Biennial Spectrum Plan

2009

U.S. Department
of Transportation

US Department of Transportation (USDOT) Operating Administrations

Federal Aviation Administration

Federal Highway Administration

Federal Motor Carrier Safety Administration

Federal Railroad Administration

Federal Transit Administration

Maritime Administration

National Highway Traffic Safety Administration

Pipeline and Hazardous Materials Safety Administration

Research and Innovative Technology Administration

Saint Lawrence Seaway Development Corporation

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U.S. Department of
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Introduction to the US Department of Transportation's 2009 Spectrum Plan

In May 2003, the President established the Spectrum Policy Initiative to promote the development and implementation of a U.S. spectrum management policy for the 21st century. The intent of the Spectrum Policy Initiative is to " ... foster economic growth; promote our national and homeland security; maintain U.S. global leadership in communications technology; and satisfy other vital U.S. needs in areas such as public safety, scientific research, Federal transportation infrastructure, and law enforcement."

The Initiative requires all agencies, including the Department of Transportation, to provide an agency-specific strategic spectrum plan (agency plan) to the Secretary of Commerce that includes:

1) spectrum requirements, including bandwidth and frequency location for future technologies or services;
2) the planned uses of new technologies or expanded services requiring spectrum *over* a period of time agreed to by the selected agencies; and
3) suggested spectrum efficient approaches to meeting identified spectrum requirements.

The heads of agencies are required to update their agency plans biennially. This report represents the biennial update to the Department of Transportation's Spectrum Plan, first released in 2005.

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Agency-wide Spectrum Policy

US Department of Transportation

Impact of Spectrum Use on the US Department of Transportation's Mission

> *Traditionally innovation has been a hallmark of progress in transportation. Challenges today may be different from the past, but the role of technology and innovation is just as important. Technology will be central to our efforts to improve safety, reduce congestion, and manage our infrastructure more effectively. We must make a substantial investment in research and development if we are to fully, effectively, and efficiently maintain our aging infrastructure. Absent such investment, we will have no choice but to apply old and inadequate technologies to solve new and more complex problems. Our Nation can ill-afford the financial and system performance costs of attempting to address 21st century challenges with 20th century solutions.*
>
> ***Ray LaHood, Secretary of Transportation,***
> ***Testimony to the Committee on Environment and Public Works***
> ***United States Senate***
> ***March 25, 2009***

The United States has the world's largest transportation system. This system has enabled unprecedented growth in domestic and international trade and has provided a critical foundation for the economic prosperity that has taken place in the U.S. and around the world in the last 60 years. The Secretary has recognized that advanced technologies, especially those technologies utilizing spectrum, will be critical in maintaining and improving performance and safety of transportation infrastructure in all modes: aviation, highway, rail, pipeline, and maritime.

The Department has significant equities in spectrum allocations that provide the foundation for vital telecommunications, navigation, and surveillance services. These services in some cases are provided directly by the Department's operating administrations, and in other cases, by other organizations that are guided by or receive support from the Department.

DOT Organization and Mission

DOT is comprised of the Office of the Secretary, the Surface Transportation Board, the Office of the Inspector General and 10 operating administrations.

- Federal Aviation Administration
- Federal Highway Administration
- Federal Motor Carrier Safety Administration
- Federal Railroad Administration
- Federal Transit Administration
- Maritime Administration
- National Highway Traffic Safety Administration
- Pipeline and Hazardous Materials Safety Administration
- Research and Innovative Technology Administration
- Saint Lawrence Seaway Development Corporation

The national objectives of general welfare, economic growth and stability, and the security of the United States require the development of transportation policies and programs that contribute to providing fast, safe, efficient, and convenient transportation at the lowest cost consistent with those and other national objectives, including the efficient use and conservation of the resources of the United States.

DOT's Role in Federal Spectrum Management

The Office of the Secretary of Transportation coordinates spectrum policy, among DOT modal administrations, and interacts with the National Telecommunications and Information Administration (NTIA), other Federal Agencies and the Federal Communications Commission (FCC) to support national spectrum policy. In this capacity, the Office of Secretary (OST) delegates day-to-day responsibility for spectrum management to the Federal Aviation Administration (FAA) for aviation and space transportation issues, and to the Research and Innovative Technology Administration (RITA) for cross-modal transportation issues such as positioning, navigation and timing; and surface transportation research, development and technology (RD&T).

DOT's policy is to establish systems that meet the needs of the public by facilitating efficient and safe transportation while supporting national security. Use of the radio frequency spectrum is vital to the support of DOT programs, operations, and services to the traveling public, and to the freight transportation and logistics industry. DOT looks to each operating administration to follow a formal process to evaluate spectrum needs as it determines, in the light of its responsibilities and national and departmental policies, the extent to which radio frequency equipment is required to carry out its missions.

The DOT Under Secretary for Policy signed DOT Order 5421.1, "Radio Spectrum Management for Effective and Efficient Telecommunications Service," dated September 3, 2004, which provides policy and guidance for using the radio frequency spectrum and for requesting funds for systems requiring radio frequency support. Each DOT operating administration issues the necessary directives to comply with the overarching DOT policy, to include assuring that proposals for new, improved, or expanded systems, services, or equipment receive consideration and evaluation while considering the most spectrum-efficient options from a spectrum engineering standpoint and assurance of spectrum support by the National Telecommunications and Information Administration (NTIA) prior to their approval or funding if the particular service, system, or equipment requires radio frequency support. This is in accordance with the Office of Management and Budget's Circular A-11 (Preparation, Submission and Execution of the Budget), Section 33.

In a 2007 memo issued to the heads of the Operating Administrations, Secretary Mary E. Peters delegated to the Research and Innovative Technology Administration (RITA) responsibility for coordinating and developing Positioning, Navigation and Timing (PNT) policy and spectrum management. In this capacity, RITA acts as the executive secretariat to the DOT Positioning and Navigation Executive Committee, chaired by the Department's Under Secretary for Policy. Because of the growing importance of cross-modal positioning, navigation and timing services such as the Global Positioning System, RITA has taken the lead in promoting the Department's interests in this area.

Other important references affecting DOT's use of spectrum include: Title 49, United States Code (U.S.C.), § 101; The Maritime Act of 1981 (Public Law 97-31 as amended); Title 23, U.S.C. § 307, providing authority for the Intelligent Transportation System program; Title 49, U.S.C. § 301 specifying duties of the Secretary of Transportation; Title 33, U.S.C. §§981 et seq, St. Lawrence Seaway Act; Title 49, U.S.C. §103; Public Law 98-575 as amended; Title 14, U.S.C. § 81; Title 14, U.S.C. §; and 49 U.S.C. 540103. The Federal Aviation Administration's (FAA) Order 6050.32C provides FAA with more detailed policy, direction, and procedures as required by FAA responsibilities necessary to carry out its mission.

Spectrum Dependent Systems Covered by the 2009 Plan

Systems utilizing spectrum covered by this plan include:

Multi-Modal Positioning, Navigation, and Timing Systems:

Global Positioning System (GPS)
Nationwide Differential GPS (NDGPS)
High Accuracy Nationwide Differential GPS (HA-NDGPS)

Highway, Transit, and Vehicle Communications and Sensors:

Dedicated Short Range Communications (DSRC) Systems
Collision Avoidance Radar
Private Mobile Radio
Step Frequency Ground Penetrating Radar (SF GPR)
Highway Advisory Radio (HAR)
Real Time Kinematic (RTK) Global Positioning System (GPS) data links

Maritime Communications, Navigation, and Vessel Traffic Management:

Automatic Identification System (AIS)
Secure/encrypted communications

Aviation Communications, Navigation, Weather and Surveillance:

Very High Frequency (VHF) Air-Ground Communications
Ultra High Frequency (UHF) Air-Ground Voice Communications
High Frequency (HF) Air-Ground Voice Communications
Satellite (AMS(R)S) Communications
Support Communications
Non Directional Beacon System (NDB)
Instrument Landing System (ILS) Localizer Related System Elements
Very High Frequency Omni-directional Range (VOR) System Elements
Local Area Augmentation System (LAAS)
Instrument Landing System (ILS) Glideslope Related System Elements
Distance Measuring Equipment System (DME)
Traffic Alert and Collision Avoidance System (TACAN)
Universal Access Transceiver (UAT)
GPS Elements
Microwave Landing System (MLS)
Air Traffic Control Radar Beacon System / Secondary Surveillance Radar (ATCRBS/SSR) Air Route Surveillance Radar (ARSR)
Airport Surveillance Radar (ASR)
Next Generation (Weather) Radar (NEXRAD)
Terminal Doppler Weather Radar (TDWR)
Airport Surface Detection Equipment (ASDE)
Automatic Dependent Surveillance-Broadcast (ADS-B) / Future
Unmanned Aircraft System (UAS) / Future
Airport Wireless Local Area Network / Future

Surface Domain

DOT Spectrum Plans covering Highway, Rail, Transit and Pipeline

Federal Highway Administration (FHWA)

Agency Missions and Strategic Vision for Spectrum Management

Spectrum resources are vital for enabling FHWA to meet its broad responsibility of ensuring that America's roads and highways continue to be the safest and most technologically up-to-date. Although State, local, and tribal governments own most of the Nation's highways, FHWA provides financial and technical support to them for constructing, improving, and preserving America's highway system. The annual budget of more than $30 billion is funded by fuel and motor vehicle excise taxes. The budget is primarily divided between two programs: Federal-aid funding to State and local governments; and Federal Lands Highways funding for national parks, national forests, Indian lands, and other land under Federal stewardship.

FHWA's Vision...
Our Agency and Our Transportation System are the Best in the World.

FHWA's Mission...
Improve Mobility on our Nation's Highways through National Leadership, Innovation, and Program Delivery.

The current Spectrum Management function lies with the Office of Operations Research and Development.

Current Spectrum Use for agency systems using Federal agency or shared spectrum allocations

Spectrum is a key to enabling safe and efficient surface transportation. FHWA uses very little spectrum directly today, but that is expected to change over the next several years as Intelligent Transportation Systems applications·are deployed within the infrastructure.

FHWA works with State, Tribal, and other transportation agencies to use spectrum efficiently supporting improved safety and efficiency of the highway transportation system. There are several areas that FHWA is pursuing or is expecting to see changes in the near term. These are listed below.

Real Time Kinematic (RTK) Global Positioning System (GPS) data links:

406 - 420 MHz

FHWA's Office of Federal Lands Highways uses RTK GPS to survey road construction projects. Specific applications range from establishing project control for construction to estimating material needed for repaving. The availability of frequencies for the short range communication links that this commercial, off-the-shelf, equipment uses is limited and generally in short supply. We are working with NTIA and other Federal agencies to develop appropriate spectrum support for these systems.

Typically, these data communications systems operate within the 406-420 MHz band with an 11 KHz bandwidth and power levels less than 25 watts. These are "line of sight' systems that may require relocation within a given job site due to terrain and other obstructions.

Future Spectrum Requirements for agency systems using Federal agency or shared spectrum allocations

Step Frequency Ground Penetrating Radar: 140 MHz -3000 MHz Ultra Wide Band

FHWA is working with a manufacturer of Step Frequency Ground Penetrating Radar (SF GPR) to enable nationwide operations under Federal regulations. If this is achieved, the manufacturer can work through the FCC approval process to gain further acceptance and make the SF GPR available to non-Federal users.

The SF GPR is used for non-destructive assessment of subsurface conditions in roadways and bridges at highway speeds. The technique has shown great promise and offers many advantages over existing techniques.

The SF GPR uses a technique similar to that used by Ultra Wide Band (UWB) devices, utilizing a more controlled frequency synthesis method to generate the needed frequencies rather than an ultra wide band impulse. This allows for critical frequencies to be notched, enabling a more flexible and less interference-prone device to be developed. The SF GPR is capable of generating signals every 2 MHz from 140 MHz to 3000 MHz at levels below the existing Annex K levels, similar to what is allowed for Part 15 devices under FCC regulations.

The Interdepartment Radio Advisory Committee (IRAC) has provided a way forward through the spectrum planning process. Preliminary spectrum assessments have been completed and further testing is needed to fully characterize the signal levels.

Recommended Actions for NTIA

FHWA will continue to participate with NTIA and other organizations to find an appropriate solution for the RTK GPS needs of FHWA's Office of Federal Lands Highways that also supports other agencies needs.

FHWA will continue to work through the IRAC to gain spectrum certification as stage 4 Operational for the SF GPR. This process has been ongoing for approximately 3 years with substantial progress toward FHWA's operational goal.

