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

Table of Contents

Executive Summary

This report has been produced as part of the Commerce Spectrum Management Advisory Committee's (CSMAC) ongoing analysis of ways to facilitate the implementation of commercial wireless broadband in the 1755-1850 MHz band. The systems that Working Group (WG) 4 was responsible for assessing were Fixed Point-to-Point, Microwave, Tactical Radio Relay (TRR), and ground-based Joint Tactical Radio Systems (JTRS).

The WG decided quickly that the recommendation for Fixed Microwave would be relocation per the conditions outlined in the National Telecommunications and Information Administration (NTIA) 1755-1850 MHz Assessment Report. This decision was prompted by the outcomes of the 1755-1850 MHz evaluation that fixed microwave systems are considered to be relatively easy to relocate due to the ready availability of commercial technology to re-establish these systems in other frequency bands and the low estimated cost associated with relocating these systems, assuming favorable site conditions.

With regard to TRR and JTRS, the WG conducted initial analysis using agreed methodology and approaches for four representative sites each based on analysis of interference into both Department of Defense (DoD) systems and commercial systems. The results of the sharing analyses conducted thus far indicated that separation distances on the order of hundreds of kilometers would be necessary to ensure that federal and commercial Long Term Evolution (LTE) systems would not cause harmful interference to each another. Based upon the results of these analyses, the WG makes the following recommendations:

- Relocate Fixed Point-to-Point Microwave Systems.
- Vacate TRR systems from the 1755-1780 MHz band into the 1780-1850 MHz band and into alternate spectrum.
- Transition Plans for TRR systems should be developed with consideration of the list of Economic Areas (EAs) ordered according to industry geographic implementation priorities, noting the exact order in which DoD would be able to relocate or compress would be based on operational requirements that may vary from the order of commercial priorities.
- Study Protection Zone analysis methodologies for TRR and JTRS with a goal of improving the assumptions and approach used in the analysis.
- Apply any changes in the analysis methodology to all locations identified as requiring Protection Zones for TRR and JTRS.
- Impacted federal agencies will develop Transition Plans for their respective TRR systems that address relocation of assignments, compression above 1780 MHz and comparable spectrum.
- Develop a sharing approach to permit commercial wireless broadband deployment in Protection Zones for both TRR and JTRS.
- Allow TRR systems to remain in the 1755-1850 MHz band in regions where there is little or no commercial deployment.

- Develop a sharing approach to permit the deployment of TRR systems in the 1755-1850 MHz band in regions where there is no current or forecasted commercial deployment.
- Develop a sharing approach to address point or local area TRR assignments that are replacements for statewide assignments. A sharing approach is only necessary if relocation compression is not feasible.
- Develop a method, including a testing program, to demonstrate the viability and effectiveness of interference protection/mitigation methods proposed by licensees before commencing deployments of base stations in any Protection Zones. This effort should include industry, impacted federal agencies and regulators.

The WG notes that while there was general agreement on most recommendations, there were two areas where DoD and Industry did not fully agree.

With respect to the fourth bullet above (Study Protection Zone analysis methodologies for TRR and JTRS with a goal of improving the assumptions and approach used in the analysis), there is disagreement on the study of interference protection criteria (IPC). Industry believes that the study of interference criteria would be beneficial, while DoD believes that the current interference criteria are appropriate for all the systems that are operating in the band.

With respect to the seventh bullet above (Develop a sharing approach to permit commercial wireless broadband deployment in Protection Zones for both TRR and JTRS), there is disagreement regarding commercial licensee operations within Protection Zones, specifically regarding interference into commercial licensees. DoD requires commercial licensees to demonstrate technology or techniques that ensure LTE operations/networks can accept interference from operations within the Protection Zones, all prior to deployment of base stations. However, industry insists that long-standing practices for agreeing to accept interference in such situations is sufficient.

The WG also notes that several of the above recommendations suggest additional work and study.

1 Introduction

On March 27, 2012, NTIA released a report, developed in collaboration with those incumbent federal agencies, on the viability of accommodating commercial wireless broadband in the 1755-1850 MHz band.[1] The report concluded that the entire 95 MHz of this band could be repurposed for wireless broadband; however, in light of several critical challenges related to the estimated timelines, costs, and complexities of completely clearing all of the federal users currently in the band, methods employed in the past for freeing up federal spectrum for commercial wireless by relocating federal users to other bands is, in this case, problematic. As a consequence, NTIA proposed a new path forward that relies on a combination of relocating federal users and sharing spectrum between federal agencies and commercial users while ensuring no loss to federal critical capabilities.

It was in this spirit that in May 2012, the NTIA formed five working groups (WGs) under the CSMAC as a means for federal agency representatives to interface with industry experts to address the aforementioned challenges and to develop clear relocation, transition, and sharing plans for the 1695-1710 MHz band and the 1755-1850 MHz band. The working groups, each tasked with addressing a specific set of federal operations within these two bands, are as follows:

- Working Group 1 – 1695-1710 MHz Meteorological-Satellite[2];
- Working Group 2 – 1755-1850 MHz Law Enforcement Video, Explosive Ordnance Disposal, and other short distance links;
- Working Group 3 – 1755-1850 MHz Satellite Control and Electronic Warfare;
- Working Group 4 – 1755-1850 MHz Tactical Radio Relay, Fixed Microwave, and ground-based software defined radios; and
- Working Group 5 – 1755-1850 MHz Airborne Operations (Air Combat Training Systems, Unmanned Aerial Vehicles, Precision Guided Munitions, airborne software defined radios, and Aeronautical Telemetry)

NTIA provided a set of instructions to the WGs for working within CSMAC including:[3]

- The WGs should first emphasize approaches to sharing, whether as a permanent solution (Do the agencies actually have to move?) or as the means to facilitate access during relocation transition.
- Noting both the 1755-1850 MHz report findings and the industry priority to get access to the 1755-1780 MHz band, approaches should be considered that make that lower band available first, but approaches that consider providing 1755-1780 MHz access without also dealing with the rest of band up to 1850 MHz will not meet agency concerns.

[1] NTIA, "An Assessment of the Viability of Accommodating Wireless Broadband in the 1755 – 1850 MHz Band", March 2012 (NTIA Report)

[2] Due to the fact that WG had a deadline much sooner than the other groups, it also developed an agreed set of technical parameters for the commercial LTE systems, that was subsequently used by all work groups.

[3] NTIA "Instructions to the CSMAC Working Groups", June 28, 2012

- The WGs should explore, where appropriate, whether commercial network solutions can support agency needs via a shared technology approach.
- WGs should seek to determine, via analysis or testing as appropriate:
    - what the potential real impact is from or to the government operations,
    - whether that impact is acceptable, and
    - what restrictions have to be placed on the commercial operations.
- Where the commercial providers determine that the potential impact is acceptable, based on current federal operational parameters, the WG should develop a regulatory concept that ensures that operators do not raise future issues regarding such interference.
- If, in any case, the WGs conclude that sharing is not possible, then they need to discuss transition approaches and critical information to support transition. Furthermore, NTIA will need to begin efforts to conclude on alternative spectrum. This may require additional FCC rulemakings which may further delay entry into the band. Therefore, WGs should explore all possible sharing solutions before reporting that sharing is not possible.

On March 20, 2013, the FCC notified the NTIA that it planned to commence the auction of licenses in the 1695-1710 MHz band and the 1755-1780 MHz band as early as September 2014.[4] The noticed recognized that:

> "CSMAC's recommendations, if adopted by NTIA, will inform service rules for both the 1695-1710 MHz and 1755-1780 MHz bands, including terms of sharing and required protections. Accordingly, we expect that an auction of these bands would follow successful completion of the CSMAC process the acceptance of the recommendations by NTIA, completion of the CSEA technical review process, and completion of the Commission's rulemaking process with respect to these bands."

In response to this letter, the NTIA informed the FCC that:

> "…while we recognize that pairing and auctioning the 25 megahertz of spectrum in the 2155-2180 MHz band with the same amount in the 1755-1780 MHz band will be a primary option for the FCC and the commercial mobile wireless industry, we appreciate your recognition of the potential need to address rules to accommodate the phased reallocation of the entire 95 MHz of the 1755-1850 MHz band. Most federal functions in the band require and operate throughout the entire 1755-1850 MHz band to meet their missions.[5] Given the focus on the lower 25 megahertz, whether as part of a relocation or a sharing arrangement, the FCC will need to consider the potential for a phased transition to facilitate commercial access to the 1755-1780 MHz band in a shorter timeframe while preserving longer-term repurposing and transition opportunities for the entire 1755-1850

---

[4] See FCC letter to The Honorable Lawrence E. Strickling, March 20, 2013, DOC-319708A1.pdf

[5] See Letter from Assistant Secretary Strickling to FCC Chairman Genachowski on the planned auction of licenses in the 1695-1710 MHz Band and the 1755-1780 MHz Band; April 19th; http://www.ntia.doc.gov/files/ntia/publications/ntia_letter_to_fcc_chair_re_1695_and_1755_auction_20130419.pdf

MHz band. If an FCC auction of the 1755-1780 MHz band results in the relocation of or sharing with federal systems that currently have access to the entire 1755-1850 MHz band, agency Transition Plans for the lower 25 megahertz will need to account for those systems, even if the FCC holds multiple auctions over time."

Accordingly the main focus of WG-4 has been on investigating sharing, with a view to early access of the 1755-1780 MHz band, but always in the context of a solution for the entire 1755-1850 MHz band.

This report presents the results of WG-4's investigation of the prospects for sharing between incumbent Tactical Radio Relay and ground-based software defined radio operations (JTRS) with broadband wireless entities in the 1755-1850 MHz band.

2 Background

The systems identified in the NTIA Report for review and analysis by the WG included: Fixed Point-to-Point Microwave, Military Tactical Radio Relay (TRR) and Software Defined Radio (SDR) / Joint Tactical Radio Systems (JTRS). These systems are described briefly below and in more detail in Appendix 2.

2.1 Fixed Point-to-Point Microwave

Fixed point-to-point microwave systems are used for the transmission of voice, data, and/or video in support of law enforcement, military command and control, emergency preparedness and response, the national air space system, energy grid control, and resource management activities. These systems also support the distribution of meteorological data to a variety of users including the public. These microwave systems provide service where commercial options are either unavailable, too expensive, or do not provide the level of reliability required by federal users.

2.2 Military Tactical Radio Relay (TRR)

The DoD operates tactical communications systems that provide mid- to high-capacity digital information to battlefield commanders. The locations of all TRR operations are provided in Appendix 2, Table 6. There are several types of systems that include Army High-Capacity Line-of-Sight (HCLOS) systems and multiple types within the Navy and Marine Corps Digital Wideband Transmission System (DWTS). These are outlined below and described in more detail in Appendix 2.

2.2.1 Army High-Capacity Line-of-Sight (HCLOS)

Army TRR systems provide wide area communications for Army tactical deployments at the battalion, brigade, and division levels. These systems, typically deployed up to 30-50 kilometers apart, provide high-throughput data communications from command and control traffic to intelligence imagery, logistics, medical, and morale and welfare support. The HCLOS system currently tunes to the 225-400 MHz and 1350-2690 MHz bands and provides a digital microwave backbone to link battlefield commanders. These systems operate like high-capacity cellular telephone systems with highly transportable base stations. The ability to set up, to establish a link to higher headquarters and subordinate units, and then to take the link down and to move it is key to the survivability of the headquarters units and supports the concept of maneuver warfare. Frequent field training is required to ensure that soldiers can quickly establish a network of tactical microwave links. The AN/GRC-245 is the Army's primary TRR system that will replace its legacy TRR systems (AN/GRC-226 and AN/VRC-99B).

2.2.2 Navy and Marine Corps Digital Wideband Transmission System (DWTS)

The DWTS provides a backbone digital communications capability supporting amphibious and ground combat operations. The DWTS supports command, control, and data transfer from the Marine Expeditionary Force and supports training and operations at a number of locations throughout the United States. The Marine Corps version of this system provides digital backbone services (voice, video, and data) for shore-to-shore and/or ship-to-shore communications links. This radio system is the only transmission media available to the Marine Corps with sufficient bandwidth to carry large quantities of critical data, such as maps, overlays, intelligence pictures, and other data to battlefield commanders. The Marine Corps currently employs three variants of the DWTS. The Navy shipboard DWTS system tuning range is limited to 1350-1850 MHz. Two variants are limited to the tuning range between 1350 and 1850 MHz. The third tunes between 1350-2690 MHz, but is not compatible with the other two variants. The Navy has a ship-to-shore version of DWTS.

2.2.3 Relocation of TRR systems and updated information

While the relocation details of the TRR systems were provided in the March NTIA report[6], DoD provided the following updates on May 21, 2013[7], based on further operational impact assessment conducted concurrent with the WG4 analysis effort, which determine:

- The following highest priority training DoD installations/locations would require Protection Zones indefinitely:

Continuing Army TRR Locations	Continuing USN/USMC TRR Locations
Fort Irwin, CA	Bogue Field, NC
Fort Polk, LA	Panama City, FL
Fort Bliss; TX and WSMR	MCAS Yuma, AZ
Fort Hood, TX	Twenty-Nine Palms, CA
Fort Bragg, NC (Includes Camp MacKall)	MCB Camp Pendleton, CA
Yuma Proving Ground , AZ	MCB Hawaii (Kaneohe Bay), HI
	Apra Harbor, Guam

- The remaining TRR locations would either compress into 1780-1850 MHz if feasible to fit TRR assignments in the 1755-1780 MHz band into the upper 70

[6] NTIA Report at Table 4-3, p 28.

[7] This information was provided as edits to this WG-4 report.

MHz[8] or relocate out of the 1755-1850 MHz band to identified comparable spectrum (consistent with the NTIA Report).

- Army National Guard statewide assignments would be replaced with point or local area assignments at the National Guard base locations as follows:

State	Cities With Continued TRR Operation
Arizona	Casa Grandee, Papago Mine, Chandler, Marana, Phoenix
Illinois	Chicago, Carbondale, Crestwood, Marion, Kewanee, North Riverside, Springfield
Indiana	Elwood, Anderson, Greenfield, Indianapolis
Iowa	Cedar Rapids, Johnston
Michigan	Adrian, Augusta, Wyoming
Mississippi	Meridian, Camp Shelby
Missouri	Warrensburg, Whiteman, Kansas City, Saint Joseph, Fort Leonard Wood
North Dakota	Fargo, Devils Lake
Ohio	Newark, Springfield, Columbus
Oklahoma	Norman, Mustang, Oklahoma City
New Hampshire	Manchester, Strafford
Pennsylvania	York, Johnstown, Tobyhanna, Harrisburg, Annville

- DoD proposed sharing in remote locations where commercial interest is determined to be low and sharing is technically feasible.
- DoD stressed that the TRR relocation results must be considered in the full context of all systems operating in the band.
- Implementation timeline should be established during the transition planning process.

2.3 Software Defined Radio (SDR) / Joint Tactical Radio Systems (JTRS)

SDR systems generate different waveforms and RF modulations of varying complexity through modifiable software and by the use of digital synthesis. The WG dealt exclusively with the Joint Tactical Radio System (JTRS). The locations of all JTRS operations are provided in Appendix 2, Table 6.

No relocation information for these systems was provided in the NTIA Report, and the WG learned that data on these systems is considered "For Official Use Only" (FOUO). However, DoD provided the following updated information to the WG on SDR/JTRS relocation on May 21, 2013, based on further operational impact assessment conducted concurrent with the WG4 analysis effort, which determine:[9]

[8] The WG notes that compressing TRR assignments into 1780-1855 MHz was not addressed in the NTIA report and was among the information provided to the WG in the May 21, 2013 update.

[9] Like with TRR systems, the updated information was provided as edits to this WG4 report.

- The following highest priority training DoD installations/locations would require Protection Zones indefinitely to minimize impacts to operational training requirements:

Continuing JTRS Locations
Fort Irwin, CA
Fort Polk, LA (JRTC)
Fort Bliss; TX and WSMR
Fort Hood, TX
Fort Bragg, NC (Includes Camp MacKall)
Yuma Proving Ground , AZ

- The remaining JTRS locations can compress above 1780 MHz without requiring new spectrum assignments to replace the ones in the 1755-1780 MHz band.
- DoD proposed sharing the entire 1755-1850 MHz band in remote locations where commercial interest is determined to be low and sharing is technically feasible.
- DoD stressed that the JTRS results must be considered in the full context of all systems operating in the band.
- DoD suggested that an implementation timeline should be established during the transition planning process.

2.4 Commercial Systems

Commercial LTE systems were described in detail by a subcommittee of WG-1 and are presented in Appendix 3 of this report.[10] This description was used by all Working Groups in their analyses.

3 Scope of Work, Analysis and Results

The key elements of WG-4's work plan include determining system descriptions and characteristics, performing technical analysis, and determining sharing methodologies and recommendations.

3.1 System descriptions and characteristics.

DoD provided information that was publicly releasable. This information is shown in Appendix 2. Briefing slides and word documents were used to depict:

(1) Summary of system descriptions including name and nomenclature as well as high-level information on functionality.

(2) Architecture diagrams were presented illustrating TRR notional deployment.

(3) System characteristics for TRR were organized into the tabular format.

---

[10] See "Commerce Spectrum Management Advisory Committee Final Report Working Group 1 – 1695-1710 MHz Meteorological-Satellite", January 22, 2013.

(4) Quantity of TRR frequency assignments in the 1755-1850 MHz range for each location.

3.2 Technical analysis

The analysis methodology and associated assumptions were agreed upon by the WG. Since the list of locations was lengthy, it was realized that there was insufficient time and resources to analyze every installation. The WG decided to study three Army locations and one Navy/Marine Corps location based on proximity to major market areas. The LTE characteristics were derived from the parameters used by CSMAC WG-1. The analysis results were presented to WG-4 in presentation format which contained tables and protection zone diagrams. These are provided in Appendix 4.

3.3 Sharing methodologies

Experience gained from AWS-1 coordination was used as a starting point for discussion. The membership provided other input related to their experiences establishing coordination processes. Disaster relief scenarios were addressed and resolved through input from frequency assignment experts at NTIA.

3.4 Functioning of WG-4

The work methods of the WG focused on mostly on telephone conferences and online correspondence. The WG generally held meetings on a bi-weekly basis. The majority of the meetings were conducted via conference call. However, there were four face-to-face meetings to accelerate the maturation of information presented at CSMAC meetings and to move the writing of the final output report forward. In order to streamline completion of the WG report, an editorial sub-committee was established and meet bi-weekly via conference call on weeks when the full WG did not meet. The list of WG-4 participants is provided in Appendix 1, Table 1.

4 Recommendations

The recommendations of the Working Group focus on future work that would lead to development of viable sharing scenarios. Alternative analysis approaches were explored that could potentially result in a reduction in the size of protection zones which were generated under WG 4 purview.

Based upon the work performed by the WG, we make the following recommendations:

4.1 Fixed Point-to-Point Microwave

The NTIA Report determined that fixed microwave systems are considered to be relatively easy to relocate due to the availability of commercially available technology to re-establish these systems in other frequency bands and the low estimated cost associated with relocating these systems, assuming favorable site conditions.[11] In addition, there is considerable

[11] See NTIA Report, p. vii.

experience with long-term and transitional sharing with microwave systems in the 1710-1755 MHz band and AWS-1 commercial systems.

4.1.1 Relocate Fixed Point-to-Point Microwave Systems.

The Working Group recommends that Fixed Point-to-Point Microwave Systems be relocated. In addition, the WG recommends that NTIA provide guidance to the federal agencies to incorporate consideration of commercial industry market area priorities in the development of their required Transition Plans and in the establishment of a relocation schedule for fixed point-to-point systems. The NTIA guidance should request that agencies concentrate on the 1755-1780 MHz band initially, and also consider the list of Economic Areas (EAs) ordered according to industry's geographic implementation priorities, noting that the exact order in which agencies will be able to relocate will be based on their operational requirements and may vary from the commercial deployment priority. [12]

The WG also recommends that the NTIA, in consultation with FCC and impacted federal agencies, establish transitional sharing methodologies similar to the AWS-1 band (1710-1755 MHz) entry coordination process to allow access to the band in areas where microwave systems are not able to be relocated before commercial access is required. The WG recommends using TSB-10F interference analysis methodologies and objectives[13] and coordination procedures developed for AWS-1.[14] The WG suggests that this process must address the sharing of data on fixed microwave systems (e.g., assignments, operational characteristics, technical parameters, etc.) with commercial operators or their designees. The WG notes that this issue applies across all WGs.

4.2 Tactical Radio Relay Systems

The WG makes the following recommendations for TRR systems:

4.2.1 Relocate or compress TRR systems as indicated in NTIA Report.

The WG recommends that DoD vacate its TRR systems from the 1755-1780 MHz band into the 1780-1850 MHz band and to alternate spectrum as described above in Section 3 and in the NTIA Report.[15]

The WG notes that there are a total of 13 high-priority training areas where relocation is not feasible (See Section 2.2. above). This will require the establishment of Protection Zones for the entire 1755-1850 MHz band at these locations to minimize impacts to operational training requirements. See Recommendation 4.2.2 below.

[12] See WG 2 Final Report, Table A (reproduced herein as Table 5)

[13] TIA/EIA Telecommunications Systems Bulletin, “Interference Criteria for Microwave Systems”,TSB-10F, June 1994.

[14] See, 47CFR § 27.1134 *Protection of Federal Government operations* and FCC 06-50, April 20, 2006.

[15] NTIA Report at . 26 – 28.

