

# 1755-1850 MHz

## 1. Band Introduction

Operations in the 1755-1850 MHz band consist of military tactical radio relay, air combat training systems, tracking, telemetry, and control data communications for control of spacecraft. Federal agencies and the military also use this band for law enforcement video surveillance and robotics, terrestrial telemetering operations for aircraft, missile flight testing, fixed point-to-point microwave relay communications and unmanned aerial systems. This band is currently under review as a candidate for accommodating wireless broadband.

## 2. Allocations

### 2a. Allocation Table

The frequency allocation table shown below is extracted from the Manual of Regulations and Procedures for Federal Radio Frequency Management, Chapter 4 – Allocations, Allotments and Plans.

#### *Table of Frequency Allocations*

1755 - 1850 MHz

#### *United States Table*

| <b>Federal</b>  | <b>Non-Federal</b> | <b>FCC Rule Part(s)</b> |
|---|--------------------|-------------------------|
| 1755-1850<br>FIXED<br>MOBILE<br>SPACE OPERATION<br>(Earth-to-space) G42 | 1755-1850          |                         |

### 2b. Additional Allocation Table Information

**G42** The space operation service (Earth-to-space) is limited to the band 1761-1842 MHz, and is limited to space command, control, range, and range rate systems.

### 3. Federal Agency Use:

The following analysis is extracted from the Department of Commerce’s National Telecommunications and Information Administration’s – An Assessment of the Viability of Accommodating Wireless Broadband in the 1755 – 1850 MHz Band and reflects federal agency use as of December, 2011. The complete report, with in-depth system descriptions, can be found at: <http://www.ntia.doc.gov/report/2012/assessment-viability-accommodating-wireless-broadband-1755-1850-mhz-band>

#### 3a. Federal Agency Frequency Assignments Table:

The following table identifies the frequency band, types of allocations, types of applications, and the number of frequency assignments by agency. (Note: the “type of application” categories are based on the "system use" categories used in the assessment report identified above.)

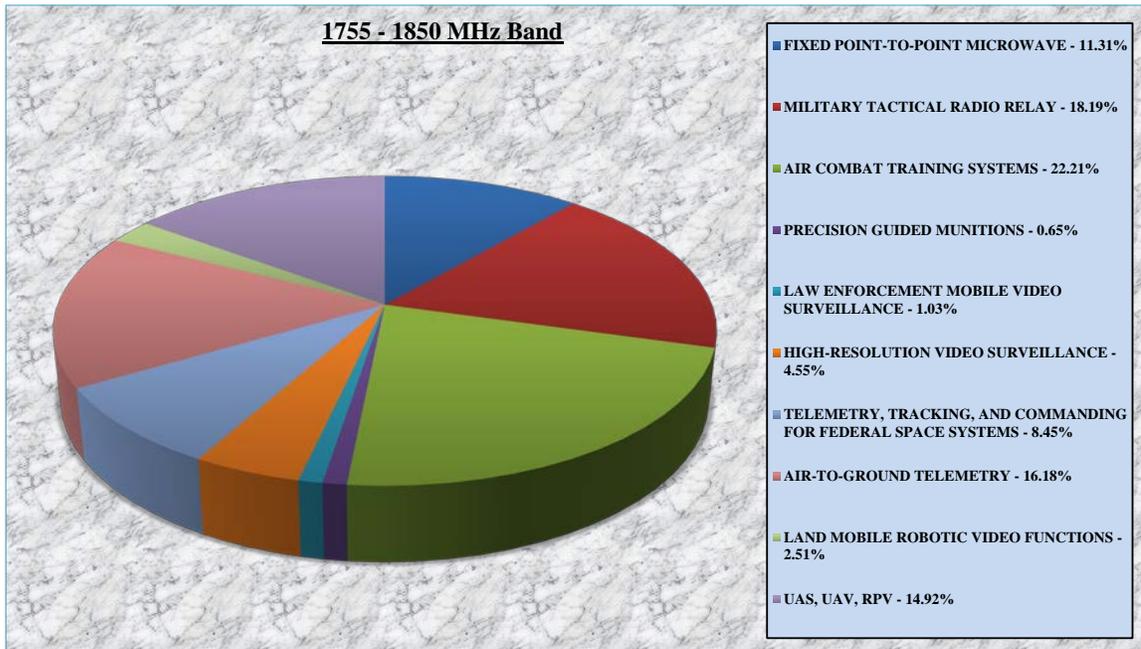
*Federal Frequency Assignment Table*

| 1755-1850 MHz Band     |   |                               |                             |                            |  |   |  |                         |  |               |             |
|------------------------|---|-------------------------------|-----------------------------|----------------------------|--|---|--|-------------------------|--|---------------|-------------|
| FEDERAL EXCLUSIVE BAND |   |                               |                             |                            |  |   |  |                         |  |               |             |
| AGENCY                 | FIXED MOBILE SPACE OPERATION (Earth-to-Space) |                               |                             |                            |  |   |  |                         |  |               |             |
|                        | TYPE OF APPLICATION                           |                               |                             |                            |  |   |  |                         |  |               |             |
|                        | FIXED POINT-TO-POINT MICROWAVE                | MILITARY TACTICAL RADIO RELAY | AIR COMBAT TRAINING SYSTEMS | PRECISION GUIDED MUNITIONS | LAW ENFORCEMENT MOBILE VIDEO SURVEILLANCE APPLICATIONS | HIGH-RESOLUTION VIDEO SURVEILLANCE (FIXED OR TRANSPORTABLE) | TELEMETRY, TRACKING AND COMMANDING FOR FEDERAL SPACE SYSTEMS | AIR-TO-GROUND TELEMETRY | LAND MOBILE ROBOTIC VIDEO FUNCTIONS (e.g. EOD & HAZARDOUS WASTE DISPOSAL, ETC) | UAS, UAV, RPV | TOTAL       |
| AF                     | 12  |                               | 273                         | 1                          |  | 2   | 220  | 186                     | 61   | 45            | 800         |
| AR                     | 45  | 408                           |                             |                            |  | 36  |  | 19                      | 4  | 378           | 890         |
| DHS                    | 152   |                               | 4                           |                            | 25   |   |  |                         |  |               | 181         |
| DOC                    | 8   |                               |                             |                            |  |   | 1  |                         |  |               | 9           |
| DOE                    | 91  |                               |                             |                            |  |   |  |                         | 2  |               | 93          |
| DOI                    | 26  |                               |                             |                            | 1  | 1   |  |                         |  |               | 28          |
| DOJ                    |   |                               |                             |                            | 7  | 75  |  |                         | 7  | 6             | 95          |
| FAA                    | 8   |                               |                             |                            |  |   |  |                         |  |               | 8           |
| HHS                    |   |                               |                             |                            |  | 1   |  |                         |  |               | 1           |
| HUD                    |   |                               |                             |                            |  | 6   |  |                         |  |               | 6           |
| MC                     | 4   | 169                           |                             |                            |  |   |  |                         |  | 21            | 194         |
| N                      | 14  | 2                             | 430                         | 20                         |  |   | 48   | 303                     | 6  | 14            | 837         |
| NASA                   |   |                               |                             |                            |  |   |  | 6                       |  | 11            | 17          |
| OPM                    |   |                               |                             |                            |  | 1   |  |                         |  |               | 1           |
| T                      |   |                               |                             |                            |  | 10  |  |                         |  |               | 10          |
| USAID                  |   |                               |                             |                            |  | 1   |  |                         |  |               | 1           |
| USCP                   |   |                               |                             |                            |  | 5   |  |                         |  |               | 5           |
| USPS                   |   |                               |                             |                            |  | 3   |  |                         |  |               | 3           |
| VA                     |   |                               |                             |                            |  | 4   |  |                         |  |               | 4           |
| <b>TOTAL</b>           | <b>360</b>                                    | <b>579</b>                    | <b>707</b>                  | <b>21</b>                  | <b>33</b>  | <b>145</b>  | <b>269</b>   | <b>514</b>              | <b>80</b>  | <b>475</b>    | <b>3183</b> |

The number of actual systems, or number of equipments, may exceed and sometimes far exceed, the number of frequency assignments in a band. Also, a frequency assignment may represent, a local, state, regional or nationwide authorization. Therefore, care must be taken in evaluating bands strictly on the basis of assignment counts or percentages of assignments.