Federal Motor Carrier Safety Administration (FMCSA)

The Federal Motor Carrier Safety Administration (FMCSA) is focused on reducing crashes, injuries, and fatalities involving large trucks and buses. The Office of Research and Analysis is FMCSA's organization devoted to technology issues, with its main goal to reduce the number and severity of commercial motor vehicle (CMV) crashes and enhance the efficiency of CMV operations. FMCSA has no specific spectrum assignment or responsibilities, but in fulfillment of its overall mission it coordinates with NHTSA and RITA in the development of standards and applications for DSRC to ensure that the benefits of this technology extend to CMVs.

Federal Railroad Administration (FRA)

Spectrum plays a major role in providing for enhancements to the U.S. rail systems. The Passenger Rail Investment and Improvement Act of 2008 (PRIIA) directed the Administrator of the Federal Railroad Administration (FRA) to develop a Preliminary National Rail Plan (PNRP) to address the rail needs of the Nation. The PNRP was published in October 2009. The PRIIA also reauthorized Amtrak for 5 years and authorized funding to improve the U.S. rail passenger network.

High-Speed Intercity Passenger Rail

Subsequent to PRIIA, the American Reinvestment and Recovery Act of 2009 (Recovery Act) was signed into law by President Obama on February 17, 2009. The Recovery Act contains funding and sets forth requirements for the development of high-speed intercity passenger rail. For the first time, the Recovery Act designated $8 billion as a down payment on the development of efficient, high-speed intercity rail in 100—600 mile intercity corridors that connect communities across America. In total, the Recovery Act contains more than $48 billion in vital transportation funding to help bring about economic recovery and make lasting investments in our Nation's infrastructure.

FRA Research & Development

Within FRA the Office of Research and Development is responsible for technology issues. The Office of Research and Development conducts research, development, test, and evaluation projects to support its safety mission and to enhance the railroad system as a national transportation resource. It contributes vital benefits to safety regulatory processes, to railroad suppliers, to railroads involved in the transportation of freight, to intercity and commuter passengers, to railroad employees, and to rail labor organizations. The following ongoing research and development themes will likely lead to the need for new radio spectrum to support these emerging systems.

Intelligent Railroad Systems

A theme cutting across virtually all the Research, Development and Demonstration (RD&D) program elements is the use of sensors, computers, and digital communications to collect, process, and disseminate information to improve the safety, security, and operational effectiveness of railroads. Intelligent Transportation Systems (ITS) for highways and mass transit are based on these technologies, as are advanced air traffic control and maritime vessel tracking systems. Military services, major parcel delivery companies, pipeline operators, and police, fire, and ambulance services also use these technologies. The FRA and the railroad industry are working on the development of Intelligent Railroad Systems that would incorporate the new sensor, computer, and digital communications technologies into train control, braking systems, grade crossings, and defect detection, and into planning and scheduling systems as well. Intelligent Railroad Systems are key to making railroad operations—freight, intercity passenger, and commuter—safer and more secure, reducing delays, reducing costs, raising effective capacity, improving customer satisfaction, improving energy utilization, reducing emissions, and becoming more economically viable. The systems can be implemented as independent systems, in which case their benefits will be limited, or they can be implemented as integrated systems, in which case the benefits will be compounded. FRA, through its RD&D program elements, is encouraging the railroad industry to adopt the integrated approach when implementing these systems.

Positive Train Control (PTC)

Positive Train Control (PTC) systems are integrated command, control, communications, and information systems for controlling train movements with safety, security, precision, and efficiency.

PTC systems will improve railroad safety by significantly reducing the probability of collisions between trains, casualties to roadway workers and damage to their equipment, and over speed accidents. PTC systems are comprised of digital data link communications networks, continuous and accurate positioning systems, on-board computers with digitized maps on locomotives and maintenance-of-way equipment, in-cab displays, throttle-brake interfaces on locomotives, wayside interface units at switches and wayside detectors, and control center computers and displays. PTC systems may also interface with tactical and strategic traffic planners, work order reporting systems, and locomotive health reporting systems.

PTC systems issue movement authorities to train and maintenance-of-way crews, track the location of the trains and maintenance-of-way vehicles, have the ability to automatically enforce movement authorities, and continually update operating data systems with information on the location of trains, locomotives, cars, and crews. The remote intervention capability of PTC will permit the control center to stop a train should the locomotive crew be incapacitated. In addition to providing a greater level of safety and security, PTC systems also enable a railroad to run scheduled operations and provide improved running time, greater running time reliability, higher asset utilization, and greater track capacity. They will assist railroads in measuring and managing costs and in improving energy efficiency.

Under the 2008 Rail Safety Improvement Act, Congress mandated that the railroad industry deploy PTC systems by the end of 2015 on over 90,000 miles of track to greatly reduce the accident rates on these routes. FRA has been cooperating with the industry to develop an interoperability standard among various PTC designs and a 220 MHz higher performance digital radio system to facilitate the deployment.

Federal Transit Administration (FTA)

Agency Missions and Strategic Vision for Spectrum Management

The Federal Transit Administration (FTA) administers federal funding to support a variety of locally planned, constructed, and operated public transportation systems throughout the United States including buses, subways, light rail, commuter rail, streetcars, monorail, passenger ferry boats, inclined railways, and people movers that provide safe, affordable, and dependable mobility to more than nine billion riders each year. The vast majority of this takes place in major metropolitan areas where public transit provides mobility to more than 30 percent of the workforce in those cities, as well as to large percentages of the disabled and aging populations. In the largest of American cities, public transit forms the backbone of urban life without which the financial and commercial centers of the United States would simply shut down.

FTA manages the Federal public transportation program. Public transportation, "transit" for short, is scheduled and on-demand local transportation service provided for, and available to, the general public. Every year, local agencies leverage FTA funds in combination with fares and other regional, state and local revenue sources to deliver more than nine billion trips on transit. For millions of people, local transit provides an affordable, safe and dependable alternative to driving a car on congested roads. For many other Americans, transit is the vital link to employment or other activities, services, friends and family.

FTA's overall role is to:

- Assist transit providers;
- Encourage transit service in support of urban development;
- Assist in funding transit systems to meet locally identified needs; and,
- Provide financial assistance to support mobility for elderly individuals, individuals with disabilities, and economically disadvantaged individuals.

FTA provides funding primarily for capital investments, but also provides some operating assistance for specific types of transit agencies. Through dozens of programs or initiatives aimed at serving different customer segments, FTA provides the following products and services:

- GRANTS: Government agreements to provide funds for state and local transit authorities to purchase or construct new or rehabilitated transit equipment and facilities, and in some cases, operate services.
- TECHNICAL ASSISTANCE: Consultative services including one-on-one dialogue, site visits and meetings, publications and website information to enable grantees to successfully meet Federal grant requirements.
- PROGRAM MANAGEMENT: Oversight policies, best practices and e-commerce tools to ensure that Federal funds are effectively and efficiently managed and to build technical capacity in transit authorities to complete projects on time and within budget.
- TRANSIT POLICY: Proposing legislative initiatives to Congress and translating legislative requirements into regulations and/or practical guidance for grantees.
- PROMOTION OF INNOVATION THROUGH RESEARCH: Ideas and strategies to increase ridership, improve operations, introduce new technologies and promote multi-modal transportation solutions.

FTA Vision

People Moving People into America's Future.

FTA Mission

Improve public transportation for America's communities.

FTA Goals

FTA's Annual Performance Plan considers the needs of the transit industry and provides specific goals and objectives for the delivery of a comprehensive, national transit program. FTA aggressively pursues it vision and mission by focusing on the following goals:

1. Human Capital;
2. Safety;
3. Livability and Environmental Sustainability;
4. State of Good Repair; and,
5. Program Delivery.

FTA's Current and Future Spectrum Needs

FTA's future spectrum needs involve continuing support for mission-influenced requirements, policy-mandated requirements, and responses to technology and service provision advancements. FTA anticipates the domestic public transit industry's need for upgrading or purchasing new systems or equipment to provide services that may include land mobile radio, ultra-high frequency and data and voice, microwave, satellite, supervisory control and data acquisition, radar, ultra wideband, radio-frequency identification, and dedicated-short range communication (DSRC).

Since September 11, 2001 and the Hurricane Katrina disasters, the role of public transit in local communities has expanded greatly to encompass emergency evacuations during major natural and man made disasters. Currently, nearly 100 percent of transit agencies with bus fleet sizes larger than 500 vehicles and nearly 80 percent of transit agencies with fleets larger than 100 vehicles participate actively in multi-agency, regional emergency preparedness exercises. Experts have found that public transit becomes critical in such circumstances when the majority of a population needs to evacuate in a short time. Other forms of transportation, including automobiles and aviation, simply cannot move the vast numbers required during an emergency. In both day-to-day operations of transit systems and emergency operations, the availability of dedicated, secure spectrum is vital to the continued mission of public transit.

Additionally, a number of rail transit systems operate in tunnels where radios used by emergency responders either do not work or work only on line of sight. Some transit systems set aside an emergency frequency and issue radios to responders to use during response. Preserving a frequency for such use is critical to effective emergency response and public safety.

Private Mobile Radio: 806 – 869 MHz, 450 MHz – 470 MHz, 150 – 170 MHz, 900 MHz, and 25 – 50 MHz

Private mobile radio, using owned or leased spectrum, is used by 89 percent of all transit agencies, with usage at nearly 100 percent for agencies with fleet sizes larger than 100 vehicles. Private mobile radio is used for mission critical voice and data services between operational centers and mobile staff and vehicles. The most common bands used are 806-869 MHz (30 percent), 450-470 MHz (30 percent), 150-170 MHz (17 percent), 900 MHz (10 percent), and 25-50MHz (5 percent). Many agencies find it necessary to operate across multiple bands in order to achieve sufficient band width to meet their needs. Moreover, many agencies utilized trunked radio (75 percent of all large agencies with more than 500 vehicles and 40 percent of agencies with more than 100 vehicles) in order to improve spectral efficiency. Some, particularly agencies with less than 500 vehicles, lease or share trunked radio service with other regional agencies such as police or fire services for both cost sharing and for access in areas where spectrum is difficult to obtain. Typically, large agencies with fleet sizes greater than 500 vehicles utilize more data than can be accommodated on a P25 radio system and have implemented their own trunked radio systems.

In spite of the vast use of private mobile radio, the use of commercial cellular or equivalent service is prevalent across the industry for instant messaging and other needs not met by each agency's radio system. Nearly 100 percent of all agencies use such services with some even using other devices such as pull cords and hard wired indicators built many decades ago to fulfill the need.

As for the future spectrum plan and needs for the public transit industry, this is currently under study within the Transit Cooperative Research Program (TCRP) as Task 67. Part One of this study surveyed the transit industry to develop agency profiles of spectrum usage to begin the process of outlining current industry concerns and future spectrum requirements (TCRP Report J-06, "Strategic Assessment of Wireless Capabilities and Needs for the Public Transportation Industry," March 2008). Part Two is intended to develop a series of options for the transit industry that will satisfy its future needs and address concerns.

From the data collected in the TCRP study, FTA found that over the past five years the dominant reason for communications system replacement or upgrade was as a result of obsolescence. In the next five years, the dominant reasons for system upgrade or replacement will be interoperability and Federal Communications Commission (FCC) frequency changes. Some 60 percent of all transit agencies are affected by narrow banding and 38 percent affected by 800 MHz rebanding. While most agencies would like to implement data to improve spectral efficiency and expand badly needed services, most are primarily concerned with keeping what spectrum they have that keeps their agency delivering quality service each day. Few have sufficient staff or funding to look into system upgrades.

In Part Two, TCRP's Task 67 is investigating the feasible options for ensuring long term availability of spectrum for mission critical systems used in transit, including planned future services. This plan will take on as its mission FCC's goals of spectral efficiency; USDOT's goal for 'a safer, simpler, and smarter transportation system for all Americans'; and maximum interoperability with all of public transit's partners such as public safety and homeland security. Through this effort the public transit industry expects to more fully articulate a clear direction and plan for spectrum usage.