4.2.2 Establish a relocation schedule in the transition planning process in concert with the carrier community.

For those TRR systems that can relocate, the WG recommends that NTIA provide guidance to the federal agencies to incorporate consideration of commercial industry market area priorities in the development of their required Transition Plans and in the establishment of a relocation schedule for these TRR systems. The NTIA guidance should request that agencies concentrate on the 1755-1780 MHz band initially, and also consider the list of EAs ordered according to industry's geographic implementation priorities, noting that the exact order in which agencies will be able to relocate will be based on their operational requirements and may vary from the commercial deployment priority.

4.2.3 Proposed Study Topics to potentially improving the current analysis

The WG identified proposed study items with a goal to improve the analysis that was conducted based on the WG-4 agreed assumptions These include the impact of clutter, the use of antenna effects (i.e., off-axis and polarization discrimination, the effects of operational tempo, and interference protection criteria.

Regarding interference protection criteria (IPC), the WG notes that current WG-4 analyses use long-standing interference criteria established by the ITU. The wireless industry believes that the study of interference relative to a desired carrier taking into account actual system operations would be beneficial to understand how government and LTE systems would interact in a shared environment with close coordination between users, and believe that could significantly reduce required separation distances. DoD believes that the current interference criteria are appropriate for all the systems that are operating in the band. Further, DoD believes that any consideration of changes in IPC on a system-by-system basis is risky and inappropriate. This is because IPCs are developed over a long period of time to ensure that protection criteria are based on underlying physical phenomena rather than on short-term technological specifications of individual systems. As a result, these long standing IPCs successfully form the basis for many national and international spectrum use agreements, including allocation and reallocation decisions, despite the often rapid evolution and improvement of new and incumbent systems.

4.2.4 Any changes in analysis methodology should be applied to all Protection Zone analyses.

The WG recommends Protection Zone analyses should be performed, taking into account any agreed upon approach and assumption changes (as mentioned above), for all locations that cannot relocate or compress.

Protection Zone analyses will first be performed starting at the 13 areas where relocation is not feasible. The remaining Protection Zone analyses should be prioritized considering the list of EAs ordered according to industry's geographic implementation priorities, noting that the exact order in which agencies will be able to relocate will be based on their operational requirements and may vary from the commercial deployment priority.

4.2.5 Develop Transition Plans that address relocation of assignments, compression into 1780-1850 MHz, and comparable spectrum

The WG recommends that DoD and NTIA consider relocation and compression time frames in addition to comparable spectrum for relocation as they develop Transition Plans.

4.2.6 Develop a sharing approach to permit deployment in Protection Zones

The WG recommends that NTIA, in consultation with impacted federal agencies, work with all stakeholders to develop an approach that allows access to the 1755-1780 MHz band in areas where TRR systems will remain indefinitely or where they cannot relocate or compress before commercial access is required within a given Protection Zone. This will require the development of interference analysis methodologies and objectives sufficient to perform interference analyses between specific carrier sites and TRR systems. The WG suggests that TSB-10F mentioned above for fixed microwave systems represents a good framework for this effort.

The WG also recommends that NTIA and FCC, in coordination with the affected federal agencies and commercial wireless carriers, develop coordination procedures similar to AWS-1. These procedures should accommodate the following:

- Sharing data on TRR systems (e.g., assignments, operational characteristics, technical parameters, etc.) with commercial operators or their designees, to the extent information protection mandates are adhered to. The WG notes that this issue applies across all WGs.
- Commercial licensees must be required to coordinate any operations that could permit mobile, fixed, and portable stations to operate in the specified Protection Zones.
- Commercial licensee operations within Protection Zones will be permitted following a successful coordination process concluding that such commercial operations will not cause any loss of capability due to harmful interfere at the federal site plus certain other conditions. DoD believes that sharing between ubiquitously deployed licensed cellular mobile broadband systems and federal operations at the same location is unprecedented. In that regard, DoD requires commercial licensees to demonstrate technology or techniques that ensure LTE operations/networks can accept interference from TRR operations within the Protection Zones, all prior to deployment of base stations. However, commercial licensees note that the ability of licensees to have flexibility in deploying their networks, including what levels of interference they can accept, is fundamental to efficient spectrum management. Accordingly they insist that long-standing practices for agreeing to accept interference in such situations is sufficient, and that the requested demonstration of technology or techniques is unprecedented, untenable and would represent a new, undefined burden on operators.
- Protection of TRR facilities must continue until such time as these systems are relocated to other spectrum or compressed into 1780-1850 MHz.
- A process must be established to ensure that in the event of interference that can be sourced to commercial wireless operations, wireless operators modify

operations in the band to mitigate interference until sources are identified and resolved. Commercial operators will need to provide and maintain 24/7 point of contact should interference occur. Federal incumbents will also need to provide a list of authorized personnel who can provide bona fide requests for the modification of commercial operations in identified protection zones.

4.2.7 Develop a testing program to demonstrate the viability and effectiveness of interference protection/mitigation methods before commercial licensees commence deployments in Protection Zones.

The WG suggests that it is important to verify the methodologies and objectives mentioned above through a mutually-agreed testing program involving all stakeholders. The testing program must:

- Validate co-channel and adjacent channel sharing assumptions model and interference mitigation methods prior to the adoption of technical rules.
- Validate the effectiveness of proposed interference mitigation methods upon completion of the auction and prior to coordinated operation within Protection Zones.
- Establish mutual agreement and successful demonstration of proposed validation and verification methods.
- Clearly assign responsibility for verification test plans and schedules.
- Be adaptable for future or potentially changing TRR and commercial configurations.

4.2.8 Allow TRR systems to remain in the 1755-1850 MHz band in regions where there is little or no commercial interest.

The WG recommends that in areas where it is determined that there is little or no commercial interest for network deployment, TRR systems may be allowed to remain in the band. However, the WG suggests that further study is required to define and agree upon what is meant by “little or no commercial interest”, as well as rules of engagement that would govern such possible arrangements.

4.2.9 Develop a process to address point or local area assignments

The WG did not consider statewide and local area assignments that remain for National Guard operations that cannot relocate. The WG recommends that additional study may be required to address issues such as LTE deployment specifics, outstanding sharing methods identified in this report (particularly as they are related to these types of operations) and coordination.

4.3 Joint Tactical Radio Systems

The WG makes the following recommendations for JTRS:

4.3.1 Proposed Study Topics to potentially improve the current analyses

The WG identified proposed study items with a goal to improve the analysis that was conducted based on the WG-4 agreed assumptions These include the impact of clutter, the use of antenna effects (i.e., off-axis and polarization discrimination, the effects of operational tempo, and interference protection criteria.

Regarding interference protection criteria (IPC), the WG notes that current WG-4 analyses use long-standing interference criteria established by the ITU. The wireless industry believes that the study of interference relative to a desired carrier taking into account actual system operations would be beneficial to understand how government and LTE systems would interact in a shared environment with close coordination between users, and believe that could significantly reduce required separation distances. DoD believes that the current interference criteria are appropriate for all the systems that are operating in the band. Further, DoD believes that any consideration of changes in IPC on a system-by-system basis is risky and inappropriate. This is because IPCs are developed over a long period of time to ensure that protection criteria are based on underlying physical phenomena rather than on short-term technological specifications of individual systems. As a result, these long standing IPCs successfully form the basis for many national and international spectrum use agreements, including allocation and reallocation decisions, despite the often rapid evolution and improvement of new and incumbent systems.

4.3.2 Any changes in analysis methodology should be applied to all Protection Zone analyses.

The WG recommends Protection Zones should be established at six JTRS locations, taking into account any agreed upon approach and assumption changes, for the highest priority DoD training installations/locations identified in Section 2.3 to minimize impacts to operational training requirements.

4.3.3 For remaining locations, compress systems into 1780-1850 MHz.

The WG recommends that for the remaining locations, JTRS compress above 1780 MHz. Time frames to compress should be established based on the timelines in federal agencies' Transition Plans, taking into account commercial deployment time frames where feasible. Actual system tuning into 1780-1850 MHz could also be occasioned upon request from a commercial licensee to access area within Protection Zone. The WG recommends that a process can be established similar to the one described above for TRR.

4.3.4 Develop a transitional sharing approach to permit deployment in Protection Zones at six high-priority training locations.

The WG recommends that NTIA, in consultation with impacted federal agencies, develop an approach to allow access to the 1755-1780 MHz band in areas where JTRS cannot compress before commercial access is required within a given Protection Zone. This will require the development of interference analysis methodologies and objectives sufficient to perform interference analyses between specific carrier sites and TRR systems. The WG suggests that TSB-10F mentioned above for fixed microwave systems represents a good framework for this effort.

The WG also recommends that NTIA and FCC, in coordination with the affected federal agencies and commercial wireless carriers, develop coordination procedures similar to AWS-1. These procedures should accommodate the following:

- Sharing data on JTRS systems (e.g., assignments, operational characteristics, technical parameters, etc.) with commercial operators or their designees, to the extent information protection mandates are adhered to. The WG notes that this issue applies across all WGs and may be accomplished through the Trusted Agent.[16]

- Commercial licensees must be required to coordinate any operations that could permit mobile, fixed, and portable stations to operate in the specified Protection Zones.
- Commercial licensee operations within Protection Zones will be permitted following a successful coordination process concluding that such commercial operations will not cause any loss of capability due to harmful interfere at the federal site plus certain other conditions. DoD believes that sharing between ubiquitously deployed licensed cellular mobile broadband systems and federal operations at the same location is unprecedented. In that regard, DoD requires commercial licensees to demonstrate technology or techniques that ensure LTE operations/networks can accept interference from JTRS operations within the Protection Zones, all prior to deployment of base stations. However, commercial licensees note that the ability of licensees to have flexibility in deploying their networks, including what levels of interference they can accept, is fundamental to efficient spectrum management. Accordingly they insist that long-standing practices for agreeing to accept interference in such situations is sufficient, and that the requested demonstration of technology or techniques is unprecedented, untenable and would represent a new, undefined burden on operators.
- Protection of JTRS facilities must continue until such time as these systems are relocated to other spectrum or compressed into 1780-1850 MHz.
- A process must be established to ensure that in the event of interference that can be sourced to commercial wireless operations, wireless operators modify operations in the band to mitigate interference until sources are identified and resolved. Commercial operators will need to provide and maintain 24/7 point of contact should interference occur. Federal incumbents will also need to provide a list of authorized personnel who can provide bona fide requests for the modification of commercial operations in identified protection zones.

4.3.5 Develop a testing program to demonstrate the viability and effectiveness of interference protection/mitigation methods before commercial licensees commence deployments in Protection Zones.

The WG suggests that it is important to verify the methodologies and objectives mentioned above through a mutually-agreed testing program involving all stakeholders. The testing program must:

- Validate co-channel and adjacent channel sharing assumptions model and interference mitigation methods prior to the adoption of technical rules.

[16] The WG notes that the Trusted Agent concept is still under discussion and development among stakeholders.

- Validate the effectiveness of proposed interference mitigation methods upon completion of the auction and prior to coordinated operation within Protection Zones.
- Establish mutual agreement and successful demonstration of proposed validation and verification methods.
- Clearly assign responsibility for verification test plans and schedules.
- Be adaptable for future or potentially changing JTRS and commercial configurations.

Appendices

Appendix 1: Working Group 4 Participants

Appendix 2: Description of Federal Systems

Appendix 3: Commercial Systems

Appendix 4: Sharing Analyses and Results

Appendix 1: Working Group 4 Participants

Below is a list of participants in the WG. The leadership team included:

Dave Pierce	ASMO	Co-Chair
Mike Chartier	Intel	Co-Chair
Mark Gibson	Comsearch	CSMAC Liaison
Gary Patrick	NTIA	NTIA Representative
Steve Buenzow	FCC	FCC Representative

Note: the Editorial Sub-Committee consisted of the above leadership team plus those members listed below denoted by an *.

Table 1: List of WG-4 Participants

First Name	**Last Name**	**Representing**
Colin	Alberts	Federal (DoD)
Tom	Banger	Federal (PMW/A 170)
Eric	Batteiger	Federal (Navy)
Brent	Bedford	Federal (NTIA/ITS)
Jeffrey	Boksiner	Federal (CERDEC)
Mark	Brushwood	
Milind	Buddhikot	Industry (Bell-Labs)
Stephen	Buenzow	Federal (FCC)
Duane	Calloway	Federal (ATEC)
David	Campbell	Federal (DHS)
Jason	Chabot	Federal (USAF)
Bryan	Chapman	Federal (ASMO)
Mike	Chartier	Industry (Intel)
Jay	Chauhan	Federal (DSO)
Chrysanthos	Chrysanthou	Federal (CERDEC)
Tim	Clancy	Federal (Army)
William	Copeland	Federal (Navy)
John	Cornicelli	Federal (Homeland Security)
Joseph	Cramer	Industry (Boeing)
Arthur	DeLeon	Federal (USMC)
Richard	Desalvo	Federal (ASMO)
* Thomas	Dombrowsky, Jr.	Industry (CTIA)
David	Duncan	Federal (Army)
Thomas	Fagan	Industry (Raytheon)
Gregory	Formosa	Federal (Army)

Jason	Fortenberry	Federal
Paul	Frew	Industry (Research in Motion)
David	Garrabrant	Federal (Army)
Alexander	Gerdenitsch	Industry (Motorola)
Mark	Gibson	Industry (Comsearch)
David	Greenberg	Federal (ASMO)
David	Gurney	Industry (Motorola)
* Eric	Hagerson	Industry (T-Mobile)
Muhammad	Hasan	Federal (PEO C3T)
Robert	Higgonbotham	Federal (DSO)
* George	Hirvela	Industry (AT&T)
David	Hughes	Industry (Plateautel)
John	Hunter	Federal (NTIA)
Saiful	Islam	Federal (CERDEC)
Arthur	Jackson	Industry (T-Mobile)
David	Johnson	Federal (Navy)
Cal	Jordan	Federal (Army)
Stevan	Jovancevic	Federal (Army)
Gitangli	Khushlani	Constratus
Thomas	Kidd	Federal (Navy)
Rob	Kubik	Industry (Samsung)
Michael	Landry	Federal(Homeland Security)
Robert	Lara	Federal (JTRS)
Eric	Leisure	
Willie	Loper	Federal (ATEC)
David	Manzi	Industry (Raytheon)
Jeffrey	Marks	alcatel-lucent
Bob	Martin	Federal (Army)
Tim Fitz	Maurice	Federal (WIN-T)
Andy	McGregor	Industry (Ericsson)
* Mark	McHenry	Industry (Shared Spectrum)
Dan	Mieszala	Industry (Alltel Wireless)
Pierre	Missud	Federal (DOI)
Fred	Moorefield	Federal (Air Force)
Prakash	Moorut	Industry (NSN)
Vincent	Morgan	Federal (DSO)

James	Norton	Industry (General Dynamics)
Janice	Obuchowski	Industry (Freedom Technologies)
LTC Troy	Orwan	Federal
Mark	Paolicelli	Federal (USMC)
Gary	Patrick	Federal (NTIA)
Randy	Peterson	
Dave	Pierce	Federal (Army)
Samuel	Pirrone	Federal
Chuck	Powers	Industry (Motorola)
Mark	Racek	Industry (Ericsson)
Donald	Reese	Federal (Air Force)
Nancy	Savage	Federal (ATEC)
Gary	Scheer	Federal (FBI)
Steve	Schwartz	Federal (Army)
Thomas	Shanholtz	Federal (DSO)
Steve	Sharkey	T-Mobile
Capt. Bradley	Smith	Federal (Air Force)
Alden	Smith	Federal (DSO)
Edward	Smith	Federal (DHS)
Mike	Smith	Industry (Harris)
Jim	Snider	Industry (iSolon)
Peter	Staxen	Industry (Ericsson)
John	Suhy	Federal (Army)
Shawn	Sweeney	Federal
David	Tenney	Industry (Booze-Allen)
Eric	Thomas	Federal (Army)
John Allen	Thompson	Federal (Army)
Ralph	Walborn	WSMR DOD AFC
Randolph	Wardle	Federal (Army)
Jennifer	Warren	Industry (Lockheed-Martin)
Gary	Williams	
Maurice	Winn	Federal (Army)
LTC Lori	Winn	Federal (Joint Staff)
Bryan	Wright	Federal (DOI)
Richard	Wyman	Federal (Army)
Joe	Yavorsky	Federal (Army)

Stephen	Zak	Federal (FCC)
* Ken	Zdunek	Industry (Roberson &
Lily	Zeleki	Federal (DoD CIO)

Appendix 2: Description of Federal Systems

A.2.1 Fixed Point-to-Point Microwave Systems

Federal agencies use fixed point-to-point microwave systems for the transmission of voice, data, and/or video in support of law enforcement, military command and control, emergency preparedness and response, the national air space system, energy grid control, and resource management activities. These systems also support the distribution of meteorological data to a variety of users including the public. Fixed point-to-point microwave systems provide service where commercial options are either unavailable, too expensive, or do not provide the level of reliability required by federal users. Relocation time frames for Fixed systems are shown below in Table 2.[17]

Table 2: Relocation Time Frames for Fixed Systems

Agencies/Services	Relocation Time Frame	
	1755-1780 MHz	1755-1850 MHz
Army	5 Years	10 Years
Air Force	5 Years	
Navy	-	-
USMC	-	-
DOE	5 Years	5 - 10 Years
DHS	5 Years	
DOI	5 Years	10 Years
DOC	5 Years	
FAA	2 Years	

A.2.2 Tactical Radio Relay (TRR)[18,19]

DoD requires efficient methods of exchanging large quantities of digital data throughout the battlefield and are expected increase exponentially in support of command and control, intelligence, logistics, etc. The DoD operates various Tactical Radio Relay

[17] NTIA Report, Tables 4-1 and 4-2, pp 25 and 26 respectively.

[18] Department of Defense Investigation of the Feasibility of Accommodating the International Mobile Telecommunications (IMT) 2000 Within the 1755-1850 MHz Band (9 Feb 2001).

[19] NTIA Report

(TRR) capabilities across the 1755-1850 MHz band. TRR link various subordinate, lateral and strategic headquarters, functional and component nodes, into an integrated area-wide network. TRR are transportable, fixed, point-to-point microwave communications systems which provide mid-to-high capacity digital information to battlefield commanders for command and control for forces. TRR provides highly transportable lightweight, survivable systems and antenna that can be quickly set-up and taken down to establish robust communications links that support the concept of maneuver warfare. TRR usage within the United States and Possessions (US&P) is primarily for training. However, TRR systems may be operationally deployed for DoD support to state and local governments in the event of national emergencies, natural disasters or humanitarian relief missions. There are two major TRR capabilities currently fielded by DoD; the Army's High Capacity Line-of-Site (HCLOS) system and the Navy and Marine Corps Digital Wideband Transmission System (DWTS). TRR operating locations are shown below in Table 4. Relocation time frames for TRR systems are shown below in Table 3.[20]

Table 3: Relocation Time Frames for TRR Systems

Agencies/Services	Relocation Time Frame	
	1755-1780 MHz	1755-1850 MHz
Army (HCLOS)	5 Years	8 - 10 Years
Navy USMC (DWTS)	8 - 10 Years	

The following system descriptions are provided:

A.2.2.1 High Capacity Line-of-Site (HCLOS)

Army HCLOS is comprised of the AN/GRC-245 HCLOS system. HCLOS is a multi-band, multi-mode, radio providing high data throughput communications for command and control, intelligence, imagery, logistics, medical and morale and welfare support. HCLOS comprises a major functional component of the Army's Warfighter Information Network – Tactical (WIN-T) capability. HCLOS provides the Army with wide-area communications for tactical operations at the battalion brigade and division levels. The AN/GRC-245 tunes across the 1350-2690 MHz frequency band, requires 50 MHz separation between the transmit and receive frequencies and has a typical transmission link distance from 30-50 km. Technical characteristics of the HCLOS system are shown below in Table 4 and the architecture is shown below in Figure 1.

[20] NTIA Report at Table 4-3, p 28.

