Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands	)	GN Docket No. 13-185

COMMENTS OF OCEUS NETWORKS, INC.

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EXECUTIVE SUMMARY

Oceus Networks, Inc. ("Oceus Networks") is a Reston, Va.-based provider of 4G, LTE-based wireless broadband solutions for Federal and commercial customers and uses, including for Department of Defense (DoD) tactical uses. Oceus Networks respectfully submits these comments in response to the Notice of Proposed Rulemaking ("NPRM") issued by the Federal Communications Commission ("FCC" or "Commission") on rules for the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz bands (hereinafter "the 1755-1780 MHz NPRM").[i]

In the NPRM, the FCC seeks comments on whether Federal users such as DoD could be provided access to the paired 1755-1780 MHz and 2155-2180 MHz bands "on Federal lands or properties that are generally unserved by commercial wireless networks."[ii] The 1755-1780 MHz band, a Federal band, is under consideration for reallocation for commercial use, while the non-Federal 2155-2180 MHz band is the desired downlink pair for U.S. wireless carriers to deploy LTE.[iii] Oceus Networks supports DoD access, on a limited geographic sharing basis, to the 1755-1780 MHz and 2155-2180 MHz bands on U.S. military bases and ranges for mission-oriented tactical LTE. With such access, the U.S. military could enjoy the benefits of a globally standardized technology, including commercial economies of scale and advanced capabilities for certain tactical applications. Moreover, those capabilities would be able to evolve alongside a commercial technology roadmap.

4G LTE is the national and global standard for advanced wireless networking. Manufacturers and wireless operators around the globe have invested billions of dollars in making 4G LTE technologies the commercial standard for delivering high-speed wireless communications. The four national U.S. wireless carriers have deployed 4G LTE networks, and Congress has established LTE as the standard for the new nationwide public safety network, FirstNet.[iv] As a global standard, LTE has a large "ecosystem" of standards and equipment established by manufacturers and operators. Global economies of scale foster the availability of a wide range of devices and equipment at varying price points. Each year, this ecosystem generates more network and device development, driving a "virtuous circle" of innovation and improvement.

Leveraging this ecosystem for certain tactical applications for the U.S. warfighter can provide advanced capabilities needed to meet the 21st century mission requirements. These technologies and applications will ensure that the U.S. military maintains information superiority and fields modern, enhanced situational awareness-based tactics and operations. Applications such as high-definition video delivery, transferring thermal imaging data, 3-D mapping, and

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[i] FCC, Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands (hereinafter "1755-1780 MHz NPRM"), *Notice of Proposed Rulemaking*, FCC Docket No. 13-102, rel. July 23, 2013.

[ii] *Id* at para 81.

[iii] *Id*.

[iv] Middle Class Tax Relief and Job Creation Act of 2012 § 6203(c)(2), Pub. L. No. 112-96 (2012).

other cloud-based services can be delivered over a 4G LTE tactical network onto a warfighter's smartphone or tablet. The ecosystem provides these capabilities at attractive price points, in the context of a technology roadmap that will continuously advance the latest technology.

In order to receive these benefits, it is critical to obtain access to frequencies that are supported by the LTE ecosystem. Limited geographic sharing of spectrum will allow the U.S. military to leverage the rapid development of LTE systems without impacting commercial service delivery in the 1755-1780 MHz and 2155-2180 MHz bands. Moreover, allowing sharing in these bands will promote the achievement of U.S. policy directives on sharing and commercial use of Federal spectrum bands.

Providing a limited geographic carve-out in the paired bands for U.S. bases and ranges located in remote and rural counties will enable these benefits. Limiting Federal access to these areas will provide more commercial spectrum throughout most of the country, while still allowing DoD to fulfill its "train as they fight" requirement before deploying systems overseas. As the most recent FCC 2013 Mobile Competition Report found, rural counties have fewer commercial providers of mobile broadband service than in urban counties, making such limited geographic sharing and coordination feasible.[v]

Providing access through geographic spectrum-sharing also is consistent with, and supportive of, directives by top spectrum policymakers up to, and including, the White House. It also encourages military adoption of commercial technology, another long-standing U.S. policy goal. By ensuring that spectrum is put to its fullest use across all geographic zones, the Commission can fulfill the public interest by maximizing the use of our nation's finite spectrum resources in pursuit of both economic and national security objectives.

Oceus Networks is attaching to this filing a white paper prepared for presentation to the FCC's Technological Advisory Council (TAC) Expanding Wireless COTS working group, in which representatives from Oceus Networks have been invited to participate. The white paper, titled "How Spectrum Sharing Enables DoD Tactical Use of LTE and Can Bring the Benefits of LTE to Other Specialized Users," highlights currently available solutions to accommodate sharing by different users groups. It also establishes that there is a strong technical basis for sharing to support a Commission decision to allow shared access to the paired bands.

With such a strong technical and policy basis to adopt the proposed sharing framework, Oceus Networks urges the Commission to help support a stronger national defense while promoting innovation and providing more spectrum for commercial services.

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[v] FCC, Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services,[hereinafter "2013 FCC Mobile Competition Report"], FCC 13-34, rel Mar 21, 2013 http://transition.fcc.gov/Daily_Releases/Daily_Business/2013/db0321/FCC-13-34A1.pdf at para 392. ("While rural mobile broadband coverage has improved, 1.3 million people in rural areas have no mobile broadband access. In addition, while 97.7 percent of the population in non-rural areas was covered by two or more mobile broadband providers, only 89.7 percent of the rural population was covered by two or more providers as of October 2012….Furthermore, 65.4 percent of the rural population was covered by at least three providers and 37.4 percent by at least four providers, compared to 97.7 percent and 92.4 percent, respectively, for the non-rural population as of October 2012.")

COMMENTS OF OCEUS NETWORKS

I. Introduction

Oceus Networks Inc. ("Oceus Networks") submits these comments in response to the Federal Communications Commission's (FCC's) Notice of Proposed Rulemaking on rules for the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz bands (hereinafter, the "1755-1780 MHz NPRM").[1] The FCC seeks comments on providing Federal users, such as the Department of Defense (DoD), shared access to 1755-1780 MHz. This is a Federal band that is under consideration for commercial use as a downlink band, to be paired with 2155-2180 MHz, a non-Federal band, for LTE deployment.[2] Oceus Networks supports limited geographic access for Federal users to these paired bands, 1755-1780 MHz and 2155-2180 MHz, on U.S. military bases and ranges for mission-based LTE solutions, if the National Telecommunications and Information Administration (NTIA) determines that reallocation of the Federal band is feasible and an auction of the lower 25 MHz proceeds. As the 1755-1780 MHz NPRM recognizes, limited, shared access to the paired bands would give the U.S. military the ability to leverage commercial, standards-based 4G LTE technology domestically to support U.S. military requirements to "train as they fight" before these systems deploy in overseas missions.

- Countless market studies and the current and projected global operator deployment plans bear out that LTE is the global standard for high-speed wireless communications. With 200 commercially launched networks and more than 200 more in trials or in various stages of planning or deployment[3], manufacturers, operators, and regulators have made LTE the

[1] FCC, Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands (hereinafter "1755-1780 MHz NPRM"), *Notice of Proposed Rulemaking*, FCC Docket No. 13-102, rel. July 23, 2013.

[2] *Id* at para 81.

[3] GSA - The Global mobile Suppliers Association, *GSA confirms 200 LTE networks are commercially launched in*

wireless technology standard for delivering mobile broadband. In doing so, they have invested billions of dollars in the technology.

- This investment in 4G LTE networks and equipment far outpaces the spending made on traditional U.S. military wireless technologies. 4G LTE's capability to deliver high-bandwidth data provides advantages over what many traditional military wireless communications systems can provide. The 21st century U.S. warfighter increasingly relies on modern, high-bandwidth communications to complete missions successfully. Enabling military use of 4G LTE can maintain U.S. information superiority and support modern, enhanced situational awareness – a requirement for U.S. military tactics and operations.

