD is repaid. Additionally, the legislation calls

³⁹ Batista, Elisa. “Anybody Got Some Spare Spectrum?” Wired News, July 2, 2001.
<<http://www.wired.com/news/print/0,1294,44885,00.html>>

⁴⁰ “Bush administration to delay airwaves sale,” CNET.com from Reuters, July 10, 2001;
<http://news.cnet.com/news/0-1004-200-6536483.html?tag=cd_mh>

⁴¹ Peacock, Steve. “3G Legislation Said to Ensure DoD Spectrum Migration Funds.” Comm Daily, 18 June, 2001.

for an advisory committee to be set up in order to aid the Commerce Department and the FCC in identifying and allocating spectrum for commercial use.⁴²

Several weeks ago, a letter sent to the President by Senate Democrats advocating that a strong stand be taken on spectrum issues. “This is a serious management challenge that demands active White House leadership,” they said in the letter. They stated that the economic competitiveness of our country could be at risk if action is not taken soon, citing a study done by the Council of Economic Advisors under past President Clinton.⁴³

In more recent news, the House Energy and Commerce Subcommittee on Telecommunications and the Internet is holding a hearing on “3G Wireless Services” on Tuesday, July 24th. Reportedly, the Secretary of Commerce, Donald Evans, as well as top officials and the FCC and DoD and industry representatives, will be involved in the hearing.⁴⁴

Government Agencies

In its Sixth Annual Report on the state of competition in the wireless marketplace, the FCC said that the wireless industry continued to see increased competition and innovation, resulting in lower prices and increased diversity in service options for consumers. Additionally, the report stated that during the year 2000, mobile telephony

⁴² Pelofsky, Jeremy. “Lawmakers to Propose Deal for More 3G Spectrum,” Yahoo! News, June 14, 2001. <http://dailynews.yahoo.com/h/nm/20010614/pl/congress_spectrum_dc_1.html>

⁴³ Pelofsky, Jeremy. “Senate Democrats Push White House on Wireless Airwaves,” Yahoo! News, July 2, 2001. <http://dailynews.yahoo.com/h/nm/20010702/pl/congress_spectrum_dc_1.html>

⁴⁴ “Bush administration to delay airwaves sale,” CNET.com from Reuters, July 10, 2001; <http://news.cnet.com/news/0-1004-200-6536483.html?tag=cd_mh>

generated over \$52.5 billion in revenues, increased users from 86 million to 109.5 million, and achieved a nationwide penetration rate of approximately 39 percent.⁴⁵

In a letter sent on June 26, 2001, FCC Chairman Michael Powell urged Secretary of Commerce Donald Evans to allow more time for the proper assessment of spectrum allocation, related to 3G technology. He specifically asked for an extension on the date of the auction, scheduled for October 2002. “I believe that the public interest would be best served by additional time for informed consideration, even if this results in some delay in reaching allocation decisions,” Chairman Powell said.⁴⁶

The NTIA has not made any statements recently, but at the upcoming hearing, I’m sure that they will give a statement declaring their commitment to resolving the issue.

Conclusions

Throughout this paper, I have given analysis where it was needed, but I didn’t give many complete judgments or recommendations. In response to the overall issue of allocating space in the radiofrequency spectrum for third generation wireless technology to operate, I have come up with several key conclusions:

1. 3G is needed.
2. 1.7 GHz is the best location for 3G services to be placed.
3. Auctioning the 3G spectrum should have lower and upper limits.
4. More time is needed to establish a better management process for the radio frequency spectrum.

⁴⁵ McCarrick, Meribeth. “FCC Adopts Annual Report on State of Competition in the Wireless Industry.” Federal Communications Commission News Release, June 20, 2001.

⁴⁶ Powell, Michael K. Letter to Secretary of Commerce Donald L. Evans concerning “Allocation of spectrum for new advanced wireless services, including third generation (3G) wireless services.” FCC, June 26, 2001.