Table 4: Army Tactical Radio Relay (TRR) Analysis Characteristics

	AN/GRC-245
Radio Function	High Capacity LOS
Frequency Range	1350 – 2690 MHz
Transmit power	31 mW - 1.6 W
Emission Bandwidth* (MHz)	2.0 (-3dB), 2.9 (-20dB), 7.2 (-60dB)
Antenna Mainbeam Gain	23 dBi
Antenna Heights	DoD Equipment – 15 meters User Equipment – 1.5 meters (initial analysis), will be varied in follow-on analysis
Receiver Bandwidth, MHz	6.7 (-3dB), 8.1 (-20dB), 10.0 (-60dB)
Receiver Noise Figure	7 dB
Receiver Sensitivity	-86 dBm @ 8192 Kb/s and BER = 10E-5
Receiver Noise Power	-99 dBm
Interfering Signal Threshold	-105 dBm
Waveform	2M50W1D, 320-8256 kb/s, 32 TCM, rate 4/5 code
Analysis Locations (This type of radio is located at all Army sites)	Ft Lewis, WA Ft Carson, CO Camp Blanding, FL
Antenna Locations	DoD radios use directional antennas. For worst case scenario, the backlobe of the antenna will be analyzed against the borders at each of the locations. Additional runs will be made at each of the three bases with links running parallel to the border of the base for a side-lobe analysis.
DoD Link Distance	10 Km
User Equipment Characteristics	Baseline Characteristics Provided by LTE Working Group

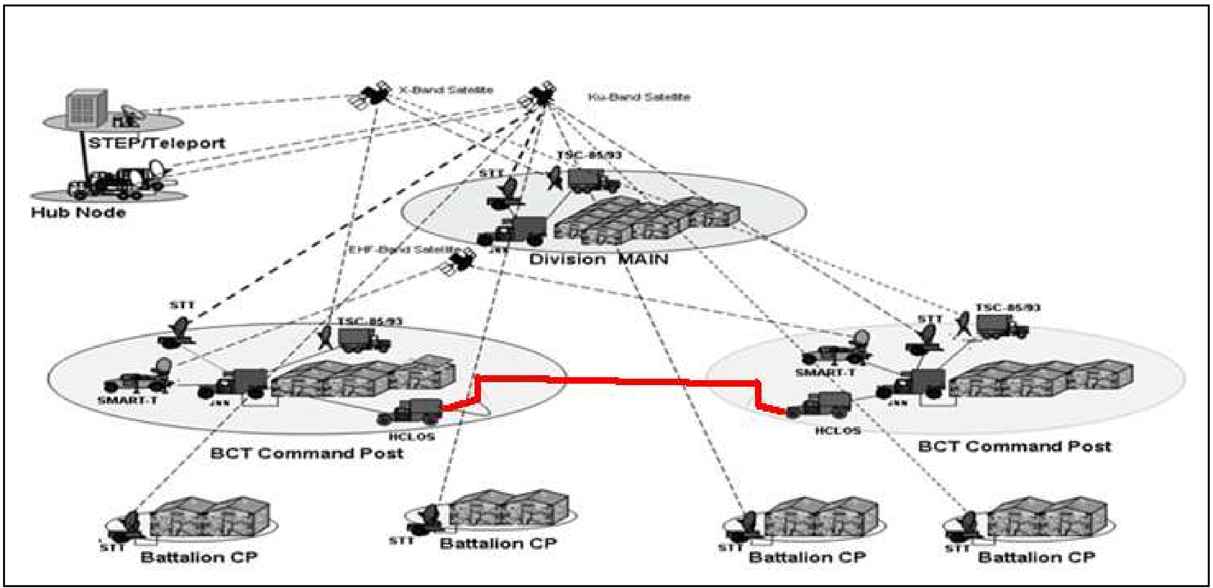


Figure 1: Army Tactical Radio Relay (TRR) Architecture

A.2.2.2 Digital Wideband Transmission System (DWTS)

DWTS is comprised of the Navy's AN/SRC-57 (ship-board system) and the Marine Corps AN/MRC-142B and AN/MRC-142C (the AN/MRC-142C is a vehicle mounted variant of the AN/GRC-245 HCLOS system above). DWTS provides the back-bone digital communications capability (voice, data and video) which supports the Marine Expeditionary Force (MEF) down to the regiment levels for both amphibious and ground combat operations (ship-to-ship/ship-to-shore/shore-to-shore). The AN/SRC-57 and AN/MRC-142B variant tune across the 1350-1850 MHz frequency band and requires 63 MHz separation between transmit and receive frequencies. The AN/MRC-142C variant tunes across the 1350-2690 MHz frequency band and requires 50 MHz separation between transmit and receive. The typical DWTS transmission link distance is 30-50 km. Technical characteristics of the DWTS are shown below in Table 5 and the architecture is shown below in Figure 2.

Table 5: Navy-Marine Corps Tactical Radio Relay (TRR) Analysis Characteristics

	AN/MRC-142C (a.k.a. AN/GRC-245)	AN/MRC-142B	AN/SRC-57
Radio Function	High Capacity LOS	Digital Wideband Transmission System (DWTS)	
Frequency Range	1350 – 2690 MHz	1350-1850 MHz	1350 – 1850 MHz
Transmit power	1.6 W	60 W	100 W
Emission Bandwidth (MHz)	2.0 (-3dB), 2.9 (-20dB), 7.2 (-60dB)	0.4 (-3dB), 1.05 (-20dB), 3.15 (-60dB)	1.0 (-3dB), 3.0 (-20 dB), 8.0 (-60 dB)
Antenna Mainbeam Gain	23 dBi	20.3 dBi (Parabolic), 6.3 dBi at 26-deg	6 dBi Omni
Antenna Heights	USMC Equipment – 15 meters Navy Equipment – 120 feet (above water) User Equipment – 1.5 meters (initial analysis), will be varied in follow-on analysis		
Receiver Bandwidth, MHz	6.7 (-3dB), 8.1 (-20dB), 10.0 (-60dB)	0.8 (-3dB), 1.0 (-40 dB), 4.4 (-60 dB)	4.0 (-3 dB), 8.0 (-20 dB), 25.0 (-60 dB)
Receiver Noise Figure	7 dB	8 dB	7 dB
Receiver Sensitivity	-86 dBm @ 8192 Kb/s and BER = 10E-5	-93 dBm BER = 10 E-4	-84 dBm BER = 10E-5
Receiver Noise Power	-99 dBm	-107 dBm	-105 dBm
Interfering Signal Threshold	-105 dBm	-113 dBm	-111 dBm
Waveform	2M50W1D, 320-8256 kb/s, 32 TCM, rate 4/5 code	610K0F7W, 576kb/s FSK	2M85F7D, 2048 kb/s FSK
Analysis Locations	Camp Pendleton/San Diego Norfolk		
Antenna Locations	DoD radios use directional antennas. For worst case scenario, the backlobe of the antenna will be analyzed against the borders at each of the locations. Additional runs will be made at each of the three bases with links running parallel to the border of the base for a side-lobe analysis. The above locations will include a ship to shore link. the ship antennas (SRC-57) are omni-directional..		
DoD Link Distance	10 Km /35 KM		
User Equipment Characteristics	Baseline Characteristics Provided by LTE Working Group		

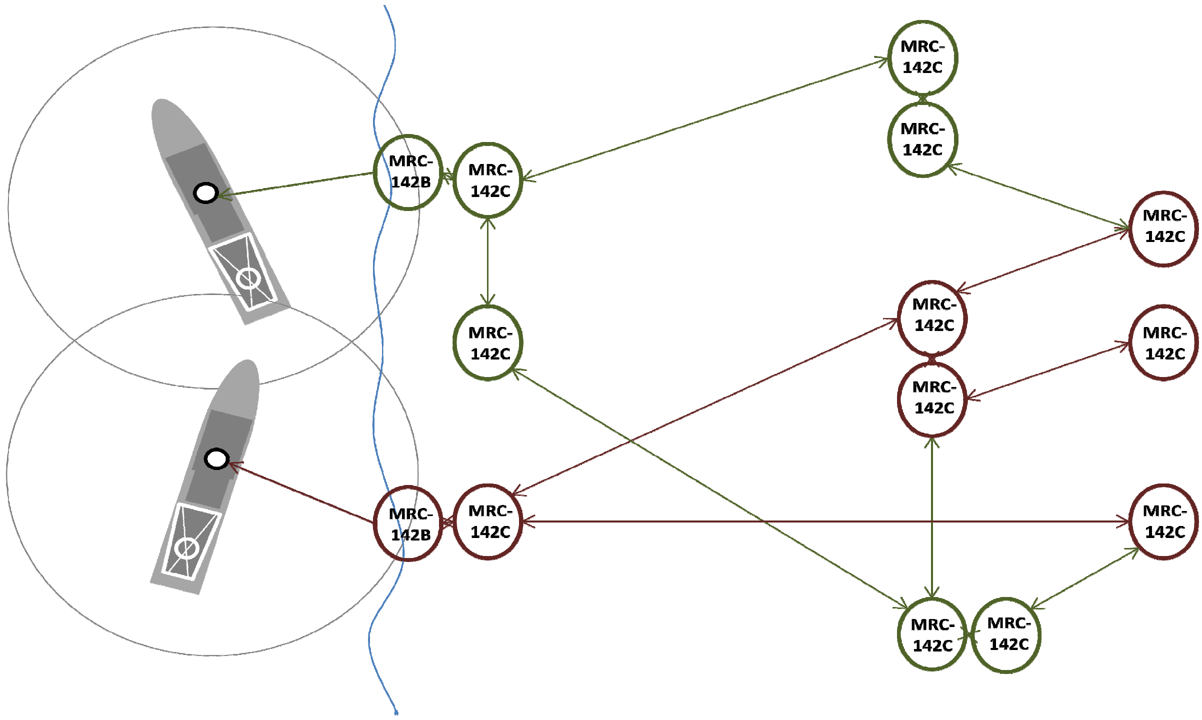


Figure 2: Navy-Marine Corps Tactical Radio Relay (TRR) Architecture

A.2.3 Joint Tactical Radio System / Software Defined Radio (JTRS/SDR)

SDR systems are capable of generating different waveforms and Radio Frequency (RF) modulations of varying complexity through modifiable software and by the use of digital synthesis. Systems under various stages of development include the Harris AN/PRC-117G, the Joint Tactical Radio System (JTRS) Handheld Manpack Small Form-Fit (HMS) Manpack Radio (AN/PRC-155), the handheld Rifleman Radio (AN/PRC-154) and the Mid-Tier Networking Vehicular Radio (MNVR).

JTRS is not just about the radios or waveforms. The JTRS suite provides the capability to network combat units. Also, JTRS allows DoD to deploy functionality through software enhancements.

JTRS represents a family of multi-band/multi-mode Software Defined Radios (SDRs), designed to provide communications within the 2 MHz to 2 GHz frequency range. The NTIA Assessment of the Viability of Accommodating Wireless Broadband in the 1755 – 1850 MHz Band released in March of 2012 identified comparable spectrum bands above 2 GHz. Since the software defined radios have design limitations that prevent tuning above 2 GHz, the JTRS radios will not relocate entirely out of the band. Specifically, JTRS locations will compress up to operate at in 1780 – 1850 MHz band except at the six installations identified in Section 2.3 above; those sites will continue to operate throughout the 1755-1850 MH band.

JTRS operates with new advanced waveforms that have enhanced performance capabilities. The JTRS Wideband Networking Waveform (WNW) and the Soldier Radio Waveform (SRW) are capable of operating in the 225-400 MHz, 1350-1390 MHz, and 1755-1850 MHz frequency bands. The SRW is optimized for constrained bandwidth and is carried by a soldier (manpacked and handheld variants). The WNW allows greater bandwidth, optimizes network throughput and is platform mounted.

The Joint Enterprise Network Manager (JENM) software product enables control of these wideband networks. Many variants of JTRS will exist and be used by all three military departments. DoD projects JTRS operations to occur at all major testing, training, and Infantry Brigade Combat Team locations, most of which are shown in Table 6.

The WNW will be used with the JTRS MNVR, and the Airborne, Maritime, and Fixed Station (AMF) equipment (Small Airborne Networking Radio (SANR)). The SRW will be used on the JTRS Handheld, Man-Pack, Small-Form-Fit (HMS) variants, the MNVR, as well as the AMF SANR. The AN/PRC-154 (Rifleman Radio) is a single channel radio mainly used by dismounted soldiers. The AN/PRC-155 (HMS Manpack) is a 2-channel radio operated by dismounted soldiers as well as vehicular mounted.

In addition, a critical aspect to consider regarding SDR operations is that the terrestrial Intelligence, Surveillance, and Reconnaissance (ISR) and communications relay capabilities must be available for training, testing and system development.

Table 6: Location of TRR & JTRS Operations

Location	State	TRR		JTRS
		HCLOS	DWTS	
Aberdeen Proving Ground*	Maryland	X		X
Alpena CRTC	Michigan			
Apra Harbor	Guam		X	
Barksdale AFB	Louisiana			
Bogue Field	North Carolina		X	
Bridgeport	California		X	
Brooklyn	New York		X	
Camp Atterbury	Indiana	X		X
Camp Blanding	Florida	X		X
Camp Grayling	Michigan			X
Camp Guernsey	Wyoming			X
Camp Lejeune*	North Carolina		X	
Camp Mabry	Texas	X		
Camp Pendleton	California		X	
Camp Ripley	Minnesota	X		X
Camp Roberts*	California	X		X

Location	State	TRR		JTRS
		HCLOS	DWTS	
Camp Shelby*	Mississippi	X		X
Cincinnati	Ohio		X	
Craney Island*	Virginia		X	
Dugway Proving Ground*	Utah	X		
Eglin AFB	Florida			
Eielson AFB	Alaska			
El Centro	California			
Elizabeth City*	North Carolina		X	
Ellsworth AFB	South Dakota			
Elmendorf AFB	North Carolina			
England Industrial Park	Louisiana	X		
Faribault	Minnesota	X		
Fort A. P. Hill	Virginia	X		
Fort Benning*	Georgia	X		X
Fort Bliss*	Texas	X		X
Fort Bragg	North Carolina	X		X
Fort Bragg/Camp McKall	North Carolina			
Fort Campbell	Kentucky	X		X
Fort Carson	Colorado	X	X*	X
Fort Drum	New York	X		X
Fort Gordon	Georgia	X		X
Fort Greely	Alaska	X		
Fort Hood	Texas	X		X
Fort Huachuca*	Arizona	X		X
Fort Hunter Liggett	California	X		
Fort Indiantown GAP	Pennsylvania	X		X
Fort Jackson	South Carolina	X		
Fort Leavenworth*	Kansas	X		
Fort Lee*	Virginia	X		
Fort Leonard Wood	Missouri	X		
Fort McCoy	Wisconsin	X		
Fort Pickett	Virginia			X
Fort Polk	Louisiana	X		X

Location	State	TRR		JTRS
		HCLOS	DWTS	
Fort Riley	Kansas	X		X
Fort Rucker*	Alabama	X		X
Fort Sill	Oklahoma	X		X
Fort Stewart	Georgia	X		X
Fort Wainwright	Alaska			X
Fox Lake	Illinois		X	
Fort Chaffee	Arkansas			X
Fort Knox*	Kentucky	X		X
Great Falls ANGB	Montana			
Great Lakes	Illinois		X	
Greensboro	North Carolina		X	
Grissom	Indiana		X	
Gulfport CRTC	Mississippi			
Hawthorne	Nevada		X	
Hill AFB	Utah			
Holloman AFB	New Mexico			
Homestead ARB	Florida			
Huntington Beach*	California	X		
Iowa	Iowa	X		
Jacksonville ANGB	Florida			
Joint Base Charleston	South Carolina		X	
Joint Base Elmendorf-Richardson	Alaska	X		
Joint Base Langley-Eustis*	Virginia	X		
Joint Base Lewis-McChord	Washington	X		X
Joint Base Pearl Harbor-Hickam	Hawaii		X	
JRTC (Fort Polk North)	Louisiana	X		X
Kaneohe	Hawaii		X	
Kauai	Hawaii	X		
Langley AFB	Virginia			
Letterkenny	Pennsylvania	X		
Luke AFB	Arizona			
MCAS Beaufort	South Carolina			
MCAS Cherry Point	North Carolina			

Location	State	TRR		JTRS
		HCLOS	DWTS	
McEntire JNGB	South Carolina			
McGregor	New Mexico	X		
Midway Research Center*	Virginia		X	
Miramar	California		X	
Morehead City	North Carolina		X	
Mt Home AFB	Idaho			
NAS Fallon	Nevada			
NAS Key West	Florida			
NAS Lemoore	California			
NAS New Orleans	Louisiana			
NAS Oceana	Virginia			
Nellis AFB	Nevada			
NTC/Fort Irwin	California	X		X
Oahu	Hawaii	X		
Ohio	Ohio	X		
Orchard Park	Idaho			X
Panama City	Florida		X	
Patuxent River NAS	Maryland			
Pinon Canyon	Colorado	X	X*	X
Pohakuloa Training Area (PTA)	Hawaii	X		X
Point Mugu*	California		X	
Portland ANGB	Oregon			
Portsmouth*	Virginia		X	
Quantico	Virginia		X	
Redstone Arsenal*	Alabama	X		
Rosemount	Minnesota	X		
Saint Joseph	Missouri	X		
San Clemente Island*	California		X	
Sand Ridge	Illinois		X	
Savannah CRTC	Georgia			
Seymour Johnson AFB	North Carolina			
Shaw AFB	South Carolina			
St. Juliens Creek	Virginia		X	

Location	State	TRR		JTRS
		HCLOS	DWTS	
Sub-California Off Range Environ (SCORE)	California			
Telegraph Pass*	Arizona		X	
Twenty Nine Palms	California		X	
Two Rivers	Wisconsin	X		
Tyndall AFB	Florida			
Vacapes	Virginia		X	
Vichy Airfield	Missouri	X		
Volk Field CRTC	Wisconsin			
White Sands Missile Range	New Mexico	X		X
Yakima Firing Center	Washington	X		
Yakima Training Area	Washington			X
Yukon Range	Alaska	X		
Yuma Proving Grounds*	Arizona	X	X	X
*indicates planned location for TRR & JTRS		57	33	37