In short, providing access to 4G LTE will allow U.S. national defense users to access economies of scale found in the commercial ecosystem, which will bring greater choice in equipment and end user devices, such as smartphones and tablets, and lower costs as compared to traditional military systems.

II. Background

Oceus Networks, headquartered in Reston, Va., is a provider of 4G, LTE-based wireless broadband solutions for Federal and public safety customers, including for DoD tactical uses. By adapting standards-based commercial technologies to military applications, Oceus Networks offers DoD and its other customers the ability to use best-in-class capabilities and to access the latest commercial devices at far lower costs than those associated with traditional proprietary solutions. In adapting, but not deviating from, 4G LTE standards, Oceus Networks is solving relevant challenges with regard to the use of commercial technology for military and other users

76 countries, August 7, 2013; 4G Americas, 4G Americas Global Deployment Status Update, 15 August 2013 (197 LTE Networks in Service, 240 LTE Networks in Trial, Planned or in Deployment).

that rely on secure equipment in mobile tactical scenarios. These challenges include security, jamming, resilience, and mobility (i.e. how to maintain communications where the radio access layer is also moving) to meet the unique requirements of Federal government spectrum users.

In 2013, Oceus Networks helped the Naval Air Systems Command (NAVAIR) establish the first successful deployment of 4G LTE in a trial.[4] Oceus Networks is also working with other branches of the military on 4G LTE trials in various operating scenarios to demonstrate the value of 4G LTE for mobile tactical use. Oceus Networks helped the Navy introduce the first deployment of standard 3GPP LTE into the DoD. A key component of delivering a 4G LTE tactical solution to the Navy was assisting DoD and the National Security Agency (NSA) in developing a security architecture that could meet both agencies' security certifications for mobile secure communications.

III. LTE Provides a Commercial Technology Roadmap for Federal Users

Federal government use of commercial technology can provide greater capabilities than proprietary technologies at lower costs. Just as importantly, such use can provide a path for evolving capabilities as LTE technology advances. Nowhere is this trend seen more than in the rapid evolution of advanced wireless communications technologies. However, unlike commercial use in other domains, the use of commercial wireless technology by Federal agencies is dependent on access to frequencies that support a commercial technology ecosystem. Without this, Federal agencies lose access to economies of scale for equipment and the underlying research and development to evolve these technologies.

Spectrum policy is at a crossroads, in which sharing options are increasingly under study as viable options to maximize end users' growing spectrum needs. To this end, Oceus Networks applauds the FCC for considering shared use of a future commercial spectrum band by military

[4] Oceus Networks Press Release, *Oceus Enables 4G LTE Ship-to-Ship NAVAIR Communications,* March 21, 2013.

users. Oceus Networks submits these comments from the perspective of a real-world understanding of how to deploy commercial wireless systems for use by Federal agencies -- particularly the U.S. military. Oceus Networks looks forward to helping advance sharing principles that give the U.S. military critical capabilities for its 21st century mission.

IV. The Case for Geographically Limited Sharing of 1755-1780 MHz

The 1755-1780 MHz NPRM states that "shared use of spectrum bands by Federal and non-Federal users could facilitate the increased use of 'commercial-off-the-shelf' ('COTS') communication technologies to support important government missions, including military uses." The NPRM seeks comment on giving the U.S. military continued access to the existing Federal band, 1755-1780 MHz and its non-Federal pair, 2155-2180 MHz, on a geographically limited basis – i.e., "on Federal lands or properties that are generally unserved by commercial wireless networks." [5] Oceus Networks strongly supports this form of geographically limited sharing for military use of tactical LTE systems. Providing U.S. military access to this spectrum pairing is critical to support testing and training for tactical LTE systems domestically (on DoD bases and training ranges) before those systems are deployed overseas. This section establishes: (1) the sound national security basis for military use of tactical LTE; (2) the need for access to spectrum that is supported by a commercial ecosystem; and (3) the alignment of current U.S. spectrum and acquisition policies that underpin this type of sharing.

A. The U.S. Military Requires Advanced Communications Capabilities to Maintain Information Superiority

Military spectrum requirements are growing. Driven by increasing reliance on bandwidth-intensive applications, the military has a critical need for reliable, resilient, high-speed, high-bandwidth communications to complete its missions. Real-time, high-definition video feeds,

[5] *See* 1755-1780 MHz NPRM at para 81.

thermal imaging sensor data, mapping, and advanced messaging are just some of the applications driving the need for advanced wireless communications.

Over the last decade, however, commercial wireless technology development has outpaced military tactical communications capabilities, while reducing costs. Incoming U.S. military personnel are not only familiar with the capabilities of modern smartphones and tablets operating on high-speed networks, they expect to see and use those capabilities in their military roles. Failure of U.S. military technology to keep up with commercial advances would prevent U.S. soldiers from accessing, in the field, the advanced wireless broadband capabilities that are fully available to the average citizen.

Furthermore, without the capabilities available through commercial networks, the U.S. military may face real operational mission threats. Other countries could move faster in providing advanced wireless communications to their forces. In effect, enemy forces' willingness to leapfrog proprietary systems' lengthy development cycles, will, in some instances, present an operational risk to the U.S. military. In short, without access to commercially developed technologies, the U.S. military's wireless communications capabilities may fall behind those of other nations, including existing and future adversaries.[6]

B. LTE is the Global Standard That Can Provide U.S. Military Advanced Tactical Communications Today

The United States is the leader in deploying 4G LTE networks, and U.S. operators claim the largest LTE subscriber base.[7] Congress has established that LTE is the standard for the U.S.

[6] LCDR J.D. McCreary, Gaining the Economic and Security Advantage for the 21st Century: A Strategy Framework for Electromagnetic Spectrum Control, 31 August 2010, http://www.disa.mil/Services/Spectrum/~/media/Files/DISA/Services/Strategy_EMS_Control_31AUG2010.pdf

[7] CTIA The Wireless Association, CTIA-The Wireless Association® Semi-Annual Survey Shows U.S. Wireless Providers Invested Almost Six Times More Per Subscriber than Rest of World, May 2, 2013; *See Also* Steve Largent, U.S. is (Still) the World's 4G Wireless Leader, CTIA Blog, July 25, 2013.

nationwide interoperable public safety network, FirstNet.[8] Nations around the globe are coalescing around LTE as the wireless standard for delivering advanced communications to consumers. For certain military mobile broadband tactical applications, LTE can meet military needs, and it is supported by a robust ecosystem of devices, chipsets, and networking equipment that is available off-the-shelf today.

C. Providing DoD Access to Commercial Frequencies Supports U.S. Policy

In the past two decades, policymakers have increasingly sought opportunities for Federal agencies to use commercial technologies to lower costs and increase capabilities. The 1994 Federal Acquisition Streamlining Act simplified procurement of COTS technology. More recently, Federal advisory committees for the Department of Defense and the Department of Commerce have studied the benefits of purchasing commercial equipment. A task force established by the Defense Science Board, a Federal advisory committee to the Secretary of Defense, recommended acquisition policies that promote greater use of commercial and government off-the-shelf systems and programs to get new technologies into the field faster.[9] Last year, the DoD adopted its DoD Mobile Device Strategy, which recognizes the potential of commercial mobile device technologies to provide greater workforce mobility, increase mission effectiveness, and improve operational advantages.[10] So, the use of commercial technology by DoD is well established as U.S. policy and is endorsed by the DoD in recent policy documents.

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[8] Middle Class Tax Relief and Job Creation Act of 2012 § 6203(c)(2), Pub. L. No. 112-96 (2012).

[9] *See* Defense Science Board Task Force on Integrating Commercial Systems in the DoD, Effectively and Efficiently, Buying Commercial: Gaining the Cost/Schedule Benefits for Defense Systems, Report, February 2009, http://www.acq.osd.mil/dsb/reports/ADA494760.pdf.