Some of the key drivers for radio system changes in transit, beyond interoperability and FCC changes, lie in larger macro-economic trends such as a rise in demand for public transit, the decline in skilled labor, and the rise in security concerns and requirements. The rise of oil prices has demonstrated that the public is sensitive to gas prices, to the price of goods and services in general, and to rising traffic congestion. It is projected that increasingly more people will demand public transit to fulfill their mobility needs and will correspondingly choose to fund these options. This rise in demand will fly in the face of a declining transit labor force as the backbone of transit's skilled labor, the baby-boomer generation, retires. What all of this means for transit's use (or demand) for spectrum is that transit will need more and more channels to grow service and use more and more data for automation to offset the decline in the availability of skilled labor. Combined with growing video demands imposed by transit security agencies, these trends mean exponential growth in future spectrum needs for transit. Broadband spectrum will be necessary to improve spectral efficiency and to meet the need. Broadband is currently in use or being evaluated by the FCC for other critical infrastructure, public safety and commercial needs in the ranges of 5.9GHz (DSRC), 4.9GHz, and 700 MHz.

Dedicated Short Range Communications (DSRC): 5.9 GHz

DSRC allows high-speed communications between all vehicles and the roadside or between all vehicles for Intelligent Transportation Systems (ITS). Potential “Day One” DSRC applications for public transit include:

- Intersection collision avoidance;
- Approaching emergency vehicle warning;
- Vehicle safety inspection;
- Signal priority/preemption;
- Electronic fare payments;
- In-vehicle signing;
- Rollover warning;
- Customer travel information;
- Probe data collection; and,
- Rail grade crossing intersection warning.

FTA’s Leadership Role

FTA is in a position to help transit agencies with several aspects of the frequency spectrum issues, including providing guidance, outreach, technical assistance, and exploring funding options. For this leadership role, FTA has agreed to lead a Tracking Committee of Transit Wireless Joint Council which works with the American Public Transit Association (APTA) and the industry regarding transit wireless communication issues.

FTA will chair the Tracking Committee which will meet the following objectives:

- Track and provide comments on FCC notices on wireless communication
- Provide status on wireless standard developments and interoperability
- Work with FTA to collect transit communications data through reporting as part of FTA funding requirements
- Regularly report on the status of transit wireless communications at meetings of the transit industry and related groups (e.g. AASHTO)
- Post the status information in the web and create a web-link to Joint Council website
- Meet 2-3 times a year

Rail Signaling and Train Control

FTA supports deployment of control systems by the transit industry that improve the safety, security, and operational effectiveness of intercity (subways, metros, light rail) and commuter rail. Continued improvements to the various systems of monitoring and controlling intercity and commuter rail train movements such as automatic train control (ATC), communications-based train control (CBTC), and positive train control (PTC) will likely lead to the need for new spectrum to support current and emerging needs.

Coordination with USDOT ITS Program

To promote transit ITS and spectrum utilization in the transit industry, FTA needs to be an integral part of, to the extent practical, all current and future USDOT-lead ITS initiatives. FTA supports the overall USDOT ITS Program via advancement of transit ITS through investments in major initiatives, exploratory studies, and a cross-cutting core program. Increasingly, these ITS investments will be directed at targets of opportunity that have the potential for significant payoff in improving safety, mobility, and system productivity. These targets of opportunity will include the infrastructure and vehicles and, to the greatest extent possible, will focus on the integration between vehicles and infrastructure, between modes of transportation, and between jurisdictions. FTA also supports a cross-cutting core program consisting of the National ITS Architecture, standards, learning, evaluation, and technical assistance for the deployment of ITS transit.

The current USDOT ITS initiatives include:

- Clarus (National Surface Transportation Weather Observing and Forecasting System);
- Cooperative Intersection Collision Avoidance Systems;
- Electronic Freight Management;
- Emergency Transportation Operations;
- Integrated Corridor Management Systems (ICM);
- Integrated Vehicle-Based Safety Systems (IVBSS);
- IntelliDrive^{SM};
- ITS Operational Testing Program to Mitigate Congestion
- Mobility Services for All Americans (MSAA); and
- Next Generation 9-1-1(NG 9-1-1).

FTA currently has a significant role in the congestion mitigation, ICM, MSAA, and IntelliDrive^{SM} initiatives, and in a smaller role in the IVBSS initiative.

<u>External Factors</u>

FTA identified external factors that are not within its direct control that could have an impact on the transit industry's spectrum use and needs. They are:

- Budget constraints;
- Availability/lack of spectrum management personnel;
- Lack of a transit spectrum management strategic plan;
- Interagency and intergovernmental cooperation;
- Unknown effects of congressional direction;
- Unplanned needs of a changing transit and energy environment;
- Availability and reliability of commercial services to supplement or replace dedicated government systems;
- Viability of alternatives to spectrum usage; and,
- New initiatives from USDOT, Congress, or the President in response to emerging national needs or situations (e.g., disaster response, terrorism).

Summary

The current profile of spectrum usage by public transit can be characterized as a disorganized array of choices that work for each agency and their particular circumstances. Unlike highways, railroads, or the airline industry, there is no plan to coordinate spectrum usage amongst public transit agencies. Each agency is left to its own to obtain its needed spectrum. This has resulted in the implementation of a confused and wide assortment of systems in multiple bands using both private mobile radio and commercial carrier service. As noted prior, a TCRP (Task 67) study is currently underway to vet the development of a spectrum plan for the public transit industry.

DOT's Strategic Spectrum Plan considers many other internal and external factors relating to spectrum management. FTA's contribution to the Plan should be considered as a baseline, and accordingly, the beginning of a long-term process to improve the management of, and investment, in spectrum utilization and other telecommunications assets for the domestic transit industry.

National Highway Traffic Safety Administration (NHTSA)

Agency Missions and Strategic Vision for Spectrum Management

Spectrum resources are important to National Highway Traffic Safety Administration (NHTSA) in helping ensure that America's automobiles continue to be the safest they can be. Although NHTSA does not own any vehicles, NHTSA develops the Federal Motor Vehicle Safety Standards which apply to new vehicles. NHTSA also sponsors cooperative research with the automotive industry that uses Dedicated Short Range Communication (DSRC) to support vehicle safety applications. From the viewpoint of spectrum management, NHTSA is an R&D organization and has no agency-specific spectrum requirements.

NHTSA uses Intelligent Transportation Systems Joint Program Office (ITS JPO) funds to support the development of DSRC and 44-77 GHz automotive collision avoidance radars. NHTSA does not have a strategic spectrum management function or activity, organization, key staff, or reporting structure.

The Society of Automotive Engineers (SAE) and the Institute of Electrical and Electronics Engineers (IEEE) committees develop the standards necessary to implement DSRC. The committees include a variety of representatives from the private, public and academic sectors.

Dedicated Short Range Communication (DSRC): 5.9 GHz

Since the FCC allocated 5.850-5.925 GHz for DSRC in October 1999, several groups have been working on standards including IEEE and ASTM. The physical layer (PHY) and media access layer (MAC) standards (IEEE 9-2.11p) and the upper layer standards (1609.x) are progressing through the various committees and are expected to be completed in late 2010. For further information please see the Research and Innovative Technology Administration (RITA) section of this Plan.

Collision Avoidance Radar: 47-77 GHz

Collision Avoidance Radar: The automotive industry has pursued allocations successfully for these services on their own, with support from DOT. Cooperative research and development between industry and NHTSA on these systems has been ongoing for several years.

Pipeline and Hazardous Materials Administration (PHMSA)

Agency Missions and Strategic Vision for Spectrum Management

Pipeline and Hazardous Materials Administration's (PHMSA) mission is to protect people and the environment from the risks inherent in transportation of hazardous materials – by pipeline and by all modes of transportation. In carrying out its mission, PHMSA uses only commercially available services licensed by the Federal Communications Commission.

Current Spectrum Use for Agency Systems Using Federal agency or shared Spectrum

The commercial systems are used by all employee levels to facilitate communications between the office and other locations. Cellular telephones and wireless handheld devices for e-mail support the Office of Pipeline Safety (OPS) response to pipeline incidents allowing the timely transfer of information. In addition, satellite telephones support PHMSA emergency functions in remote locations without cellular service and as an additional communications method during national emergencies. Continuity of Operations (COOP) initiatives incorporate the use of cellular and satellite telephone systems for voice communications.

Current Use of Commercial Spectrum-Dependent Licensed Systems

PHMSA uses commercially provided services and equipment for: cellular telephone voice communications, satellite telephone voice communications, wireless handheld device for e-mail, wireless broadband cards, and wireless networks. For PHMSA, no new spectrum requirements are anticipated at this time. As PHMSA is not a stakeholder in government radio spectrum use, PHMSA has no recommendations or comments at this time for NTIA.

Research and Innovative Technology Administration (RITA)

U.S. DOT Strategic Spectrum Communications Issues that Impact Intelligent Transportation Systems (ITS)

Spectrum is a key enabler for the dissemination of traffic and traveler information. DOT's ITS program is based on the fundamental principles of:

1) vehicles enabled with intelligent technologies;
2) intelligent infrastructure; and
3) creation of an intelligent transportation system through integration across and between these two components of surface transportation.

The Federal ITS program supports the overall advancement of ITS through investments in major initiatives, exploratory studies, and a crosscutting core program. Federal investments will be directed at targets of opportunity (major initiatives and operational test demonstrations) that have the potential for significant payoff in improving safety, mobility, efficiency, and economic productivity. These targets of opportunity will include the infrastructure and vehicles and, to the greatest extent possible, will focus on the integration between vehicles, infrastructure, between modes of transportation, and between jurisdictions. DOT works to create ITS technological solutions to address significant surface transportation problems. DOT supports a crosscutting core program – architecture, standards, evaluation, and technical assistance – that fosters the widespread deployment of ITS applications and services.

The following are spectrum and/or wireless communications issues that have the potential to impact ITS and therefore are of interest to RITA's ITS Joint Program Office (JPO).

Highway Advisory Radio: 535-1710 KHz

Typically provided in the AM broadcast band (535-1710 KHz), Highway Advisory Radio (HAR) is being implemented with advanced features such as synchronized transmissions, remote message uploads, and portable equipment for emergency or special events. The focus of HAR remains safe and efficient transportation. This is supported by current Federal Communications Commission (FCC) rules that require siting transmitters adjacent to roadways and disseminating information that broadly serves to protect life and property.

Cellular Telephony

Wireless E-911: Implementation of this service will greatly facilitate deployment of the Emergency Notification and Personal Security user service. Comments have been submitted by the Intelligent Transportation Society of America (ITS America) and DOT during this FCC rulemaking process.

Dedicated Short Range Communications (DSRC): 902 - 928 MHz

DSRC Protocols: This frequency band is being used for applications such as legacy tolling, commercial vehicle electronic clearance, railroad fleet management and automated rail car location, transit signal priority, and in a few select locations, traffic management systems. The DSRC devices used are based on both active and passive Radio Frequency Identification (RFID) technology, and the roadside devices are licensed by the FCC. There are several standards-based and proprietary technologies used in this band; there is no agreed-upon nationwide standard for ITS applications. These applications could, in the future, transition to DSRC systems operating in the 5850-5925 MHz band.

Dedicated Short Range Communications: 5.850 – 5.925 GHz

DSRC: A non-dedicated spectrum allocation to allow deployment of all envisioned ITS safety, mobility, efficiency, travel information and other user services that require secure and dedicated communications

What is DSRC?

DSRC allows high-speed communications between vehicles and the roadside or between vehicles for ITS applications; it has a range of up to 1000 meters. Potential DSRC applications for public safety and traffic management include:

- Intersection collision avoidance
- Approaching emergency vehicle warning
- Vehicle safety inspection
- Emergency or transit vehicle signal priority
- Commercial vehicle clearance and safety inspections
- In-vehicle signing
- Rollover warning
- Probe data collection
- Highway-rail intersection warning
- Real time traffic information
- Traffic signal timing optimization
- Emergency electronic brake light
- Electronic payments (e.g., open tolling, parking)

DSRC applications now in use include electronic toll collection, and electronic credentialing and monitoring of commercial vehicle operations. Current applications operate at 915 MHz and primarily use proprietary technology, although some standards-compliant devices have been developed.

The FCC allocated 5.9 GHz spectrum for DSRC. This allocation permits much higher data transmission rates than the lower frequency 915 MHz band and provides 75 megahertz of spectrum for DSRC applications. The FCC rules for 5.9 MHz also specify a standard to achieve nationwide interoperability. The 915 MHz frequency has only 12 megahertz of spectrum available, which is shared with cordless telephones, garage door openers, and many other non-licensed wireless applications. In the case of 5.9 GHz, other users in the band include military radars and satellite communications systems.