Table 1

### 3b. Percentage of Frequency Assignments Chart



## 4. Frequency Band Analysis By Application

The following analysis is an extract of Appendix B from the Assessment of the Viability of Accommodating Wireless Broadband in the 1755 – 1850 MHz Band report. The footnotes are an integral part of the Appendix B and can be viewed by accessing Appendix A of the complete report as identified in item 3 above.

### 4a. Fixed Point-to-Point Microwave Systems

Fixed microwave networks provide backbone links for many federal agencies' voice, data, and/or video communications. These links provide service where commercial options are either unavailable, too expensive, or do not provide the reliability percentages required by federal mandate. These systems support voice, data, and/or video communications for law enforcement, military command and control networks, emergency preparedness and response, the national air space system, power generation and distribution, and resource management activities. In addition, fixed microwave links may provide data or video relay, timing distribution signals, and covert video surveillance for forensic investigations.<sup>1</sup>

<sup>1</sup> National Telecommunications and Information Administration, *The Potential of Accommodating Third Generation Mobile Systems in the 1710-1850 MHz Band: Federal Operations, Relocation Costs, and*

## ***1755 – 1850 MHz***

The DOD uses fixed microwave relay systems in the band on military installations and test and training ranges for a variety of functions. These functions include providing general-purpose communications to remote areas; relaying radar data from remote ranges to control centers; transmitting video data from bombing and gunnery ranges; supporting command and control networks; and sending control data to tethered aerostat balloons, radar data from the tethered aerostat balloons to the ground control stations, and power grid and hydroelectric data.<sup>2</sup>

The Air Force uses the band for the ground infrastructure of the Air Combat Training Systems. The non-ACTS frequency assignments for the Air Force fixed point-to-point systems are associated either with local range instrumentation and data retrieval or with installation security.

The Army operates long-haul communications links and air traffic control links at airfields in the CONUS.

The Army Corps of Engineers uses this band for its fixed microwave radio systems providing backbone communications for the engineering districts in the continental United States. The Corps also uses this frequency band for various purposes such as operating remotely-controlled hydro-electric generating stations, communications support for emergency civilian relief, flood control and sensor telemetry, temporary communications in each district, and maintenance and traffic control of approximately 48,000 kilometers of inland waterways, including harbors, locks, and dams. The fixed microwave communications systems ensure the safety and integrity of the nation's waterways, help prevent catastrophes, and provide emergency civilian relief.<sup>3</sup>

The Navy operates fixed microwave radio systems in this frequency band at certain facilities to provide infrastructure connectivity. These systems support both one-way and two-way communications, depending on connectivity requirements. These fixed microwave radio systems provide cost-effective and reliable solutions for isolated facilities in remote areas.

The Department of Commerce's National Weather Service relays valuable meteorological data to a variety of users, including the public.

DHS uses this band to support security enforcement along the United States' Texas/Mexican Border. Several point-to-point microwave systems provide a critical link for the various communications and surveillance technologies used by DHS field personnel. These wireless systems route communications media, voice from tactical radios, video imagery from remote video surveillance systems, and data from ground

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*Operational Impacts, NTIA Special Publication 01-46 (NTIA 01-46) (March 2001) at 3-2, available at <http://www.ntia.doc.gov/files/ntia/publications/3g33001.pdf>.*

<sup>2</sup> DOD-2 at § 4.2.

<sup>3</sup> DOD Strategic Spectrum Plan, *supra* note 30, at 3-2.

sensors to the key decision makers in central command and communications centers. The systems operate on a continuous basis and provide itinerant video imaging and critical border operations information to the border patrol and law enforcement.<sup>4</sup>

The Department of the Interior system supports relaying seismic monitoring data. The seismic monitors collect and disseminate near real-time data used for emergency response to significant earthquakes, tsunami warning, detection of volcanic unrest, and public information.<sup>5</sup>

The FAA uses fixed links to interconnect the nation's air traffic control facilities in support of aviation safety. FAA radar and air-to-ground radio facilities are frequently located in remote mountain areas to facilitate clear communications with commercial and military aircraft. These locations usually lack commercial communications access and require the FAA to use microwave radio systems.<sup>6</sup>

DOE uses this band for a wide-area network to supervise, control, and protect electric power transmission systems.<sup>7</sup> The system connects federal power marketing control facilities in the western half of the United States. The system can interconnect with the private sector for critical communications dealing with generating and distributing power. This critical infrastructure operates 24 hours a day/seven days a week. The microwave systems allow power system dispatchers to monitor the health and the amount of load on the energy grid, to be able to add or drop load, and to monitor generation. These microwave systems also allow protective relay and remedial action schemes to operate in order to prevent phase or ground faults from taking down the power grid, as well as preventing damage to power substation equipment and loss of life. This entire system works to ensure the western United States does not lose power. In addition, the microwave system also carries the very high frequency (VHF) land mobile radio system channels. The VHF mobile systems allow maintenance personnel to perform maintenance of the energy grid at Fort Chaffe and Pinnacle Peak in Arizona.<sup>8</sup>

#### **4b. Military Tactical Radio Relay Systems**

The DOD operates tactical communications systems in the band that provide mid/high capacity digital information to the battlefield commanders. Tactical radio relay is a transportable fixed microwave system often deployed to multiple locations to interoperate

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<sup>4</sup> DHS-1 at 8.

<sup>5</sup> DOI-1 at 6.

<sup>6</sup> FAA-1 at 1.

<sup>7</sup> National Telecommunications and Information Administration, *Federal Operations in the 1755-1780 MHz Band: The Potential for Accommodating Third Generation Mobile Systems Interim Report* (NTIA 2000 Interim Report) (Nov. 15, 2000) at 23, available at <http://www.ntia.doc.gov/files/ntia/publications/imt2000.pdf>.

