Testimony
of
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Hearing on
Spectrum Management and Third Generation Wireless Service

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Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to appear before you today. I commend you for holding this hearing on spectrum management and Third Generation (3G) wireless – two critical issues facing the wireless communications industry today.

My name is Martin Cooper. I am the Chairman and CEO and Co-Founder of ArrayComm, Inc., a U.S.-founded and based technology company headquartered in Silicon Valley, California. We founded the company in 1992 and now have over 200 employees including many renowned scientists, engineers, and industry leaders in the field of wireless communications.

Today, I would like to present my views on spectrum allocation, including how we can ensure that our nation's scarce spectrum is put to its most valuable use, and the need to encourage new technologies and the timely deployment of these technologies to all Americans. While these technologies originated in American laboratories and were often paid for by the Department of Defense, ironically, many are more widely deployed abroad than here at home.

Wireless personal communications have contributed importantly to the productivity, safety, and convenience of people in this country over the past 60 years, but especially during the most recent 18 years of commercial cellular service. I would like to share with the Subcommittee the vision that inspired the creation of cellular service, to express an opinion on how well we have done in fulfilling that vision, and to project that vision into a future that includes the Internet.

Specifically, I would like to make two points relative to this Committee and its role in overseeing the Federal Communications Commission (FCC) and the Department of Commerce:

1. Despite enormous progress in the personal communications industry, that industry is still in its infancy. Future services will require 10 to 20 times the spectrum allocated today. That spectrum just does not exist – *unless* the industry continues to aggressively adopt new technology that *multiplies* capacity of existing spectrum.

2. 3G is one of a number of new personal communications services, each of which will serve different constituencies who have different needs. All of these services need to be accommodated in the fixed amount of spectrum that is available as limited by physical laws.

When we created cellular 30 years ago, we envisioned a personal portable telephone service that unshackled people, all people, from the wires that tied them to their desks, their homes, and their workplaces. We knew that wireless technology had the capability of delivering high quality speech, at low cost, with good reliability to all the people. And further, we promised the FCC, which was a crucial participant in the creation of cellular service, that cellular technology was capable of continuously improving spectral efficiency. "Allocate 40 MHz," we said, "and we will grow the service indefinitely."

Despite the enormous strides made by the industry and the FCC – and without question, there has been progress – the cellular vision remains incomplete today. Some segments of the population are served effectively, others, not at all. Data over cellular pales in comparison with data over wireline. Despite the obvious convenience of wireless service, those of us who use the service still suffer from the lower reliability and higher cost that characterize wireless compared to wired service. As a result, although over 100 million people in the United States use cellular service, they still, on the average, use old-fashioned wired phones for over 90% of their talking and over 99% of their Internet access.

The initial 40 MHz of cellular spectrum has grown to 170 MHz and here we are, asking for more. Consider that, with today's technology, if the industry proposed to serve all personal traffic, the FCC would have to allocate virtually *all* of the usable spectrum to cellular service to the exclusion every other defense and commercial service. Not to mention, I add, the demand for new classes of data services that will consume, again, with today's technology, far more spectrum than voice services.

And that is the real problem faced by this Committee. If we rely on today's technology, the need is not for just another 100 or 200 MHz, the demand is for another 2000 or 4000 MHz and that spectrum simply does not exist.

The *only* answer is new technology that multiplies spectrum capacity. Technology has come to the rescue in the past and, properly stimulated, it will come through in the future. It is that stimulation that is the crucial role for this Committee, Congress, the FCC and the Department of Commerce. There are industry standards for automobile fuel efficiency – why are there not standards for efficient use of the radio spectrum? We have huge reserves of fossil fuels – but only about 2000 MHz of spectrum that *is* useful to connect people.

The message is clear. The demand for more services is going to accelerate. People are learning the value of freedom from the wired tether and that freedom is every bit as important for the Internet as

it is for plain old voice service. The only hope for providing this new freedom is continuing technological progress. We must, and will, continue to extract more and more value from the spectrum, just as we have been doing for the hundred odd years since radio was invented. We must ensure that our nation's scarce spectrum is put to its most valuable use, to enable U.S. telecommunications companies to meet consumer demands, and remain competitive globally.