Table 7: Military Bases Located in Economic Areas, Ranked by EA

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Aberdeen Proving Ground	10	1	(NYC-Long Is. NY-NJ-CT-PA-MA-VT)	2	(New York City)	1	(Northeast)
Fort Indiantown GAP	10	1	(NYC-Long Is. NY-NJ-CT-PA-MA-VT)	2	(New York City)	1	(Northeast)
Letterkenny	10	1	(NYC-Long Is. NY-NJ-CT-PA-MA-VT)	2	(New York City)	1	(Northeast)
Camp Pendleton	160	2	(LA-Riverside-Orange Cnty CA-AZ)	44	(Los Angeles-San Diego)	6	(West)
Camp Roberts	160	2	(LA-Riverside-Orange Cnty CA-AZ)	44	(Los Angeles-San Diego)	6	(West)
Fort Hunter Liggett	160	2	(LA-Riverside-Orange Cnty CA-AZ)	44	(Los Angeles-San Diego)	6	(West)
Huntington Beach	160	2	(LA-Riverside-Orange Cnty CA-AZ)	44	(Los Angeles-San Diego)	6	(West)
Miramar	160	2	(LA-Riverside-Orange Cnty CA-AZ)	44	(Los Angeles-San Diego)	6	(West)
NTC/Fort Irwin	160	2	(LA-Riverside-Orange Cnty CA-AZ)	44	(Los Angeles-San Diego)	6	(West)
Point Mugu	160	2	(LA-Riverside-Orange Cnty CA-AZ)	44	(Los Angeles-San Diego)	6	(West)
San Clemente Island	160	2	(LA-Riverside-Orange Cnty CA-AZ)	44	(Los Angeles-San Diego)	6	(West)
Telegraph Pass	160	2	(LA-Riverside-Orange Cnty CA-AZ)	44	(Los Angeles-San Diego)	6	(West)
Twenty Nine Palms	160	2	(LA-Riverside-Orange Cnty CA-AZ)	44	(Los Angeles-San Diego)	6	(West)
Yuma Proving Grounds	160	2	(LA-Riverside-Orange Cnty CA-AZ)	44	(Los Angeles-San Diego)	6	(West)
Fox Lake	64	3	(Chicago-Gary-Kenosha IL-IN-WI)	18	(Chicago)	3	(Great Lakes)
Great Lakes	64	3	(Chicago-Gary-Kenosha IL-IN-WI)	18	(Chicago)	3	(Great Lakes)
Grissom	64	3	(Chicago-Gary-Kenosha IL-IN-WI)	18	(Chicago)	3	(Great Lakes)
Camp Mabry	131	4	(Houston-Galveston-Brazoria TX)	31	(Houston)	5	(Central)
England Industrial Park	131	4	(Houston-Galveston-Brazoria TX)	31	(Houston)	5	(Central)
Fort Hood	131	4	(Houston-Galveston-Brazoria TX)	31	(Houston)	5	(Central)
Fort Polk	131	4	(Houston-Galveston-Brazoria TX)	31	(Houston)	5	(Central)
JRTC (Fort Polk North)	131	4	(Houston-Galveston-Brazoria TX)	31	(Houston)	5	(Central)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Bridgeport	163	6	(San Fran.-Oakland-San Jose CA)	43	(San Francisco-Oakland-San Jose)	6	(West)
Camp Roberts	163	6	(San Fran.-Oakland-San Jose CA)	43	(San Francisco-Oakland-San Jose)	6	(West)
Fort Hunter Liggett	163	6	(San Fran.-Oakland-San Jose CA)	43	(San Francisco-Oakland-San Jose)	6	(West)
Hawthorne	163	6	(San Fran.-Oakland-San Jose CA)	43	(San Francisco-Oakland-San Jose)	6	(West)
Fort Bliss	158	7	(Phoenix-Mesa AZ-NM)	40	(Phoenix)	5	(Central)
Fort Huachuca	158	7	(Phoenix-Mesa AZ-NM)	40	(Phoenix)	5	(Central)
McGregor	158	7	(Phoenix-Mesa AZ-NM)	40	(Phoenix)	5	(Central)
Telegraph Pass	158	7	(Phoenix-Mesa AZ-NM)	40	(Phoenix)	5	(Central)
White Sands Missile Range	158	7	(Phoenix-Mesa AZ-NM)	40	(Phoenix)	5	(Central)
Yuma Proving Grounds	158	7	(Phoenix-Mesa AZ-NM)	40	(Phoenix)	5	(Central)
Camp Mabry	127	8	(Dallas-Fort Worth TX-AR-OK)	32	(Dallas-Fort Worth)	5	(Central)
Fort Hood	127	8	(Dallas-Fort Worth TX-AR-OK)	32	(Dallas-Fort Worth)	5	(Central)
Fort Polk	127	8	(Dallas-Fort Worth TX-AR-OK)	32	(Dallas-Fort Worth)	5	(Central)
Fort Sill	127	8	(Dallas-Fort Worth TX-AR-OK)	32	(Dallas-Fort Worth)	5	(Central)
Ft Chaffee	127	8	(Dallas-Fort Worth TX-AR-OK)	32	(Dallas-Fort Worth)	5	(Central)
JRTC (Fort Polk North)	127	8	(Dallas-Fort Worth TX-AR-OK)	32	(Dallas-Fort Worth)	5	(Central)
Aberdeen Proving Ground	12	9	(Phil.-Atl. City PA-NJ-DE-MD)	4	(Philadelphia)	1	(Northeast)
Fort Indiantown GAP	12	9	(Phil.-Atl. City PA-NJ-DE-MD)	4	(Philadelphia)	1	(Northeast)
Letterkenny	12	9	(Phil.-Atl. City PA-NJ-DE-MD)	4	(Philadelphia)	1	(Northeast)
Quantico	12	9	(Phil.-Atl. City PA-NJ-DE-MD)	4	(Philadelphia)	1	(Northeast)
Camp Pendleton	161	10	(San Diego CA)	44	(Los Angeles-San Diego)	6	(West)
Huntington Beach	161	10	(San Diego CA)	44	(Los Angeles-San Diego)	6	(West)
Miramar	161	10	(San Diego CA)	44	(Los Angeles-San Diego)	6	(West)
San Clemente Island	161	10	(San Diego CA)	44	(Los Angeles-San Diego)	6	(West)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Twenty Nine Palms	161	10	(San Diego CA)	44	(Los Angeles-San Diego)	6	(West)
Camp Grayling	57	11	(Detroit-Ann Arbor-Flint MI)	16	(Detroit)	3	(Great Lakes)
Camp Blanding	30	14	(Orlando FL)	10	(Tampa-St. Petersburg-Orlando)	2	(Southeast)
Aberdeen Proving Ground	13	15	(Wash.-Balt. DC-MD-VA-WV-PA)	5	(Washington)	2	(Southeast)
Craney Island	13	15	(Wash.-Balt. DC-MD-VA-WV-PA)	5	(Washington)	2	(Southeast)
Fort A. P. Hill	13	15	(Wash.-Balt. DC-MD-VA-WV-PA)	5	(Washington)	2	(Southeast)
Fort Indiantown GAP	13	15	(Wash.-Balt. DC-MD-VA-WV-PA)	5	(Washington)	2	(Southeast)
Fort Lee	13	15	(Wash.-Balt. DC-MD-VA-WV-PA)	5	(Washington)	2	(Southeast)
Fort Pickett	13	15	(Wash.-Balt. DC-MD-VA-WV-PA)	5	(Washington)	2	(Southeast)
Joint Base Langley-Eustis	13	15	(Wash.-Balt. DC-MD-VA-WV-PA)	5	(Washington)	2	(Southeast)
Letterkenny	13	15	(Wash.-Balt. DC-MD-VA-WV-PA)	5	(Washington)	2	(Southeast)
Midway Research Center	13	15	(Wash.-Balt. DC-MD-VA-WV-PA)	5	(Washington)	2	(Southeast)
Portsmouth	13	15	(Wash.-Balt. DC-MD-VA-WV-PA)	5	(Washington)	2	(Southeast)
Quantico	13	15	(Wash.-Balt. DC-MD-VA-WV-PA)	5	(Washington)	2	(Southeast)
St. Juliens Creek	13	15	(Wash.-Balt. DC-MD-VA-WV-PA)	5	(Washington)	2	(Southeast)
Vacapes	13	15	(Wash.-Balt. DC-MD-VA-WV-PA)	5	(Washington)	2	(Southeast)
Joint Base Lewis-McChord	170	16	(Seattle-Tacoma-Bremerton WA)	46	(Seattle)	6	(West)
Yakima Firing Center	170	16	(Seattle-Tacoma-Bremerton WA)	46	(Seattle)	6	(West)
Yakima Training Area	170	16	(Seattle-Tacoma-Bremerton WA)	46	(Seattle)	6	(West)
Camp Blanding	34	17	(Tampa-St. Petersburg FL)	10	(Tampa-St. Petersburg-Orlando)	2	(Southeast)
Camp Atterbury	49	18	(Cincinnati-Hamilton OH-KY-IN)	13	(Cincinnati-Dayton)	3	(Great Lakes)
Cincinnati	49	18	(Cincinnati-Hamilton OH-KY-IN)	13	(Cincinnati-Dayton)	3	(Great Lakes)
Grissom	49	18	(Cincinnati-Hamilton OH-KY-IN)	13	(Cincinnati-Dayton)	3	(Great Lakes)
Fort Benning	40	19	(Atlanta GA-AL-NC)	8	(Atlanta)	2	(Southeast)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Fort Gordon	40	19	(Atlanta GA-AL-NC)	8	(Atlanta)	2	(Southeast)
Fort Rucker	40	19	(Atlanta GA-AL-NC)	8	(Atlanta)	2	(Southeast)
Redstone Arsenal	40	19	(Atlanta GA-AL-NC)	8	(Atlanta)	2	(Southeast)
Letterkenny	53	20	(Pittsburgh PA-WV)	12	(Pittsburgh)	3	(Great Lakes)
Camp Mabry	134	21	(San Antonio TX)	38	(San Antonio)	5	(Central)
Fort Hood	134	21	(San Antonio TX)	38	(San Antonio)	5	(Central)
Fort Campbell	96	22	(St. Louis MO-IL)	30	(St. Louis)	4	(Mississippi Valley)
Fort Leonard Wood	96	22	(St. Louis MO-IL)	30	(St. Louis)	4	(Mississippi Valley)
Sand Ridge	96	22	(St. Louis MO-IL)	30	(St. Louis)	4	(Mississippi Valley)
Vichy Airfield	96	22	(St. Louis MO-IL)	30	(St. Louis)	4	(Mississippi Valley)
Camp Atterbury	67	23	(Indianapolis IN-IL)	19	(Indianapolis)	3	(Great Lakes)
Cincinnati	67	23	(Indianapolis IN-IL)	19	(Indianapolis)	3	(Great Lakes)
Grissom	67	23	(Indianapolis IN-IL)	19	(Indianapolis)	3	(Great Lakes)
Fort Bragg	23	24	(Charlotte-Gastonia NC-SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Bragg/Camp McCall	23	24	(Charlotte-Gastonia NC-SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Jackson	23	24	(Charlotte-Gastonia NC-SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Greensboro	23	24	(Charlotte-Gastonia NC-SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort McCoy	63	25	(Milwaukee-Racine WI)	17	(Milwaukee)	3	(Great Lakes)
Fox Lake	63	25	(Milwaukee-Racine WI)	17	(Milwaukee)	3	(Great Lakes)
Great Lakes	63	25	(Milwaukee-Racine WI)	17	(Milwaukee)	3	(Great Lakes)
Two Rivers	63	25	(Milwaukee-Racine WI)	17	(Milwaukee)	3	(Great Lakes)
Dugway Proving Ground	152	26	(Salt Lake City-Ogden UT-ID)	42	(Salt Lake City)	6	(West)
Camp Ripley	107	27	(Minneapolis-St. Paul MN-WI-IA)	20	(Minneapolis-St. Paul)	3	(Great Lakes)
Faribault	107	27	(Minneapolis-St. Paul MN-WI-IA)	20	(Minneapolis-St. Paul)	3	(Great Lakes)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Fort McCoy	107	27	(Minneapolis-St. Paul MN-WI-IA)	20	(Minneapolis-St. Paul)	3	(Great Lakes)
Rosemount	107	27	(Minneapolis-St. Paul MN-WI-IA)	20	(Minneapolis-St. Paul)	3	(Great Lakes)
Camp Mabry	130	28	(Austin-San Marcos TX)	32	(Dallas-Fort Worth)	5	(Central)
Fort Hood	130	28	(Austin-San Marcos TX)	32	(Dallas-Fort Worth)	5	(Central)
Camp Shelby	83	29	(New Orleans LA-MS)	27	(New Orleans-Baton Rouge)	4	(Mississippi Valley)
Bogue Field	19	30	(Raleigh-Durham-Chapel Hill NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Camp Lejeune	19	30	(Raleigh-Durham-Chapel Hill NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Craney Island	19	30	(Raleigh-Durham-Chapel Hill NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Elizabeth City	19	30	(Raleigh-Durham-Chapel Hill NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Bragg	19	30	(Raleigh-Durham-Chapel Hill NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Bragg/Camp McCall	19	30	(Raleigh-Durham-Chapel Hill NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Lee	19	30	(Raleigh-Durham-Chapel Hill NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Pickett	19	30	(Raleigh-Durham-Chapel Hill NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Greensboro	19	30	(Raleigh-Durham-Chapel Hill NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Joint Base Langley-Eustis	19	30	(Raleigh-Durham-Chapel Hill NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Morehead City	19	30	(Raleigh-Durham-Chapel Hill NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Portsmouth	19	30	(Raleigh-Durham-Chapel Hill NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
St. Juliens Creek	19	30	(Raleigh-Durham-Chapel Hill NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Vacapes	19	30	(Raleigh-Durham-Chapel Hill NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Camp Guernsey	141	31	(Denver-Boulder CO-KS-NE)	33	(Denver)	5	(Central)
Fort Carson	141	31	(Denver-Boulder CO-KS-NE)	33	(Denver)	5	(Central)
Pinon Canyon	141	31	(Denver-Boulder CO-KS-NE)	33	(Denver)	5	(Central)
Bridgeport	153	32	(Las Vegas NV-AZ-UT)	44	(Los Angeles-San Diego)	6	(West)
Hawthorne	153	32	(Las Vegas NV-AZ-UT)	44	(Los Angeles-San Diego)	6	(West)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
NTC/Fort Irwin	153	32	(Las Vegas NV-AZ-UT)	44	(Los Angeles-San Diego)	6	(West)
Telegraph Pass	153	32	(Las Vegas NV-AZ-UT)	44	(Los Angeles-San Diego)	6	(West)
Twenty Nine Palms	153	32	(Las Vegas NV-AZ-UT)	44	(Los Angeles-San Diego)	6	(West)
Yuma Proving Grounds	153	32	(Las Vegas NV-AZ-UT)	44	(Los Angeles-San Diego)	6	(West)
Cincinnati	51	33	(Columbus OH)	14	(Columbus)	3	(Great Lakes)
Camp Blanding	29	34	(Jacksonville FL-GA)	9	(Jacksonville)	2	(Southeast)
Fort Stewart	29	34	(Jacksonville FL-GA)	9	(Jacksonville)	2	(Southeast)
Bridgeport	162	35	(Fresno CA)	43	(San Francisco-Oakland-San Jose)	6	(West)
Camp Roberts	162	35	(Fresno CA)	43	(San Francisco-Oakland-San Jose)	6	(West)
Fort Hunter Liggett	162	35	(Fresno CA)	43	(San Francisco-Oakland-San Jose)	6	(West)
Hawthorne	162	35	(Fresno CA)	43	(San Francisco-Oakland-San Jose)	6	(West)
NTC/Fort Irwin	162	35	(Fresno CA)	43	(San Francisco-Oakland-San Jose)	6	(West)
Joint Base Pearl Harbor-Hickam	172	37	(Honolulu HI)	48	(Hawaii)	8	(Hawaii)
Kaneohe	172	37	(Honolulu HI)	48	(Hawaii)	8	(Hawaii)
Kauai	172	37	(Honolulu HI)	48	(Hawaii)	8	(Hawaii)
Oahu	172	37	(Honolulu HI)	48	(Hawaii)	8	(Hawaii)
Pohakuloa Training Area (PTA)	172	37	(Honolulu HI)	48	(Hawaii)	8	(Hawaii)
Bridgeport	164	38	(Sacramento-Yolo CA)	43	(San Francisco-Oakland-San Jose)	6	(West)
Hawthorne	164	38	(Sacramento-Yolo CA)	43	(San Francisco-Oakland-San Jose)	6	(West)
Fort Sill	125	39	(Oklahoma City OK)	37	(Oklahoma City)	5	(Central)
Fort Campbell	73	40	(Memphis TN-AR-MS-KY)	26	(Memphis-Jackson)	4	(Mississippi Valley)
Redstone Arsenal	73	40	(Memphis TN-AR-MS-KY)	26	(Memphis-Jackson)	4	(Mississippi Valley)
Sand Ridge	73	40	(Memphis TN-AR-MS-KY)	26	(Memphis-Jackson)	4	(Mississippi Valley)
Camp Atterbury	70	41	(Louisville KY-IN)	23	(Louisville-Lexington-Evansville)	4	(Mississippi Valley)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Cincinnati	70	41	(Louisville KY-IN)	23	(Louisville-Lexington-Evansville)	4	(Mississippi Valley)
Fort Campbell	70	41	(Louisville KY-IN)	23	(Louisville-Lexington-Evansville)	4	(Mississippi Valley)
Fort Campbell	71	42	(Nashville TN-KY)	25	(Nashville)	4	(Mississippi Valley)
Redstone Arsenal	71	42	(Nashville TN-KY)	25	(Nashville)	4	(Mississippi Valley)
Sand Ridge	71	42	(Nashville TN-KY)	25	(Nashville)	4	(Mississippi Valley)
Fort Leavenworth	99	43	(Kansas City MO-KS)	29	(Kansas City)	4	(Mississippi Valley)
Fort Leonard Wood	99	43	(Kansas City MO-KS)	29	(Kansas City)	4	(Mississippi Valley)
Fort Riley	99	43	(Kansas City MO-KS)	29	(Kansas City)	4	(Mississippi Valley)
Saint Joseph	99	43	(Kansas City MO-KS)	29	(Kansas City)	4	(Mississippi Valley)
Vichy Airfield	99	43	(Kansas City MO-KS)	29	(Kansas City)	4	(Mississippi Valley)
Bogue Field	20	44	(Norfolk-Virginia Beach VA-NC)	6	(Richmond)	2	(Southeast)
Camp Lejeune	20	44	(Norfolk-Virginia Beach VA-NC)	6	(Richmond)	2	(Southeast)
Craney Island	20	44	(Norfolk-Virginia Beach VA-NC)	6	(Richmond)	2	(Southeast)
Elizabeth City	20	44	(Norfolk-Virginia Beach VA-NC)	6	(Richmond)	2	(Southeast)
Fort A. P. Hill	20	44	(Norfolk-Virginia Beach VA-NC)	6	(Richmond)	2	(Southeast)
Fort Lee	20	44	(Norfolk-Virginia Beach VA-NC)	6	(Richmond)	2	(Southeast)
Fort Pickett	20	44	(Norfolk-Virginia Beach VA-NC)	6	(Richmond)	2	(Southeast)
Joint Base Langley-Eustis	20	44	(Norfolk-Virginia Beach VA-NC)	6	(Richmond)	2	(Southeast)
Midway Research Center	20	44	(Norfolk-Virginia Beach VA-NC)	6	(Richmond)	2	(Southeast)
Morehead City	20	44	(Norfolk-Virginia Beach VA-NC)	6	(Richmond)	2	(Southeast)
Portsmouth	20	44	(Norfolk-Virginia Beach VA-NC)	6	(Richmond)	2	(Southeast)
Quantico	20	44	(Norfolk-Virginia Beach VA-NC)	6	(Richmond)	2	(Southeast)
St. Juliens Creek	20	44	(Norfolk-Virginia Beach VA-NC)	6	(Richmond)	2	(Southeast)
Vacapes	20	44	(Norfolk-Virginia Beach VA-NC)	6	(Richmond)	2	(Southeast)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Joint Base Lewis-McChord	167	45	(Portland-Salem OR-WA)	45	(Portland)	6	(West)
Yakima Firing Center	167	45	(Portland-Salem OR-WA)	45	(Portland)	6	(West)
Yakima Training Area	167	45	(Portland-Salem OR-WA)	45	(Portland)	6	(West)
Fort Indiantown GAP	8	46	(Buffalo-Niagara Falls NY-PA)	3	(Buffalo)	1	(Northeast)
Fort Benning	78	47	(Birmingham AL)	24	(Birmingham)	4	(Mississippi Valley)
Redstone Arsenal	78	47	(Birmingham AL)	24	(Birmingham)	4	(Mississippi Valley)
Fort Bragg	18	49	(Greensboro-Winston-Salem NC-VA)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Bragg/Camp McCall	18	49	(Greensboro-Winston-Salem NC-VA)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Jackson	18	49	(Greensboro-Winston-Salem NC-VA)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Pickett	18	49	(Greensboro-Winston-Salem NC-VA)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Greensboro	18	49	(Greensboro-Winston-Salem NC-VA)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Camp Atterbury	50	51	(Dayton-Springfield OH)	13	(Cincinnati-Dayton)	3	(Great Lakes)
Cincinnati	50	51	(Dayton-Springfield OH)	13	(Cincinnati-Dayton)	3	(Great Lakes)
Grissom	50	51	(Dayton-Springfield OH)	13	(Cincinnati-Dayton)	3	(Great Lakes)
Fort Huachuca	159	52	(Tucson AZ)	40	(Phoenix)	5	(Central)
Telegraph Pass	159	52	(Tucson AZ)	40	(Phoenix)	5	(Central)
Yuma Proving Grounds	159	52	(Tucson AZ)	40	(Phoenix)	5	(Central)
Fort Leavenworth	118	54	(Omaha NE-IA-MO)	34	(Omaha)	5	(Central)
Saint Joseph	118	54	(Omaha NE-IA-MO)	34	(Omaha)	5	(Central)
Camp Shelby	84	55	(Baton Rouge LA-MS)	27	(New Orleans-Baton Rouge)	4	(Mississippi Valley)
England Industrial Park	84	55	(Baton Rouge LA-MS)	27	(New Orleans-Baton Rouge)	4	(Mississippi Valley)
Fort Polk	84	55	(Baton Rouge LA-MS)	27	(New Orleans-Baton Rouge)	4	(Mississippi Valley)
JRTC (Fort Polk North)	84	55	(Baton Rouge LA-MS)	27	(New Orleans-Baton Rouge)	4	(Mississippi Valley)
Craney Island	15	56	(Richmond-Petersburg VA)	6	(Richmond)	2	(Southeast)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Elizabeth City	15	56	(Richmond-Petersburg VA)	6	(Richmond)	2	(Southeast)
Fort A. P. Hill	15	56	(Richmond-Petersburg VA)	6	(Richmond)	2	(Southeast)
Fort Lee	15	56	(Richmond-Petersburg VA)	6	(Richmond)	2	(Southeast)
Fort Pickett	15	56	(Richmond-Petersburg VA)	6	(Richmond)	2	(Southeast)
Greensboro	15	56	(Richmond-Petersburg VA)	6	(Richmond)	2	(Southeast)
Joint Base Langley-Eustis	15	56	(Richmond-Petersburg VA)	6	(Richmond)	2	(Southeast)
Midway Research Center	15	56	(Richmond-Petersburg VA)	6	(Richmond)	2	(Southeast)
Portsmouth	15	56	(Richmond-Petersburg VA)	6	(Richmond)	2	(Southeast)
Quantico	15	56	(Richmond-Petersburg VA)	6	(Richmond)	2	(Southeast)
St. Juliens Creek	15	56	(Richmond-Petersburg VA)	6	(Richmond)	2	(Southeast)
Vacapes	15	56	(Richmond-Petersburg VA)	6	(Richmond)	2	(Southeast)
Fort Gordon	41	57	(Greenville-Spartanburg SC-NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Jackson	41	57	(Greenville-Spartanburg SC-NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Drum	7	58	(Rochester NY-PA)	2	(New York City)	1	(Northeast)
Fort Indiantown GAP	7	58	(Rochester NY-PA)	2	(New York City)	1	(Northeast)
Fort Bliss	157	59	(El Paso TX-NM)	39	(El Paso-Albuquerque)	5	(Central)
McGregor	157	59	(El Paso TX-NM)	39	(El Paso-Albuquerque)	5	(Central)
White Sands Missile Range	157	59	(El Paso TX-NM)	39	(El Paso-Albuquerque)	5	(Central)
Fort Leavenworth	124	60	(Tulsa OK-KS)	36	(Tulsa)	5	(Central)
Fort Riley	124	60	(Tulsa OK-KS)	36	(Tulsa)	5	(Central)
Ft Chaffee	124	60	(Tulsa OK-KS)	36	(Tulsa)	5	(Central)
Fort McCoy	104	61	(Madison WI-IL-IA)	17	(Milwaukee)	3	(Great Lakes)
Fox Lake	104	61	(Madison WI-IL-IA)	17	(Milwaukee)	3	(Great Lakes)
Great Lakes	104	61	(Madison WI-IL-IA)	17	(Milwaukee)	3	(Great Lakes)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Two Rivers	104	61	(Madison WI-IL-IA)	17	(Milwaukee)	3	(Great Lakes)
Orchard Park	150	62	(Boise City ID-OR)	42	(Salt Lake City)	6	(West)
Fort Bragg	24	63	(Columbia SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Bragg/Camp McCall	24	63	(Columbia SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Gordon	24	63	(Columbia SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Jackson	24	63	(Columbia SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Joint Base Charleston	24	63	(Columbia SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Leonard Wood	90	64	(Little Rock AR)	28	(Little Rock)	4	(Mississippi Valley)