<sup>8</sup> DOE-2 at 14.

with other systems for training exercises or operational missions.<sup>9</sup> DOD uses TRRs for the command and control of forces and high-capacity digital information to the battlefield.<sup>10</sup>

There are two TRR systems within the DOD. One is the Army's HCLOS and the second is the Navy and Marine Corps' DWTS. These tactical systems quickly establish microwave links in support of combat operations and maneuver warfare. TRRs provide the DOD with transportable base stations and the capability of backhaul high-capacity voice and data communications.<sup>11</sup>

The HCLOS radio (AN/GRC-245) is a multi-band, multi-mode, software-defined radio that allows the operating frequency and waveform to be selected in real-time to meet operational requirements of the digital battlefield. The HCLOS radio is a primary component of the Warfighter Information Network-Tactical (WIN-T) Increment-1. WIN-T includes network management tools, radios, routers and small, vehicle-mounted satellite dishes able to transmit signals via terrestrial and satellite from the company level up to division echelons. It also supports communication connectivity to vehicles on the move, to other command posts, and higher headquarters. The WIN-T Increment 2 will support the purchasing and fielding of 20 brigade-sized maneuver units.<sup>12</sup>

The HCLOS provides the Army with wide area communications for Army tactical deployments at the battalion, brigade, and division levels. The Army uses these systems for high-throughput data communications from command and control traffic to intelligence imagery, logistics, medical, and morale and welfare support. In addition, the Army's TRR systems deploy up to 30-50 km apart. These systems provide a digital microwave backbone to link mid-level and lower-level battlefield commanders. The TRR system operates like a high-capacity cellular telephone system with highly transportable base stations. The ability to set up, establish a link to higher headquarters and subordinate units, and then take down the link and move it to a new location is key to the survivability of the headquarters' units and supports the concept of maneuver warfare. Soldiers require frequent field training to ensure that they can quickly establish a network of tactical microwave links.<sup>13</sup>

### **Navy and Marine Corps Digital Wideband Transmission System**

The Navy and Marine Corps DWTS provides a backbone digital communications capability supporting amphibious and ground combat operations. DWTS is used by the U.S. Joint Forces Command to support the Joint Task Force-Civil Support (JTF-CS) in

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<sup>9</sup> A "transportable station" is a station, which is transferred to various fixed locations, but is not intended to be used while in motion. NTIA Manual, *supra* note 20, at § 6.1.1.

<sup>10</sup> NTIA 2000 Interim Report, *supra* note 107, at 24.

the event of a weapon of mass destruction incident.<sup>14</sup> The mission of the JTF-CS is to provide support to a designated lead federal agency in the conduct of consequence management operations in response to a chemical, biological, radiological, nuclear, and high yield explosives incident or accident in the United States. Additionally, the Navy and Marine Corps use DWTS for other contingency operations within the United States to include disaster relief, national emergencies, and other DOD support requirements to civil authorities, as directed from the National Command Authority.<sup>15</sup> The DWTS supports command, control, and data transfer from the Marine Expeditionary Force level down to the regimental level. The Marine Corps DWTS provides digital backbone services (voice, video, and data) for shore-to-shore and/or ship-to-shore communications links. This is the Marine Corps' radio system with sufficient bandwidth to carry large quantities of critical data such as maps, overlays, intelligence pictures, and other data to the battlefield commanders. The Navy has a ship-to-shore version of DWTS that is a LOS radio system used for communications between Expeditionary Strike Group ships and Marine Corps units ashore, where most of the critical information flow is from the ship to the landing. The Navy's shipboard DWTS tunes in the band 1350-1850 MHz

#### 4c. Air Combat Training Systems

Current air combat training involves live air-to-air encounters and may include a network of ground stations monitoring the training activity. ACTS incorporates fixed and aeronautical mobile components. The aircraft relays flight parameter data to ground stations and the ground stations send information to the aircraft. In some cases, training and related ACTS data and communications involve only interaction between the aircraft, without the ground links. Training staff, subsequently, retrieve the recorded data for use in training debriefings. The Tactical Combat Training System/P5 Combat Training System is a cooperative program between the Navy (TCTS) and Air Force (P5 CTS) to procure a single instrumented tactical aircrew training capability. This system is replacing the Air Force's Aircrew Combat Maneuvering and Instrumentation system and the Navy and Marine Corps Tactical Aircrew Combat Training System. The TCTS/P5 CTS supports training aircrews using realistic warfighting scenarios. It is the primary tool at virtually all air combat training ranges and supports every level of training from initial schools where pilots first learn to fly the aircraft they will take into battle to advanced-tactics training schools that hone combat skills. The system provides real-time monitoring, tracking, and recording of training activities, which includes post-mission reconstruction capabilities for pilots to receive accurate debriefing and critiques.<sup>16</sup> Allied

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<sup>14</sup> Department of Defense, *Investigation of the Feasibility of Accommodating the International Mobile Telecommunications (IMT) 2000 Within the 1755-1850 MHz Band* (DOD IMT 2000 Assessment)(Feb. 9, 2001) at C-3, available at <http://www.ntia.doc.gov/files/ntia/publications/dodassessment.pdf>.

<sup>15</sup> DOD Strategic Spectrum Plan, *supra* note 30, at 38.

<sup>16</sup> DOD Strategic Spectrum Plan, *supra* note 30, at 38.

## **1755 – 1850 MHz**

Forces ensure cooperative capabilities by conducting joint training sorties. This joint training occurs inside and outside of the United States.<sup>17</sup>

The DOD uses the air combat training and tactical combat training systems for daily proficiency training and as the final readiness training prior to deployment to combat areas around the world. ACTS and TCTS provide, during exercises and training, real-time monitoring of aircraft combat operations and maneuvering, such as gun-scoring, no-drop bombing training, evasion and intercept tactics, and electronic warfare. Most systems are composed of the ground-based tactical instrumentation subsystem (ground-to-air) and the aircraft instrumentation subsystem (air-to-ground) mounted internally or via a pod on the aircraft. The two-way data link between these two subsystems is the only means by which they interact and allow the overall system to function.

The air-to-air frequencies must be separated by at least 11 megahertz and adjacent range facilities must be separated by at least five megahertz. Operating altitudes may be as high as 60,000 feet, with normal operations occurring up to 40,000 feet.

ACTS and TCTS support every level of training a pilot receives from first learning to fly to advanced tactics. They operate at all test and training ranges, as well as at other bases, including Reserve and National Guard locations that may include civilian airports.<sup>18</sup> U.S. Allied Forces use identical frequencies and the same equipment.

The P5 Combat Training System is the principal Air Force Air Combat Training System in use today. Additional P5 CTS capabilities include real-time monitoring and control of aircraft during large and joint force, and small unit training, while being able to record events for post-mission debrief and analysis.

The P5 CTS also includes ground system integration, location specific architecture, internal pod replacement subsystems, and integration of new operational flight programs. Mission lengths and frequencies may vary from facility to facility depending on the using unit and the training mission underway. Additional factors affecting mission length and frequency include local quiet hour regulations, airspace agreements with the FAA, and overall range operations. There are operational areas in the US&P that include Air Force, Navy, and Marine Corps usage.<sup>19</sup> The Air Force P5 CTS units operate on discrete frequencies in the 1755-1850 MHz band at Air Force training facilities.

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<sup>17</sup> DOD-2 at § 4.5.

<sup>18</sup> NTIA 2000 Interim Report, *supra* note 107, at 25.

<sup>19</sup> DOD-2 at § E.3.

The Navy and Marine Corp's TCTS consists of various types of Participant Subsystems (PS). The PS includes Airborne Subsystem pods and Internal Subsystems carried onboard or inside numerous Navy, Marine Corps, and Air Force fixed wing and rotary platforms, as well as various Ground Subsystem components designed to receive this information via RF communication and to interface with other training range system infrastructure, such as the electronic warfare server system. TCTS merges all of this information into one comprehensive real-time operating picture and includes post mission reconstruction capabilities so that crews can receive accurate debriefing and critique of their mission, thereby maximizing the benefit of the training activities.<sup>20</sup>

TCTS was designed to operate in two modes. In the live monitor mode, communication is received by remote range units located throughout the range ground system infrastructure and passed to a fixed ground system for recording and display. In the rangeless or autonomous mode, the airborne participants transmit aircraft and weapons information via communication amongst themselves and data collected is recorded to a data recording device, and then downloaded post-flight. This rangeless capability makes system operation and emission possible worldwide.<sup>21</sup> The Navy TCTS operates on discrete frequencies in the band.