[10] *See* Department of Defense Mobile Device Strategy, June 8, 2012, http://www.defense.gov/news/dodmobilitystrategy.pdf.

D. Spectrum Sharing is the Key to Meeting Growing Demand for Spectrum Access

Providing U.S. military users access to globally or regionally harmonized commercial frequencies will further the policy of promoting LTE use by Federal agencies. Use of Federal-exclusive spectrum alone cannot deliver the benefits of the LTE ecosystem that has been shaped by commercial industry drivers. Commercially available LTE technology can provide equal or better capabilities for certain tactical communications requirements.

The inherent challenge in giving the U.S. military access to commercial frequencies is that development of the commercial ecosystem could be undermined by reducing the geographic availability of spectrum needed to meet consumer demand. This could be an issue in dense urban markets, where the commercial need is greatest. But the current sharing and relocation assessment for 1755-1780 MHz presents a historic opportunity to address this challenge proactively. If an auction moves forward for this band, the Commission can help ensure that government users have continued, limited access to spectrum that is standardized for wireless 4G technology without jeopardizing the ability of commercial operators to deploy a network. This is because the geographic areas that these military installations cover, which are at issue in this part of the NPRM, are not densely populated and thus are not a priority for advanced network deployment by most operators. Further, the focus of this access would be to facilitate mission oriented tactical LTE coverage, rather than to replicate enterprise offerings provided by the major carriers. The FCC can develop an intelligent sharing framework for this band that strikes the appropriate balance between commercial and military access to 1755-1780 MHz and its paired downlink band, 2155-2180 MHz.

1. The Importance of Spectrum Sharing as Future Policy

Policymakers, academics, industry and DoD all acknowledge that some form of spectrum

sharing is the way forward to accommodate growing spectrum needs across many sectors in the U.S. NTIA's assessment of the potential for repurposing 1755-1850 MHz has underlined conclusions on the high cost and long timeline to accommodate exclusive commercial use. In its assessment, NTIA stated "that spectrum sharing is a vital component of satisfying the growing demand for access to spectrum and that both Federal and non-Federal users will need to adopt innovative sharing techniques to accommodate this demand." [11] The President's Council of Advisors on Science and Technology (PCAST) came to a similar conclusion after completing a two-year study on U.S. spectrum management policy. PCAST's study was spurred, in part, by the 2010 Presidential Memorandum titled "Unleashing the Wireless Broadband Revolution," which established the goal of making 500 MHz available for commercial use within 10 years. PCAST concluded that "clearing and reallocation of Federal spectrum is not a sustainable basis for spectrum policy due to the high cost, lengthy time to implement, and disruption to the Federal mission." [12] PCAST proposed a new, *de facto* norm that "spectrum use should be sharing, not exclusivity."[13]

2. Need for Bi-Lateral Sharing

While PCAST studied sharing as a solution to increase access to Federal frequencies for non-Federal/commercial use, its broader view that sharing should be the norm should lead to sharing as a "two-way street." That is, Federal agencies should have access to non-Federal frequencies.

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[11] *See* U.S. Department of Commerce, An Assessment of the Viability of Accommodating Wireless Broadband in the 1755-1850 MHz Band (Mar. 2012) *("NTIA 1755-1850 MHz Assessment Report")* (available at http://www.ntia.doc.gov/report/2012/assessment-viability-accommodating-wireless-broadband-1755-1850-mhzband) (last visited August 26, 2013).

[12] President's Council of Advisors on Science and Technology, Realizing the Full Potential of Government-Held Spectrum To Spur Economic Growth, July 2012.

[13] *Id.*

Recently, both the White House and the CSMAC[14] have advanced this two-way street view of sharing. A June 2013 Presidential Memorandum titled "Expanding America's Leadership in Wireless Innovation" strongly encouraged the FCC to work with NTIA to identify "spectrum allocated for non-Federal uses that can be made available to agencies, on a shared or exclusive basis."[15]

Sharing between existing U.S. military and new commercial systems in 1755-1780 MHz inevitably will occur for certain systems until they can be moved out of the band, or if NTIA and FCC agree to allow certain systems to continue to operate in certain areas. The NPRM considered this likelihood.[16] In fact, one CSMAC working group recommended that Tactical Radio Relay (TRR) and ground-based Joint Tactical Radio Systems (JTRS) share spectrum with commercial licensees on a limited basis, if the band is to be reallocated.[17] Hence, sharing within the band appears inevitable. Geographically limited sharing in the 1755-1780 MHz band to allow for the U.S. military to operate tactical LTE systems would occur on remote, rural training bases and range areas, minimizing the likelihood of interference to commercial operations. These areas in and around military bases historically have seen little or no commercial wireless

[14] Commerce Spectrum Management Advisory Committee, Proposed Future CSMAC Work, (July 18, 2013) (available at http://www.ntia.doc.gov/files/ntia/publications/proposed_future_csmac_work_07182013.pdf) (last visited August 26, 2013).

[15] Memorandum for the Heads of Executive Departments and Agencies, Expanding America's Leadership in Wireless Innovation (rel. Jun. 14, 2013), published at 78 Fed. Reg. 37431 (June 20, 2013) ("2013 Presidential Memorandum").

[16] *See* 1755-1780 NPRM at para 75. ("In the event that clearing is not feasible, we must prepare for the possibility that CSMAC may present a "hybrid" recommendation, in which some operations would be relocated, some would share the band with commercial licensees, and some (in geographic exclusion zones) would not share the band.")

[17] Commerce Spectrum Management Advisory Committee (CSMAC) Working Group 4: 1755-1850 MHz,Point-to-Point Microwave Tactical Radio Relay (TRR) Joint Tactical Radio System / Software Defined Radio (JTRS/SDR), Final Report, July 24, 2013.

network deployment of advanced services due to low population densities and poor economics.[18]

Further, Oceus Networks agrees with the FCC that "the use of such technologies might also increase electromagnetic compatibility with commercial uses, thereby facilitating greater shared use of spectrum."[19] In-band sharing between like systems (LTE) will be easier as opposed to sharing between LTE and radar, for example. Coordination between a DoD use and commercial LTE use will need to occur. However, coordination will be similar to negotiations between two neighboring commercial LTE licensees that need to assure network compatibility at their cell edges.

Shared access to 1755-1780 MHz and 2155-2180 MHz in these remote locations will allow the U.S. military to meet its "Train as We Fight" requirement domestically and maintain key capabilities while operating overseas.

V. The Advantages of Federal Use of Standard Commercial Wireless Technologies

The commercial wireless industry's spending on research and development of technology dwarfs investments in the proprietary systems traditionally used by Federal agencies, including the DoD. For example, for LTE, manufacturers invest billions of dollars annually in research and development.[20] Carriers, in turn, have spent billions of dollars more to deploy network

[18] Prior to awarding funding for the FCC's Mobility Fund Phase 1 Potentially Eligible Areas map, available at http://www.fcc.gov/maps/mobility-fund-phase-1-potentially-eligible-areas, shows no 3G coverage at portions of the Army's largest installation at White Sands Missile Range in Southern New Mexico, the Army's second largest installation at the neighboring McGregor Range Complex at Fort Bliss, and the Air Force's Nevada Test and Training Range. After awarding of Phase 1, the FCC Mobility Fund Phase 1 Auction Results Map showed many of these areas still unserved with 3G coverage. http://apps.fcc.gov/auction901/map/auction_result_ext.html These large military land areas have little population or populations concentrated at one location and are reserved for military training exercises. These areas are ideal candidates for two-way sharing.

[19] *1755-1780 MHz NPRM* at para 81.