Standards Development Status

When the FCC allocated the 5.9 GHz band for DSRC in October 1999, an ASTM International standards committee began working on the standards for this new service. ASTM approved the first DSRC standard for 5.9 GHz, ASTM E2213-02, in May 2002 for layers 1 and 2, the physical and data link layers of the open systems interconnection (OSI) model of network architecture. In October 2002, ASTM published this standard. This standard, based on the Institute of Electrical and Electronics Engineers (IEEE) 802.11 wireless local area networks standard, is specified in the FCC rules. In the last several years an IEEE task group has been working to make this standard part of the full IEEE 802.11 standard. IEEE 802.11 Task Group (p) is writing this standard and is making modifications and improvements based upon studies and experimentation by stakeholders.

The IEEE 1609 committee has published four standards that address legacy applications, security, network, and transport protocols for DSRC. These standards, in conjunction with 802.11 (p), create an entire protocol suite to ensure nationwide DSRC interoperability. DSRC stakeholders continue to update the IEEE 1609 standards based on their studies and experimentation (and harmonize them with 802.11 (p)) so they can be published as full use standards. There is a 1609 draft architecture standard being developed that will describe how all these protocols work together.

Wireless communication for traffic surveillance and signal control: 11, 23, & 31 GHz

Wireless communication for traffic surveillance and signal control: FCC reallocation of the 31 GHz band to the new Local Multipoint Distribution System service will result in displacement of certain secondary users who operate point-to-point microwave links for traffic signal control. DOT filed comments in this proceeding and advises the field on developments.

Collision Avoidance Radar: 47 – 77 GHz

Collision Avoidance Radar: The automotive industry has pursued allocations successfully for these services directly, with support from DOT. Cooperative research and development between industry and DOT/NHTSA on these systems has been ongoing for several years.

Wireline Issues

A number of wireline telecommunications issues are of interest to ITS planning and applications:

- Resource sharing of highway rights-of-way with communications service providers.
- Development of national and international communications standards and protocols.
- Deployment of 5-1-1 telephone number to support travel/transportation information.
- Open Video Systems and other new services that could support traffic management. surveillance needs, or otherwise impact the sharing of communication resources.
- Other Telecommunications Act and related provisions/implications.

Telecommunications, Spectrum Sharing, and New Technologies

A number of recent developments have coalesced to change conventional wisdom regarding transportation-related communications technology. The Telecommunications Act of 1996, the explosive growth of the Internet, the remarkable technical advances in wireless communications, and rapid change in the worldwide logistics industry are all a part of this transformative change.

These new communications developments bring opportunities and benefits to transportation engineers even though these technologies were not designed specifically for transportation uses. This plan explores several examples of new transportation applications and some near-future developments.

Identify Transportation Information Needs

To take advantage of telecommunications opportunities that already exist or will exist in the near future, it is necessary to look first at why telecommunications technology is needed for freight and traveler transportation safety and operations, and then to carefully evaluate alternatives for meeting those needs.

The transportation planning process provides the basis for this analysis by defining problems that must be solved, and identifying possible solutions. Some of these solutions routinely involve the use of electronics to enhance the operation of the transportation network. Upgrading traffic signals, adding video surveillance of freeways or intersections, constructing or expanding a traffic management center (TMC), and installing other ITS equipment all require telecommunications technology.

It is essential to understand the telecommunications implications of each project proposed in regional, state, local and Metropolitan Planning Organization (MPO) transportation plans. These planning processes requires analysis of geographic and information requirements. These analyses feed into the regional architectures for transportation information exchange. In turn, the regional architectures, to be prepared by every State and metropolitan region over the next several of years, provide the basis for defining the detailed requirements for telecommunications services needed to implement the transportation plans.

Once the information needs are defined in the regional architecture or other documents, a communications technology specialist can determine the corresponding specifications for telecommunications. Telecommunications systems can be configured several different ways, and the specific attributes of different configurations will be important. Options will depend in part on the communications services available in the area.

Evaluation of New Alternatives

Three broad areas exist where transportation engineers can capitalize on new telecommunications developments include:

1) new infrastructure from new competitors;
2) new technologies for wireline networks, and
3) new services from the wireless industry.

Regardless of the telecommunications architecture chosen by a transportation agency, there generally will need to be some form of backbone or wide area network technology that can collect, and subsequently disseminate, information from widely dispersed field equipment, such as signal controllers, cameras, and other sensors in the infrastructure and on vehicles.

New options continue to become available for virtually every transportation-related telecommunications application. However, alternative analyses and trade-off studies continue to be required as new communication technologies and consumer devices are developed. The ITS Joint Program Office will continue to assess emerging technology trends and market-ready applications to leverage available surface transportation solutions for both near-term deployments and longer-term research that yield safety, mobility, environmental, productivity, and economic benefits.

2.4 GHz, 5 GHz, and 700 MHz

Several years ago, the FCC authorized the use of new segments of the radio frequency spectrum for a variety of services. Three regions of the spectrum are of particular importance: the 2.4 GHz and 5 GHz unlicensed bands, and the 700 MHz band.

Four aspects of this development are important for transportation agencies:

1) These bands can support broadband operation (i.e., high-speed data transmission).
2) The associated technologies are portable and can establish communications without being constrained by physical infrastructure, such as cables.
3) Broadband wireless equipment and the applications they support have proliferated, subsequently reducing deployment costs.

4) The 2.4 and 5 GHz allocations are approved for license-free operation (no FCC license required). This significantly reduces recurring costs.

The FCC is taking steps to foster a nationwide interoperable public safety band at 700MHz. The Commission has preliminarily determined not to expand access to this band beyond traditional first responders (police, fire, and emergency medical teams), but is now considering petitions from various local and regional government bodies to allow them to establish their own public safety networks in their areas on an accelerated basis, some of which would allow transportation professionals and other infrastructure providers access to this band. DOT is working with the NTIA to craft a sound policy position on this issue across the Executive Branch.

The new broadband wireless technologies can support point-to-point. point-to-multipoint, and mobile architectures. An example of point-to point communications is center-to-center communications, and an example of the point-to-multipoint is communications between multiple field devices and a hub. Some of these technologies are capable of supporting multiple video signals, telephone service, Internet access, local area networks, and other data exchanges over a single link.

In addition to the many technologies for providing raw connectivity, new devices can be used to integrate voice, data, and video services. These are called multi-service access devices (MSAD) or integrated service devices. A variety of information sources can be accommodated by MSAD for a wireless link. This equipment makes a telecommunications facility much more flexible by supporting a variety of services. It also makes the provision of many services much simpler and cheaper.

Inland (Terrestrial) Nationwide Differential GPS (NDGPS)

The Secretary of Transportation has authority under PL 105-66, § 346 to implement the Nationwide Differential GPS (NDGPS) service in support of surface transportation and other terrestrial civil positioning and navigation missions. RITA is currently acting as the lead agency for this function; operations are provided by the United States Coast Guard (USCG) under a Memorandum of Agreement (MOA) in a coordinated fashion with the USCG-provided Maritime DGPS. Maritime and Inland DGPS systems are managed as a combined national differential GPS utility.

The NDGPS service augments GPS by providing increased accuracy and integrity using land-based reference stations to transmit correction messages over radiobeacon frequencies from local beacons. The service has been implemented through agreements between multiple Federal agencies including the USCG, DOT, and USACE, as well as several states, and scientific organizations, all cooperating to provide the combined national DGPS utility. The interagency NDGPS Policy and Implementation Team has plans to complete NDGPS system coverage throughout the lower 48 states.

The two major deployment milestones have been established as nationwide single station coverage and nationwide dual station coverage (CONUS only). Under single station coverage, predicted to occur no earlier than 2012 (pending funding availability), users anywhere within CONUS will be able to receive at least one DGPS differential correction broadcast. The second major milestone is full coverage by at least two DGPS broadcasts, is expected to occur no earlier than 2014.

In addition to providing a real-time broadcast of differential corrections, the NDGPS provides a robust operational backbone to:

1) the National Geodetic Survey's Continuously Operating Reference Stations (CORS) application for post-processing survey applications and Web-enabled location solutions. Each CORS site provides Global Navigation Satellite System carrier phase and code range

measurements in support of 3-dimensional positioning activities throughout the United States and its territories.

2) the National Weather Service's Forecast Systems Laboratory for short-term precipitation forecasts. Earth Systems Research Laboratory uses NDGPS data to estimate the amount of water vapor over the U.S. every 30 minutes to monitor rapidly changing conditions, and is used in several operational NOAA weather models. This knowledge is critical for forecasting severe weather events such as tornados, hurricanes, thunderstorms, and severe snow storms
3) NOAA's Space Weather Prediction Center for mapping the spatial distribution of free electrons in the ionosphere, once every 15 minutes. The distribution of free electrons in the ionosphere affects HF radio communication and delays the arrival of GPS signals, the Center uses NDGPS data to predict solar storms, which are proven to affect on-orbit satellite performance and transmissions, including GPS.
4) the University NAVSTAR Consortium (UNAVCO) for plate tectonic monitoring.

The NDGPS also provides an organic sensor network to the Department of Homeland Security's (DHS) GPS Interference Mitigation and Detection (IDM) program to identify, analyze, locate, attribute, and mitigate sources of interference to the GPS and its augmentations.

Where operational considerations allow, additional operational capability may be added, such as the broadcast of navigational or meteorological warnings and marine safety information to support safe navigation at sea.

The NDGPS service, when completed, will provide uniform coverage of the CONUS and portions of Hawaii and Alaska, regardless of terrain, or man-made and other surface obstructions. This coverage is achieved by using a medium frequency broadcast optimized for surface applications. The broadcast has been demonstrated to be sufficiently robust to work throughout mountain ranges, difficult terrain and other obstructions. The NDGPS service will provide a highly reliable GPS integrity function to users to meet the growing requirements of surface users (transportation, precision agriculture, natural resources and environmental management, emergency management and response, and surveying and construction communities).

Today, 50 USCG and 9 USACE broadcast sites make up the MDGPS, and provide coastal coverage of the continental U.S. (CONUS), the Great Lakes, Puerto Rico, portions of Alaska and Hawaii, and portions of the Mississippi River Basin. DOT sponsors 29 sites in the inland portion of the NDGPS program providing signal coverage over inland surface areas of the U.S. to meet the growing requirements of terrestrial users. The NDGPS network provides single coverage over 92 percent and dual coverage over 65 percent of CONUS.

High Accuracy (HA) NDGPS

The HA-NDGPS research prototyping effort is sponsored by DOT to enhance the performance of NDGPS. The first HA-NDGPS station began broadcasting in a test mode in 2001 with funding from the Interagency GPS Executive Board (IGEB). IGEB recognized the potential benefit to many Federal agencies, states, and the general public of having a nationwide high accuracy system. Two HA-NDGPS reference stations are currently operational and providing 10 to 15 cm accuracy throughout the coverage area. Further improvements to accuracy and the development of 1 to 2 second time-to-alarm integrity are anticipated. Once these improvements are complete, a HA-NDGPS standard will be developed. HA-NDGPS engineering documentation and systems requirements are being developed by DOT and the USCG. A decision on HA-NDGPS system investment and deployment may be made after the USCG requirements definition and prototyping process is complete, and data from the prototyping phase analyzed.

Maritime Domain

Spectrum Plans covering Inland-Waterway, Coastal and Oceanic Transportation

Maritime Administration (MARAD)

Introduction, agency missions and agency strategic vision for spectrum management

The Maritime Administration's mission is to strengthen the U.S. maritime transportation system, including infrastructure, industry, and labor, to meet the economic and security needs of the Nation. The U.S. water transportation industry serves the needs of both foreign and domestic commerce. It comprises companies that carry freight or passengers on the open seas or inland waterways, offer towing services, charter vessels, and operate canals and terminals. MARAD does not directly manage spectrum but is a user of available spectrum similar to the users of the marine transportation system: maritime radionavigation, maritime safety and security, and personal mobile communications.

Saint Lawrence Seaway Development Corporation (SLSDC)

Agency Missions and Strategic Vision for Spectrum Management

Spectrum is necessary for maintaining the St. Lawrence Seaway System as one of the world's most comprehensive inland navigation systems. Following years of construction and intergovernmental cooperation between the United States and Canada, the system of channels, locks, and hydroelectric power stations that comprise the Seaway opened in 1959. The Seaway is a critical transportation link that connects the markets and manufacturing, mining, and agricultural producers of the upper Midwest and Canada to each other and to the Atlantic.