#### 4d. Precision Guided Munitions

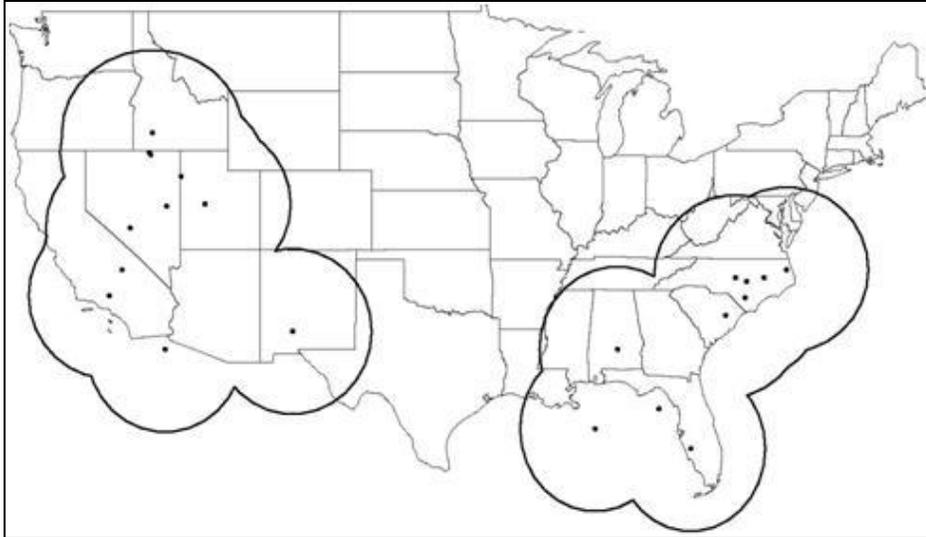
PGMs operate in this band to communicate between a launched weapon and a controlling platform, allowing for precise targeting. PGMs provide the capability to attack single military targets with one aircraft or one standoff weapon with greater probability of success than by flying waves of aircraft dropping conventional, unguided bombs. PGMs increase aircrew survivability by allowing the launch of weapons outside of enemy's anti-air system threat envelope, thereby significantly decreasing aircrew vulnerability. The Air Force and the Navy both use PGMs that carry television cameras or infrared sensors, and GPS receivers, which provide operators the ability to attack targets in all weather conditions, day or night. Weapon operators require access to a video and a command link frequency throughout the mission; including ground, pre-launch, post take-off, and post-launch weapon flight operations. Training operations require use of the frequencies for two hours at a time.<sup>22</sup> Figure B-1 provides a map of the contours of nominal radio line-of-sight distances surrounding many of the operational training areas for PGMs within the United States.

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<sup>20</sup> DOD-2 at § F.3.

<sup>21</sup> *Id.*

<sup>22</sup> *Id.* at § F.4.



**Figure B-1. Line-of-Sight Distances from PGM Operational Areas**

The Air Force uses PGMs to attack fixed, high-value, and hardened enemy targets.<sup>23</sup> These 2,000-pound class weapons are launched from tactical aircraft from either low or high altitude, at ranges from five to more than 30 nautical miles. Weapon control data-link systems provide operators with the ability to control the precision guided weapons. Video from the weapon’s seeker apparatus is transmitted to a weapon systems officer who manually identifies the target, via a command frequency, and controls the bomb to the designated impact point.

The Navy PGM operating in the 1755 – 1850 MHz band is a highly survivable, air-to-surface man-in-the-loop guided missile system. Its usage within United States and Possessions is limited to testing and training.<sup>24</sup> A pod on the aircraft provides terminal control for the Navy PGM. The pod provides commands to the Navy PGM missile via an RF data link, allowing the weapon to be directed remotely to a target by the launch aircraft or a remotely stationed controlling aircraft.

#### **4e. Video Surveillance**

To satisfy their congressionally mandated law enforcement requirements, federal agencies maintain and conduct authorized electronic video surveillance operations on multiple frequency assignments in the band. Thirteen federal agencies (DOD, DOE, DOI, DOJ, DHS, HHS, HUD, OPM, Treasury, USAID, USCP, USPS and VA) hold all of the frequency assignments for video surveillance.

<sup>23</sup> NTIA 01-46, *supra* note 99, at 3-22, 3-23.

<sup>24</sup> DOD-2 at § F.4.

Federal agencies performing law enforcement functions operate mobile, fixed, and high-definition video surveillance systems in this band throughout the United States. These systems provide the agencies with the capability of enhancing law enforcement by providing measures for agent safety, protective service, criminal investigation, and crime detection and prevention functions. Video surveillance operations are typically covert in nature and occur both indoors and outdoors.

Agencies operate three types of video surveillance systems: law enforcement mobile, high-resolution video surveillance (fixed and transportable), and land robotic systems.

Law Enforcement Mobile - Federal law enforcement agencies use the 1755-1850 MHz band to employ undercover low-power video surveillance devices during criminal investigations. These devices are authorized throughout the US&P for agent safety, protective operations, and criminal investigations. The video footage obtained during these investigations is critical for providing rapid response support to undercover officers and agents and used as evidence during criminal trials and procedures. These systems may operate in any part of the band, at any location, at any time.

DHS operates a nationwide system of portable and mobile video surveillance devices used in the investigation of criminal activities and the protection of national leaders, visiting heads of state and government, designated sites and National Special Security Events. These systems incorporate multiple transmitters and receivers that collect, transport, and store video and audio evidentiary and intelligence information. The nature of the operations requires that the devices be highly concealable, portable, and capable of short notice deployment.

DOJ operates a nationwide system of portable and mobile video surveillance devices used in the investigation of terrorist and criminal activities in addition to supporting joint protective operations during major national events. These systems incorporate multiple transmitters and receivers that collect, transport, and store video and audio evidentiary and intelligence information. The nature of the operations requires that the devices be highly concealable, portable, and be capable of short notice deployment. They are typically secured from both physical and electronic detection in order to ensure mission integrity and officer/agent safety. The video surveillance activities include primary evidence and intelligence collection, management and control of data and information from various surveillance and data backhaul platforms, manned and unmanned aircraft, and remotely controlled robotic devices.<sup>25</sup>

DOI operates a nationwide system of portable and mobile video surveillance devices supporting U.S. Fish and Wildlife Service, Office of Law Enforcement Services, operations throughout US&P. The video surveillance system is comprised of portable and mobile video devices for the collection of evidence and information during law

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<sup>25</sup> See generally DOJ-1 at 12-14.

## ***1755 – 1850 MHz***

enforcement operations in support of criminal investigations and Secretarial, Executive staff and other Very Important Person(s) (VIP) protection details.<sup>26</sup>

High-Resolution Video Data Links (fixed or transportable) - The DOD and other federal agencies maintain and conduct authorized electronic video surveillance operations on multiple frequency assignments in the band. Mission requirements, in most cases, necessitate that surveillance equipment be highly mobile or transportable (although some equipment operates from fixed sites) and therefore must be lightweight and easily assembled; must be concealable because they are used for law-enforcement activities; and must be secured from both physical and electronic detection in order to ensure officer/agent safety.