Ft Chaffee	90	64	(Little Rock AR)	28	(Little Rock)	4	(Mississippi Valley)
Fort Gordon	26	65	(Charleston-North Charleston SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Jackson	26	65	(Charleston-North Charleston SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Stewart	26	65	(Charleston-North Charleston SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Joint Base Charleston	26	65	(Charleston-North Charleston SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Riley	122	67	(Wichita KS-OK)	35	(Wichita)	4	(Mississippi Valley)
Pinon Canyon	122	67	(Wichita KS-OK)	35	(Wichita)	4	(Mississippi Valley)
Fort Leavenworth	119	68	(Lincoln NE)	34	(Omaha)	5	(Central)
Fort Riley	119	68	(Lincoln NE)	34	(Omaha)	5	(Central)
Saint Joseph	119	68	(Lincoln NE)	34	(Omaha)	5	(Central)
Fort Bliss	156	69	(Albuquerque NM-AZ)	39	(El Paso-Albuquerque)	5	(Central)
McGregor	156	69	(Albuquerque NM-AZ)	39	(El Paso-Albuquerque)	5	(Central)
White Sands Missile Range	156	69	(Albuquerque NM-AZ)	39	(El Paso-Albuquerque)	5	(Central)
Fort Drum	6	70	(Syracuse NY-PA)	2	(New York City)	1	(Northeast)
Fort Indiantown GAP	6	70	(Syracuse NY-PA)	2	(New York City)	1	(Northeast)
Cincinnati	56	71	(Toledo OH)	16	(Detroit)	3	(Great Lakes)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Grissom	56	71	(Toledo OH)	16	(Detroit)	3	(Great Lakes)
Faribault	100	72	(Des Moines IA-IL-MO)	21	(Des Moines-Quad Cities)	3	(Great Lakes)
Fort Leavenworth	100	72	(Des Moines IA-IL-MO)	21	(Des Moines-Quad Cities)	3	(Great Lakes)
Fort McCoy	100	72	(Des Moines IA-IL-MO)	21	(Des Moines-Quad Cities)	3	(Great Lakes)
Rosemount	100	72	(Des Moines IA-IL-MO)	21	(Des Moines-Quad Cities)	3	(Great Lakes)
Saint Joseph	100	72	(Des Moines IA-IL-MO)	21	(Des Moines-Quad Cities)	3	(Great Lakes)
Bogue Field	25	73	(Wilmington NC-SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Camp Lejeune	25	73	(Wilmington NC-SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Bragg	25	73	(Wilmington NC-SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Bragg/Camp McCall	25	73	(Wilmington NC-SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Jackson	25	73	(Wilmington NC-SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Joint Base Charleston	25	73	(Wilmington NC-SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Morehead City	25	73	(Wilmington NC-SC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Camp Shelby	77	74	(Jackson MS-AL-LA)	26	(Memphis-Jackson)	4	(Mississippi Valley)
England Industrial Park	77	74	(Jackson MS-AL-LA)	26	(Memphis-Jackson)	4	(Mississippi Valley)
Fort Polk	77	74	(Jackson MS-AL-LA)	26	(Memphis-Jackson)	4	(Mississippi Valley)
JRTC (Fort Polk North)	77	74	(Jackson MS-AL-LA)	26	(Memphis-Jackson)	4	(Mississippi Valley)
Fort Rucker	81	75	(Pensacola FL)	27	(New Orleans-Baton Rouge)	4	(Mississippi Valley)
Panama City	81	75	(Pensacola FL)	27	(New Orleans-Baton Rouge)	4	(Mississippi Valley)
Fort Drum	5	76	(Albany-Schenectady-Troy NY)	2	(New York City)	1	(Northeast)
Bridgeport	151	77	(Reno NV-CA)	43	(San Francisco-Oakland-San Jose)	6	(West)
Dugway Proving Ground	151	77	(Reno NV-CA)	43	(San Francisco-Oakland-San Jose)	6	(West)
Hawthorne	151	77	(Reno NV-CA)	43	(San Francisco-Oakland-San Jose)	6	(West)
NTC/Fort Irwin	151	77	(Reno NV-CA)	43	(San Francisco-Oakland-San Jose)	6	(West)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Twenty Nine Palms	151	77	(Reno NV-CA)	43	(San Francisco-Oakland-San Jose)	6	(West)
Fort McCoy	59	78	(Green Bay WI-MI)	17	(Milwaukee)	3	(Great Lakes)
Two Rivers	59	78	(Green Bay WI-MI)	17	(Milwaukee)	3	(Great Lakes)
Camp Grayling	62	79	(Grand Rapids-Muskegon MI)	16	(Detroit)	3	(Great Lakes)
Fox Lake	62	79	(Grand Rapids-Muskegon MI)	16	(Detroit)	3	(Great Lakes)
Great Lakes	62	79	(Grand Rapids-Muskegon MI)	16	(Detroit)	3	(Great Lakes)
Grissom	62	79	(Grand Rapids-Muskegon MI)	16	(Detroit)	3	(Great Lakes)
Two Rivers	62	79	(Grand Rapids-Muskegon MI)	16	(Detroit)	3	(Great Lakes)
England Industrial Park	85	80	(Lafayette LA)	27	(New Orleans-Baton Rouge)	4	(Mississippi Valley)
Fort Polk	85	80	(Lafayette LA)	27	(New Orleans-Baton Rouge)	4	(Mississippi Valley)
JRTC (Fort Polk North)	85	80	(Lafayette LA)	27	(New Orleans-Baton Rouge)	4	(Mississippi Valley)
Camp Shelby	80	81	(Mobile AL)	27	(New Orleans-Baton Rouge)	4	(Mississippi Valley)
Fort Rucker	80	81	(Mobile AL)	27	(New Orleans-Baton Rouge)	4	(Mississippi Valley)
Panama City	80	81	(Mobile AL)	27	(New Orleans-Baton Rouge)	4	(Mississippi Valley)
Sand Ridge	97	83	(Springfield IL-MO)	18	(Chicago)	3	(Great Lakes)
Vichy Airfield	97	83	(Springfield IL-MO)	18	(Chicago)	3	(Great Lakes)
Bogue Field	21	85	(Greenville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Camp Lejeune	21	85	(Greenville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Craney Island	21	85	(Greenville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Elizabeth City	21	85	(Greenville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Bragg	21	85	(Greenville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Bragg/Camp McCall	21	85	(Greenville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Lee	21	85	(Greenville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Pickett	21	85	(Greenville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Joint Base Langley-Eustis	21	85	(Greenville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Morehead City	21	85	(Greenville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Portsmouth	21	85	(Greenville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
St. Juliens Creek	21	85	(Greenville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Vacapes	21	85	(Greenville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Camp Atterbury	68	86	(Champaign-Urbana IL)	18	(Chicago)	3	(Great Lakes)
Great Lakes	68	86	(Champaign-Urbana IL)	18	(Chicago)	3	(Great Lakes)
Grissom	68	86	(Champaign-Urbana IL)	18	(Chicago)	3	(Great Lakes)
Sand Ridge	68	86	(Champaign-Urbana IL)	18	(Chicago)	3	(Great Lakes)
Aberdeen Proving Ground	11	87	(Harrisburg-Lebanon-Carlisle PA)	4	(Philadelphia)	1	(Northeast)
Fort Indiantown GAP	11	87	(Harrisburg-Lebanon-Carlisle PA)	4	(Philadelphia)	1	(Northeast)
Letterkenny	11	87	(Harrisburg-Lebanon-Carlisle PA)	4	(Philadelphia)	1	(Northeast)
Midway Research Center	11	87	(Harrisburg-Lebanon-Carlisle PA)	4	(Philadelphia)	1	(Northeast)
Quantico	11	87	(Harrisburg-Lebanon-Carlisle PA)	4	(Philadelphia)	1	(Northeast)
Fort Leonard Wood	94	88	(Springfield MO)	30	(St. Louis)	4	(Mississippi Valley)
Ft Chaffee	94	88	(Springfield MO)	30	(St. Louis)	4	(Mississippi Valley)
Vichy Airfield	94	88	(Springfield MO)	30	(St. Louis)	4	(Mississippi Valley)
Camp Blanding	35	89	(Tallahassee FL-GA)	9	(Jacksonville)	2	(Southeast)
Fort Benning	35	89	(Tallahassee FL-GA)	9	(Jacksonville)	2	(Southeast)
Fort Rucker	35	89	(Tallahassee FL-GA)	9	(Jacksonville)	2	(Southeast)
Panama City	35	89	(Tallahassee FL-GA)	9	(Jacksonville)	2	(Southeast)
Ft Chaffee	92	90	(Fayetteville AR-MO-OK)	28	(Little Rock)	4	(Mississippi Valley)
Fort Gordon	28	91	(Savannah GA-SC)	8	(Atlanta)	2	(Southeast)
Fort Jackson	28	91	(Savannah GA-SC)	8	(Atlanta)	2	(Southeast)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Fort Stewart	28	91	(Savannah GA-SC)	8	(Atlanta)	2	(Southeast)
Joint Base Charleston	28	91	(Savannah GA-SC)	8	(Atlanta)	2	(Southeast)
Fort Leonard Wood	98	92	(Columbia MO)	30	(St. Louis)	4	(Mississippi Valley)
Vichy Airfield	98	92	(Columbia MO)	30	(St. Louis)	4	(Mississippi Valley)
Redstone Arsenal	74	93	(Huntsville AL-TN)	24	(Birmingham)	4	(Mississippi Valley)
Camp Atterbury	66	94	(Fort Wayne IN)	18	(Chicago)	3	(Great Lakes)
Cincinnati	66	94	(Fort Wayne IN)	18	(Chicago)	3	(Great Lakes)
Grissom	66	94	(Fort Wayne IN)	18	(Chicago)	3	(Great Lakes)
Camp Shelby	82	95	(Biloxi-Gulfport-Pascagoula MS)	27	(New Orleans-Baton Rouge)	4	(Mississippi Valley)
Fort Carson	140	96	(Pueblo CO-NM)	33	(Denver)	5	(Central)
Pinon Canyon	140	96	(Pueblo CO-NM)	33	(Denver)	5	(Central)
Redstone Arsenal	43	97	(Chattanooga TN-GA)	8	(Atlanta)	2	(Southeast)
England Industrial Park	88	98	(Shreveport-Bossier City LA-AR)	32	(Dallas-Fort Worth)	5	(Central)
Fort Polk	88	98	(Shreveport-Bossier City LA-AR)	32	(Dallas-Fort Worth)	5	(Central)
JRTC (Fort Polk North)	88	98	(Shreveport-Bossier City LA-AR)	32	(Dallas-Fort Worth)	5	(Central)
Fox Lake	65	99	(Elkhart-Goshen IN-MI)	18	(Chicago)	3	(Great Lakes)
Great Lakes	65	99	(Elkhart-Goshen IN-MI)	18	(Chicago)	3	(Great Lakes)
Grissom	65	99	(Elkhart-Goshen IN-MI)	18	(Chicago)	3	(Great Lakes)
Camp Atterbury	69	100	(Evansville-Henderson IN-KY-IL)	23	(Louisville-Lexington-Evansville)	4	(Mississippi Valley)
Fort Campbell	69	100	(Evansville-Henderson IN-KY-IL)	23	(Louisville-Lexington-Evansville)	4	(Mississippi Valley)
Sand Ridge	69	100	(Evansville-Henderson IN-KY-IL)	23	(Louisville-Lexington-Evansville)	4	(Mississippi Valley)
Fort Drum	4	102	(Burlington VT-NY)	2	(New York City)	1	(Northeast)
Bogue Field	22	103	(Fayetteville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Camp Lejeune	22	103	(Fayetteville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Fort Bragg	22	103	(Fayetteville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Bragg/Camp McCall	22	103	(Fayetteville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Fort Jackson	22	103	(Fayetteville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Greensboro	22	103	(Fayetteville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
Morehead City	22	103	(Fayetteville NC)	7	(Charlotte-Greensboro-Greenville-Raleigh)	2	(Southeast)
England Industrial Park	87	104	(Beaumont-Port Arthur TX)	31	(Houston)	5	(Central)
Fort Polk	87	104	(Beaumont-Port Arthur TX)	31	(Houston)	5	(Central)
JRTC (Fort Polk North)	87	104	(Beaumont-Port Arthur TX)	31	(Houston)	5	(Central)
Fort McCoy	60	105	(Appleton-Oshkosh-Neenah WI)	17	(Milwaukee)	3	(Great Lakes)
Two Rivers	60	105	(Appleton-Oshkosh-Neenah WI)	17	(Milwaukee)	3	(Great Lakes)
Fort Benning	39	106	(Columbus GA-AL)	8	(Atlanta)	2	(Southeast)
Fort Rucker	39	106	(Columbus GA-AL)	8	(Atlanta)	2	(Southeast)
Redstone Arsenal	39	106	(Columbus GA-AL)	8	(Atlanta)	2	(Southeast)
Pinon Canyon	139	108	(Santa Fe NM)	39	(El Paso-Albuquerque)	5	(Central)
Yakima Firing Center	147	109	(Spokane WA-ID)	41	(Spokane-Billings)	6	(West)
Yakima Training Area	147	109	(Spokane WA-ID)	41	(Spokane-Billings)	6	(West)
England Industrial Park	89	111	(Monroe LA)	32	(Dallas-Fort Worth)	5	(Central)
Fort Polk	89	111	(Monroe LA)	32	(Dallas-Fort Worth)	5	(Central)
JRTC (Fort Polk North)	89	111	(Monroe LA)	32	(Dallas-Fort Worth)	5	(Central)
Fort Gordon	27	112	(Augusta-Aiken GA-SC)	8	(Atlanta)	2	(Southeast)
Fort Jackson	27	112	(Augusta-Aiken GA-SC)	8	(Atlanta)	2	(Southeast)
Fort Stewart	27	112	(Augusta-Aiken GA-SC)	8	(Atlanta)	2	(Southeast)
Joint Base Charleston	27	112	(Augusta-Aiken GA-SC)	8	(Atlanta)	2	(Southeast)
Fort Benning	79	114	(Montgomery AL)	24	(Birmingham)	4	(Mississippi Valley)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Fort Rucker	79	114	(Montgomery AL)	24	(Birmingham)	4	(Mississippi Valley)
Camp Atterbury	47	116	(Lexington KY-TN-VA-WV)	23	(Louisville-Lexington-Evansville)	4	(Mississippi Valley)
Cincinnati	47	116	(Lexington KY-TN-VA-WV)	23	(Louisville-Lexington-Evansville)	4	(Mississippi Valley)
Greensboro	47	116	(Lexington KY-TN-VA-WV)	23	(Louisville-Lexington-Evansville)	4	(Mississippi Valley)
Fort Bragg/Camp McCall	46	117	(Hickory-Morganton NC-TN)	7	(Charlotte-Greensboro-Greenville-Raleigh)	4	(Mississippi Valley)
Greensboro	46	117	(Hickory-Morganton NC-TN)	7	(Charlotte-Greensboro-Greenville-Raleigh)	4	(Mississippi Valley)
Fort Bliss	136	118	(Hobbs NM-TX)	39	(El Paso-Albuquerque)	5	(Central)
McGregor	136	118	(Hobbs NM-TX)	39	(El Paso-Albuquerque)	5	(Central)
White Sands Missile Range	136	118	(Hobbs NM-TX)	39	(El Paso-Albuquerque)	5	(Central)
Telegraph Pass	154	119	(Flagstaff AZ-UT)	40	(Phoenix)	5	(Central)
Yuma Proving Grounds	154	119	(Flagstaff AZ-UT)	40	(Phoenix)	5	(Central)
Aberdeen Proving Ground	14	122	(Salisbury MD-DE-VA)	5	(Washington)	2	(Southeast)
Craney Island	14	122	(Salisbury MD-DE-VA)	5	(Washington)	2	(Southeast)
Elizabeth City	14	122	(Salisbury MD-DE-VA)	5	(Washington)	2	(Southeast)
Fort A. P. Hill	14	122	(Salisbury MD-DE-VA)	5	(Washington)	2	(Southeast)
Fort Lee	14	122	(Salisbury MD-DE-VA)	5	(Washington)	2	(Southeast)
Joint Base Langley-Eustis	14	122	(Salisbury MD-DE-VA)	5	(Washington)	2	(Southeast)
Midway Research Center	14	122	(Salisbury MD-DE-VA)	5	(Washington)	2	(Southeast)
Portsmouth	14	122	(Salisbury MD-DE-VA)	5	(Washington)	2	(Southeast)
Quantico	14	122	(Salisbury MD-DE-VA)	5	(Washington)	2	(Southeast)
St. Juliens Creek	14	122	(Salisbury MD-DE-VA)	5	(Washington)	2	(Southeast)
Vacapes	14	122	(Salisbury MD-DE-VA)	5	(Washington)	2	(Southeast)
Fort Benning	38	123	(Macon GA)	8	(Atlanta)	2	(Southeast)
Fort Gordon	38	123	(Macon GA)	8	(Atlanta)	2	(Southeast)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Fort Rucker	38	123	(Macon GA)	8	(Atlanta)	2	(Southeast)
Fort Stewart	38	123	(Macon GA)	8	(Atlanta)	2	(Southeast)
England Industrial Park	86	124	(Lake Charles LA)	31	(Houston)	5	(Central)
Fort Polk	86	124	(Lake Charles LA)	31	(Houston)	5	(Central)
JRTC (Fort Polk North)	86	124	(Lake Charles LA)	31	(Houston)	5	(Central)
Camp Mabry	129	125	(San Angelo TX)	32	(Dallas-Fort Worth)	5	(Central)
Fort Hood	129	125	(San Angelo TX)	32	(Dallas-Fort Worth)	5	(Central)
Orchard Park	148	126	(Idaho Falls ID-WY)	42	(Salt Lake City)	6	(West)
Fort Leavenworth	123	128	(Topeka KS)	29	(Kansas City)	5	(Central)
Fort Riley	123	128	(Topeka KS)	29	(Kansas City)	5	(Central)
Saint Joseph	123	128	(Topeka KS)	29	(Kansas City)	5	(Central)
Faribault	106	130	(Rochester MN-IA-WI)	20	(Minneapolis-St. Paul)	3	(Great Lakes)
Fort McCoy	106	130	(Rochester MN-IA-WI)	20	(Minneapolis-St. Paul)	3	(Great Lakes)
Rosemount	106	130	(Rochester MN-IA-WI)	20	(Minneapolis-St. Paul)	3	(Great Lakes)
Faribault	105	131	(La Crosse WI-MN)	17	(Milwaukee)	3	(Great Lakes)
Fort McCoy	105	131	(La Crosse WI-MN)	17	(Milwaukee)	3	(Great Lakes)
Rosemount	105	131	(La Crosse WI-MN)	17	(Milwaukee)	3	(Great Lakes)
Fort Sill	138	132	(Amarillo TX-NM)	32	(Dallas-Fort Worth)	5	(Central)
Pinon Canyon	138	132	(Amarillo TX-NM)	32	(Dallas-Fort Worth)	5	(Central)
Greensboro	45	134	(Johnson City-Kingsport TN-VA)	22	(Knoxville)	4	(Mississippi Valley)
Fort Benning	36	135	(Dothan AL-FL-GA)	24	(Birmingham)	4	(Mississippi Valley)
Fort Rucker	36	135	(Dothan AL-FL-GA)	24	(Birmingham)	4	(Mississippi Valley)
Panama City	36	135	(Dothan AL-FL-GA)	24	(Birmingham)	4	(Mississippi Valley)
Fort Indiantown GAP	9	136	(State College PA)	12	(Pittsburgh)	3	(Great Lakes)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Letterkenny	9	136	(State College PA)	12	(Pittsburgh)	3	(Great Lakes)
Camp Blanding	37	137	(Albany GA)	8	(Atlanta)	2	(Southeast)
Fort Benning	37	137	(Albany GA)	8	(Atlanta)	2	(Southeast)
Fort Rucker	37	137	(Albany GA)	8	(Atlanta)	2	(Southeast)
Fort Stewart	37	137	(Albany GA)	8	(Atlanta)	2	(Southeast)
Fort A. P. Hill	17	138	(Roanoke VA-NC-WV)	6	(Richmond)	2	(Southeast)
Fort Lee	17	138	(Roanoke VA-NC-WV)	6	(Richmond)	2	(Southeast)
Fort Pickett	17	138	(Roanoke VA-NC-WV)	6	(Richmond)	2	(Southeast)
Greensboro	17	138	(Roanoke VA-NC-WV)	6	(Richmond)	2	(Southeast)
Joint Base Lewis-McChord	169	139	(Richland-Kennewick-Pasco WA)	46	(Seattle)	6	(West)
Yakima Firing Center	169	139	(Richland-Kennewick-Pasco WA)	46	(Seattle)	6	(West)
Yakima Training Area	169	139	(Richland-Kennewick-Pasco WA)	46	(Seattle)	6	(West)
Fort Campbell	75	140	(Tupelo MS-AL-TN)	26	(Memphis-Jackson)	4	(Mississippi Valley)
Redstone Arsenal	75	140	(Tupelo MS-AL-TN)	26	(Memphis-Jackson)	4	(Mississippi Valley)
Camp Grayling	61	141	(Traverse City MI)	16	(Detroit)	3	(Great Lakes)
Two Rivers	61	141	(Traverse City MI)	16	(Detroit)	3	(Great Lakes)
Ft Chaffee	91	142	(Fort Smith AR-OK)	28	(Little Rock)	4	(Mississippi Valley)
Camp Ripley	109	143	(Duluth-Superior MN-WI)	20	(Minneapolis-St. Paul)	3	(Great Lakes)
Fort Sill	128	144	(Abilene TX)	32	(Dallas-Fort Worth)	5	(Central)
Camp Guernsey	143	146	(Casper WY-ID-UT)	33	(Denver)	5	(Central)
Orchard Park	149	147	(Twin Falls ID)	42	(Salt Lake City)	6	(West)
Fort Sill	126	148	(Western Oklahoma OK)	37	(Oklahoma City)	5	(Central)
Fort A. P. Hill	16	149	(Staunton VA-WV)	6	(Richmond)	2	(Southeast)
Fort Pickett	16	149	(Staunton VA-WV)	6	(Richmond)	2	(Southeast)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Midway Research Center	16	149	(Staunton VA-WV)	6	(Richmond)	2	(Southeast)
Quantico	16	149	(Staunton VA-WV)	6	(Richmond)	2	(Southeast)
Cincinnati	48	150	(Charleston WV-KY-OH)	13	(Cincinnati-Dayton)	3	(Great Lakes)
Camp Ripley	116	151	(Sioux Falls SD-IA-MN-NE)	20	(Minneapolis-St. Paul)	3	(Great Lakes)
Camp Ripley	113	152	(Fargo-Moorhead ND-MN)	20	(Minneapolis-St. Paul)	3	(Great Lakes)
Fort Leonard Wood	95	153	(Jonesboro AR-MO)	28	(Little Rock)	4	(Mississippi Valley)
Sand Ridge	95	153	(Jonesboro AR-MO)	28	(Little Rock)	4	(Mississippi Valley)
Fort McCoy	108	154	(Wausau WI)	17	(Milwaukee)	3	(Great Lakes)
Two Rivers	108	154	(Wausau WI)	17	(Milwaukee)	3	(Great Lakes)
Fox Lake	102	155	(Davenport-Moline IA-IL)	21	(Des Moines-Quad Cities)	3	(Great Lakes)
Camp Guernsey	142	156	(Scottsbluff NE-WY)	33	(Denver)	5	(Central)
Orchard Park	168	159	(Pendleton OR-WA)	41	(Spokane-Billings)	6	(West)
Yakima Firing Center	168	159	(Pendleton OR-WA)	41	(Spokane-Billings)	6	(West)
Yakima Training Area	168	159	(Pendleton OR-WA)	41	(Spokane-Billings)	6	(West)
Camp Guernsey	115	160	(Rapid City SD-MT-NE-ND)	33	(Denver)	5	(Central)
Fort Campbell	72	165	(Paducah KY-IL)	23	(Louisville-Lexington-Evansville)	4	(Mississippi Valley)
Sand Ridge	72	165	(Paducah KY-IL)	23	(Louisville-Lexington-Evansville)	4	(Mississippi Valley)
Fort Greely	171	166	(Anchorage AK)	47	(Alaska)	7	(Alaska)
Fort Wainwright	171	166	(Anchorage AK)	47	(Alaska)	7	(Alaska)
Joint Base Elmendorf-Richardson	171	166	(Anchorage AK)	47	(Alaska)	7	(Alaska)
Yukon Range	171	166	(Anchorage AK)	47	(Alaska)	7	(Alaska)
Fort Riley	120	167	(Grand Island NE)	34	(Omaha)	5	(Central)
Camp Grayling	58	169	(Northern Michigan MI)	16	(Detroit)	3	(Great Lakes)
Apra Harbor	173	174	(Guam-Northern Mariana Islands)	49	(Guam-Northern Mariana Islands)	9	(Guam-Northern Mariana Isl.)