Management of the Seaway is shared by and coordinated between the United States and Canada, through the Saint Lawrence Seaway Development Corporation (SLSDC) for the United States and the St. Lawrence Seaway Management Corporation (SLSMC) for Canada. In the broadest terms, SLSDC is responsible for the operations and maintenance of the U.S. portion of the Seaway between Montréal and Lake Ontario. More specifically, the SLSDC's statutory obligations extend to vessel traffic control and management in areas of the St. Lawrence River and Lake Ontario, maintaining and operating surveillance and communications systems, locks, and navigation aids. SLSDC has authority to prescribe that specific communications, navigation, and other electronic equipment be installed aboard ships transiting the Seaway and prescribe their use in the interests of safety pursuant to the Ports and Waterways Safety Act.

Current Spectrum Use for Agency Systems Using Federal Agency or *shared spectrum*

The Seaway Automatic Identification System (AIS): 162.025 MHz and 161.975 MHz

SLSDC and SLSMC have long employed a Vessel Traffic Services (VTS) system to monitor the progress of commercial maritime traffic and thereby help to ensure thousands of safe and expeditious passages through the Seaway annually. In the mid·1990s, SLSDC and SLSMC began to sponsor the development of a GPS-based VTS system using AIS at its core. AIS is a shipboard broadcast transponder system operating in the VHF maritime band that is capable of sending and receiving ship information, such as identification, position, heading, speed, ship length, beam, type, draft, and hazardous cargo information, to other ships and to shore.

In 1999, SLSDC and SLSMC erected nine transmission stations along the Seaway, from Montreal to Lake Erie. In 2003, SLSDC and SLSMC amended their joint regulations to mandate use of AIS in Seaway waters from Saint-Lambert, Québec, to Long Point Ontario (Mid-Lake Erie), effective at the beginning of the 2003 Navigation Season.

The Seaway AIS system supports and is vital to the SLSDC's responsibilities for maritime safety and homeland security. Since 2003, all vessel control centers in the Seaway share a common electronic vessel information database. The Seaway AIS system operates using two channels, 87B and 88B. NTIA has provided the SLSDC frequency assignments for both channels. In addition, the Canadian government (through Industry Canada) has also assigned the use of Channels 88B and

87B for the SLSMC's operation of the Canadian portion of the Seaway AIS. The SLSDC and SLSMC AIS operation is thus an international, unified system.

The International Maritime Organization (IMO), an international agency of the United Nations established to promote marine safety, has designated AIS as a primary means of avoiding ship collisions, especially during inclement weather when shipboard radar can be impaired. The IMO requirements provide for vessels to carry AIS equipment and have also designated Channels 87B and 88B as the international maritime AIS frequencies. VHF Channel 88B (162.025MHz) has been designated AIS 2, and VHF Channel 87B (161.975 MHz) has been designated AIS 1 by Appendix 18 of the ITU-R Radio Regulations, for universal shipborne AIS purposes. In 2001, the International Electrotechnical Commission (IEC) also adopted AIS standards, which the SLSDC and SLSMC systems meet.

Since September 11**,** 2001, AIS has been recognized as an important tool for maritime domain awareness, a critical component for homeland security. As a result, Federal law expanded the AIS carriage requirement for security purposes, effectively making it applicable domestically. The Seaway AIS is fully consistent with the Maritime Transportation Security Act of 2002, which requires that certain passenger vessels and other ships carry AIS equipment within the navigable waters of the United States consistent with the IMO requirements.

Vessel Traffic Centers, operated by the SLSDC and SLSMC, closely scrutinize the movement of all vessels designated as homeland security concerns. The SLSDC and SLSMC also monitor so-called “high interest vessels” (HIVs) like fuel tankers, hazardous-cargo ships, and passenger vessels. Should it become necessary, security information about HIVs may be transmitted through AIS rather than communicated via voice radio transmissions, which are more susceptible to interception.

Other Spectrum Needs

SLSDC utilizes radio frequencies for many other operations and maintenance activities. Frequencies are used by the Office of Lock Operations and Marine Services for maintaining *voice* communications with vessels transiting the Seaway, for transmitting weather and visibility information from stations along the river*,* for aids to navigation (i.e., racons), for sharing traffic management data with SLSMC via microwave links, and for hydrographic surveying operations. The Office of Maintenance utilizes various frequencies to maintain voice communications between work crews.

Future Planned or Anticipated Use of Commercial Spectrum-Dependent Licensed Systems

Projects/issues that would require the use of additional frequencies in the future could include the following: secure (i.e., encrypted voice*)* communications for use during national and/or international crises; and secure/encrypted communications for use by law enforcement vessels not using AIS.

Aviation Domain

Spectrum Plans Covering Aviation & Space Transportation

FAA 2009 Radio Frequency Spectrum Plan

I. Introduction, agency missions and agency strategic visions for spectrum management

Overview of 2009 Radio Spectrum Plan: This 2009 revision of the Radio Spectrum Plan provides an update on communications, navigation, and surveillance services spectrum requirements, looking ahead to the 2018 and beyond time-period. This spectrum plan is a support element in the FAA's planning documents including Next Generation Air Transportation System (NextGen) Implementation Plan 2009, Capital Investment Plan (CIP) for Fiscal Years 2009 - 2013, National Airspace System (NAS) Architecture (presently Version 6), Flight Plan 2009-2013 and Joint Planning and Development Office (JPDO) Concept of Operations for the NextGen. In addition, it is consistent with the 2008 Federal Radionavigation Plan. New requirements for communications, navigation, and surveillance systems will continue to be addressed as they surface.

FAA Mission: The Federal Aviation Administration's (FAA) mission is to provide the safest, most efficient air transportation system in the world; and the FAA vision is to improve the safety and efficiency of the airspace system, while being responsive to its customers and accountable to the public.

The FAA is responsible for providing the national airspace infrastructure by operating the NAS to support the nation's air operations within the United States and certain oceanic areas. This responsibility extends from air traffic control, system security, and safety to international coordination. The FAA is charged with the responsibility of serving the flying public, 24 hours a day, 365 days a year. The FAA also provides a service supporting national security by providing air traffic control and vital information to Department of Defense (DOD) and law enforcement aircraft.

A key resource for providing these critical safety services to the aviation community is the continuing availability of sufficient radio spectrum to support the air traffic control system. Spectrum integrity and aviation safety are inextricably linked. International spectrum use harmonization is necessary to ensure worldwide seamless safe air travel. Thus, the FAA spectrum utilization is harmonized through the International Civil Aviation Organization (ICAO, a United Nations organization). The FAA, sometimes in conjunction with the National Aeronautics and Space Administration (NASA), conducts extensive research aimed at modernizing the systems used to support the NAS.

The FAA utilization of interference-free spectrum is crucial to the safe operation of the NAS. The use of spectrum falls primarily into the following four main functions:

1) Pilot-controller communications, supported by, for example, the air/ground (A/G) voice and data communications system operating in the 118-137 MHz band;
2) Aeronautical radionavigation, supported by, for example, the instrument landing system (ILS) operating in the 108-112 MHz band and the Global Positioning System (GPS) operating in the 1215-1260 MHz and the 1559-1610 MHz bands;
3) Aeronautical surveillance, supported by, for example, the long-range air traffic surveillance radars in the 1215-1390 MHz band; and
4) Critical aviation support, supported by, for example, data links for weather sensors in the 162-174 MHz and 406.1-420 MHz bands.

Air-Ground Communications: The FAA uses HF, VHF, UHF, and satellite-based systems for two-way controller to pilot communications. The 2-23 MHz High Frequency (HF) band is used for

A/G communications in oceanic and Alaskan airspace where direct VHF A/G communications is not available. The 118-137 MHz VHF band is used to provide direct pilot-air traffic controller communications nationwide and for other air traffic services (ATS) communications. According to the FAA's NextGen Plan, the currently used controller to pilot air traffic communications system for air traffic control (ATC) purposes in this VHF band will be replaced by a future mixed system of voice and data. To accommodate the future ATC data communications requirements, the FAA is developing a frequency plan within the VHF band to support both voice and data communications requirements. Phase I of the data communications plan will more than likely utilize the 136 MHz to 136.475 MHz portion of the band. Therefore, the FAA will not be making any new assignments for ATC voice communications requirements above 136 MHz.

To support the operations of DOD aircraft in the NAS, portions of the 225 – 400 MHz band are used.

The 1545-1559 MHz, 1610-1626.5 MHz, and the 1646.5-1660.5 MHz bands are used to support air-ground voice and data communications, and automatic dependent surveillance (ADS), via satellite systems in oceanic and remote locations. It is recognized that, while the 2483.5-2500 MHz band is a non-Government band, it is potentially useful for leased satellite communications services.

Aeronautical Radionavigation: The FAA operates numerous aeronautical radionavigation systems in 12 frequency bands. The Instrument Landing System (ILS) uses the 74.8-75.2 MHz, 108.0-111.95 MHz, and 328.6-335.4 MHz bands. The Non-Directional Beacon (NDB) system operates in the 190-435 kHz and 510-535 kHz bands. The VHF Omni-Range (VOR) system uses the 108.0-117.975 MHz band, and the Distance Measurement Equipment/Tactical Air Navigation (DME/TACAN) systems operate in the 960-1215 MHz band. The Microwave Landing System (MLS) operates in the 5000-5250 MHz band.

One of the key elements of the NextGen Plan is to transition the existing ground-based navigation systems to satellite-based systems. Accordingly, a number of FAA planned future systems will be GPS based; the GPS service links use the 1215-1260 MHz and the 1559-1610 MHz bands. The frequency 1176.45 MHz is being developed for future use as a third civil GPS frequency called L-5.

The 9.2-10 GHz and 34.7-35.2 GHz bands are being considered for airborne enhanced vision systems for precision landing systems in low-visibility conditions.

Aeronautical Surveillance: The FAA uses a number of radars for aeronautical surveillance functions. The band 1215-1390 MHz is used for long-range en-route radars, most of which are joint DOD/FAA radars; the band 2700-2900 MHz is used for terminal surveillance and 2700-3000 MHz for weather radars. Frequency channels centered at 1030 MHz and 1090 MHz are used for the Air Traffic Control Radar Beacon System (ATCRBS), also known as the Secondary Surveillance Radar (SSR). The NextGen Plan focuses on transitioning from the current ground-based surveillance systems to satellite-based Automatic Dependent Surveillance (ADS) using GPS.

The band 5600-5650 MHz is used for Terminal Doppler Weather Radars (TDWR). The 9300-9500 MHz and 13.25-13.4 GHz bands are used for airborne weather navigation radars.

The new Airport Surface Detection Equipment (ASDE) version X operates in the 9000-9200 MHz band. Other versions of the ASDE system operate in the band 15.7-16.2 GHz.

In addition, 5091-5150 MHz is expected to be needed for future airport surveillance functions; this band is currently an expansion band for MLS.

Critical Aviation Support: The FAA operates numerous aviation support systems in nine frequency bands to provide voice and data link communications between various FAA facilities. For example, the band 7125-8500 MHz is used for microwave communications links between the FAA surveillance radar sites and associated air traffic control center facilities, the bands 162-174/406.1-420 MHz are used for FAA's land mobile/fixed radios as well as for data links between weather sensors and associated air traffic control towers and the band 2-22 MHz is used for the FAA's NAS Recovery Communications System (RCOM).

FAA Office of Commercial Space Transportation (AST): In addition to the other spectrum functions highlighted above, the FAA also provides spectrum support for the mission of AST, whose roles are to ensure the protection of personnel and property, foster the national security and foreign policy interests of the United States in the event of a commercial launch or reentry activity, and encourage, facilitate, and promote U.S. commercial space transportation. The availability of radio spectrum is critical to commercial space industry for many telecommunications services, ranging from air and space traffic control, to communications and telemetry, and radio navigation. The commercial space industry uses the existing rocket launch facilities operated by U.S. military agencies. The systems used for range safety, telemetry, and radar tracking operate on frequencies assigned to the military agencies.

II. Current Spectrum Use (Changes since 2007 Agency Plan Submission) for Federal agency systems using Federal-agency or shared spectrum allocations

A.1 Function of System – VHF Air-Ground Communications

The A/G safety communications element (Air Traffic Service (ATS) communications) is provided in the NAS through the use of very high frequency (VHF) spectrum resources within the 118-137 MHz band. The 118-137 MHz frequency band has been used for many years to satisfy the ever-increasing ATS A/G voice communication requirements in the NAS. (For clarification, it should be noted that ATS communications, i.e., safety communications, are sometimes informally called air traffic control (ATC) communications, even though the requirements extend beyond ATC usage, to such communications as weather broadcasts.) However, while a new system, providing increased communications capacity and data link communications, has been pursued for over ten years, the burden still lies on the present VHF voice system to continue to satisfy the ever increasing requirements until well into the post-2010 time period. New system elements are projected to begin to be implemented in the 2012 time period. To accommodate the future ATC data communications requirements, the FAA is developing a frequency plan within the VHF band to support both voice and data communications requirements. Phase I of the data communications plan will more than likely utilize the 136 MHz to 136.475 MHz portion of the band. Therefore, the FAA will not be making any new assignments for ATC voice communications requirements above 136 MHz.