[20] Marie Mawad, Huawei Ready to Outspend Ericsson in R&D Race to Woo Clients, Bloomberg News July 3, 2013. (In 2012 both Ericsson and Huawei spent nearly $5 billion each on research and development activities. Alcatel-Lucent's 2013 R&D budget forecasted at $2.6 billion)

infrastructure and update it as the technology advances. One analyst's study predicts that by 2017, U.S. LTE operators will incur $37 billion in capital expenditures building networks.[21] The Global mobile Suppliers Association's (GSA's) latest LTE device study, released in July 2013, found that 948 LTE-enabled devices from 100 manufacturers were available, of which 531 were launched within the last year.[22] As this trend demonstrates, the number of LTE devices available will only increase. Moreover, as LTE networks proliferate,[23] more powerful and capable devices will be available that are compatible with these networks. By tapping into these large economies of scale, DoD can take advantage of relatively lower price points and greater capabilities for certain applications.

Provision of U.S. military shared access to commercial frequencies such as 1755-1780 MHz is critical to opening up the use of this wide array of commercial-off-the-shelf devices and networking technologies. Deviation from standards or customization of equipment to non-standard 3GPP bands (i.e., bands not included among the 31 LTE spectrum band profiles) forecloses cost-effective and scalable access to the ecosystem of COTS equipment and future evolutions of the technology, multiplying the costs of system development.

The use of COTS LTE hardware also provides the ability to negotiate roaming deals with national and international carriers. The use of devices compatible with frequencies used by commercial network operators could, with appropriate commercial agreements in place, seamlessly roam from a military tactical network to a commercial network.

Access to commercial frequencies is the necessary ingredient to allow U.S. military users to

[21] New iGR study forecasts LTE infrastructure CapEx and OpEx spending for Regional & Small Operator market, Press Release, August 8, 2013.

[22] GSA confirms 948 LTE user devices announced by 100 manufacturers, Press Release, July 6, 2013 (http://www.gsacom.com/news/gsa_379.php)

[23] *See supra* note 3 (200 LTE Networks and 240 LTE Networks in Trial, Planned or in Deployment)

take advantage of commercial device and network capabilities, equipment cost savings, and device use while roaming off-base. Providing the DoD limited, shared access to 1755-1780 MHz and its downlink pair, 2155-2180 MHz, would realize these benefits.

VI. Accommodating Sharing for Military Use of Tactical LTE in 1755-1780 MHz

The 1755-1780 MHz NPRM seeks "comment on whether Federal users should be able to access the AWS-3 band(s), including spectrum not presently allocated for Federal use (e.g., 2155-2180 MHz), on Federal lands or properties that are generally un-served by commercial wireless networks."[24] Further, the NPRM notes "that such locations might include, for example, military training ranges in otherwise unpopulated areas and that Federal use of the band would be on terms and conditions consistent with the commercial service rules we establish in this proceeding and in future proceedings."[25] The Commission added, "We seek specific comment on any amendments to Section 2.103 of our rules or any other rules that might be appropriate for Federal use of such bands."[26]

This section specifically addresses these issues raised in the 1755-1780 MHz NPRM.

A. The FCC and NTIA Should Grant DoD a Primary Allocation for 1755-1780 MHz and 2155-2180 MHz for Military Use of Tactical LTE on Geographically Remote Military Bases and Training Ranges

Policymakers should enable geographically limited, shared access to the 1755-1780 MHz band and its downlink pair 2155-2180 MHz for use on remote military bases to support tactical LTE training. The current allocation for the 1755-1780 MHz band is for primary fixed-mobile use by Federal users. The current allocation for the 2155-2180 MHz band is for primary fixed-

[24] *See* 1755-1780 MHz NPRM at para 81.

[25] *Id.*

[26] *Id.*

mobile use by non-Federal users. Oceus Networks supports retaining Federal primary access to 1755-1780 MHz, with the addition of a primary or co-primary allocation for Federal users to 2155-2180 MHz on a geographically limited basis to allow use of the paired band on remote military bases and training ranges.

1. A Population Density Measure Should Be Used to Determine Whether a Military Base or Training Range is Eligible for a Primary or Co-Primary Allocation

To determine which bases should be deemed remote and thus eligible for shared access, Oceus Networks would recommend, as a starting point, the baseline definition the FCC adopted to designate between urban and rural areas. This definition was reiterated in the recent 2013 Mobile Competition Report to analyze service in rural areas.[27] The '"baseline" definition characterized as "rural" any county with a population density of 100 persons or fewer per square mile. As the Mobile Competition Report noted in observing the rural-to-urban population breakout: "These [rural] counties comprise 3.1 million square miles, or 86 percent of the geographic area of the United States." The report further noted that 19 percent of the U.S. population lives on 85 percent of the land.

An examination of the U.S. Census Bureau's July 2011 population estimates[28] shows some counties that have large military bases are slightly over the 100 person threshold. Densely populated areas in some of these counties could skew the density measure. To account for this, NTIA and FCC should provide flexibility in the rules to allow for military use on bases in portions of such counties that may have low population densities and, in fact, are far from dense

[27] FCC, Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services,[hereinafter "2013 FCC Mobile Competition Report"], FCC 13-34, rel Mar 21, 2013 http://transition.fcc.gov/Daily_Releases/Daily_Business/2013/db0321/FCC-13-34A1.pdf.

[28] *See* Population Estimates: Population Density for States and Puerto Rico: July 1, 2011, http://www.census.gov/popest/data/maps/2011/popdens-2011.html.

population clusters.

2. Limited Geographic Sharing on Remote Military Bases and Training Ranges Will Not Impact Commercial Services

Providing an allocation for tactical LTE on portions of bases or training ranges in rural counties would allow the DoD to test and train with LTE tactical systems while minimizing potential harmful interference to commercial services in populated areas. Areas with high population densities benefit the most from the availability of additional spectrum. These areas are primarily focused in urban centers or locations where large gatherings of people congregate, such as a sports stadium or music venue. Meanwhile, spectrum in rural counties is generally less congested, because the population is spread out over greater distances and fewer subscribers are being served by each cell tower.

The 2013 FCC Mobile Competition Report finding that rural counties have fewer providers offering mobile broadband service than in urban counties is reflective of this reduced demand for services and thus spectrum.[29] The need for spectrum is even less for potential commercial subscribers on large bases and training ranges in these remote counties, where there is actually zero population on much of the land outside of the base administrative center.

In adopting service rules for the 700 MHz band, the FCC agreed with commenters who asked that government lands be excluded when using geographic build-out benchmarks.[30] The Commission offered several reasons for doing so, including that "[i]n many locations, covering

[29] 2013 FCC Mobile Competition Report at para 392. ("While rural mobile broadband coverage has improved, 1.3 million people in rural areas have no mobile broadband access. In addition, while 97.7 percent of the population in non-rural areas was covered by two or more mobile broadband providers, only 89.7 percent of the rural population was covered by two or more providers as of October 2012….Furthermore, 65.4 percent of the rural population was covered by at least three providers and 37.4 percent by at least four providers, compared to 97.7 percent and 92.4 percent, respectively, for the non-rural population as of October 2012.")

[30] *See* FCC, In the Matter of Service Rules for the 698-746, 747-762 and 777-792 MHz Bands, *Second Report and Order*, WT Docket No. 06-150, et al., adopted July 31, 2007.

certain government land may be impractical, because these lands are subject to restrictions that prevent a licensee from providing service, or make provision of service extremely difficult." The Commission added that "government lands often include only very small portions of the population in a license area. [31] For these licenses, the FCC allowed the licensees to meet build-out benchmarks "by providing signal coverage and offering service to the relevant percentages of land in the service area that is not owned or administered by government."[32]

Limiting Federal use to certain remote areas in rural counties characterized by "small portions of the population," and where "provision of [commercial] service is extremely difficult," will allow spectrum that would otherwise lay fallow to be put to use for important national security and defense purposes.