Location	EA #	Median Rank	EA Name	MEA #	MEA Name	REAG #	REAG Name
Camp Shelby	176	176	(Gulf of Mexico)	52	(Gulf of Mexico)	12	(Gulf of Mexico)
Fort Rucker	176	176	(Gulf of Mexico)	52	(Gulf of Mexico)	12	(Gulf of Mexico)
Panama City	176	176	(Gulf of Mexico)	52	(Gulf of Mexico)	12	(Gulf of Mexico)

Appendix 3: Commercial Systems

Baseline LTE Uplink Characteristics

12 November 2012 - Rev.2

This document reflects the consensus of the LTE Technical Characteristics group of the CSMAC Working Groups. Participants include:

WG-1 Co-Chairs

Ivan Navarro – DOC/NOAA
Steve Sharkey – T-Mobile

Industry Representatives

Maqbool Aliani – Lightsquared
Kumar Balachandran – Ericsson
Mike Chartier – Intel
Doug Duet – AT&T
Tom Dombrowsky – Wiely Rien
Rick Engelman – Sprint
Paul Frew – RIM
John Graybeal – Cisco
Alexander Gerdenitsch – Motorola Mobility
Arunabha Ghosh – AT&T
Frank Jager – Verizon
Jorgen Karlsson – Ericsson
Rob Kubik – Samsung
Milap Majmundar – AT&T
Joe Marx – AT&T
Mark McHenry – Shared Spectrum
Prakash Moorut – Nokia Siemens Networks
Mark Racek – Ericsson
Sanyogita Shyamsunder – Verizon
Doug Smith – Lightsquared
David Steer – RIM
Neeti Tandon – AT&T
Nelson Ueng –T-Mobile
Patrick Welsh – Verizon
Christopher Wieczorek – T-Mobile
Stephen Wilkus – Alcatel-Lucent
Ken Zdunek – Roberson & Associates

Government Representatives

Lloyd Apirian – Alion Science
Lawrence Crippen – Alion Science
David Greenberg – Alion Science
Jason M Greene – Alion Science
Robert Martin – Alion Science
Robert L. Higginbotham – CIV DISA DSO
Gerald Hurt – Consultant to Exelis, Inc.
Daniel Jablonski – JHU Applied Physic Lab
Peter G. Kim – Aerospace Corp
Lawrence Lambert – Exelis, Inc.
Paul McKenna – NTIA/ITS
Albert 'Buzz' Merrill - Aerospace
Pierre Missud – ATDI
Eric Nelson – NTIA/ITS
Emil Olbrich – NIST
Thomas Shanholtz – Exelis, Inc.
O. Alden Smith – CTR DISA DSO; Scitor Corp.
Martin Rais – ATDI
Brian Wright - DOI

NTIA Liaisons

Ed Drucella
John Hunter

FCC Liaisons

Navid Golshahi
Michael Ha
Chris Helzer
Robert Pavlak
Robert Weller
Janet Young

Baseline LTE Uplink Characteristics

For use in Interference Analysis for Protection of Federal Operations in the 1695-1710 and 1755-1850 MHz Bands, including adjacent bands

Introduction

The information regarding LTE Uplink Characteristics is intended for use in general analysis of the potential for interference between commercial LTE operations and Federal Government operations in the 1755-1850 MHz band. The information represents a collaborative effort between industry and government representative experts to agree on LTE parameters that are closer to realistic operational parameters than have been used in past analysis. However, because these parameters will be used in general analysis, it is not possible to fully capture the parameters that will be observed in an actual deployment, which will vary by carrier implementation and site specific geography. In order to provide a uniform set of information to apply in a wide variety of analysis, a number of simplifying assumptions have been made that may continue to result in analysis showing a greater level of interference that would actually occur. These include, but are not limited to, the assumptions being based on 100% loading rather than a more realistic loading level and use of propagation curves that may result in higher calculated power. In addition, because the transmit power and interference potential of a UE device is highly dependent on the UE distance to a base station, developing and applying UE information that is uncorrelated to interfering path is likely to overestimate the amount of interference. None-the-less, given the difficulty of developing and running a fully correlated model, the Technical Group participants agreed that it is reasonable to proceed with uncorrelated values in order to develop a general understanding of the interference potential given limited time and resources. Analysis based on this information will serve as useful guidance in understanding the potential for systems to coexist and the potential for interference. However, site specific coordination will be necessary to maximize efficient use of the spectrum.

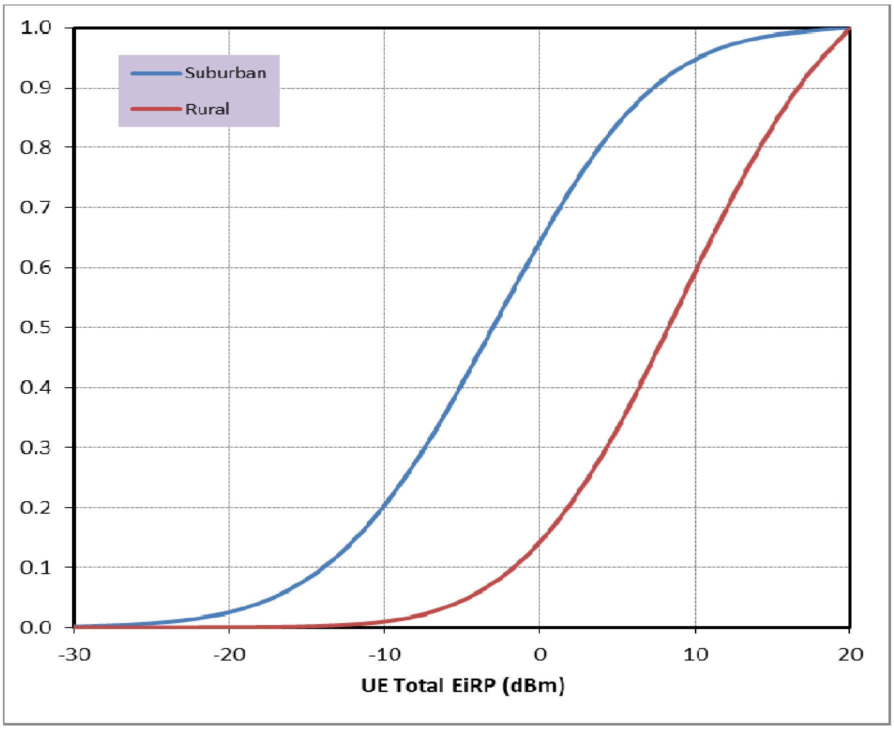
User Equipment (UE) Transmit Characteristics

Cumulative Distribution Function (CDF) of Total EIRP per Scheduled User Equipment

- Assumptions for generation of CDF data:

- LTE Frequency Division Duplex (FDD) system
- 10 MHz LTE Bandwidth
- 100% system loading at LTE Base Station (eNodeB)
  - All Physical Resource Blocks (PRB) are occupied at all times
- 100% outdoor UE distribution
- P_0 = -90 dBm and alpha = 0.8 for UL Power Control (urban/suburban/rural)
- Proportional fair algorithm for LTE Scheduler
- Full-buffer traffic model (i.e. All UEs have data in their Radio Link Control (RLC) layer buffer at all times)

• Graphical CDF Data



- Tabulated CDF Data

	Urban/Suburban (1.732 Km ISD) (6 UE scheduled/TTI/sector)		Rural (7 Km ISD) (6 UE scheduled/TTI/sector)	
UE EiRP (dBm)	**PDF**	**CDF**	**PDF**	**CDF**
-40	0.0000	0.0000	0.0000	0.0000
-37	0.0001	0.0001	0.0000	0.0000
-34	0.0002	0.0003	0.0000	0.0000
-31	0.0008	0.0011	0.0000	0.0000
-28	0.0020	0.0031	0.0000	0.0000
-25	0.0040	0.0071	0.0000	0.0000
-22	0.0083	0.0154	0.0002	0.0002
-19	0.0166	0.0320	0.0004	0.0006
-16	0.0327	0.0647	0.0007	0.0013
-13	0.0547	0.1194	0.0026	0.0039
-10	0.0839	0.2033	0.0060	0.0099
-7	0.1128	0.3160	0.0153	0.0252
-4	0.1370	0.4530	0.0325	0.0577
-1	0.1429	0.5959	0.0575	0.1152
2	0.1338	0.7297	0.0911	0.2062
5	0.1094	0.8390	0.1245	0.3307
8	0.0753	0.9143	0.1536	0.4843
11	0.0450	0.9594	0.1605	0.6448
14	0.0236	0.9830	0.1473	0.7920

	Urban/Suburban (1.732 Km ISD) (6 UE scheduled/TTI/sector)		Rural (7 Km ISD) (6 UE scheduled/TTI/sector)	
UE EiRP (dBm)	**PDF**	**CDF**	**PDF**	**CDF**
17	0.0106	0.9936	0.1203	0.9123
20	0.0064	1.0000	0.0877	1.0000

Assumed Number of Scheduled (transmitting) UE per Sector

- Assume Physical Downlink Control Channel (PDCCH) = 6 is typical for a 10 MHz LTE Channel
  - PDCCH contains Downlink Control Information (DCI) blocks, which provide downlink and uplink resource allocations, and power control commands for UEs
  - Use UEs per sector (i.e. the number of simultaneously transmitting UEs is 6 per sector or 18 per eNodeB, for a 10 MHz Channel)
  - 100 % of uplink resources (PRBs) are equally distributed among transmitting UEs in each sector
- Randomly assign power in accordance with UE power CDF for each independent Monte-Carlo analysis trial
- The PDCCH value and corresponding number of UE should be adjusted based on the LTE channel bandwidth:

PDCCH Value / Channel Bandwidth			
5 MHz	**10 MHz**	**15 MHz**	**20 MHz**
PDCCH = 3	PDCCH = 6	PDCCH = 9	PDCCH = 12

Assumed Inter-Site Distance (ISD) for Generic LTE eNodeB Deployment

- Use concentric circles centered around metropolitan area unless other site specific assumptions are agreed upon.
- Urban/suburban area assumed to be 30 km radius with rural area covering outer circle up to 100 km, unless other site specific assumptions are mutually agreed upon
- Surrounding rural deployment may be adjusted by mutual agreement if and when there is more than one urban/suburban area within 100km of the site being analyzed

Deployment	ISD	eNodeB Antenna Height	UE Antenna Height
Urban/Suburban (r <= 30 km)	1.732 km	30 m	1.5 m
Rural (U/S Edge < r <= 100 km)	7 km	45 m	1.5 m

Requirements for Unwanted Emissions

LTE specification defines requirements for two separate kinds of unwanted emissions, with those for spurious emissions being the more stringent. In addition to these minimum requirements, additional spectrum emission requirements defined in the 3GPP standard must be fulfilled for a specific deployment scenario such as intra-band contiguous Carrier Aggregation, cell handover, UL-MIMO, etc.

1) **Out-of-Band (OOB) Emissions**

a) **Spectrum Emissions Mask (SEM)**

- OOB specification is defined with respect to the edge of the occupied bandwidth and it is absolute value
- The 3GPP defines standard identifies two resolution measurement bandwidths (30 kHz and 1 MHz). For example, -15 dBm/30 kHz for $\Delta f_{OOB} \pm$ 0-1 in 5 MHz can be converted to 1 MHz bandwidth resolution results in a limit of 0.23 dBm/1MHz
- For frequencies greater than (Δf_{OOB}) as specified in Table below for Band Class 4, the spurious emissions requirements are applicable

Spectrum Emission Limit (dBm)/ Channel Bandwidth							
Δf_{OOB} (MHz)	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz	Measurement Bandwidth
± 0-1	-10 *(5.23)*	-13 *(2.23)*	-15 *(0.23)*	-18 *(-2.77)*	-20 *(-4.77)*	-21 *(-5.77)*	30 kHz *(1 MHz)*
± 1-2.5	-13	-13	-13	-13	-13	-13	1 MHz
± 2.5-2.8	-25	-13	-13	-13	-13	-13	1 MHz
± 2.8-5		-13	-13	-13	-13	-13	1 MHz
± 5-6		-25	-13	-13	-13	-13	1 MHz
± 6-10			-25	-13	-13	-13	1 MHz
± 10-15				-25	-13	-13	1 MHz
± 15-20					-25	-13	1 MHz
± 20-25						-25	1 MHz

2) Adjacent Channel Leakage Ratio (ACLR)

- ACLR is the ratio of the filtered mean power centered on the assigned channel frequency to the filtered mean power centered on an adjacent channel frequency at nominal channel spacing
- Defines ACLR requirements for two scenarios for an adjacent LTE (Evolved Universal Terrestrial Radio Access (E-UTRA)) channels and/or UMTS channels
- The minimum requirement of ACLR for LTE is specified, as follows:

	Channel bandwidth / E-UTRA$_{ACLR1}$ / Measurement Bandwidth					
	1.4 MHz	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
E-UTRA$_{ACLR1}$	30 dB	30 dB	30 dB	30 dB	30 dB	30 dB
E-UTRA channel Measurement bandwidth	1.08 MHz	2.7 MHz	4.5 MHz	9.0 MHz	13.5 MHz	18 MHz
Adjacent channel center frequency offset (in MHz)	+1.4 / -1.4	+3.0 / -3.0	+5 / -5	+10 / -10	+15 / -15	+20 / -20

3) Spurious Emissions

- Occurs well outside the bandwidth necessary for transmission and may arise from a large variety of unwanted transmitter effects such as harmonic emission, parasitic emissions, intermodulation products and frequency conversion products, but exclude OOB emissions unless otherwise stated

- This value would be used for all the blank spaces in SEM mask

Frequency Range	Maximum Level	Measurement Bandwidth	Notes
9 kHz ≤ f < 150 kHz	-36 dBm *(-6 dBm)*	1 kHz *(1 MHz)*	
150 kHz ≤ f < 30 MHz	-36 dBm *(-16 dBm)*	10 kHz *(1 MHz)*	
30 MHz ≤ f < 1000 MHz	-36 dBm *(-26 dBm)*	100 kHz *(1 MHz)*	
1 GHz ≤ f < 12.75 GHz	-30 dBm	1 MHz	
12.75 GHz ≤ f < 19 GHz	-30 dBm	1 MHz	Note 1
Note 1:	Applies for Band 22, Band 42 and Band 43		

LTE Base Station Receive Characteristics

This table endeavors herein to provide an overview of Base Station Receiver characteristics established by international standards. While the characteristics can be used in a preliminary analysis of the potential for interference from Government operations to commercial operations there are numerous implementation specific methods that a carrier can deploy to significantly impact the potential for interference. Examples include, but are not limited to antenna down tilt, antenna orientation, power control to improve link margin, temporal use of specific channels to avoid using channels during periods when interference is likely, and use of natural terrain to provide shielding. Annex 1 provides a more detailed discussion of the potential impact of antenna down tilt and orientation. Because these features are implementation specific it is difficult to include them as part of a general analysis and specific features should not be included as part of final rules. While a general analysis may be useful in determining the overall viability as to whether some form of sharing is possible, rules should not include a defined exclusion or coordination zone that precludes commercial deployments in a given area based on the potential for interference to the commercial operation. Instead, as much information as possible regarding the government operations should be provided, thus allowing the commercial licensee to determine the most effective method to mitigate interference.

- LTE (FDD) Base Station Receiver Characteristics

<table>
<tr><th>Parameter</th><th colspan="2">Base Station</th></tr>
<tr><td>Receiver Channel Bandwidth (MHz)</td><td colspan="2">1.4, 3, 5, 10, 15 and 20
With signal bandwidths of 1.08, 2.7, 4.5, 9, 13.5 and 18 MHz</td></tr>
<tr><td>Adjacent Channel Selectivity (ACS)</td><td>Channel BW
Wide Area BS</td><td>Wide Area BS
Wanted Signal Mean Power (dBm)</td></tr>
</table>

Parameter	Base Station	
	1.4 MHz 3 MHz 5 MHz 10 MHz 15 MHz 20 MHz	-95.8 ($P_{REFSENS}$ + 11dB) -95.0 ($P_{REFSENS}$ + 8dB) -95.5 ($P_{REFSENS}$ + 6dB) -95.5 ($P_{REFSENS}$ + 6dB) -95.5 ($P_{REFSENS}$ + 6dB) -95.5 $P_{REFSENS}$ + 6dB
	Reference TS 36.104 Table 7.5.1-3	Interfering signal mean power: -52 dBm [i]
	Channel BW Local Area BS	Local Area BS Wanted Signal Mean Power (dBm)
	1.4 MHz 3 MHz 5 MHz 10 MHz 15 MHz 20 MHz	-87.8 ($P_{REFSENS}$ + 11dB) -87.0 ($P_{REFSENS}$ + 8dB) -87.5 ($P_{REFSENS}$ + 6dB) -87.5 ($P_{REFSENS}$ + 6dB) -87.5 ($P_{REFSENS}$ + 6dB) -87.5 ($P_{REFSENS}$ + 6dB)
	Reference TS 36.104 Table 7.5.1-4	Interfering signal mean power: -44 dBm [ii]
Noise Figure (dB)	5	

Parameter	Base Station	
Reference Sensitivity (dBm) $P_{REFSENS}$ for Wide Area BS [iii]	1.4 MHz 3 MHz 5 MHz 10 MHz 15 MHz 20 MHz	-106.8 -103.0 -101.5 -101.5 -101.5 -101.5
Reference Sensitivity (dBm) $P_{REFSENS}$ for Local Area BS	1.4 MHz 3 MHz 5 MHz 10 MHz 15 MHz 20 MHz	-98.8 -95.0 -93.5 -93.5 -93.5 -93.5
Antenna Gain (Mainbeam) (dBi) [i, ii, iii]	18	
Azimuth Off-Axis Antenna Pattern (dBi as a function of off-axis angle in degrees)	ITU-R Recommendation F.1336-3 with an elevation 3 dB beamwidth of 10 degrees, k=0.2 and the equations in Section 3.2[vi]	
Elevation Off-Axis Antenna Pattern (dBi as a function of off-axis angle in degrees)	ITU-R Recommendation F.1336-3 with an elevation 3 dB beamwidth of 10 degrees, k=0.2 and the equations in Section 3.2[vi]	
Antenna Polarization	Linear	
Antenna Height (meters) [1]	30 (Urban/Suburban) 15 to 60 (Rural)	
Antenna Azimuth 3 dB Beamwidth (degrees) [2]	70	
Antenna Down Tilt Angle (degrees)	3	
Cable, Insertion, or Other Losses (dB)	2	

Parameter	Base Station
Interference Criterion	1dB desense. This translates into a maximum interference = Noise floor - 5.87 dB (I/N= ~ -6dB).
Note 1: For single entry analysis the maximum antenna height of 45 meters for base stations will be used for rural. For aggregate analysis antenna heights will be varied between the minimum and maximum values shown in the table. Note 2: A base station typically has three sectors each 120 degrees wide.	

ANNEX

Example: Interference Mitigation via Antenna Downtilting and Antenna Azimuth Orientation

Commercial cellular deployments do regularly take into account interference considerations. Even inter-cell interference within the same service provider network typically results in finite antenna downtilt, particularly for systems with full spectral reuse (i.e., 3G, 4G). Also in the commercial cellular world there exist numerous instances where adjacent band and other interference scenarios have been successfully mitigated via proper RF design (e.g., between service providers in adjacent spectrum, etc).

To illustrate the potentially significant impact of these antenna techniques on the interference issues, we evaluate two representative commercial base station antennas from CommScope/Andrew in the discussion below. Depending on the Federal Government systems involved, different assumptions might be appropriate.