The DOD, specifically the Air Force and Army, use the band for area surveillance using HRV systems. HRV are point-to-point data communications systems designed to meet Army and National Guard requirements for highly capable, multi-role helicopter missions that range from homeland security and medical evacuation to drug interdiction, support, and logistics operations. HRVs are typically used at active duty installations and National Guard and Reserve locations throughout the United States; however, during periods of national emergency and other significant events, HRV systems can be required to support operations anywhere within the US&P. This type of service supports critical missions and must be protected when considering comparable spectrum.<sup>27</sup>

The Army currently uses multiple HRV systems. These systems have both an airborne and a ground component associated with its operation. The system creates the ability to conduct a real-time aerial survey of bridges, roads, and structures immediately after a natural disaster to assess damage and direct relief operations from a remote command center. Army National Guard security and support battalions are able to support Operation Jump Start by patrolling along the Texas border and to provide full motion video to ground reaction elements for immediate intercept and streaming of full motion video to distant command posts over the Internet. Military Intelligence C3 Analysis Teams receive real-time full motion information and imagery from airborne forward-looking infrared cameras.<sup>28</sup>

The Air Force also operates multiple HRV systems that include Advanced Targeting pod, and the Remotely Operated Video Enhanced Receiver (ROVER) family of systems. ANG RC-26B aircraft carry the ROVER system onboard to provide aerial surveillance and reconnaissance for law enforcement agencies. The Advanced Targeting Pod is an advanced electro-optical targeting system mounted in a single, lightweight pod, which may be configured for multiple types of fighter aircraft. A video downlink provides the capability to transmit pod-generated video with embedded symbology to a ROVER

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<sup>26</sup> DOI-2 at § 5a.

<sup>27</sup> DOD-2 at § D.5.

<sup>28</sup> *Id.*

ground station receiver. The ROVER family of systems includes capabilities to transmit and receive data and full motion video. Systems within this family were initially receive-only, but have been enhanced to include transmit functions.

DOI uses aeronautical mobile video surveillance transmitters located on rotor blade aircraft to provide real-time video surveillance downlinks to federal agencies' Command Posts for video surveillance, mission management, law enforcement, homeland security, search and rescue, and medical evacuation operations within the National Capitol Region. This aviation asset has also deployed to support National Emergency Response situations (e.g., U.S. Park Police deployed the video surveillance equipment to Louisiana to provide emergency response support during Hurricane Katrina relief operations).<sup>29</sup>

Treasury utilizes this band for covert/body-worn and "pole cam" audio and video surveillance as a method of collecting evidence during administrative and/or criminal investigations. These systems are primarily mounted on outdoor light posts and electrical poles, installed covertly in offices and cubicles, or worn by undercover agents and/or cooperating witnesses (body worn). Treasury may deploy video surveillance systems "anytime, anywhere," gathering evidence for investigations. Systems may be operational for a specific event, typically a few hours, or may be employed to survey and record activity at a business over several weeks or months.<sup>30</sup>

High-capacity fixed point-to-point systems support most of DOJ's surveillance operations. They transmit video and voice data at locations across the United States. The fixed systems also receive data from the transportable systems to backhaul and route the data to a distant command location. DOJ also operates transportable surveillance operations. The devices for these type operations are highly concealable, portable, and/or rapidly deployable assets. Transportable operations involve a device with limited or pre-tuned channel selection capability designed to support low profile, undercover, covert operations. These devices transmit video information within the 1755-1850 MHz band from a transportable device via a one-way communications link to an established fixed collection point (if available), or associated transportable collection platform. Transportable operations support the standard digitized video capture using an eight-megahertz bandwidth; however, the 17-22 MHz bandwidth supports DOJ's high definition analog video capture and robotic-based platforms.<sup>31</sup>

DOJ supports missions under current "fixed" authorizations that are typically longer in duration (days/weeks/months), and 24/7 in nature, but can routinely change based on real-time dynamic operational requirements. As the core architecture changes within each operating area, the specific application of 1755-1850 MHz dependent devices may also change in accordance with the aggregate ability to apply other in-band and

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<sup>29</sup> DOI-1 at § 4a.

<sup>30</sup> Treasury-1 at 1.

<sup>31</sup> See generally DOJ-1 at 12-14.

## *1755 – 1850 MHz*

associated out-of-band devices to support overall data capture, routing, backhaul, and recording/storage capabilities. Although DOJ can operate all 1755-1850 MHz spectrum dependent devices independently or in association with other peripheral devices within the overall network, the radio signature(s) produced from these devices is no different from that already identified in the previous transportable and point-to-point discussions.

USAID, HHS, HUD, OPM, USCP, USPS, and VA conduct video surveillance during administrative and criminal investigations. These systems are primarily mounted on outdoor light posts and electrical poles; or worn by undercover agents and/or cooperating witnesses. USAID, HHS, and HUD operate throughout the United States. OPM, USPS, and the VA accomplish their operations in the US&P. The USCP operates video surveillance specifically in Washington, District of Columbia.

**4f. Land Robotic Systems** - Normally, federal agencies employ these systems using communications links in the 1755-1850 MHz band to engage in law enforcement activities or to perform as “first responders” in support of EOD and hazardous material (Hazmat) disposal (e.g., chemical, biological, nuclear, etc.). The military services are typically the ones responsible for EOD and Hazmat disposal and use land robotic video systems for both live operations and training exercises. The EOD operation entails a video link from a remote-controlled robot to the command site to enable the operator to provide command and control for the robot and, at the same time, disable or disarm and/or monitor the ordnance or bomb disposal operation. Land robotic video systems are part of the mobile service. The 1755-1850 MHz band meets the high mobility and high path reliability requirements for these systems.

Other federal agencies, such as the DOJ, use remotely controlled vehicles or robots with onboard video links and sensors for hazardous materials identification, bomb disarmament, neutralization, and/or disposal, explosives detection, and law enforcement video. The video link operates in the 1755-1850 MHz band. The remotely controlled vehicle’s return path uses other frequency bands and transmits the command and control, voice, and/or telemetry. These missions occur with little to no notice of operational location, duration, or time of operations. The criticality associated with these operations requires nationwide access, availability, and authority to operate 24 hours a day/seven days a week.

The DOJ operates more intricate surveillance and robotic-based transportable operations. These devices require two-way communications for real-time device control and management. Similar to the transportable surveillance operations discussed above, the video component of the operation is one-way within the band, while the device receives the command, control, voice, and/or telemetry signal using various out-of-band signaling methods.<sup>32</sup>

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<sup>32</sup> DOJ-1 at 12.

DOE has two assignments within the 1755-1850 MHz band that support the deployment of robots in response to emergency situations involving hazardous material that are too risky to compromise the safety of personnel. The land robotic video systems are primarily used for live operations and training, but may serve other functions as required. The robots provide a one-way LOS video link to observe and assess critical situations.