The wireless industry today stands at a crossroads. The momentum of the past 18 years has made mobile connectivity a part of our lifestyle. But, this is just the beginning. The next 20 years offer even greater promise for the American public and the American economy. But the mission has expanded. We started with voice. The technology of the entire communications world is now *data*. Voice is now just one of many applications that must be served within a limited amount of spectrum and voice is fast becoming a minor part of the demand. The Committee members know, I am certain, that I raise these challenges only because I am confident that solutions exist for all of them and I will touch briefly on those today.

Let us look at the issues that this profound change of mission raises.

A Basic and Scarce Resource: The Spectrum "Sweet Spot" for Mobility Services

There is a "sweet spot" for the frequencies allocated to mobile wireless systems, influenced by the physics of radio-communications, which extends from about 500 MHz to 2500 MHz, or about 2000 MHz in total. The size of this sweet spot cannot be expected to change dramatically over time. We must accept that there will always be competing interests for this spectrum, all in one form or another important for our country. The decisions made on 3G spectrum must include a comprehensive approach to all spectrum allocation in this range of frequencies or the problems we face today will resurface every few years indefinitely.

Today, the cellular industry uses about 170 MHz of spectrum between 850 MHz and 1.9 GHz, or 8.5% of the 2 GHz sweet spot. Let us assume that an additional 140 MHz (located between 1710 and 1850 MHz) is allocated to the cellular industry, and its share of the sweet spot goes to more than 15%. Without passing judgment on whether this is an equitable allocation of the sweet spot for this very important industry, it is clear that the amount of spectrum available for commercial mobile wireless cannot continue to increase without limit, given all of the other demands on the spectrum – other commercial, scientific, public safety, aviation and defense interests which consume a considerable portion of the rest of this frequency range.

New Services are More Spectrally Demanding

Compounding the difficulty is the fact that many of the new services that may be desired by the public and are contemplated by the cellular industry require more bandwidth than today's voice and low-rate data services. The critical issue here is the price at which wireless operators can afford to offer new services to consumers. The techniques that are most effective at using the spectrum better and improving spectral efficiency also reduce deployment and operating costs for the carriers that use them.

Efficient use of the spectrum can lower an operator's costs and bring wireless services to

constituencies that would otherwise not be served.

Without adequate spectral capacity, there is a risk that advanced services will not be available to the public at a price-point that most Americans can afford. Congress has already heard from some wireless carriers that spectrum shortages could cause their companies to increase their prices for cellular voice service. Of course, this is true using 30-year old technology. But there are technologies in widespread use today that have the opposite effect and carriers will soon have access to these technologies – *if* they are encouraged to adopt technologies that use spectrum more efficiently, rather than to solve capacity demands with more spectrum.

There will be no benefit from 3G services to the American economy if they are not affordable.

ArrayComm, Inc.

ArrayComm, Inc. is the global leader in fully adaptive *smart antenna*-based wireless communications. Our technologies are independent of the air-interface. They can work with *every* generation of cellular deployment; in fact, with any personal wireless communication system, and we license that technology to manufacturers of wireless communications equipment.

ArrayComm has created one of the key technologies that will form the basis of the rescue that I just alluded to. Our technology, called IntelliCell, is an advanced form of smart antenna technology that is technically called adaptive array processing. A traditional cellular base station blankets a wide area with radio energy. Our smart antenna technology directs that energy to the person for whom it is intended and avoids putting energy in locations where it could interfere with others who wish to use a radio channel. This technology can be applied to any personal communications system. The result is an increase in the number of users, lower deployment costs, higher profitability, fewer dropped calls, faster data rates and improved customer satisfaction.

There are, today, over 80,000 cellular base stations using this adaptive smart antenna technology serving many millions of people in Asia and the Middle East. In these developments, we have created a nine-times improvement in spectral efficiency over systems that were already using advanced technology. That is effectively multiplying the spectrum used in those systems by nine times. These systems are capable of serving nine times more people than earlier versions that did not incorporate adaptive smart antennas.