- Andrew HBX-6516DS-T0M: 18 dBi max gain (along the main beam or "bore sight" direction), 65° horizontal beamwidth, 0° electrical downtilt, 7.1° vertical beamwidth.
- Andrew HBX-9016DS-T0M: 18.3 dBi max gain, 90° horizontal beamwidth, 0° electrical downtilt, 4.8° vertical beamwidth.

Using these antennas, and orienting them with a 60° azimuthal offset from the Federal Government system direction, the gain reductions for various reasonable antenna downtilts are calculated (in the table, the gain reductions listed below are with respect to the max ~18dBi gain of these antennas). The displayed gain reductions as a function of the downtilt angles are for the case of an interferer at the horizon. Note that an interference source like JTRS may be at an elevation (e.g., the WG-5 draft calculation assumed 10,000 feet), which would result in higher gain reductions.

Antenna	Gain reduction from 60° azimuthal orientation	Gain reduction from 4° vertical downtilt [Total reduction from azimuth + downtilt]	Gain reduction from 6° vertical downtilt [Total reduction from azimuth + downtilt]	Gain reduction from 8° vertical downtilt [Total reduction from azimuth + downtilt]
Andrew HBX-6516DS-T0M	8.6 dB	2.8 dB [11.4 dB]	7.4 dB [16.0 dB]	16.3 db [24.9 dB]
Andrew HBX-9016DS-T0M	6.3 dB	8.7 dB [15.0 dB]	26.9 dB [33.2 dB]	24.1 dB [30.4 dB]

As can be seen, total gain reductions (summing the reductions due to azimuthal orientation plus those from vertical downtilt) can be very large, anywhere from 11.4 to 30.4 dB – assuming the Federal Government interfering transmitter is at the horizon in our example.

Notes:

[i] This interfering signal mean power is for a wanted signal mean power at P_REFSENS + xdB (where x=6dB for 3-20MHz channels and 11dB for 1.4MHz channel). One way to interpret this spec is that this is the maximum interference level for xdB desense criterion. For instance, if 1dB desense is used in the coexistence studies, a conversion can be done to adjust for the lower desense criterion. For example, if adjacent channel selectivity is specified as -52dBm and wanted signal mean power is P_REFSENS + 6dB, the level can be adjusted by 11dB for the smaller sensitivity degradation allowed giving -52-11= -63dBm:

- 1 dB desense: maximum interference = Noise floor - 5.87 dB

[ii] Same as in footnote i, interfering signal mean power can be adjusted for 1dB desense if this criterion is used in the coexistence studies. For example, in the case of wanted signal mean power at P_REFSENS + 6dB, the level can be adjusted by 11dB for the smaller sensitivity degradation allowed giving -44-11=-55dBm.

[iii] See 3GPP TS 36.104, §7.2. $P_{REFSENS}$ is the power level of a single instance of the reference measurement channel. This requirement shall be met for each consecutive application of a single instance of FRC A1-3 mapped to disjoint frequency ranges with a width of 25 resource blocks each.

[iv] Base station antennas, both receive and transmit, typically have strongly angle-dependent gain characteristics characterized by a horizontal and vertical beamwidth. The gain value listed here corresponds to the maximum gain corresponding to the main lobe of the antenna.

[v] Assuming full bore-sight gain of the LTE BS receive antenna (18dBi) may not reflect interference mitigation techniques as would be naturally deployed. Significant interference mitigation can be achieved via several factors, which are standard in the industry: e.g., antenna downtilts (point below the horizon, achieved by either mechanical and/or electrical means), antenna azimuth orientation (orient away from the interferer), and use of available terrain (where it exists) for additional refraction loss, etc. This needs to be taken into account when doing interference studies. The antenna techniques are further discussed in the Annex.

[6] See Annex 8 of ITU-R Recommendation F.1336-3, which observes that the recommended equations for antenna gains often do not accurately reflect the gains of actual antennas – particularly with regard to the side lobes, as indicated in Figs 24 to 27 in Annex 8. This should be taken account when considering interference in directions far from the main antenna lobe.

Appendix 4: Sharing Analyses and Results

A.4.1 Technical Approach

The technical approach for interference analysis and Protection Zone determination is roughly the same for TRR and for JTRS.

Information on the LTE UE, LTE Base Stations and JTRS/TRR systems was obtained from the appropriate sources. The information included the following:

- Technical characteristics and operational characteristics
- Deployment/operational scenarios
- Projected density of deployments
- Interference protection requirements: interference thresholds

The aforementioned information was obtained from the WG1 LTE Subcommittee, the Technical Working Group and appropriate federal agencies.

The primary analysis tool agreed upon by the WG used for this assessment was Visualyse (Note: a description of Visualyse is provided below). The potential interference risks between the systems were summarized and recommendations for required testing, and any mitigation/sharing approaches that need to be developed and implemented was documented in a report. The approach and methodology used for the analysis was also agreed by the WG.

Electromagnetic Interference Analysis:

The compatibility analysis was performed to assess the interference impact of the LTE UE devices on the operations of JTRS/TRR and the interference impact of JTRS/TRR on the LTE Base Stations by determining the undesired received signal power of the victim receiver and required protection distances.

The undesired received signal power at a victim Rx IF stage due to an undesired RF signal from a Tx is computed using equation (1) below.

JTRS/TRR and LTE UE Interference Impact Assessment:

Visualyse was used to determine Protection Zones where the LTE UE devices must protect the operations of JTRS/TRR from harmful interference. Data on base station locations was provided by Industry and was used to determine the deployment of LTE UE devices based on the Urban and surrounding rural areas of the designated JTRS/TRR installation site.[21] The Protection Zones were predicted by positioning JTRS/TRR at designated installations on a software grid of terrain data, and computing the level of received undesired power. The boundary at which the interference threshold is exceeded was mapped around the installation. This boundary indicates the area that must be avoided to prevent harmful interference to the JTRS/TRR operations. For this analysis, the grid system used in Visualyse was based on the size of the installation site.

[21] A "randomized cell layout" was provided for use by the Technical Working Group. Please refer to the WG5 final report for a detailed description.

JTRS/TRR and LTE Base Stations Interference Impact Assessment:

Visualyse was used to determine Protection Zones where the LTE Base Station might be subject to interference from JTRS/TRR operations. Industry data was used to determine the deployment, technical and operational characteristics of the LTE Base Stations. Protection Zones were predicted by positioning JTRS/TRR at designated installations on a software grid of terrain data, assuming that the base station is at every grid point (typically spaced at increments of 2 km) within an area surrounding the military base, and computing the level of received undesired power. Interference was assessed for on-azimuth, 60° off-axis, and 180° off-axis cases. The boundary at which the interference threshold is exceeded was mapped around the installation. This boundary indicates the area that must be avoided to prevent harmful interference to the LTE Base Stations. For this analysis, the grid system used in Visualyse was based on the size of the installation site.

Critical Assumptions:

A list of critical technical and operational assumptions was discussed within the WG based on the appropriate data. The current assumptions are as follows:

- I/N threshold value of - 6 dB was used.
- NTIA's Irregular Terrain Model (ITM) Version 1.2.2, Longley-Rice, was used for the propagation loss.
- The JTRS/TRR equipment was placed along the perimeter of the installation site unless otherwise noted.
- In cases where calculated Protection Zones are broken points, they were manually interpolated..
- When the Protection Zone trace goes within the installation site, the installation boundary was used as the exclusion zone.
- Aggregation of interferors was used to assess the operational impact between the LTE UE devices and JTRS and TRRs.

Reason for representative sample:

Due to the need to first determine the viability of the approach before performing analyses for over 70 discrete sites, a representative sample of three sites was selected. The criteria included such factors as proximity to population centers and physical geography. In regards to the former, bases located closer to population centers were preferred because it is in those areas that carriers likely will have the most interest in access to additional spectrum in the near term. For geography, it was desirous that each sample had different topographical features.

The following TRR systems locations were chosen:

- Ft. Lewis, WA (Army)
- Ft. Carson, CO (Army)
- Camp Blanding, FL (Army)
- Camp Pendleton, CA (Navy/USMC)

Ft. Lewis was selected for its proximity to the Seattle metropolitan area and its topology that includes both mountains and bodies of water.

Ft. Carson was selected for its high altitude mountains and the proximity to Colorado Springs, Denver and the I-25 corridor.

Camp Blanding was selected for its central Florida location which is proximal to population centers and major transportation arteries, as well as the surrounding flat terrain and bodies of water.

Camp Pendleton was chosen for its geography including mountains, canyons and the Pacific Ocean. It is also located almost equally distant between Los Angeles and San Diego. Furthermore, the TRR architecture is unique in the sense that TRR operations at Camp Pendleton include a mobile ship-to-shore component.

Methodology:

JTRS and TRR characteristics were modeled in accordance with information provided in WG-4 and its associated J/F-12.

LTE Handset characteristics were modeled in accordance with information provided by LTE Technical Working Group associated with WG-1.

Geographic distribution of handsets was based on the randomized real network in baseline document and according the EA rankings provided by WG-2.

Interference power calculations were then performed based on the Worst Case Azimuth pointing angle of the JTRS and TRR systems.

Analysis for the JTRS and TRR backlobe/sidelobe antenna gain at the perimeter was performed, however the TRR located at the center of the installation with the mainbeam antenna gain resulted in the worst case scenario.

Interference Power Calculation

Interference power at victim receiver:

$$I = Pt + Gt + Gr - Lp - Lsys - OTR \quad (1)$$

Where:

I	=	Interference power at victim Rx antenna output (dBm)
Pt	=	Transmitter power of the interferor (dBm)
Gt	=	Antenna gain of interferer in direction of victim (dBi)
Gr	=	Antenna gain of victim receiver in direction of interferer (dBi)
Lp	=	Propagation loss between victim and interferor (dB)
Lsys	=	Additional receive system losses (dB)
OTR		On-tune rejection, dB LTE Systems (dB)

Notes to Interference Power Calculation:

- Interference power calculations were performed using Visualyse automated software tool
- When UE is source, Pt plus Gt not to exceed 20 dBm

- Propagation loss calculated using Longley-Rice and terrain data (30’ USGS data) used for ground/ground interactions, antenna heights above local terrain
- Additional receive system losses estimated ~ 4 dB
- On-tune rejection taken as 10log(BWtx/BWrx) in dB
- In this initial analysis, on-tune case considered only

Calculation of Aggregate Interference:

Total interference at JTRS and TRR receiver is taken as aggregate of on-tuned UE emissions

Aggregate calculated as:

$$I_{agg} = 10\log\{\textstyle\sum_{j=1}^{N} Ij\} + 30 \quad (2)$$

Where,

Iagg	=	Aggregate interference at victim receiver (dBm)
N	=	number of UEs
I	=	Interference power at victim receiver from a single UE (Watts)

Application of Interference Power Calculation:

For interference to JTRS and TRR:

- Interference is calculated for positions of around operations area boundaries and locations of JTRS and TRR systems as appropriate.
- Visualyse used to determine distances beyond which UE operations not expected to exceed interference threshold.

Analysis Assumptions

For JTRS and TRR as interference victim:

- UE transmit power modeled using urban & rural CDFs
- UEs modeled as being located a base of urban/rural base stations (three per UE carrier frequency at each base station)
- UE interference modeled as six handsets contiguous in frequency each modeled at 1.67 MHz UE emitter
- UE antenna height of 1.5m
- UE geographic distribution according to randomized real network
- Clutter has not been taken into account, 0 dB
- Rural grid extended beyond 100km radius
- Assessed TRR at the center of the installation based on the antenna pattern.
    - JTRS and TRR Directional Antenna, 23 dBi MB
    - TRR Link Distance of 10 km

For LTE Base Stations as interference victim:

- LTE Base Station Antenna heights – 30m urban, 60m rural
- LTE Base Station Sector coverage – pattern as described in ITU-R F.1336-3

- LTE Base Station Downtilt – 3 degrees from the horizontal
- LTE Base Station on-azimuth, 60° off-axis, and 180° off-axis

Visualyse:

Visualyse is a commercially available, time-based simulation and area analysis tool that was initially developed to address modeling of technical issues associated with International Telecommunication Union (ITU) activities. The capabilities and applications of Visualyse have broadened to many Radio Frequency (RF) scenarios while retaining the technical foundations and references of the ITU.

The Visualyse model allows the analyst to make an in-depth assessment of possible interference interactions using time-based simulations, detailed descriptions of technical parameters, and using different propagation models as appropriate. Of particular interest is the capability to construct and analyze aggregate environments and to assess the associated potential impact to a moving platform. The analyst can model emission parameters such as transmitter power, modulation type, emission bandwidth, cable losses, and transmit antenna patterns and scanning characteristics. Receiver parameters such as receiver bandwidths, noise figures, cable losses and receive antenna characteristics can also be modeled. Time-varying parameters of both the individual emitters in an aggregate environment and the movement and scanning antenna of a possible victim receiver can be modeled with Visualyse. The model can calculate such important performance criteria as predicted interference-to-noise levels at a victim receiver for each simulation step in an environment. An overall interference assessment can be made on the basis of predicted scenario values that can be compared to known interference thresholds.

The basic inputs to utilize Visualyse are as follows:

- Basic Visualyse Transmitter Input
- Frequency
- Power
- Emission Bandwidth
- Antenna Height Above Terrain
- Antenna Gain (or Pattern)
- Basic Visualyse Receiver Inputs
- Frequency
- Power
- Noise Figure
- Receiver Bandwidth
- Receiver Sensitivity
- Antenna Height Above Terrain
- Antenna Gain (or Pattern)
- Protection criteria

A.4.2 TRR Analysis Results:

Tables 8 and 9 provide a summary of the Protection Zone distances for interference to Army and Navy TRRs at the selected sites. Figures 3 through 8 depict the TRR Protection Zones for the selected cities.

Table 8: Summary of Protection Zone Distances for Army TRR

Interference to Army TRR from LTE Handsets						
Selected TRR Sites			**Propagation Model**	**I/N Threshold (dB)**	**Clutter (dB)**	**Protection Distance Radius (km)**
Name	**Approx. Size (width x length) (km)**	**Center Coordinates**				**TRR at Base Center (Mainbeam)**
Fort Lewis	21 x 19	47° 4'12.00"N, 122°34'12.00"W	ITM (50%)	-6	0	**115**
Camp Blanding	15 x 28	29°56'31.00"N, 81°59'13.00"W	ITM (50%)	-6	0	**45**
Fort Carson	22 x 39	38°34'48.00"N, 81°58'48.00"W	ITM (50%)	-6	0	**75**

Table 9: Summary of Protection Zone Distances for Navy/USMC TRR

Interference to Navy/Marine TRR from LTE Handsets					
TRR Site Approx. Size (width x length) (km)	**Victim System Name**	**Propagation Model**	**I/N Threshold (dB)**	**Clutter (dB)**	**Worst-Case Protection Distance Radius (km)**
Camp Pendleton 35 x 40	MRC-142B	ITM (50%)	-6	0	130
	MRC-142C	ITM (50%)	-6	0	150
	SRC-57	ITM (50%)	-6	0	120

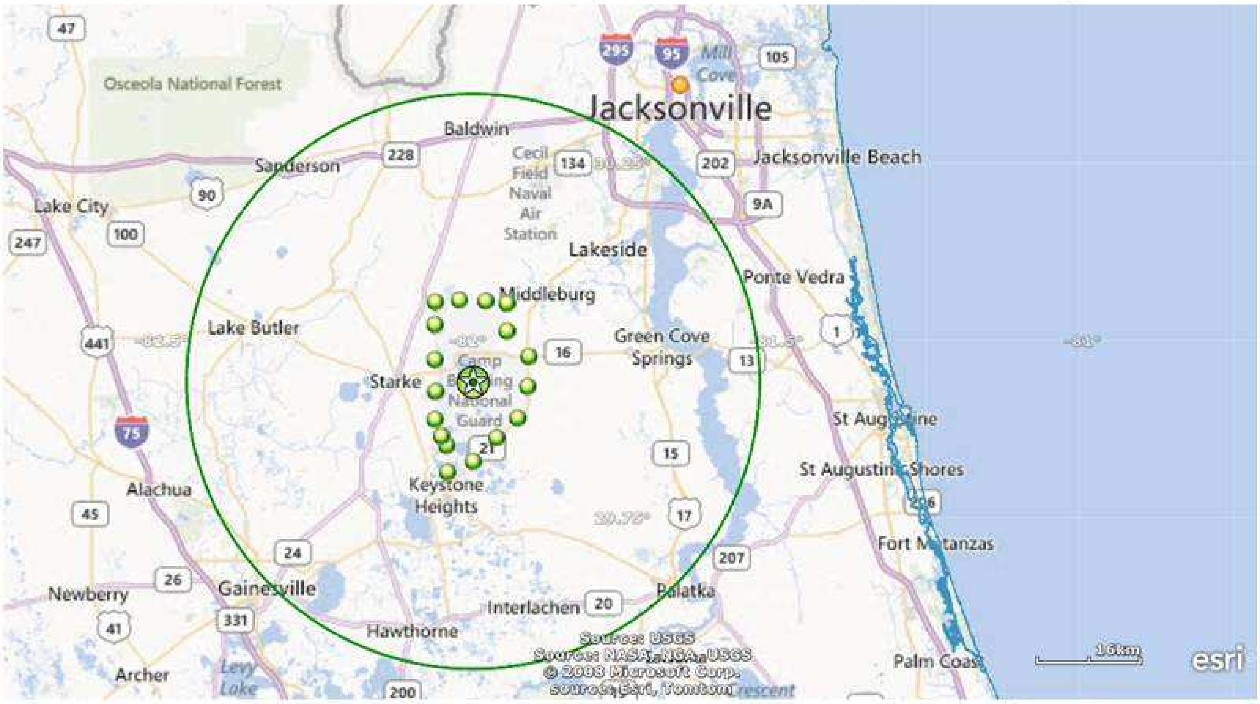
Interference to Army TRR at Fort Lewis

Interference to Army TRR from LTE Handsets						
TRR Site			Propagation Model	I/N Threshold (dB)	Clutter (dB)	Protection Distance Radius (km)
Name	Approx. Size (width x length) (km)	Center Coordinates				TRR at Base Center (Mainbeam)
Fort Lewis	21 x 19	47° 4'12.00"N, 122°34'12.00"W	ITM (50%)	-6	0	115

(orange dot)	CSMAC WG2 Top 100 Market City
(green dot)	TRR Site Perimeter
(star)	TRR Site Center Coordinate
O	TRR at Base Center Protection Distance Radius (km)

Figure 3: Army TRR Protection Zone at Fort Lewis

Interference to Army TRR at Camp Blanding

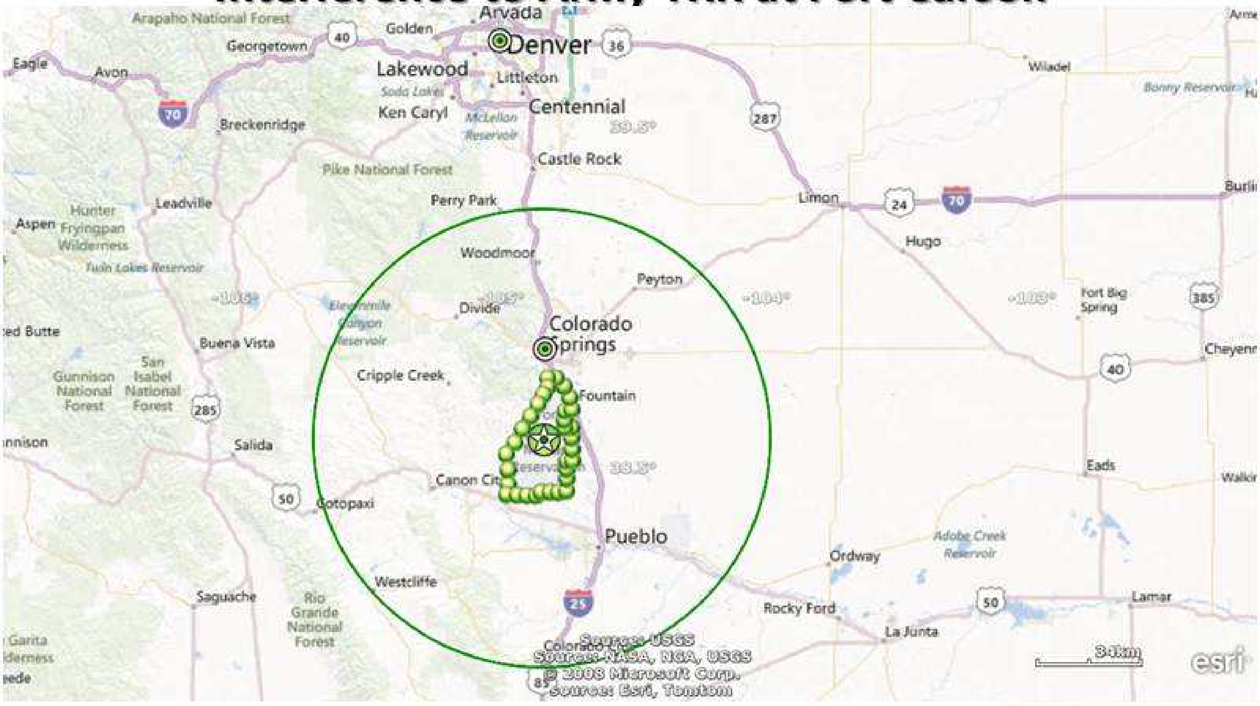


Interference to Army TRR from LTE Handsets						
TRR Site			Propagation Model	I/N Threshold (dB)	Clutter (dB)	Protection Distance Radius (km)
Name	Approx. Size (width x length) (km)	Center Coordinates				TRR at Base Center (Mainbeam)
Camp Blanding	15 x 28	29°56'31.00"N, 81°59'13.00"W	ITM (50%)	-6	0	45