B.1 Mission(s) and program(s) supported

A/G VHF communications systems in the 118-137 MHz band are implemented to satisfy aeronautical safety communications requirements, which include ATS and Aeronautical Operational Control (AOC) communications. Also satisfied in this band are such communications as Unicom/Multicom, Flight Inspection, and Flight Test. In addition, in the specific band segment allotted in the United States for AOC communications (128.8-132 MHz), non-safety Aeronautical Administrative Communications (AAC) data link communications are permitted on a non-interference basis.

C.1 User community

The user community in the United States (U.S.) consists of commercial, business, and general aviation users, and foreign civil aircraft flying into and out of the United States. In addition, the user community includes DOD and other Government aircraft utilizing the NAS.

D.1 Geographical coverage (US&P, specified areas within US&P or outside US&P)

Coverage includes the United States and possessions (US&P), and adjacent oceanic areas extending to over 100 nautical miles from the shore in many locations. However, it should be noted that in Alaska and in other geographic areas there are locations where it is impossible, or very difficult, to geographically locate communications facilities (e.g., areas with extensive mountains, areas with no commercial power, etc.); in such areas VHF A/G communications service may not be available.

E.1 Technical Parameters of System (bandwidth, frequencies, etc.)

VHF A/G channels are spaced at 25 kHz increments (e.g., 118.500 MHz, 118.525 MHz, etc.), and utilize double-sideband amplitude modulation (DSB-AM), with an emission bandwidth of 6 kHz. It should be noted that the new VHF Digital Link Mode 2 (VDL-2) data link and the potential future system VDL Mode 3 (VDL-3) have emission bandwidths of 14 kHz.

F.1 Current use of new technologies and other efforts to improve spectrum efficiency

The FAA has continued to develop and implement ATS A/G data link applications in the NAS, which uses existing communications technologies utilized for AOC communications; this includes the prospect of an early use of VDL-2. Currently, the FAA is utilizing a leased data link service within the 118-137 MHz band to provide these new ATS data link applications. This data link service, implemented and operated by an AOC communications service provider, is nominally used heavily and predominately by the commercial airlines for AOC and AAC communications.

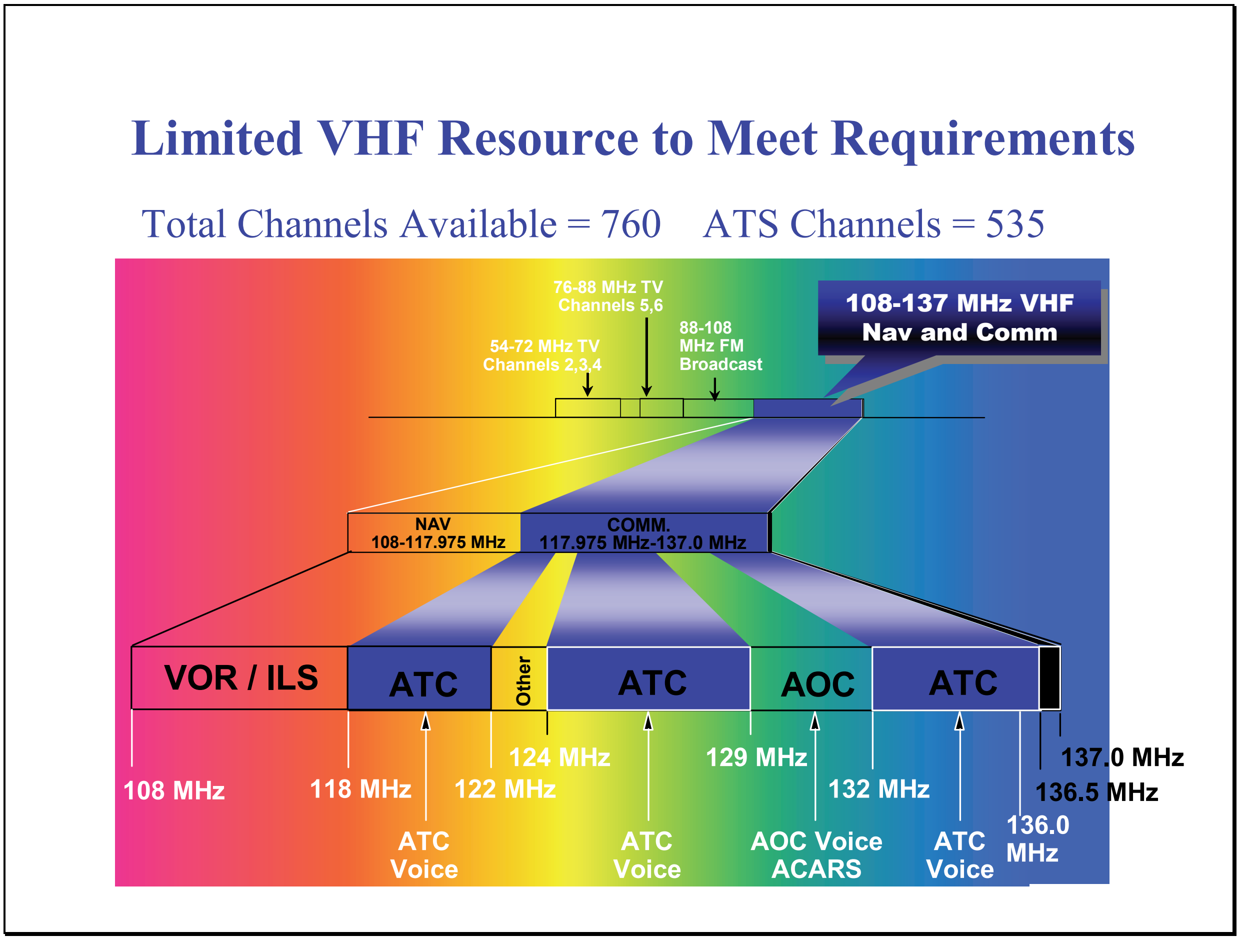
It should also be noted that the new ground radios currently being deployed in the NAS are capable of: (1) operating across the 112-118 MHz band segment (initiatives have been undertaken to determine if some portion of this band segment could be used to help satisfy VHF A/G communication requirements – this aspect is highlighted later in this document), (2) operating in the VDL-3 mode, and (3) operating in the 8.33 kHz DSB-AM mode (these capabilities have been added should it be found to be desirable to implement these ICAO standards in the NAS).

G.1 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

Several channels are allotted to a few Federal agencies for such uses as security. A segment of the 118-137 MHz band (128.8-132 MHz and 136.5-136.975 MHz) is used by the airlines to satisfy AOC and AAC communications. Other channels in the frequency band plan are used by pilots and non-Federal ground-based users to satisfy safety communication requirements around small airports. In addition, non-Federal users, such as non-Federal ATC towers, have licenses to satisfy safety communications requirements.

Figure 1 below provides a pictorial view of how the 118-137 MHz band is split up within the United States, showing that of the 760 (25 kHz) channels available in the band, only 535 are available for ATS. The remainder is used for AOC, general aviation, flight-testing, etc. In addition, some of the 535 channels are used for such purposes as coordinating fire fighting, supporting air shows, and providing for dedicated DOD channels; one channels is used by the Department of Homeland Security (DHS) for national security and border patrol purposes; and one channel is used by the Department of Justice (DOJ) to support U.S. Air Marshall services and prisoner transport. It should be noted that two further ATS channels above 136.0 MHz have been assigned nationally, until 2011, for A/G data services under the Flight Information Service – Data Link (FISDL) program.

Figure 1



H.1 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

Due to the large distances over which aircraft are able to receive A/G communications from ground sites (and vice versa), it is difficult to reuse frequencies and coordinate frequency usage with adjacent states (including specifically Canada and Mexico). However, established International Treaties, through the U.S. State Department with these states help to alleviate frequency coordination to the extent possible.

I.1 Whether system is used for Continuity of Operations (COOP) or Continuity of Government (COG) activities

Not applicable.

J.1 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

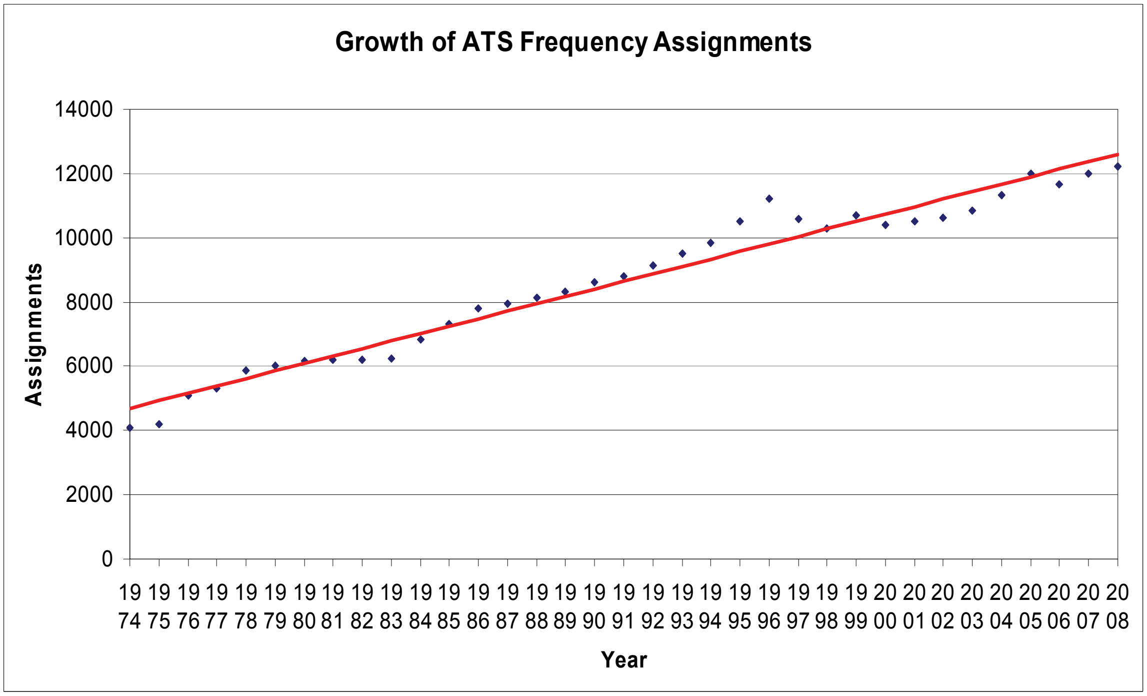
The unexpected delay in implementing a new VHF A/G voice and data link system has caused severe frequency assignment congestion to occur in some areas of the Continental United States (CONUS), requiring the FAA to develop a number of engineering and policy initiatives.

In 1995, ICAO adopted the Next Generation Air-to-Ground Communications (NEXCOM) concept. NEXCOM, utilizing the VHF digital link mode 3 (VDL-3) design, was an all-digital 25 kHz Time Division Multiple Access (TDMA) system providing four independent voice and/or data link circuits on each 25 kHz RF channel. The four circuits could be any mix of voice and/or data link circuits. It was previously estimated that the NEXCOM would be implemented and used to satisfy new requirements in the 2010 time period. However, the FAA NEXCOM program has been deferred and it is presently projected that new system elements will not begin to be implemented until 2012. The new system elements are likely to be a combination of 8.33 KHz and VHF digital link mode 2 (VDL-2) which was originally designed for and adopted by ICAO for AOC.

The FAA is continuing to work on the development of a roadmap for future aeronautical mobile communications as part of a joint European Organization for the Safety of Air Navigation (EUROCONTROL)/FAA/NASA Future Communications Study, which is aimed at recommending a future system. Adopting a new all-digital system would require replacement of all FAA and aircraft radios, voice switching equipment, and upgrading the ground-based infrastructure. The transition would be a major undertaking, and would require huge amounts of human and capital resources. Moving to an all-digital technology would require a transition period during which both the current DSB-AM and the digital system would operate simultaneously in the NAS.

The growth of VHF ATS frequency assignments, in response to ever-increasing requirements, has been quite linear over the past 25 years. Figure 2 below shows that the average increase has been about 240 frequency assignments a year since the early seventies.