#### **4g. Telemetry, Tracking, and Commanding**

DOD operates satellites orbiting the Earth in a geostationary satellite orbit or a non-geostationary satellite orbit (NGSO) to provide communications, navigation, surveillance, missile early warning and attack characterization, weather monitoring, and research and development. The critical nature of the Air Force and Navy Satellite Control Network (SCN) supports these satellites to achieve proper orbit, initialize for operations, maintain orbit and configuration, perform emergency recovery operations following on-orbit failures, and for disposal operations at end-of-life. Satellites are controlled to maintain proper orbit, and must be commanded to perform certain functions. This is the control function. The satellite controller must know the location of the satellite to determine its present orbit. This is called the tracking function. The operators also need to know the “health” of the satellites, so a telemetry link sends back to the ground station information relating to the status of all platform functions such as electrical, stabilization, temperature, and propulsion systems onboard the satellite. This is the telemetry function. The combination of these functions for satellite control is termed TT&C. The uplink TT&C function operates in the 1761-1842 MHz band for military satellites. The associated downlink for these satellites is in the 2200-2290 MHz band.<sup>33</sup>

DOD and DOC have assignments in the 1755-1850 MHz band for space operations with the DOD being the primary user. DOD uses the band for initial contact with newly launched satellites, early orbit checkout of those satellites, emergency access to spinning/tumbling satellites (anomaly resolution) and final disposition of satellites upon mission completion. This band is also vital for command and control, mission data retrieval, and on-orbit maneuvering of low and medium earth, highly elliptical, and geostationary orbit satellites.<sup>34</sup>

The 1761-1842 MHz band segment supports the TT&C for the DOD satellites, in addition to the North Atlantic Treaty Organization (NATO), United Kingdom (UK) military satellites, and various space and ballistic missile test programs. TT&C supports automatic space vehicle acquisition and tracking, ranging, reception and recording of vehicle telemetry data, and transmissions of commands to the space vehicle. The TT&C subsystem monitors and controls all of the other systems on the spacecraft, transmits the status of those systems to the control segment on the ground, and receives and processes

<sup>33</sup> NTIA 01-46, *supra* note 99, at 3-11.

<sup>34</sup> DOD Strategic Spectrum Plan, *supra* note 30, at 37.

instructions from the control segment. Telemetry is the data collected by sensors throughout the satellite that determine the status of various system components, including transmitters and antennas. This information is then transmitted to the ground segment. Telemetry also includes data on the operation and status of the satellite's payload. For example, on a communications satellite, telemetry would include data on power output of transponders, pointing direction of antennas, and antenna and transponder switch configurations. Tracking involves determining a satellite's position, altitude, and other orbital parameters. Many satellites carry a beacon that transmits a signal to help ground-tracking receivers locate the satellite. Onboard sensors, such as star trackers, horizon scanners, and inertial navigation sensors provide other tracking data. Tracking information is essential to determine a satellite's orbital parameters to predict accurately the satellite's future position. In this way, the satellite's orbital position can be adjusted so that it will be in its proper position at the proper time.<sup>35</sup>

Commanding is the act of controlling a satellite. Commanding a satellite is accomplished by sending signals to it that initiate an action or change the configuration in some way. Commands may be executed by the satellite immediately upon receipt or stored for later execution. Some commands are part of onboard software that allows the satellite to execute certain functions autonomously when a predefined condition exists. Commands may direct the thrusters to fire to change the orbit, or may reconfigure the payload to meet the needs of users. The major system operating in this band segment that supports the TT&C functions is the Space Ground Link Subsystem. The band plan for SGLS comprises 20 discrete channels within the 1761-1842 MHz band segment beginning at 1763.721 MHz and ending with 1839.795 MHz. Each channel is 4.004 megahertz wide. Although most TT&C operations are provided by fixed sites, the Air Force also uses transportable SGLS-compatible earth stations to provide additional coverage during launches, early orbit operations, anomaly resolution, and critical orbit insertion maneuvers. These transportable stations are moved as necessary to accomplish the mission. It is not possible to change the TT&C frequencies for satellites that have already been launched. While it may be possible to change the frequencies of satellites that are yet to be launched, this would be expensive, time consuming, and could impact scheduled launch dates of critical national space assets, thus affecting the government's ability to meet satellite replacement requirements. In addition to supporting TT&C for military satellites, the 1761-1842 MHz band segment supports TT&C for the cooperative DOE/DOD Proliferation Detection Technology Program. This program will demonstrate advanced system technologies for remotely monitoring nuclear facilities and for identifying and characterizing undeclared and clandestine nuclear facilities. Although this program is directed at nuclear proliferation monitoring, the technology could potentially serve a variety of other national security and civilian needs. The civilian and

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<sup>35</sup> NTIA 01-46, *supra* note 99, at 3-11, 3-12.

commercial communities also derive significant benefit from GPS., in which the 1761-1842 MHz band controls and supports. The operation of U.S. satellite control facilities internationally is authorized by specific host nation agreements in those countries in which the SGLS-compatible stations are deployed. The lack of spectrum support for continued satellite control operations in the 1761-1842 MHz band would have implications for U.S. allies as well, since both NATO and the UK depend on satellite control stations operating in the 1761-1842 MHz band to provide military spacecraft TT&C support for the NATO SATCOM IV and the UK SKYNET satellites, respectively.<sup>36</sup>

**Air Force Satellite Control Network** - The Air Force is the designated service responsible for platform control of most DOD satellites. The AFSCN is operated and maintained by the Air Force Space Command's 50<sup>th</sup> Space Wing at Schriever AFB, Colorado.

The AFSCN provides support for the operation, control, and maintenance of a variety of DOD and some non-DOD satellites. This involves continual execution of the tasks involved in TT&C. In addition, the AFSCN provides pre-launch simulation, launch support, disposal and critical orbit insertion/early orbit support while satellites are in initial or transfer orbits and require maneuvering to their final orbit. The AFSCN provides tracking data to help maintain the catalog of space objects and distributes various data such as satellite ephemeris, almanacs, and other information.

The AFSCN consists of satellite control centers, tracking stations, and test facilities located around the world. These centers are staffed around the clock and are responsible for the command and control of their assigned satellite systems. The control centers are linked to remote tracking stations (RTSs) around the world. The RTSs provide the link between the satellite being controlled and the control center. A similar relationship exists for dedicated networks. RTSs around the world are needed to maintain frequent communications with the satellite. Without RTSs, the control centers would only be able to contact a satellite when it came into the control center's view. Some satellites, especially those in geostationary orbits, never come within view of their control center (most control centers do not have antenna capabilities to communicate directly with satellites in this band). Space vehicle checkout facilities are used to test launch vehicles and satellite platforms to ensure that the onboard systems operate within specifications.<sup>37</sup>

**Remote Tracking Stations (RTS)** - Each RTS performs essential mission operations on a 24/7 basis. The AFSCN performs approximately 550 satellite contacts per day. The operations are driven by the requirements to support U.S. national security space operations, as well as by NATO, and the UK. Each RTS has one to four antennas used for transmitting in the 1761-1842 MHz band. During major maintenance or antenna

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<sup>36</sup> *Id.* at 3-12.

<sup>37</sup> *Id.* at 3-12, 3-13.

## **1755 – 1850 MHz**

replacement, transportable assets are deployed to the RTS sites to ensure continuity of operations. The antennas used are typically 60, 46, and 33 feet (18, 14, and 10 meters) in diameter. Transmitters operating between 250 and 7,000 watts, depending on the required mission operation, support them. Filters are employed to limit out-of-band radiation. The antennas may be pointed low on the horizon to communicate with low-altitude satellites, which have very short visibility times. Low-angle radiation will also occur at Vandenberg AFB, California and Cape Canaveral AFS, Florida to conduct open loop checkout of satellites on launch pads and to verify communications links prior to launch. For other satellite contacts, the antennas are typically pointed at higher elevation angles. The infrastructure at each RTS has evolved over the last 40 years and is extensive and sophisticated with regard to facility power, emergency power, and connectivity to commercial terrestrial communications. For the most part, the RTSs are located on U.S. military or host nation military/government facilities.