Our patented IntelliCell® technology (also known as a fully adaptive "smart antenna") uses advanced software and antenna arrays to continuously optimize, in real time, the communication channel with every wireless user. IntelliCell dramatically enhances the quality, capacity and overall performance of wireless voice and data networks across all air interface standards. IntelliCell multiplies spectrum re-use by creating multiple spatial channels on top of traditional time-division and code-division multiple access methods used for voice and data transmission, thereby reducing the need for spectrum. IntelliCell technology is deployed in over 80,000 cellular base stations serving millions of commercial

customers principally in China and Japan, as well as other Asian countries. This technology is not a vague future promise – its proven, real, and widely used – but not yet in the U.S.

ArrayComm created a new service, *i-BURST*™, in an effort to demonstrate the principles of our spectrally efficient technology and to offer new services not available today to constituencies that are not served effectively today. *i-BURST* is a wide-area, high-speed, portable, wireless Internet access system. It is very efficient in terms of spectrum use, and can be deployed at significantly lower cost than generic 2G and 3G cellular data systems. *i-BURST* can provide each user anywhere, with an always on, Internet connection at data rates in excess of 1 Mbps per user, even in a fully loaded network. Operating on as little as 5MHz of unpaired band of radio spectrum and using time division duplex (TDD) transmission technology, *i-BURST* can bring high-speed wireless Internet access to people at far lower cost, by orders of magnitude, than systems designed for other purposes. Perhaps most importantly, its performance and its affordability make it a candidate for an array of applications of immense social value, such as tele-education and telemedicine, which may unfortunately not be served by standard commercial wireless systems.

ArrayComm is also working with U.S. and international standards and regulatory agencies to increase their awareness of how strategic spectrum allocations and the use of technologies like spatial processing can maximize the value of spectrum and enable the wireless industry to meet consumer demand.

On a larger scale ArrayComm is also a charter member of the TDD Coalition, which is a group of like-minded U.S. and international companies, all with applications and services built on the TDD technology platform. The Coalition was founded earlier this year to: (1) promote TDD technology for wireless broadband products and services; (2) promote TDD technology into market and regulatory environments for broadband wireless; (3) inform the industry about TDD technology, and its benefits to the global broadband wireless industry; (4) pool promotional resources to develop common marketing approaches as they relate to TDD; (5) inform and educate international and national regulatory bodies to ensure that technologically neutral rules are adopted to allow economical deployment of TDD technology for broadband wireless access; (6) create a collaborative industry voice to address issues relating to TDD; (7) develop implementation guidelines that will allow TDD deployments and insure harmonious coexistence of TDD with other duplexing systems; and (8) support TDD within global, regional and national standard organizations.

The TDD Coalition believes that policy makers and regulators can benefit from the Coalition's contributions, and perhaps most importantly, appreciate that there are many companies worldwide that are developing leading edge, spectrally efficient applications and services on the TDD technology platform. Commercial deployment of these applications and services will bring innumerable low cost, advanced data and voice applications and services to consumers worldwide.

What Can The Government Do?

What can the government do in the face of the fundamental limits on mobility spectrum? I

suggest that the government can do the following:

1. *Empower the FCC to reexamine all spectrum allocations, in light of what can be done with new radio technologies and the Internet.* The FCC and the Department of Commerce are currently doing the best that can be done in a very complex situation; handling an impossible task of satisfying so many constituencies. Commerce Secretary Donald Evans and FCC Chairman Michael Powell have demonstrated a commitment to make sufficient spectrum available for advanced wireless services. They have also acknowledged that time is needed to study options to develop a new 3G allocation plan that best serves the public. As they reexamine the issue, I encourage them to develop a more unified approach to spectrum management that offers long term solutions for serving *all* Americans with a wide variety of voice and data services more efficiently. Just as the Subcommittee did under the Chairmanship of Senator Inouye and the leadership of Members like Senators Hollings, Stevens and Burns, nearly 10 years ago when it carefully reviewed the feasibility of auctioning radio spectrum, so too should it carefully explore spectrum allocation and encourage the efficient use of spectrum by licensees.