Figure 2



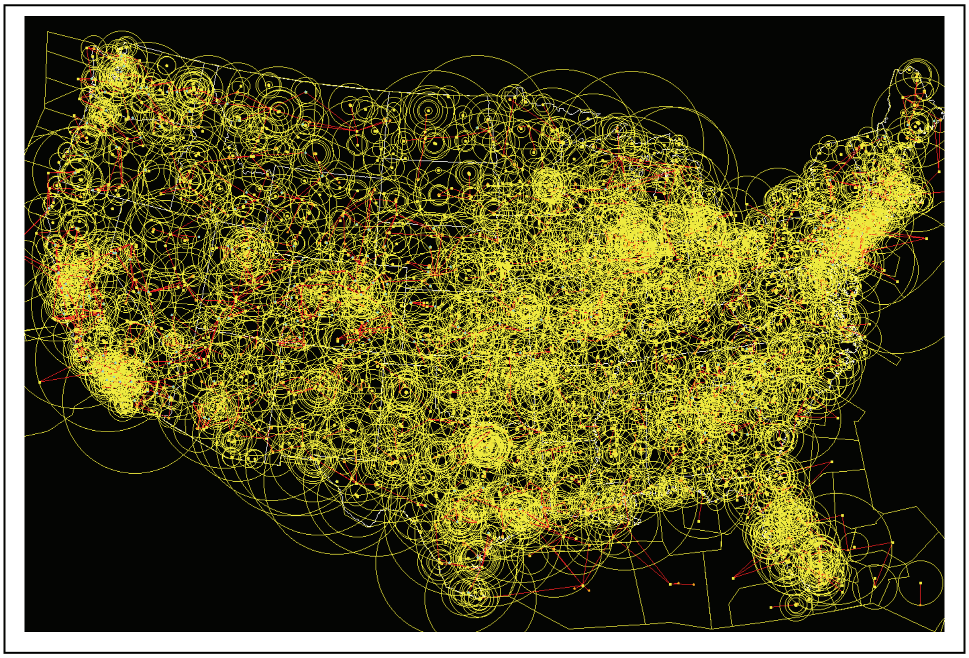
Average Growth Approximately 240 Per Year

By the year 2000, it had become difficult to satisfy the increasing VHF ATS A/G voice communications frequency assignment requirements. Consequently, the FAA undertook a broad, systematic study late that year to ensure that new ATS A/G communications requirements could be satisfied until (at that time) 2010 by extending the life of the present system. At that time, as highlighted above, new system elements were expected to be available to satisfy new requirements in the post-2010 time period. The study effort resulted in the identification of 25 improvement measures, which have been implemented or are being pursued within the FAA and through coordination with concerned United States Government and non-Government agencies.

Based on available information, the FAA believes that the present VHF A/G communications system will be able to support the efficient operation of the NAS until 2015 (a revised date for the early implementation of new system elements has been projected for 2012), assuming that the improvement measures can be implemented and action continues to be taken to conserve spectrum resources. The spectrum resources available to satisfy future requirements include the potential gain to be obtained from the 25 improvement measures and the significant spectrum resources available in many geographic areas (above and beyond that to be gained from the improvement measures), especially those outside of areas experiencing severe frequency congestion.

Figure 3

Geographic VHF A/G Frequency Assignment Congestion



A snapshot of the VHF A/G assignments in the CONUS is presented in Figure 3. Only 80% of the frequency assignments are pictured, since if all assignments were depicted, the entire CONUS would be one massive blob of highlighting.

From the pictorial, frequency congested areas include, but are not limited to:

- The corridors from New York City to Chicago and New York City to Washington, District of Columbia.
- Most of Florida
- Dallas/Ft. Worth and vicinity, and
- Southern California

It should also be noted that radio frequency interference (RFI) is a major factor in the operation of the VHF A/G system. Challenges include, but are not limited to:

- Analog crystal RFI on 60 Hz on frequency 120.0 MHz, thus making 120.0 MHz almost unusable,
- On airport congestion and potential RFI to or from Aeronautical Radio, Incorporated (ARINC) operations
- High Powered Frequency Modulation (FM) and TV Broadcast stations
- Illegal power amplifiers from citizen's band (CB) radios
- Illegal high power cordless phones
- Un-coordinated frequencies in the VHF A/G frequency band (118 – 137 MHz)
- Coordinated co-location use of FAA physical site facilities to support other non-ATC services (e.g., National Defense Program (NDP) and Customs and Border Patrol (CBP))

A.2 Function of System – Ultra High Frequency (UHF) Air-Ground Voice Communications

Provides ATS voice communication within the DOD controlled 225-399.9 MHz band (excluding 326.6-335.4 MHz) for military aircraft.

B.2 Mission(s) and program(s) supported

Parallels most VHF A/G missions and programs by providing voice communications to military aircraft.

C.2 User community

Military aircraft only.

D.2 Geographical coverage (US&P, specified areas within US&P or outside US&P)

Specified areas within the US&P.

E.2 Technical Parameters of System (bandwidth, frequencies, etc.)

The frequency assignments are 6 kHz in bandwidth, with a transmitted power between 10 and 50 watts. Frequencies are special channels assigned by the military for ATS functions within the 225-399.9 MHz band. Overall, there are 471 channels with 25 kHz spacing allocated for ATS.

F.2 Current use of new technologies and other efforts to improve spectrum efficiency

None at this time.

G.2 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

The 225-399.9 MHz (minus the 326.6-335.4 MHz Glide Slope band) is controlled by DOD. Many of the FAA assignments are for ATS functions, although the military and non-government users also have licenses for the same purpose. In addition, the FAA does support a few assignments for special military non-ATS functions (range control, etc.).

H.2 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

In accordance with the U.S.-Mexican Border Zone Sharing Protocol for 380-399.9 MHz, the FAA must migrate off several UHF A/G assignments above 380 MHz. The protocol divides the band into four segments between the U.S. and Mexico, limiting their use within 90 nautical miles of the common border based upon land mobile usage. However, for aeronautical operations, the distance is much greater due to radio line-of-sight between high altitude aircraft and the border.

I.2 Whether system is used for COOP or COG activities

N/A

J.2 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

A major challenge is to ensure that both the FAA and DOD users comply with the military channel plan and its guidelines. Audits have been performed by both agencies to identify non-compliant usage and migrate to proper allocations.

Ensuring compliance with the U.S.-Mexican border agreement for 380-399.9 MHz is also a major challenge. The FAA is taking steps to migrate from frequencies that may cause interference with Mexican primary channels in accordance with the bilateral protocol.

It is also difficult to ensure proper separation between ATS frequencies and adjacent channel non-ATS military functions. The FAA is making the DOD aware of assignments that may conflict with the FAA's adjacent channel separation criteria, especially for military land mobile and wideband operations.

A.3 Function of System – HF Air-Ground Communications

The functions of HF communications within the 2–30 MHz by the FAA are (1) to provide trans-oceanic A/G ATS communications to aircraft flying established flight routes, and (2) to provide communications to support the FAA's NAS Recovery Communications System (RCOM).

B.3 Mission(s) and program(s) supported

The aeronautical stations provide safety of flight communications to aircraft operating outside of VHF communication coverage—primarily the oceanic regions. ARINC has been contracted by the FAA to provide this service in those portions of the HF frequency band 2-30 MHz allocated for the Aeronautical Mobile (Route) Service (AM(R)S). RCOM operates on 29 frequencies throughout the 2-30 MHz frequency band at over 40 FAA facilities located throughout the US&P. Weekly tests are conducted on this network to ensure that personnel are trained to communicate in times of emergencies.

C.3 User community

The user community of the aeronautical stations and aircraft transiting outside of VHF coverage, include the major airlines, business aviation, and high-end general aviation. The FAA is the user community of the RCOM; however, frequencies for RCOM are also being shared with the nation's Shared Resources High Frequency Radio Program (SHARES) network (the FAA participates in the SHARES network).

D.3 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See B.3 above.

E.3 Technical Parameters of System (bandwidth, frequencies, etc.)

The bandwidth of both the aeronautical station and RCOM is 2.8 kHz. Typical transmit power is 1 kW. Both systems use voice and data. The aeronautical stations use ICAO standardized voice and

HF Data Link (HFDL) system designs. RCOM uses Automatic Link Establishment (ALE) technology.

F.3 Current use of new technologies and other efforts to improve spectrum efficiency

HFDL and ALE referred to in E.3 above are two technologies being used to improve spectrum utilization efficiency. Additionally, there is a draft plan that may reduce the number of RCOM sites to approximately 15 stations.

G.3 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

The HF aeronautical stations provide service to all aircraft transiting the oceans, whether that be state (including military), commercial, business, or private. In addition to providing emergency communications services to the FAA, the RCOM also participates in and has contributed spectrum to the federal/non-federal SHARES network.

H.3 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

Appendix 27 of the International Telecommunications Union (ITU) Radio Regulations governs the use of the AM(R)S frequencies used by aeronautical stations. Other established procedures help to alleviate frequency usage coordination problems to the extent possible.

I.3 Whether system is used for COOP or COG activities

The RCOM is used for COOP activities.

J.3 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

Both the FAA's aeronautical stations and the RCOM are established systems with valid frequency assignments to support both functions. The HF spectrum is very congested, however, and constant coordination is required to ensure that other agencies requirements do not interfere with existing FAA operations. Additionally, while the propagation characteristics of the HF frequency spectrum enable very long distance communications, this dramatically limits where a frequency can be reused. ALE and HFDL are two technologies the FAA is using to address these problems, as well as reducing the number of RCOM stations.

A.4 Function of System – Satellite (AMS(R)S) Communications

Aeronautical Mobile Satellite (Route) Communications (AMS(R)S) allows aircraft to be able to communicate directly (via satellite) to the ground (and vice versa) from oceanic and other remote areas in a manner analogous to air-ground VHF communications.

B.4 Mission(s) and program(s) supported

AMS(R)S communications is used to satisfy ATS and AOC voice and data link air-ground communications requirements, for those so equipped. In certain portions of the mobile satellite service bands, ATS and AOC communications have priority (and pre-emptive access if needed) over non-safety AAC communications and Aeronautical Passenger Communications (APC), which can also be provided within the same system.

C.4 User community

Largely commercial and business aircraft, and high-end general aviation aircraft.

D.4 Geographical coverage (US&P, specified areas within US&P or outside US&P)

Largely outside the US&P (in particular oceanic areas).

E.4 Technical Parameters of System (bandwidth, frequencies, etc.)

Consistent with ICAO AMS(R)S standards and recommended practices (SARPs), the specific frequencies used for the service is coordinated by the satellite service providers. Satellite feeder link frequencies are used for the ground-to-satellite and satellite-to-ground links. The aircraft-to-satellite and satellite-to-aircraft links are provided within the 1646.5 to 1660.5 MHz and 1545-1559 MHz respectively for the geostationary satellite service. Non-geostationary satellite services utilize the 1610-1626.5 MHz and 2483.5-2500 MHz band segments.

F.4 Current use of new technologies and other efforts to improve spectrum efficiency

None at this time.

G.4 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

These services are provided by private vendors (the International Maritime Satellite Organization (Inmarsat), Iridium, etc.).

H.4 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

The major challenges relate to the sharing of a very limited amount of spectrum among a number of satellite system providers. The system providers coordinate with a number of states (nations) to obtain the necessary authorization to operate their systems.

I.4 Whether system is used for COOP or COG activities

Yes.

J.4 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

No major issues. However, the FAA does review the specifications of new equipment, which is being designed to operate in the 1.5/1.6 GHz bands to ensure the emissions will not interfere with the GPS civil signal (L1).

A.5 Function of System – Support Communications

To provide voice and data link communications between various FAA aviation-related facilities. The functions include air traffic control communications, weather information, radar data, navigational aid data and control signals and emergency communications. The systems used include VHF/UHF land mobile/fixed FM, microwave, HF, and satellite communications systems.

B.5 Mission(s) and program(s) supported

These systems support a wide variety of NAS missions. In many cases, these support communications are used in lieu of Telco landlines where they are not available, impractical, do not satisfy the requirements, or too expensive. In some systems, they are an inherent part of a system design, which provides a specific function in a point-to-point or point-to-multipoint layout. Examples include the Automated Weather Observation Systems (AWOS) and other variants - such as the Automated Surface Observing System (ASOS) and the Stand Alone Weather Sensing (SAWS) system that have up to 14 sensors that measure weather data. These systems feed data directly to air traffic control facilities and support automated broadcast of weather information to pilots. The Automated Weather Observation Data Acquisition System (ADAS) is a radio link that transmits AWOS/ASOS/SAWS data to air traffic facilities.