**Other Space Operations and Space Telecommand Systems** - There are times where NASA and the Air Force operate a joint satellite; either NASA earth stations or SGLS earth stations, or both, could operate these space stations.

GPS provides navigation data to civilian and military users. There are dedicated monitoring stations located around the world at Ascension Island, Diego Garcia, Kwajalein, Cape Canaveral and Hawaii. These monitoring stations passively track the satellites and accumulate navigation signals.<sup>38</sup> There are a number of other facilities authorized to transmit on SGLS frequencies, and the Air Force maintains transportable TT&C antenna systems to support launch, early orbit, anomaly resolution, and augmentation in the event of war and natural disasters.

### **4h. Aeronautical Mobile Telemetry**

AMT supports weapons system testing and evaluation. These systems operate from manned aircraft, unmanned aerial vehicles, aerostats, missiles or other ordnance devices to provide real-time flight characteristics data and video from the airborne vehicles to the ground, real-time video of cockpit or project information, real-time monitoring of flight research/test parameters, and real-time command and control of the vehicle, including flight termination.

**Test and Training Range AMT** - DOD test and training ranges operate a complex system of telemetry tracking stations and control centers that use telemetry as a tool to test and evaluate existing and proposed weapons systems (i.e., munitions, missiles, rockets, space vehicles, and UAS). DOD telemetry serves multiple purposes in the design and testing phases of weapons systems (i.e., safety, command and control, specification compliance, system performance, and lethality). Flight test telemetry

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<sup>38</sup> NTIA 2000 Interim Report, *supra* note 107, at 20.

provides critical data on platform performance, enabling the DOD to perform hazardous complex testing events, using integrated scenarios. Airborne telemetry supports all phases of a systems development from conceptual design, initial development, milestone completion, and production testing of munitions, missiles, rockets, space vehicles, and UAS. Major DOD Test and Training Range locations are located in the southwestern part of the United States, including: Naval Air Weapons Center-Weapons Division, China Lake and Point Mugu, California; the Air Force Flight Test Center, Edwards AFB, California; the NTC, Fort Irwin, California; the YPG, Yuma, Arizona; the DOD Gulf Range (which encompasses most Florida and large portions of Georgia, Alabama, Mississippi, and southeastern Louisiana); the Atlantic Test Range, Naval Air Warfare Center-Aircraft Division, Patuxent River, Maryland; and WSMR, White Sands, New Mexico.

**Missile Testing Operations** - The 1755-1850 MHz frequency range is a part of the spectrum that the Navy chose for AMT in support of various missiles/weapons tests and evaluations to allow greater flexibility with multiple range users. However, use of specific frequencies for the AMT operation is subject to the WAFC's and Mid-Atlantic Area Frequency Coordinator's approval or local base frequency coordinators. A typical test altitude is between 5,000 to 10,000 feet. However, 50,000 feet must be considered to protect civil aviation. For this particular altitude, mandatory scheduling is required with the Integrated Frequency De-confliction System. Major Navy areas of operation are in California, Florida, and Maryland.

The Marine Corps has an AMT requirement for target acquisition. The system deployed on Yuma, Arizona is for miss distance indicator (for missile distance tracking). The system uses a narrower bandwidth of 1 megahertz and the same power of 1 watt as the Navy's system.

**Balloon-Air-to-Ground Operation** - NASA operates high altitude scientific balloons in this band. NASA's Balloon Program provides platforms for scientific and technological investigations. These investigations include fundamental scientific discoveries that contribute to understanding the Earth, the solar system, and the universe. Scientific balloons also provide a platform for the demonstration of new instrument and spacecraft technologies. The Wallops Flight Facility operates NASA's balloon missions from launch sites in Palestine, Texas and Fort Sumner, New Mexico. These balloons routinely soar above 100,000 to 150,000 feet.<sup>39</sup> They are supported by telemetry receive sites at the launch site locations, as well as, by a telemetry receive site in Winslow, Arizona. Balloon operations vary in their time and frequency of use. Shorter missions may last between two hours to three days and may occur 15 to 20 times per year. Longer duration missions, lasting up to several weeks, may occur several times (two to four) times per

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<sup>39</sup> NASA-1 at 2.

## **1755 – 1850 MHz**

year. Finally, extended duration missions, up to 100 days, may occur once or twice per year.<sup>40</sup>

The Navy operates a tethered aerostat (balloon) to test the integration of the VRC-99B radio with the aerostat to extend radio communication range between a control node ashore and an unmanned surface vehicle afloat in Elizabeth City, North Carolina.

**NASA Flight Test Research** - NASA requires access to aeronautical telemetry frequency allocations for links between in-flight experimental aerospace vehicles and ground systems for real-time data information from test vehicles to the ground, video of cockpit or project information, and command and control of the vehicle, including flight termination. Telemetry is used for the real time monitoring of flight research/test parameters that are necessary in order to minimize the risk to the pilot and aircraft during the performance of maneuvers intended to push the flight envelope of test vehicles.<sup>41</sup>

The DRFC, LaRC, and WFF perform NASA's flight test and research operations. Operations vary in both scope and time. Aircraft, which include models, may fly at altitudes from a few feet up to altitudes of approximately 5000 feet and ranges may extend from an immediate location out to a range of several hundred miles. Missions might last from minutes, to hours, and/or days. The frequency of missions is dependent upon scheduling with competing missions at the test centers.<sup>42</sup>

### **4i. Unmanned Aerial Systems**

The increased use of the UAS is due to its improved surveillance capabilities, ability to carry payloads (cameras, weapons, sensors, and communications equipment), and expanded functions of electronic attack, surveillance, communications relay, firefighting, science observation, and search and rescue.<sup>43</sup> These systems require the use of large amounts of bandwidth and DOD forecasts a significant upsurge in spectrum requirements for these systems in all bands currently supporting UAS including the 1755-1850 MHz band.<sup>44</sup> These systems can use up to 16 megahertz of spectrum for video applications. DOD, DOI, DOJ and NASA operate UAS in the 1755-1850 MHz band at a number of different locations throughout the United States.<sup>45</sup>

DOD uses a number of UAS that operate in this band. UAS transmit video and status data to the Ground Control System using both analog video and data on subcarriers and more advanced digital technology. Due to their increased use, several UAS platforms have been designed to enhance the expanded ISR mission functions. UAS are

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<sup>40</sup> *Id.* at 2, 3.

<sup>41</sup> NASA-1 at 2.

<sup>42</sup> *Id.*

<sup>43</sup> DOD-2 § 4.8.

<sup>44</sup> DOD Strategic Spectrum Plan, *supra* note 30, at 89, 90.

<sup>45</sup> NASA reports costs related to UAS under AMT, while DOJ reports theirs under Video Surveillance. DOI is currently in the process of obtaining frequency assignments for their UAS.

categorized as long-range, medium, or short-range and support multiple missions and platform interfaces with other air, space, sea, and ground platforms. Additionally, in March 2010, the Secretary of Defense directed the military services to expand UAS training at U.S. training facilities. There is a continued requirement for UAS growth not only overseas but also in the United States to support increased operations and training. UAS support military operations as well as homeland security and other federal agency missions. New small UAS (SUAS) in the design and development phase will help support increased operational requirements. DOD SUAS operations will occur at all major testing, training, and IBCT locations.

DOI's Dragon Eye is a SUAS that allows for backpack transport. It is used primarily for their natural resource core mission areas. Those missions involve numerous scientific and conservation applications to manage and protect the United States natural resources as outlined below.