	CSMAC WG2 Top 100 Market City
	TRR Site Perimeter
	TRR Site Center Coordinate
O	TRR at Base Center Protection Distance Radius (km)

Figure 4: Army TRR Protection Zone Distance at Camp Blanding

Interference to Army TRR at Fort Carson

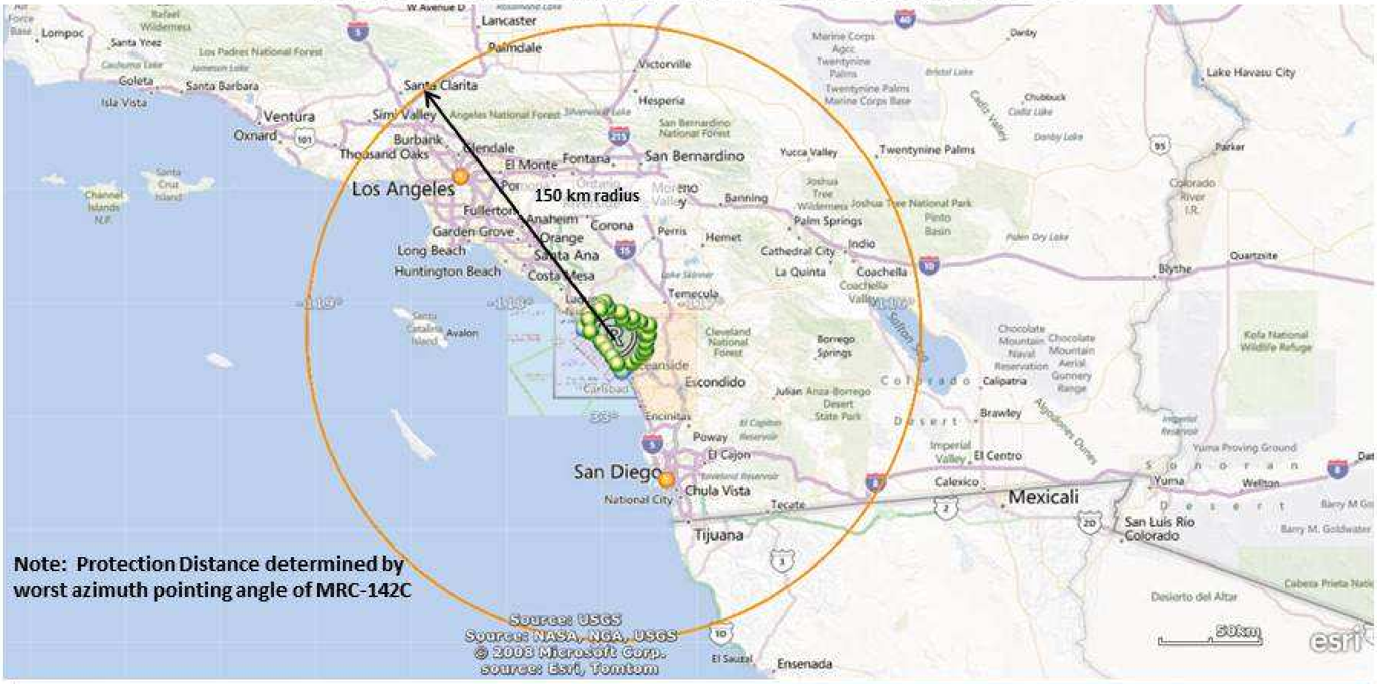


Interference to Army TRR from LTE Handsets						
TRR Site			Propagation Model	I/N Threshold (dB)	Clutter (dB)	Protection Distance Radius (km)
Name	Approx. Size (width x length) (km)	Center Coordinates				TRR at Base Center (Mainbeam)
Fort Carson	22 x 39	38°34'48.00"N, 81°58'48.00"W	ITM (50%)	-6	0	75

(orange circle)	CSMAC WG2 Top 100 Market City
(green circle)	TRR Site Perimeter
(star symbol)	TRR Site Center Coordinate
O	TRR at Base Center Protection Distance Radius (km)

Figure 5: Army TRR Protection Zone Distance at Fort Carson

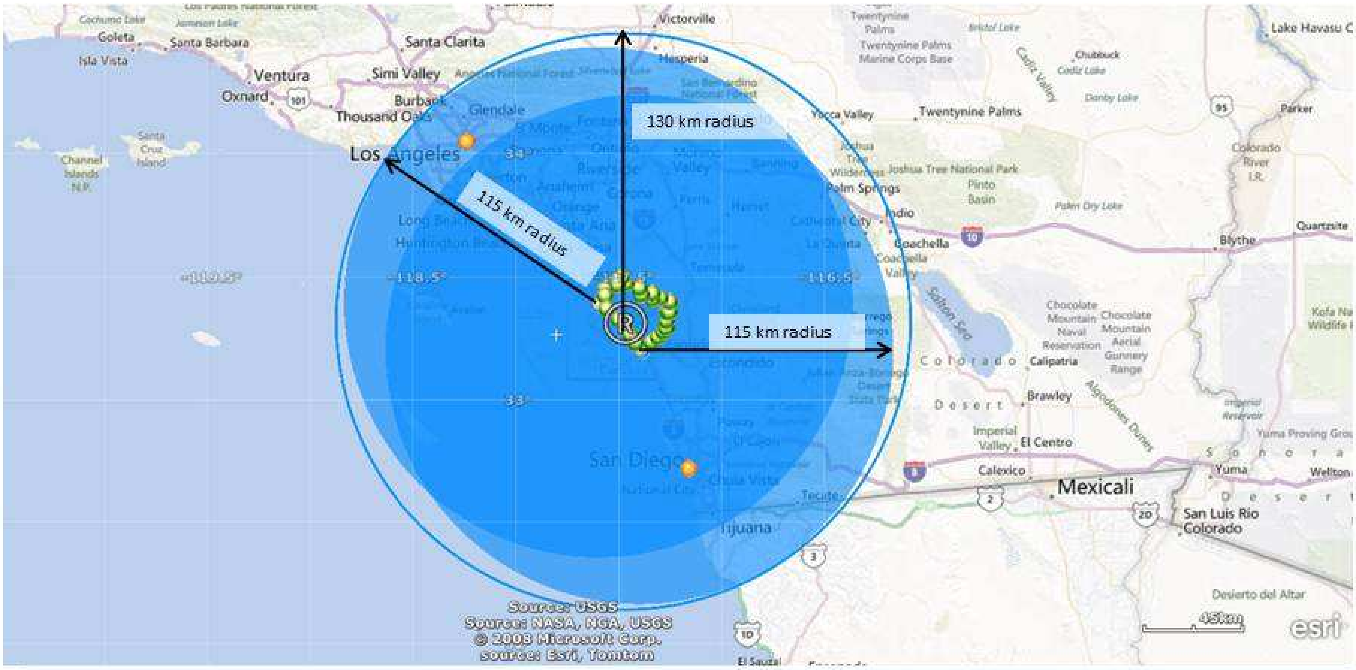
Protection Distance Assessment at Camp Pendleton
Interference to MRC-142C from LTE Handsets



Interference to MRC-142C from LTE Handsets							
TRR Site		Victim System	Propagation Model	I/N Threshold (dB)	Clutter (dB)	Center Coordinates	Worst-Case Protection Distance Radius (km
Name	Approx. Size (width x length) (km)						
Camp Pendleton	35 x 40	MRC-142C	ITM (50%)	-6	0	33°21'27.39"N, 117°26'3.66"W	150

Figure 6: Protection Zone Distance for Navy MRC-142C at Camp Pendleton

Protection Distance Assessment at Camp Pendleton
Interference to MRC-142B from LTE Handsets



Interference to MRC-142B from LTE Handsets							
TRR Site		Victim System	Propagation Model	I/N Threshold (dB)	Clutter (dB)	Center Coordinates	Worst-Case Protection Distance Radius (km
Name	Approx. Size (width x length) (km)						
Camp Pendleton	35 x 40	MRC-142B	ITM (50%)	-6	0	33°18'39.70"N, 117°28'42.98"W	130

Figure 7: Protection Zone Distance for Navy MRC-142B at Camp Pendleton

Protection Distance Assessment at Camp Pendleton
Interference to SRC-57 from LTE Handsets

Interference to SRC-57 from LTE Handsets							
TRR Site		Victim System	Propagation Model	I/N Threshold (dB)	Clutter (dB)	Center Coordinates	Worst-Case Protection Distance Radius (km
Name	Approx. Size (width x length) (km)						
Camp Pendleton	35 x 40	SRC-57	ITM (50%)	-6	0	33°18'39.70"N, 117°28'42.98"W	120

Figure 8: Protection Zone Distance for Navy SRC-57 at Camp Pendleton

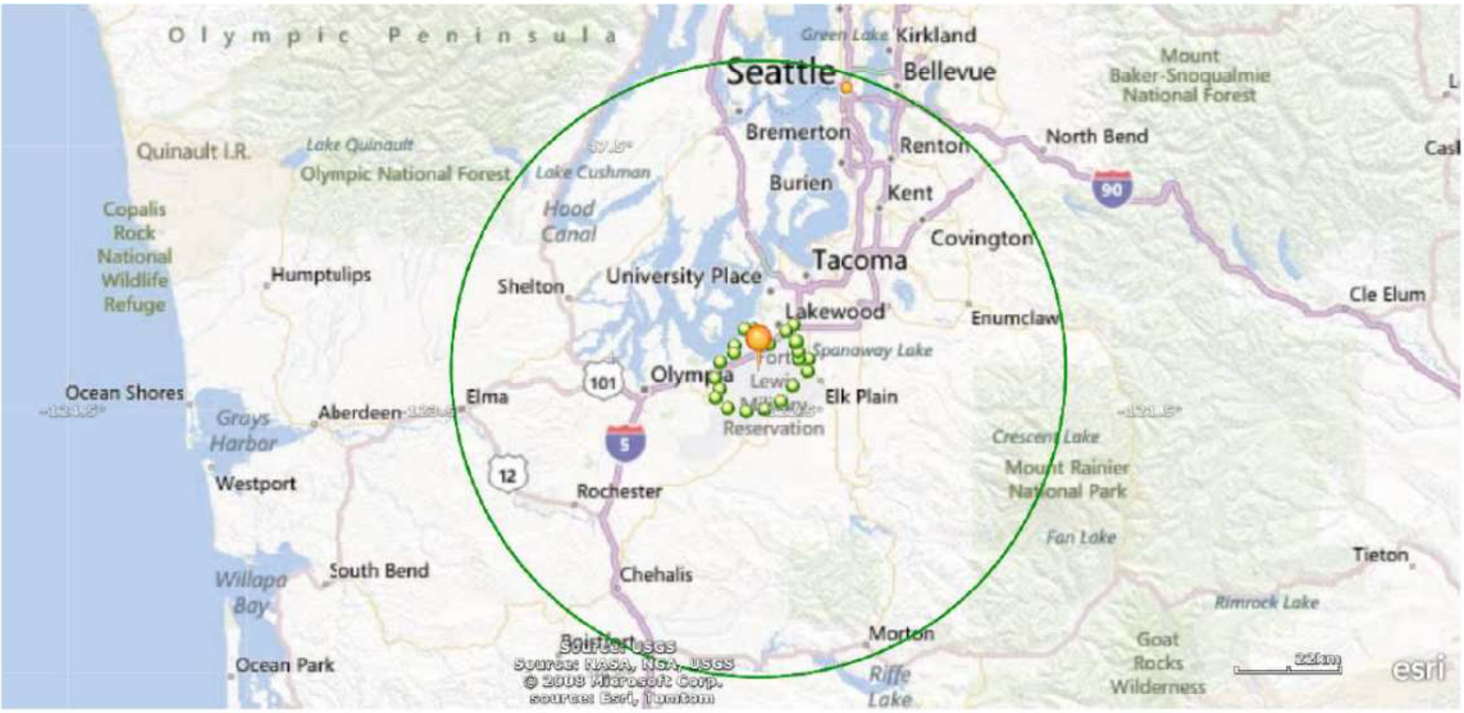
A.4.3 JTRS Analysis Results

Table 10 provides a summary of the Protection Zone distances for interference to ground-based JTRS at the selected sites. Figures 9 through 11 depict the JTRS Protection Zones for the selected cities.

Table 10: Summary of Protection Zone Distances for Ground-Based JTRS

Interference to Ground-Based JTRS from LTE Handsets						
Selected JTRS Sites			**Propagation Model**	**I/N Threshold (dB)**	**Clutter (dB)**	**JTRS Protection Distance (km)**
Name	**Approx. Size (width x length) (km)**	**Center Coordinates**				**From Center Coordinate**
Fort Lewis	21 x 19	47° 4'30.00"N, 122°34'30.00"W	ITM (50%)	-6	0	**65**
Camp Blanding	15 x 28	29°56'31.20"N, 81°59'13.20"W	ITM (50%)	-6	0	**30**
Fort Carson	22 x 39	38°34'59.88"N, 104°49'26.04"W	ITM (50%)	-6	0	**60**

Interference to Ground-Based JTRS at Fort Lewis

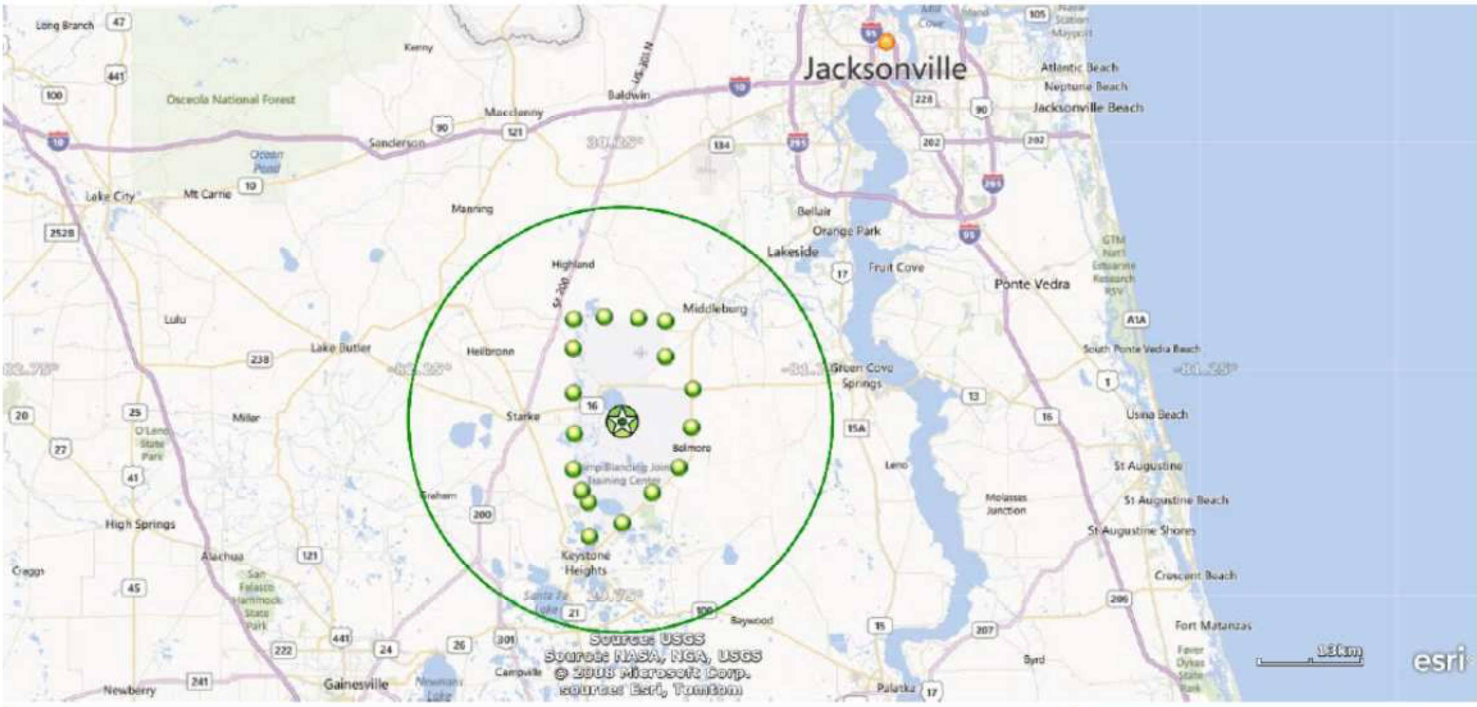


Interference to Ground-Based JTRS from LTE Handsets						
JTRS Site			Propagation Model	I/N Threshold (dB)	Clutter (dB)	JTRS Protection Distance (km)
Name	Approx. Size (width x length) (km)	Center Coordinates				From Center Coordinate
Fort Lewis	21 x 19	47° 4'30.00"N, 122°34'30.00"W	ITM (50%)	-6	0	65

	Top 100 Market City
	JTRS Site Perimeter
	JTRS Site Center Coordinate
O	Protection Distance From Center Coordinate (km)

Figure 9: Protection Zone Distance for Ground-Based JTRS at Ft. Lewis

Interference to Ground-Based JTRS at Camp Blanding

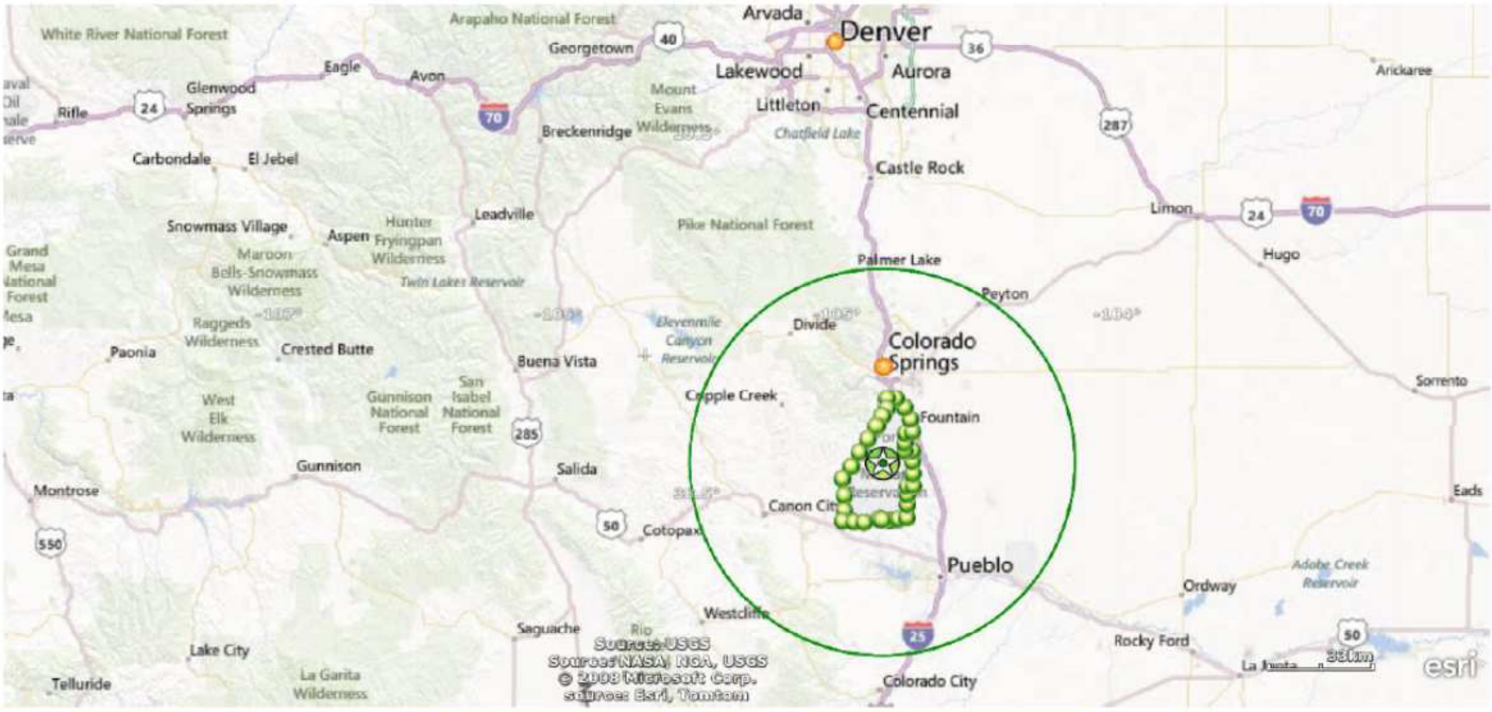


Interference to Ground-Based JTRS from LTE Handsets						
JTRS Site			Propagation Model	I/N Threshold (dB)	Clutter (dB)	JTRS Protection Distance (km)
Name	Approx. Size (width x length) (km)	Center Coordinates				From Center Coordinate
Camp Blanding	15 x 28	29°56'31.20"N, 81°59'13.20"W	ITM (50%)	-6	0	30

	Top 100 Market City
	JTRS Site Perimeter
	JTRS Site Center Coordinate
O	Protection Distance From Center Coordinate (km)

Figure 10: Protection Zone Distance for Ground-Based JTRS at Camp Blanding

Interference to Ground-Based JTRS at Fort Carson



Interference to Ground-Based JTRS from LTE Handsets						
JTRS Site			Propagation Model	I/N Threshold (dB)	Clutter (dB)	JTRS Protection Distance (km)
Name	Approx. Size (width x length) (km)	Center Coordinates				From Center Coordinate
Fort Carson	22 x 39	38°34'59.88"N, 104°49'26.04"W	ITM (50%)	-6	0	60

	Top 100 Market City
	JTRS Site Perimeter
	JTRS Site Center Coordinate
O	Protection Distance From Center Coordinate (km)

Figure 11: Protection Zone Distance for Ground-Based JTRS at Ft. Carson