B. The Need for Access to 2155-2180 MHz

Access to the paired non-Federal band 2155-2180 MHz along with the Federal band 1755 - 1780 MHz is critical to ensuring that DoD can fully leverage the commercial ecosystem. Using the same pairing as commercial licensees will ensure greater coexistence with neighboring LTE systems that commercial providers may deploy. A 25 x 25 MHz channel creates an opportunity to leverage LTE-Advanced capabilities. Moreover, the non-Federal pair will be characterized by the same likelihood of little or no deployment in remote and rural areas in and around military installations.

C. Amendments to Section 2.103 and Related Rule Changes

In the NPRM, the Commission suggested that amendments to Title 47, Section 2.103 of the

[31] *Id* at para 160.

[32] *Id.*

Code of Federal Regulations may be needed for Federal use of these bands.[33] Section 2.103 describes when the Commission can grant a Federal agency use of non-Federal frequencies above 25 MHz.[34] Among its provisions, Section 2.103 sets certain requirements that must be met for the Commission to authorize Federal use of non-Federal frequencies, including a) that "such use is necessary for coordination of Federal and non-Federal activities" and b) that "Federal operation has been certified [by the commercial licensee] as necessary."[35]

If access to the paired band cannot be accommodated through a primary or co-primary allocation in the Table of Frequency Allocations, the Commission should modify Section 2.103 of the Code of Federal Regulations to allow more flexible use of the 2155-2180 MHz paired band, as outlined above.

Additionally, the Commission may need to coordinate with NTIA to update regulations in the Manual of Regulations and Procedures for Federal Radio Frequency Management (the "Redbook").[36] Changes may be needed in three sub-sections of Chapter 7, which governs authorized frequency usage:

- Section 7.12 -- Use of Frequencies Authorized to Non-Federal Stations Under Part 90 of the FCC Rules;
- Section 7.15.3 -- Military Communications in Non-Federal Bands Above 25 MHz for Tactical and Training Operations; and
- Section 7.17 Military Communications At Test Ranges In Non-Federal Bands Above 25 MHz.

These regulations would need to be expanded to allow Federal use of the 1755-1780 MHz

[33] *See* 1755-1780 MHz NPRM at para 81.

[34] 47 C.F.R. § 2.103.

[35] *Id.*

[36] NTIA, Manual of Regulations and Procedures for Federal Radio Frequency Management (Redbook), May 2013 Edition.

and 2155-2180 MHz bands and, specifically for Section 7.17, to allow use at more bases that meet the population thresholds outlined above.

VII. Conclusion

For the reasons described above, Oceus Networks believes that the Commission has a strong policy and regulatory basis for limited geographic sharing on remote training bases and ranges for military use of LTE technology. Providing access to LTE frequencies will fulfill multiple U.S. policy objectives. Giving U.S. warfighters the capabilities they need is critical to maintaining our national security. Providing the U.S. military access to frequencies for use on military bases and training ranges encourages military adoption of commercial technology, another well-established U.S. policy. Further, providing this access through spectrum sharing will support directives by top spectrum policymakers up to, and including, the President.

However, sound spectrum policy requires firm technical grounding. The type of sharing envisioned by the Commission, and supported by Oceus Networks in this filing, is based on well understood technical principles. Attached to this filing as Appendix A is a white paper Oceus Networks prepared for consideration by the FCC's Technological Advisory Council (TAC) Expanding Wireless COTS working group, in which representatives from Oceus Networks have been invited to participate. The White Paper, titled "How Spectrum Sharing Enables DoD Tactical Use of LTE and Can Bring the Benefits of LTE to Other Specialized Users," highlights currently available solutions to accommodate sharing by different user groups.

The Commission has a strong technical and policy basis to adopt the proposed sharing framework. By doing so, the Commission can support a stronger national defense while promoting innovation and a strong economy.

Respectfully submitted,

/s Douglas C. Smith

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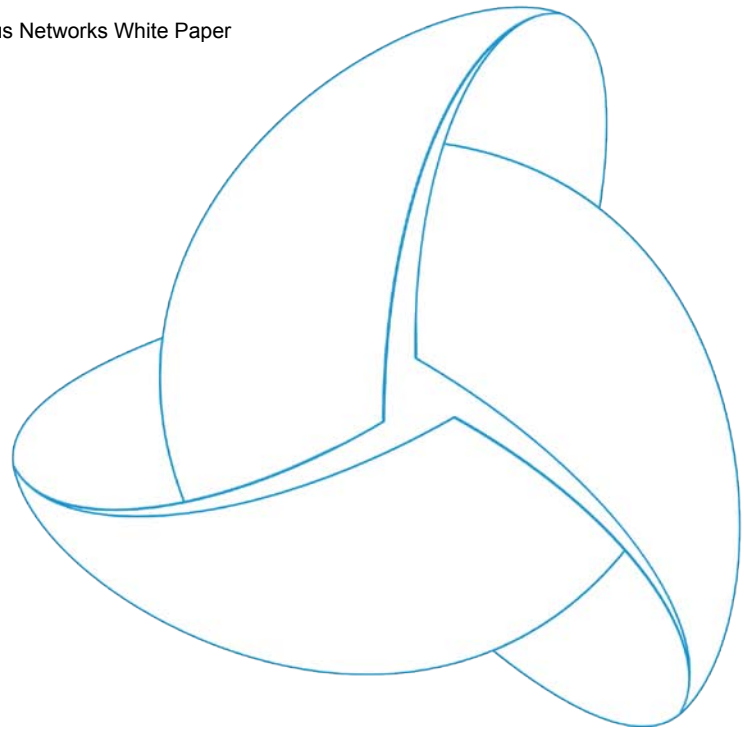
September 18, 2013



How Spectrum Sharing Enables DoD Tactical Use of LTE

and Can Bring the Benefits of LTE to Other Specialized Users

A White Paper by Oceus Networks

Prepared for the FCC TAC COTS WG

OCEUS NETWORKS

I. Introduction

Oceus Networks, Inc. is dedicated to solving some of the most challenging problems with military and other security users' reliance on commercial wireless LTE technology, including security, jamming, resilience, and full-scale mobility. The company has developed uniquely resilient and highly portable mobile broadband technologies to enable high-speed, high-bandwidth communications for the Department of Defense (DoD) in tactical environments, as well as for public safety agencies and other customers seeking these capabilities. Its modular, ruggedized, and highly portable 4G LTE broadband solution, Xiphos™, is being deployed by the DoD on a number of platforms, including airborne, maritime, ground vehicular, and soldier-carried (via backpacks), to enable specialized applications for tactical operations. These solutions offer far more capabilities than do traditional proprietary solutions -- at far lower price points. The breakthroughs achieved to support military tactical uses can be adapted to other specialized user groups that require secure, resilient and reliable communications in unique and challenging environments.

This paper explores (1) why spectrum sharing is needed to extend the benefits of LTE to a larger user base, (2) some of the inherent challenges with sharing, (3) available solutions to allow for sharing, and (4) use cases that illustrate the art of the possible. Implementing commercial technologies for non-carrier markets poses some of the most challenging conditions in which to adapt a commercial technology. Providing assured spectrum access is the key component to preserve core benefits of using a standard networking technology, including equipment economies of scale, access to applications and services, and the technology evolutionary roadmap.

On June 14, 2013, the President signed a Presidential Memorandum that directed the Commerce Department's National Telecommunications and Information Administration (NTIA) to collaborate with the Federal Communications Commission (FCC) to identify ways to provide agencies access to commercial spectrum on a shared basis.[1] In answering the President's call, the Commerce Spectrum Management Advisory Committee (CSMAC) has proposed studying how policymakers can provide government users greater flexibility to access non-federal bands.[2] The FCC has taken an important step forward in realizing the President's directive by seeking comments on whether the 1755-1780 MHz band could be shared for "increased use of `commercial-off-the-shelf' (COTS) communication technologies to support important government missions, including military uses."[3]

The FCC's Technological Advisory Council (TAC) presciently established the Expanding Wireless COTS Work Group prior to the release of the June 2013 Presidential Memorandum. As the group explores how to extend the use of wireless COTS solutions to specialized user groups, Oceus Networks' experience in developing and deploying commercial 4G LTE for DoD tactical solutions may

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[1] The White House, "Expanding America's Leadership in Wireless Innovation," *Presidential Memorandum*, June 14, 2013.