2. *Put the public first.* The wireless industry has been focused on technology (illustrated by the myriad of acronyms such as CDMA, 3G, WAP, etc.), and is driven by delivering voice services. We need to challenge the industry to find the right solutions that will genuinely serve the masses with the Internet, which is a compelling matter for the telecom industry today. This will define an inclusive approach; to serve the elderly - the disabled – teenagers - the police-rural America. To serve all of the billions of people in the world who do not fit the profile of the traditional cellular subscriber.

3. *Hold spectrum users accountable.* Many companies will indeed need new spectrum, but we must first ensure that we are all using the spectrum we have to its highest spectral efficiency. After all, there are fuel efficiency standards for cars, and planes, why should there not be efficiency standards for spectrum use – a finite national resource? According to what I call Cooper's Law, there could even be spectral efficiency timed goals. For instance, the reason we provide more spectrum fast has little to do with international standards, but much more to do with potential demand. Like with any infrastructure requirement, when the demand is here, you do not start a new technology, you do more of the same (*e.g.*, when traffic jams become widespread, county authorities will first widen the road, and at some point prepare for mass transit). The most obvious thing to do, however, is to make sure that we – the industry – use as efficiently as possible the spectrum we have been allocated.

4. *Foster new radio technologies with inherently higher spectral efficiency.* New radio technologies have been developed in the past 10 years, which are drastically more spectrally efficient than the technologies used in cellular systems today, which are all evolutions of the standards developed 30 years ago. Built from the start to accommodate the Internet Protocol, they are eminently suited to carrying very affordably the new services that the public requires. ArrayComm is just one company that has developed technologies that can increase spectral efficiency. Neither Congress nor the FCC should be in the business of mandating technology or services. However, they can very well define guidelines to foster or specify minimum levels of spectral

efficiency in radio systems. Suitable allocations of TDD spectrum in the overall 3G allocations would foster their quick adoption and deployment.

6. *Promote "real" competition at home and abroad.* Without real competition we will not have much in the way of creative new services. Other countries are stimulating innovation and rolling out new mobile services because they have allocated spectrum for these services. We too would like many of these services at home. But to do so, the U.S. must allocate spectrum for these new services. Since this has already been done overseas, in one sense we are already behind.

7. *Avoid the trap of the "universal solution."* Universal gadgets that purport to do all things for all people do not do any of them well. There is no Holy Grail of solutions. People have different needs. They will need different devices and services to satisfy those needs. Future Americans will have lots of choices for their personal communications devices and services but all of them will interconnect. There will not be a universal network. Some networks will be optimized for voice and some for data. Some will be for travelers who need to communicate all over the world. Some will just service a neighborhood or small community.

Chairman Powell and the FCC have been supportive of the initiatives regarding spectral efficiency, TDD and new systems to serve the public. The FCC has provided ArrayComm with experimental licenses to test its technologies. If 3G allocations occur, as they have elsewhere, they will embrace both FDD and TDD spectrum and this will provide for the competition that is crucial to successful consumer services.

The Future

Despite the fine progress in cellular and other personal communications services in recent years, we have experienced only a glimmer of the impact that these services will have in the future. Delivering bandwidth to people has always increased their awareness of the world. Making high interactive bandwidth available at very low cost will have a profound effect. The practice of medicine, for example, will be very different, and far more effective, when a doctor can diagnose a patient remotely and immediately when the patient is sick – not when the patient can make an appointment. The days of delivery of music by CD, by cardboard and plastic, are numbered. Someone will develop a way to pay the artists and distributors and their choice of music will be delivered to people when they want it. The workplace will expand to be anywhere that the worker wishes to be and instant collaboration, enhanced by the ability to see and hear (and why not touch, smell and taste), will be a way of life.

The Internet will be truly meaningful to people only when it can be delivered wirelessly, at low cost, and with broad bandwidth. Efficient spectrum use will make that possible and will make the Internet a tool for everybody beyond the early adopters and "techies" who use it today.

Bandwidth Is Awareness And Mobile Bandwidth Is Freedom.

I thank the Chairman and Members of the Subcommittee for this opportunity to express my views today.