So, let us discuss each assertion. First, although it cannot be concretely supported, I believe that the introduction of third generation wireless technologies into the United States market will be beneficial, not only to mobile operators, but also to consumers and our economy as a whole. The potential development of both basic and extended services is unlimited, and likewise the potential for us to be negatively affected by not being involved in 3G is enormous.

Furthermore, it is obvious to me that the 1.7 GHz frequency band is the most appropriate place for 3G operations to exist. After reviewing the recommendations of the FCC and NTIA reports, reading and hearing the interests of industry members, looking at the objections of the MDS and ITFS communities and the DoD, and trying to keep in mind the interests of the general public, it seems to be the most logical decision. The DoD can move with the least cost and presumably the least complications, even though the time necessary is more than was proposed.

When the auction for the 3G licenses occurs, certain restrictions should help ensure the best possible outcome. An upper limit should be set so that no operator pays too much for their license and has future problems because of excessive spending. Additionally, a lower limit should be set according to the amount of money that the DoD would need to vacate their spectrum and upgrade their equipment for their new location.

Lastly, the FCC and NTIA need to take their time to develop a more efficient and effective management structure for allocating portions of the radio frequency spectrum. In the past, excess spectrum made this job much simpler, but now, there is little spectrum left, so the process needs to be more stringent.

Recommendations

Given the above conclusions, I propose the following recommendations to be followed by the indicated parties. With the extreme importance of the spectrum and 3G technologies, the President needs to take a larger role. By releasing an Executive Memorandum establishing the third generation wireless technology as a national priority, he could set the wheel into motion for spectrum to be allocated for 3G. The FCC and NTIA need to work more with members of industry, the DoD, Congress, and the Executive Branch to make sure that the establishment of 3G systems will move as smoothly as possible.

APPENDIX A

Acronyms and Abbreviations

3G	Third Generation
CEA	Council of Economic Advisors
CDMA	Code Division Multiple Access
CTIA	Cellular Telecommunications & Internet Association
DoC	Department of Commerce
DoD	Department of Defense
FCC	Federal Communications Commission
GAO	General Accounting Office
GHz	Gigahertz (10^9 Hertz)
GPS	Global Positioning System
GSM	Global System for Mobile Communications
IMT-2000	International Mobile Telecommunications-2000
ITFS	Instructional Television Fixed Service
ITU	International Telecommunications Union
KHz	Kilohertz (10^3 Hertz)
MMDS	Multichannel Multipoint Distribution Service
NASA	National Aeronautics and Space Administration
NPRM & O	Notice of Proposed Rulemaking and Order
NSF	National Science Foundation
NTIA	National Telecommunications and Information Administration
PCS	Personal Communications Service
TDMA	Time Division Multiple Access
TY\$	Then-Year Dollars
WRC-2000	2000 World Radiocommunication Conference

Bibliography

- Baily, Martin N. Statement concerning “The Economic Impact of Third-Generation Wireless Technology.” The White House Council of Economic Advisors, October 13, 2000.
- Batista, Elisa. “Anybody Got Some Spare Spectrum?” Wired News, July 2, 2001.
<<http://www.wired.com/news/print/0,1294,44885,00.html>>
- Blau, John. “Europe’s Cellulars To Share Infrastructure,” IEEE Spectrum, July 2001, p.20-21.
- Brownback, Senator Sam. “Third-Generation Wireless Internet Act.” U.S. Senate Bill S. 696 , referred to Committee on Commerce, Science, and Transportation, April 4, 2001.
- “Bush administration to delay airwaves sale,” CNET.com from Reuters, July 10, 2001;
<http://news.cnet.com/news/0-1004-200-6536483.html?tag=cd_mh>
- Clinton, President William. “Memorandum for the Heads of the Executive Departments and Agencies: Advanced Mobile Communications/Third Generation Wireless Systems.” Office of the Press Secretary of The White House, October 13, 2000.
- “Comments on FCC Final Report,” The Wireless Communications Association International, Inc., April 16, 2001.
- Email correspondence with Lionel Sacks, with University College of London, on July 3, 2001; Re: Help Requested – Spectrum issues.
- FCC’s homepage on 3G technologies, < <http://www.fcc.gov/3G/>>
- Interview with Rodney Small, chief Economist at FCC working on 3G spectrum allocation issues.
- “Investigation of the Feasibility of Accommodating the International Mobile Telecommunications (IMT) 2000 Within the 1755-1850 MHz Band,” Department of Defense, February 9, 2001.
- Kruger, Lennard G. “Radiofrequency Spectrum Management: Background, Status, and Current Issues.” Congressional Research Service, Updated April 10, 2001.
- Letter to Michael K. Powell, Chairman of the FCC, from CTIA President/CEO Tom Wheeler, CTIA Board Chairman John Stanton, and Vice Chairman Richard Ekstrand, dated June 4, 2001, regarding third-generation wireless spectrum allocation.