[2] CSMAC, Proposed Future CSMAC Work, July 18, 2013. http://www.ntia.doc.gov/files/ntia/publications/proposed_future_csmac_work_07182013.pdf

[3] FCC, In the Matter of Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz, (hereinafter "1755-1780 MHz NPRM"), *Notice of Proposed Rulemaking*, FCC Docket 13-102 (Rel. July 23, 2013), para 81.

prove informative in developing the spectrum and policy framework for use by a larger, more diverse user base. To this end, we respectfully present this white paper to the FCC TAC COTS.

II. The Case for Expanding Access to LTE Frequencies: Why Specialized User Groups Need Access to Supported LTE Frequencies

Beyond question, LTE is the dominant global wireless broadband standard, in which manufacturers have invested billions of dollars annually in research and development. Carriers are spending billions more to deploy networks. The use of COTS technology provides access to the latest wireless technologies, capabilities, and low-cost gear – the end-products of these massive investments. Thus, by taking advantage of the economies of scale and using a global standard, specialized users are better situated to build world-leading applications in their respective fields, and to remain on the broadband evolution path.

To achieve the cost savings and capabilities that commercial LTE offers, specialized users need access to frequencies that carriers are using worldwide to deploy LTE. Licensed wireless carriers drive the commercial ecosystem that ensures a thriving marketplace for low-cost devices and chipsets. Without access to this ecosystem, specialized users must pay manufacturers to customize chipsets and devices to use LTE. These costs can be orders of magnitude higher, because manufacturers cannot achieve the economies of scale for customized chipsets and devices over which to spread costs. Deviation or customization of gear for non-standard bands forecloses access to the ecosystem of COTS equipment and future evolutions of the technology and multiplies the costs of development. Stated succinctly, the benefits of specialized users' reliance on commercial LTE are greater bandwidth and flexibility to use the latest handsets and devices at a much lower cost than with traditional military radios.

Specialized user groups are typically not large enough to drive the development of new equipment designs. Any request made to add a non-standard 3GPP LTE band to equipment requires a manufacturer to invest in additional engineering and hardware design. Despite its very large organizational breadth, even DoD cannot attain the same scale and purchasing power as the commercial market. DoD's orders are for units in the tens of thousands, while commercial orders range into the millions to tens of millions of units. Without the support of the much larger commercial ecosystem, the cost of equipment production dramatically increases, to the point where product lines become un-economical.

Further, even if the specialized user group incurred the cost to add a non-standard band, this deviation would throw these users off the technology roadmap and prevent easily adding evolutionary LTE features that would help meet future data demands. For example, the pairing of 1755-1780 MHz with 2155-2180 MHz is not currently a defined and supported LTE band. As the standard-setting body for LTE, 3GPP will need to develop a new band profile or extend 3GPP Band Class 10 to encompass the full band.[4] Manufacturers will expend large amounts of money, time and engineering to develop and manufacture base stations and smartphones that can employ this new band. This investment depends on operators having access to the band for commercial use and in purchasing large quantities from manufacturers.

[4] The current 3GPP Band Class 10 downlink band is 2110-2170 MHz and the uplink band is 1710-1770 MHz.

A. Use Cases

Below are a few of the different military programs currently in process, for which LTE provides capabilities that are not possible with any existing systems.

1. Maritime

The U.S. Navy Naval Air Systems Command (NAVAIR) is trialing Xiphos capabilities on two Navy ships to enable ship-to-ship communications and assist with pirate interdiction activities. In the pirate interdiction use case, a base station is mounted on a helicopter that enables sailors to transmit secure high-definition video from forward attack boats back to the ship. These seamen are equipped with COTS smartphones that capture the video as they approach a pirate ship. As a result, systems on the ship can help address critical requirements for a VBSS (visit, board, search and seizure) mission.

2. Airborne

The U.S. Navy is trialing LTE on helicopters and enabling LTE on a UAV platform. The airborne platform offers ground troops the ability to share information as never before. The bandwidth that LTE provides enables real-time video from the "bird" in the sky and allows troops to witness maneuvers in a way that was not possible before LTE. The saying that "a picture is worth a thousand words" summarizes the step-change improvement in capability.

3. Ground Vehicular

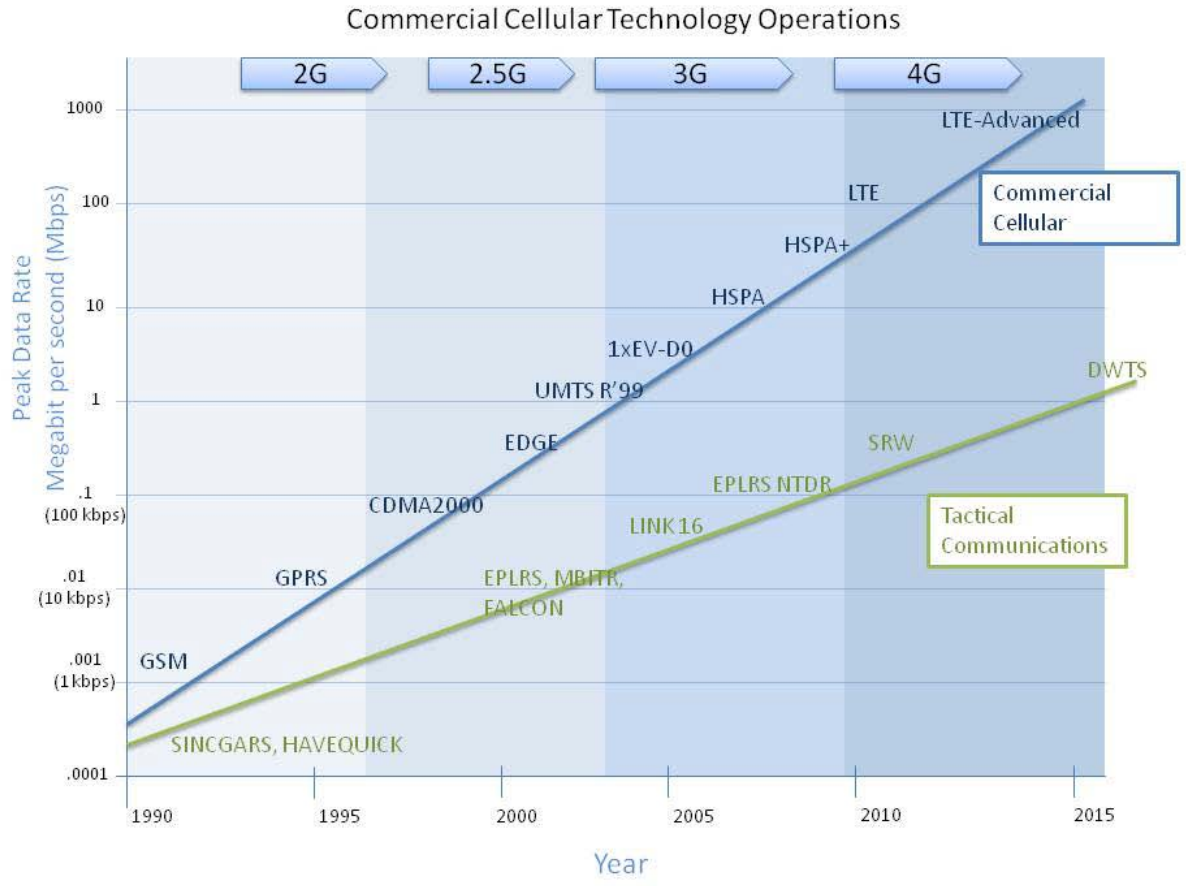
Vehicular mounted LTE systems are being used to provide troops with coverage areas around their vehicles. The soldiers that disembark from the vehicles now have access to all the sensors and systems onboard their vehicles. Previously, the soldier who disembarked was "flying blind," only accessing voice communications. That soldier now has full connectivity, whether inside or outside the vehicle.