- Environmental Mission:
  - Ecosystem, pollution, wildlife, and glacier or ice cap monitoring
  - Fishery control
  - Water resource observation and forecasting
  - Oil spill detection and control
  - Aerial mineral exploitation
  - Terrain mapping
  - Natural disaster impact and relief
  - Contamination measurements
  - Volcanic observation
  - Climate change research
- Law Enforcement:
  - Information gathering for investigative or evidence
  - Aerial crime scene inspection
  - Counter drug and anti-terrorism operations
  - Persistent LE surveillance
  - Traffic observation or law enforcement
  - Critical infrastructure protection
  - Search and rescue operations and monitoring
- Fire Fighting:
  - Fire monitoring
  - Fire investigation
  - Early warning systems

In addition, the rangelands are remote and DOI's Bureau of Land Management is required to monitor millions of acres of rangeland. The use of UAVs provides fast and

## *1755 – 1850 MHz*

repeated deployment for managing rangeland health and ecosystem change assessment and mapping vegetation or soils at very high resolution.<sup>46</sup>

SUAS are small, lightweight, man-portable, hand-launched remote monitoring and surveillance systems. They transmit real-time images and their video links operate in the 1755-1850 MHz band. The SUAS provides “over the hill” view reconnaissance to the operator. In addition, these systems can be flown autonomously or via remote control. However, SUAS have very limited operating range (100 to 300 feet and less than ten-kilometer radius) and flight duration (approximately 90 minutes).

The FBI has been operating Unmanned Aerial Systems (UAS) for several years – they use these systems for all types of investigations and the demand for this technology is increasing. The UAS provide a unique video surveillance platform that augments other fixed wing and helicopter surveillance capabilities. For some aerial surveillance operations, unmanned aerial assets are more appropriate than manned assets due to their cost effectiveness, extended duration, and suitability for use over water and rural areas.

NASA operates UAS for conducting airborne remote sensing and scientific observations. These operations may involve development and calibration of sensors, or collection of data to support NASA Earth science programs concerned with the measurement of environmental parameters.<sup>47</sup>

### **4j. Other RF Systems**

The operations of a number of additional DOD systems rely on spectrum between 1755 and 1850 MHz. These systems include:

**Electronic Warfare (EW) Testing, Training, and Exercises** – EW is the struggle for control of the electromagnetic spectrum, to assure that friendly forces can use the spectrum to their full potential across the full range of military operations, while denying that use to enemies. U.S. military success depends on unfettered access to the spectrum to enable electronic equipment such as radars, communication links, computer networks, and sensors to work. The value of electronic warfare operations and training can be seen most clearly in current operations in Iraq and Afghanistan. U.S. forces have successfully trained and applied electronic warfare to disable Remote Controlled Improvised Explosive Device (RCIED) attacks. These successes continue today and the DOD expects requirements into the foreseeable future.<sup>48</sup>

EW testing, training, and exercises in the 1755-1850 MHz band include operations that exploit data transfer, including commercial communication systems and networks that are employed to simulate operational threat environments. Global System for Mobile Communications systems and networks are critical to training Army elements in the

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<sup>46</sup> DOI-2 at 8-9.

<sup>47</sup> Costs related to the UAS belonging to NASA are reported under AMT in this report.

<sup>48</sup> DOD-2 at § 4.10.1.

development and evaluation of counter-IED and tactical communications exploitation prior to deployment. This training system is essential for maintaining the operational readiness of Brigade Combat Teams. The systems have historical precedence of operating in nonfederal spectrum and are coordinated with the FCC and local commercial service providers to ensure compatibility. These systems are limited to U.S. Army test and training ranges.<sup>49</sup>

The Department of the Navy employs hundreds of aircraft with dedicated electronic attack suites used to protect aircraft strike groups and ship battle groups from a variety of threats. This includes Navy and Marine units. Operations and training are conducted at DOD EW/EA ranges across the United States. Additionally, the Navy and Marine Corps have a continuing requirement to perform EW development testing and training on Naval Expeditionary Warfare Counter RCIED EW open-air test ranges in the 1755-1850 MHz band.<sup>50</sup>

The Air Force performs a limited amount of EA/EW training in the 1755-1850 MHz band. Training operations take place and are generally associated with Weapons Officer training school activities. Training operations in this frequency band are intermittent and coordinated.<sup>51</sup>

**Software Defined Radio Systems** - SDR systems are capable of generating different waveforms and RF modulations of varying complexity through modifiable software and by the use of digital synthesis. Systems under various stages of development include the Joint Tactical Radio System man-pack radio and the Multifunctional Information Distribution Systems for JTRS.<sup>52</sup>

**Joint Tactical Radio Systems** - JTRS represents a family of multi-band/multi-mode SDRs, designed to provide communications within the 2 MHz to 2 GHz frequency range. JTRS operates with new advanced waveforms that have enhanced performance capabilities in both military and civilian frequency bands. The Joint Enterprise Network Manager software product enables control of the new networks. Many variants of JTRS exist and will be used by all three services. DOD projects JTRS operations to occur at all major testing, training, and IBCT locations. In addition, a critical aspect to consider regarding SDR operations is that the airborne and terrestrial ISR and communications relay capabilities must be available for training, testing and system development.<sup>53</sup>

**JTRS Man-Pack Radio** - The man-pack radio is a tactical radio system that operates from 30 MHz to 2 GHz, and includes another networking waveform capability. It also includes an option for ROVER IV and V L-band receive capability. In the current

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<sup>49</sup> *Id.*

<sup>50</sup> *Id.*

<sup>51</sup> *Id.*

<sup>52</sup> *Id.* at § 4.10.2.

<sup>53</sup> *Id.*

## **1755 – 1850 MHz**

configuration, access to spectrum above 2 GHz is not achievable without significant engineering modifications.<sup>54</sup>

**Multifunctional Information Distribution System (MIDS) for JTRS** - MIDS for JTRS radios, which are part of the JTRS family of radios, include the TTNT waveform. The Air Force is also supporting TTNT waveform development, but has not made a final decision on the Joint Aerial Layer-Tactical Edge waveform they will employ. The Navy plans to use the MIDS-J radio in their combat aircraft as the host for the TTNT waveform.<sup>55</sup>

**Tactical Targeting Networking Technology** - TTNT is the high throughput, low-latency solution for addressing the sensor-to-shooter link and providing other real-time information. TTNT is an Internet Protocol-based, high-speed, dynamic ad hoc network designed to enable the U.S. military to quickly target moving and time-critical targets. TTNT enables net-centric sensor technologies to correlate information among multiple platforms, precisely locating time-critical targets. The changing nature of warfare, where real time communication exchanges are paramount, makes TTNT an important element in conducting future military operations.<sup>56</sup>

### **5. Planned Use:**

Some systems will remain in the band indefinitely. To ensure maximum flexibility, Department of Defense (DOD) seeks to maintain the 1755-1850 MHz band for satellite tracking, telemetry, and commanding (TT&C) operations including, but not limited to, vehicle anomalies and emergencies. Further, testing and training for electronic warfare and some software defined radios will require continued operation within the band.<sup>86</sup>

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<sup>54</sup> *Id.*

<sup>55</sup> *Id.* at § 4.10.3.

<sup>56</sup> *Id.* at § F.9.

<sup>86</sup> An Assessment of the Viability of Accommodating Wireless Broadband in the 1755 – 1850 MHz Band, Executive Summary, Footnote 1