Letter to President Bush from CTIA President/CEO Tom Wheeler, CTIA Board Chairman John Stanton, and Vice Chairman Richard Ekstrand, dated May 10, 2001, regarding third-generation wireless spectrum allocation.

Matise, Geraldine, et. al. "Final Report for the Spectrum Study of the 2500-2690 MHz Band: The Potential for Accommodating Third Generation Mobile Systems." Federal Communications Commission, March 30, 2001.

McCarrick, Meribeth. "FCC Adopts Annual Report on State of Competition in the Wireless Industry." Federal Communications Commission News Release, June 20, 2001.

Messer, Ian. "Cell Phones Overtake PCs as Most Popular Way to Log on in Japan," Bloomberg.com, June 25, 2001; <<http://quote.bloomberg.com>>

Nokia's website on 3G technologies, <<http://www.nokia.com/3g/whatis.html>>

NTIA's homepage on 3G technologies, <<http://www.ntia.doc.gov/ntiahome/threeg/index.html>>

Office of Spectrum Management, National Telecommunications and Information Administration homepage. <<http://www.ntia.doc.gov/osmhome/osmhome.html>>.

Paige Jr., Emmett. "Electromagnetic Spectrum: Key to Success in Future Conflicts." U.S. Department of Defense, Vol. 11, Num. 83; July 10, 1996.

Peacock, Steve. "3G Legislation Said to Ensure DoD Spectrum Migration Funds." Comm Daily, 18 June, 2001.

Pelofsky, Jeremy. "Senate Democrats Push White House on Wireless Airwaves," Yahoo! News, July 2, 2001. <http://dailynews.yahoo.com/h/nm/20010702/pl/congress_spectrum_dc_1.html>

Pelofsky, Jeremy. "Lawmakers to Propose Deal for More 3G Spectrum," Yahoo! News, June 14, 2001. <http://dailynews.yahoo.com/h/nm/20010614/pl/congress_spectrum_dc_1.html>

Powell, Michael K. Letter to Secretary of Commerce Donald L. Evans concerning "Allocation of spectrum for new advanced wireless services, including third generation (3G) wireless services." FCC, June 26, 2001.

Salomon, Kenneth D. and Gray, Todd D. "Reply Comments of the Education Community of the United States," Instructional Television Fixed Service, March 9, 2001.

Slye, Russel W., et. al. "Final Report on the Potential for Accommodating Third Generation Mobile Systems in the 1710-1850 MHz Band: Federal Operations, Relocations Costs, and Operational Impacts." National Telecommunications and Information Administration, March 2001.

"Third Generation Mobile Phone Licensing in Europe," Telecommunications Industry Association, May 9, 2001; <<http://www.tiaonline.org/international/regional/nis/licensing.cfm>>

"Wireless Internet: What the 3G Challenge Means for U.S. Competition." NTIA 3G Initiative, <<http://www.ntia.doc.gov/ntiahome/threeg/3gintro.htm>>.

"World Radiocommunications Conference 2000," <www.itu.int/br/conf/wrc-2000/docs/index.html>.