4. Soldier-Carried (Backpack)

As troops disembark from their vehicles, they can remain relatively close to those vehicles (a distance of 1-2 kilometers) or they can be left behind, hundreds of kilometers away from the vehicles. When the soldiers are dismounted and no longer in coverage range of their vehicles, they continue to need their communications applications (both voice and the *new* advanced services). In this instance, a small, pico or micro, cell can be man-packed with the unit to provide local coverage.

B. Evolution of Commercial Cellular Versus DoD Tactical Capabilities

The figure below compares the evolution of commercial cellular technologies versus military waveforms developed for tactical communications. With LTE-Advanced, the top data-rate speeds achieved by commercial wireless are three orders of magnitude higher than those of existing DoD tactical communications technologies. By leveraging commercial cellular technologies, the DoD has an opportunity to increase its capabilities for certain applications needed to meet tactical operational requirements.



Using COTS technology also gives these specialized groups the ability to negotiate roaming deals with national and international carriers. Devices could, with appropriate commercial agreements in place, seamlessly roam from a government, public safety or utility network to a commercial network, thus widening the geographic reach within which a device could be used and increasing its utility to a user. This would possibly also allow various commercial carriers to expand the roaming of their customers into these remote areas. There are multiple network architectures, as defined by 3GPP, which can be used to implement sharing and enable roaming.

III. How LTE and Spectrum Sharing Can Support Commercial Wireless and Specialized User Group Networks

Available spectrum sharing techniques can enable commercial and private use of LTE networking technology. COTS LTE technology can support both time-based and geographic sharing. Using the same underlying networking technology also facilitates spectrum sharing. Attempting to share spectrum between disparate systems, such as radar and WiFi, for example, requires greater coordination and knowledge of the operating characteristics of the systems sharing spectrum. In contrast, sharing between systems using LTE will be much easier to accomplish, as both user groups will have a common understanding of how the technology works. In fact, today's network

operators may share spectrum in some locations where they operate LTE in the same frequencies in adjacent license areas (i.e. geographic sharing) or between users on the same network (time-based).

A. Barriers to Enabling Sharing of Commercial Frequencies

Spectrum sharing between a specialized user group and a common carrier may not be workable in all cases. Regulators may not have established the licensing framework to provide an opportunity for a specialized bidder to acquire a license for a much smaller geographic area to accommodate a private use. Commercial licenses may also carry additional obligations such as universal service, reporting, and other regulatory requirements that would impose an outsized burden on a specialized user that is not serving the general public.

B. Secondary Market Rules are a Possibility, but In Practice Have Limited Success

The FCC's secondary market transaction framework is a possible avenue for specialized users to gain access to spectrum suitable for LTE. In populated areas where an FCC licensee has strong demand for wireless services, economics encourages them to utilize their licenses in building out networks. However, the economics of building out networks is less favorable in remote, sparsely populated areas. FCC licensees in these locations may not be able to justify a business case to build out spectrum. Therefore, they may consider a secondary market arrangement through a lease or disaggregated spectrum deal.

While the FCC rules permit such secondary market arrangements, in practice this path presents challenges. In some cases the frequency bands that are available may be fragmented across multiple licensees. They would not provide the adequate contiguous frequencies to enable LTE. In some other cases, the coverage area sought by a specialized user group may be too small for an FCC licensee to consider, especially where the transaction costs exceed the value of the secondary market transaction. In the absence of a functioning market for providing access to specialized users, a spectrum-sharing regulatory framework may be required to enable spectrum use in parts of the U.S. that otherwise would not be well served due to poor nationwide, regional, or rural wireless carrier economics. Making spectrum usable in geographic areas where spectrum lies fallow could enable use of commercial wireless technologies such as LTE by a broader user group.

C. FCC Consideration of Limited Geographic Sharing In 1755-1780 MHz for Military Use Presents an Opportunity To Facilitate Greater Specialized User Sharing

The recent 1755-1780 MHz NPRM proposes sharing between different user groups in a meaningful and groundbreaking way. The auction rulemaking contemplates formalizing geographic sharing rules for federal users "on Federal lands or properties that are generally un--served by commercial wireless networks." The rulemaking proposes sharing between commercial and federal users, a specialized user group, by relying on geographic sharing, a currently available sharing technique. Sharing on the proposed basis presents an ideal for sharing between users and increases the overall use of the band. Federal users' access to LTE spectrum will have limited impact upon commercial wireless deployment, as the areas suggested by the 1755-1780 MHz NPRM are in remote locations that are generally un-served or underserved by commercial carriers. While various sharing access methods are available currently, the arrangement proposed in the NPRM offers federal users long-term sustained spectrum access and therefore, the ability to make long-term investments in the technology.

D. The Policy Momentum Behind Federal Access to Non-Federal Frequencies

The FCC's NPRM sharing proposal advances sharing principles and goals recommended by the June 2013 Presidential Memorandum, which strongly encouraged the FCC to work with NTIA to identify "spectrum allocated for nonfederal uses that can be made available to agencies, on a shared or exclusive basis."[5] Previously, NTIA [6] and the President's Council of Advisors on Science and Technology (PCAST)[7] had called for increased sharing, recognizing that freeing spectrum for exclusive use is unsustainable on a long-term basis due to the high costs and long timelines of relocating Federal operations. The CSMAC is set to further study how to provide federal user access to non-federal spectrum.[8]

To summarize, technology, policy and business arrangements can all facilitate spectrum sharing. Agreements between specialized user groups and commercial wireless carriers can lead to shared use of spectrum while minimizing interference. However, the current incentives and regulatory framework must be in place to help allow greater use of commercial wireless technology.

IV. Sharing Techniques To Allow Broader LTE Use

Sharing spectrum to accommodate both commercial and government or utility use of LTE can be accomplished with a variety of solutions. Even in its current state of development, LTE supports ample sharing opportunities. Current LTE specifications provide many network architectures to support sharing.

A. Leasing and Coordination between Specialized Users and Commercial Carriers

A business arrangement between a specialized group and a commercial carrier that holds an FCC license could establish the terms of shared access. In this context, any sharing will be dictated by the terms of the agreement. Spectrum access by the specialized user could be facilitated by geographic or time-based sharing, and use would be closely coordinated between the two. One or more technical approaches could be used to allow for sharing. Geographic sharing and coordination occurs today between two LTE operators when they are both operating at the edge of their license boundaries and interfere with one another.

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[5] The White House, "Expanding America's Leadership in Wireless Innovation, Presidential Memorandum," June 14, 2013.

[6] NTIA, An Assessment of the Viability of Accommodating Wireless Broadband in the 1755 – 1850 MHz Band, March 2012. (NTIA concluded it was possible to clear 95 MHz of 1755-1850 MHz for commercial wireless, assuming relocation of most existing Federal users at an estimated cost of $18 billion over 10 years).

[7] President's Council of Advisors on Science and Technology (PCAST), Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth, *Report to the President*, July 20, 2012.

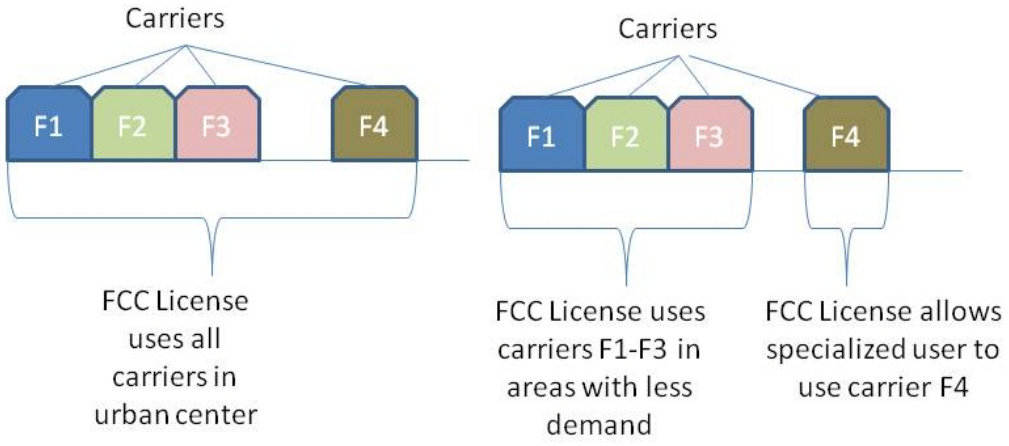
[8] CSMAC, Proposed Future CSMAC Work, July 18, 2013.
http://www.ntia.doc.gov/files/ntia/publications/proposed_future_csmac_work_07182013.pdf

However, a commercial wireless carrier must be willing to enter into a secondary market agreement, which could limit the efficacy of this approach for a specialized user to gain the necessary spectrum needed to use LTE. The willingness of the wireless carrier to provide the specialized user an acceptable price and duration for the spectrum arrangement is critical before a specialized user will invest in new technology. Historic experience to date does not inspire full confidence. Hence, the high level of risk in relying on this approach is highlighted.

B. Carrier Aggregation

A new iteration of the LTE specification allows the combination of smaller blocks of disparate spectrum to form a larger, contiguous, virtual block. This technique is known as *carrier aggregation*. It will allow more 3GPP LTE spectrum to be used in higher-capacity configurations. Carrier aggregation can also provide greater flexibility for specialized user groups to access spectrum. Equipment manufacturers currently have developed the first products to reach the market. Others are expected as the adoption of LTE-Advanced takes off.

One potential sharing mechanism based on carrier aggregation can support both time and geographic-based spectrum sharing. For example, commercial wireless operators can designate aggregated carrier bands F1 through F4 to support subscribers in some geographic areas of the network, while assigning only aggregated carrier bands F1 through F3 to support subscribers in limited geographical areas. This schema frees up carrier band F4 for sharing with specialized user groups in those limited geographical areas. Under this scenario, a commercial wireless subscriber will experience seamless connectivity throughout all geographical areas, while simultaneously allowing for specialized user network operations in certain agreed-upon areas.



V. Techniques To Manage Interference Improvements to Inter-cell Interference Cancellation in LTE

Inter-cell Interference Cancellation (ICIC) is a method to reduce the interference between adjacent LTE cells. Because LTE is designed to use the same frequencies across all cells, interference levels can be high, but this technique maximizes the efficient use of the spectrum by reducing interference and improving throughput. Adjacent cells communicate with each other across the backhaul infrastructure and decide who uses which pieces of the configured bandwidth when the cell loadings are below maximum.

However, today ICIC can only be used within one carrier's network, not across boundaries between two carriers that own or use the same licensed spectrum bands. In typical cellular systems, the full RF bandwidth is usually not utilized to allow for peak usage periods. In a new scheme called *Dynamic Inter-Operator Spectrum Allocation*, any unused spectrum could be temporarily allocated to another operator in a spectrum-sharing arrangement. Priority could be given to the primary spectrum owner, if necessary, to avoid impact to system capacity during peak usage.

Enhancements to ICIC that can allow for two or more operators to coordinate use would extend the degree of sharing possible between two systems. These enhancements could allow a moving network node, such as one mounted on a vehicular or man-portable platform, to dynamically operate within the presence of other macro, micro, and femto fixed infrastructure.

A. Self-Organizing Networks (SONs)

Self-Organizing Network (SON) technologies enable a network to dynamically and autonomously coordinate different-sized cells (macro, pico, micro) and networking technologies (e.g., WiFi and LTE) to act as one seamless "heterogeneous network" (HetNet). SONs may help increase shared use between different user groups (specialized and wireless carrier) in a similar manner. The underlying technologies may help contribute to shared spectrum access for specialized user groups with less interference to carrier operations.

Advanced interference detection and mitigation techniques are in the early stages of discussions between the various vested parties. The advancement of the ICIC is required, not only between nodes in one network, but between nodes in multiple networks. As HetNet architectures evolve, the coordination (both manual and automated) and the tools required to manage this will become increasingly complex. These need to be expanded to make efficient use of all spectrum.

B. Multi-Band Radios

As operators deploy LTE on multiple networks and strike roaming deals with international roaming partners, manufacturers must develop handsets and devices that are capable of operating on multiple LTE frequency bands. The availability of these devices gives an LTE user flexibility to operate on multiple bands if one band is occupied. Use of multiple band radios becomes important when deployable LTE systems are being used. For example, the military is currently deploying LTE systems that support multiple radios, each tuned to a separate LTE band. This multi-band LTE system not only allows for better interference management, it facilitates global roaming capabilities because operating these devices overseas may cause interference to international network operations. In a tactical setting, military use of multiband radios enables devices to be more resilient to jamming if an adversary jams one or more of the LTE spectrum bands.

VI. Conclusion

While LTE may not be appropriate for all potential uses, innovative approaches to spectrum sharing can offer the access needed to open up LTE -- the global standard and ecosystem for high-speed wireless -- to a user base that is fulfilling critical security missions, including advancing U.S. national security and public safety. In the process, a path will be opened for more expansive specialized uses for other sectors of the U.S. economy, as well. If sharing techniques to provide the necessary spectrum access are successfully achieved, not only will defense and security users realize

high dividends for LTE, but this breakthrough will pave the way for other specialized users to leverage the benefits of a globally backed commercial wireless technology and its ecosystem.

The universal adoption of LTE as the technology to deliver high-speed, high-bandwidth communications capabilities has created an opportunity for DoD as well as other specialized user groups to utilize LTE for their own tactical wireless needs. The ecosystem of devices, chipsets, and related hardware and software cannot be matched, in many cases, by specialized hardware or software that DoD or these other groups develop, nor can they keep up with the rapid evolution of the technology that we are witnessing today.

However, the key policy ingredient is assured spectrum access to bands that support 3GPP profiles for operators' LTE deployments. Without spectrum access, DoD and others cannot enjoy the cost and capability benefits of LTE. In the DoD tactical environment, LTE offers a way to deliver high-speed, high-bandwidth, secure communications that existing DoD solutions cannot match. Other specialized groups, too, need these capabilities, which cannot be obtained through alternate technologies. As the global marketplace has converged on LTE, FCC and NTIA regulators must seek solutions to provide spectrum to enable these users and industries to keep pace.

Spectrum sharing offers the best possibility for more user groups to take advantage of these benefits. Technology, business arrangements, and appropriate policies can enable greater spectrum sharing today. The current state of LTE can support spectrum sharing as long as carriers are open to entering into the necessary business arrangements. In the U.S., the current regulatory framework does not present a barrier to sharing; however, as NTIA, FCC, and the Administration have acknowledged, more effort is needed to enable greater sharing. Oceus Networks' work with DoD, public safety, and others illustrates this reality. For this reason, Oceus Networks welcomes the opportunity to contribute to identifying approaches to facilitate more sharing to extend the benefits of LTE to a larger user base.

Oceus Networks will to continue to identify and advance innovative sharing policies and techniques with policymakers, the technical community, and specialized users groups. Leveraging commercial technologies such as LTE across a large industrial base helps to maintain and extend U.S. leadership in these respective areas, a goal to which Oceus Networks is firmly committed.