Another example of critical mission provided is the FAA's NAS Recovery Communications (RCOM), which provides an emergency communications network using high frequency and very high frequency radios and satellite communications. RCOM also provides secure communications equipment for voice and facsimile messages and mobile communications devices for short-range communications.

C.5 User community

The FAA in support of the NAS, client airports and major and/or remote FAA facilities (Air Route Traffic Control Centers, Remote Radio Communication Facilities, various radar sites, etc).

D.5 Geographical coverage (US&P, specified areas within US&P or outside US&P)

Specified areas within US&P.

E.5 Technical Parameters of System (bandwidth, frequencies, etc.)

The support systems operate in a variety of bands, including 2-30 MHz, 162-174 MHz, 406.1-420 MHz, 932-935/941-944 MHz, 1755-1850 MHz, 7125-8500 MHz, 14.5-15.2 GHz, and 21.2-23.6 GHz. The bandwidths are 2.8 KHz in the 2-30 MHz band; and 16 kHz, 11 kHz, and 8.1 kHz in the 162-174 MHz and 406.1 MHz band segments. (The FAA is currently narrow-banding its FM LMR/fixed radios and is planning to complete this effort as quickly as possible subject to the availability of funds as required by U.S. law to satisfy National Telecommunications and Information Administration (NTIA) standards.) The support systems operating in the microwave bands have bandwidths that vary from 50 kHz to 30 MHz.

F.5 Current use of new technologies and other efforts to improve spectrum efficiency

Work is proceeding to reach compliance with the NTIA narrowband rules for 162-174 MHz and 406.1-420 MHz as quickly as possible subject to the availability of funds as required by U.S. law.

G.5 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

The above-mentioned frequency bands are controlled by the NTIA and shared with other government agencies. No major FAA support systems are shared with other agencies.

H.5 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

Challenges include adherence to the U.S.-Mexican border zone protocol for 406.1-420 MHz. In addition, there is heavy frequency usage congestion along U.S.-Canadian border.

I.5 Whether system is used for COOP or COG activities

Yes.

J.5 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

The challenges include the following:

Frequency assignment and usage congestion in highly populated, urban areas, and along the Canadian border zone region.

Lack of readily available, inexpensive radio equipment for intermediate sized operations (between 200 kHz and 1.5 MHz of bandwidth usage). Most FM land mobile/fixed radios are limited to 12.5 kHz bandwidth usage, which limits the capacity that can be provided with these radios. Other fixed microwave radios require equipment configurations that are too large for most modest capacity applications.

Many frequency bands have antenna requirements that, due to the size and beam width restrictions, are not practical for airport environments. For example, the 932/941 MHz bands have beam width requirements that force the use of antennas no smaller than six feet in size. The FAA has had to compromise by using half-parabolic dishes that meet the NTIA/Federal Communications Commission (FCC) standards, but are still not suitable for most installations.

A.6 Function of System – NDB System Elements

NDB signals, which operate in the 190-535 kHz range, are used by aircraft to navigate towards the location of the NDB installation. In addition, NDBs are also used as voice outlets for weather broadcasts.

B.6 Mission(s) and program(s) supported

NDBs are used for a variety of civil aviation navigational purposes, ranging from stand-alone navigational aids for short and medium distance navigation to aids to ILS installations. In each case, aircraft receivers, used in conjunction with directional antennas, are used to receive and "home in" on NDB signals, thus providing guidance to the location of the NDB installation. Many NDBs are presently also used for voice outlets for Automated Weather Observation System (AWOS), Automated Surface Observation System (ASOS), and other broadcast services. It should be noted that many NDBs are non-Federal installations, used for general aviation aircraft operations.

C.6 User community

United States commercial, business, and general aviation users, and foreign civil aircraft flying into and out of the United States. In addition, the user community includes aircraft from the DOD and other government agencies utilizing the NAS.

D.6 Geographical coverage (US&P, specified areas within US&P or outside US&P)

Coverage includes most of the United States and possessions, and adjacent oceanic areas extending offshore in many locations. However, it should be noted that in Alaska and other geographic areas there are locations where it is impossible or very difficult to locate facilities (e.g., areas with extensive mountains, areas with no commercial power, etc.); in such areas NDB services may not be available.

E.6 Technical Parameters of System (bandwidth, frequencies, etc.)

NDB channels are spaced at 100 kHz increments, and utilize DSB-AM modulation with an emission bandwidth of 1.12, 2.04, or 6 kHz.

F.6 Current use of new technologies and other efforts to improve spectrum efficiency

There is no new technology being employed to improve spectrum efficiency, and there are no other efforts being pursued.

G.6 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

A portion of the NDB spectrum, 285-325 kHz and 415-435 kHz, is shared with the Coast Guard. It should also be noted that 525-535 kHz is used by the Mobile Service and is limited to the Traveler's

Information Service (TIS), operating on a center frequency of 530 kHz. The FAA can only use this frequency on a non-interference basis to TIS.

H.6 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

It is difficult to reuse frequencies and coordinate frequency usage with adjacent states (including specifically Canada and Mexico). However, established procedures with these states help to alleviate frequency coordination to the extent possible.

I.6 Whether system is used for COOP or COG activities

Not applicable.

J.6 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

It is difficult to obtain adequate voice quality using an NDB. A contributing factor is the narrow bandwidth of the transmitting antenna, which can distort the voice signal. NDB voice is also susceptible to a significant amount of atmospheric and man-made radio frequency noise, which is inherent to the NDB frequency band. In addition, the use of voice on NDBs reduces the amount of spectrum available for NDB navigation services, since a greater bandwidth is required to provide NDB voice services. The maritime community uses radio beacons as a source for disseminating differential GPS information to users within the coverage areas of the beacons. This service is implemented in the maritime portion of the frequency band, where some FAA NDBs are implemented. The expansion of this maritime differential GPS service has required the FAA to move NDBs out of the maritime portion of the band, making it harder to engineer frequency assignments in the remaining available spectrum.

A.7 Function of System – ILS Localizer Related System Elements

The function of the ILS Localizer, which operates within the 108-112 MHz band segment, is to provide left-right guidance to aircraft during the approach and landing phases of the flight. A supporting element is the ILS Glide Slope, which operates in the 328.6-335.4 MHz band. Other supporting elements are the marker beacon, which operates in a small band centered at 75 MHz and Non Directional Beacon (NDB) operating in the 190-535 KHz band.

In addition, there is the Transponder Landing System (TLS), which is a Special Use Only (i.e., non-public use only) non-Federal system. A TLS allows one aircraft at a time to conduct precision approach operations. It will require frequency assignments on both ILS localizer and Glideslope frequency channels, as well as use of the 1030/1090 MHz SSR beacon band. Based upon inputs from a Congressionally mandated program on TLS, it is projected that only about 15 TLS systems might be implemented in the United States. To date, frequency engineering has been completed on several test bed TLS systems.

B.7 Mission(s) and program(s) supported

The ILS Localizer is a principal element of the ILS system, which is the primary civil aviation landing system in the NAS. Depending on the particular airport requirements, the ILS can be configured to operate as a Category I or Category II precision approach system, or a Category III precision landing system. The associated marker beacon operates on a single frequency channel at 75 MHz as the outer, middle, and inner marker beacons, whose purposes are to alert the pilot (via a receiver on the aircraft) of his/her progress along an ILS approach.

C.7 User community

United States commercial, business, and general aviation users, and foreign civil aircraft flying into and out of the United States. In addition, the user community includes aircraft from the DOD and other government agencies utilizing the NAS.

D.7 Geographical coverage (US&P, specified areas within US&P or outside US&P)

Coverage includes hundreds of airports and surrounding airspace (to 25 miles distance from the airport) in the United States and possessions.

E.7 Technical Parameters of System (bandwidth, frequencies, etc.)

ILS localizers operate on channel spacing of 50 kHz. The signals consist of 90 and 150 Hz tones, and a periodic identification signal, which are amplitude modulated on to the carrier. Different frequency tones are amplitude modulated onto the marker beacon transmitters, depending on the location of the marker beacon along the approach to the runway.

F.7 Current use of new technologies and other efforts to improve spectrum efficiency

A number of initiatives have been undertaken over the years to reduce ILS frequency assignment congestion. In the latter 1970s, 50 kHz channel spacing was introduced (previously 100 kHz). However, general aviation did not transition in a timely manner to the new 50 kHz spacing, and even today many general aviation users can only use 100 kHz channels. Other initiatives included reducing the standard service volume for ILS localizer coverage from 25 Nautical Miles (NM) to 18 NM, and using the same frequency (instead of separate frequencies) for "back to back" localizer assignments (i.e., for two localizers serving the opposite approaches to the same runway). The FAA also planned to implement MLS, thereby freeing up spectrum in the 108-112 MHz band segment; however, the FAA decided in the mid-1990s not to implement MLS in favor of new services supported by GPS (it should be noted that the FAA did implement a small number of MLS systems).

In the latter 1980s and 1990s, ICAO, with U.S. participation, worked extensively on the development of new FM immunity standards to help ensure that ILS localizer and VOR operations would be free from interference from FM broadcast stations. Those international standards have been in force for several years. However, the FAA has not adopted these ICAO standards, and has filed an exception to the use of the new ICAO FM immunity standards. This action was taken as a result of recommendations made by the Aviation Rulemaking Advisory Committee (ARAC), which includes Government and industry representatives. In order not to require the equipage of new receivers in the large population of general aviation aircraft, at great cost, it was decided by the ARAC to continue to protect the older radio receivers by continuing to use the criteria that already existed. Thus, the FAA continues to protect radio receivers that do not satisfy the ICAO FM immunity standards.

G.7 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

The spectrum used by the ILS Localizer systems is highly congested from a frequency assignment standpoint. As such, there is no opportunity to share this spectrum with any other entity. With regard to the very narrow Marker Beacon band, action was taken by the FCC several years ago to make this band even narrower. In addition to using this very narrow band for ILS marker beacon functions, the FAA is considering the use of the marker beacon receiver audio capability on the aircraft for runway incursion prevention. In such use, a low power marker beacon-like signal will be transmitted at key points in the runway/taxiway system to alert pilots when they are about to enter/exit certain points. Care would necessarily be exercised to ensure that such usage would not interfere with the present marker beacon function. Thus, there is no opportunity to share the marker beacon band with other entities.

H.7 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

Due to the extensive usage of the frequency band used by ILS Localizers, it is difficult to reuse frequencies and coordinate frequency usage with adjacent states (including specifically Canada and Mexico). However, established procedures with these states help to alleviate frequency coordination to the extent possible.

I.7 Whether system is used for COOP or COG activities

Not applicable.

J.7 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

Frequency assignment congestion is the number one spectrum management issue with both the ILS localizer and the VOR. This stems from the sizable number of systems that operate, or are planned to operate, in the 108-112 MHz band. The present systems operating in the band include the ILS localizer and VOR systems. The congestion stems from two aspects, the large number of service requirements and the difficulty posed by the RFI potential of nearby high power frequency FM broadcast stations operating in the adjacent 88-108 MHz band (in particular to localizers that operate in the lower, 108-112 MHz, part of the band).

Some aircraft that routinely fly into airports requiring ILS localizer operations are not equipped with 50 kHz (200 channel) receivers. Thus, it is necessary to try and find (and continue to operate) ILS localizer channels that fall on a 100 kHz center in such cases. This restriction compounds the frequency congestion situation, and sometimes limits the ability of the FAA to change channels to satisfy new nearby ILS requirements. In addition, while the ILS/VOR channelization was changed from 100 kHz to 50 kHz channels in the late 1970s, the FAA has continued to protect the operation of the many thousands of general aviation and DOD 100 kHz ILS/VOR receivers still in operation (i.e., receivers that only tune to the 100 kHz channels and have a wider, less stringent, receiver bandwidth). The protection of 100 kHz receivers has required the use of two sets of frequency assignment criteria, "interim" and "final". The less spectrum efficient "interim" criteria must still be applied to protect the 100 kHz channel assignments. The FAA will need to continue to use the criteria until most users’ transition to 50 kHz receivers.

Another factor, which increases the difficulty of engineering frequency assignments for new or modified localizer services, is requests for extended service volume (ESV) coverage. Localizer coverage areas that might have been established by very careful engineering, perhaps with changes in the service volumes or frequencies of nearby navigational aids, are nearly impossible to expand using the ESV engineering criteria.

It should also be noted that while it is the intention to initially implement Local Area Augmentation Systems (LAAS) in the NAS in the 112-118 MHz sub-band, this system capability has been standardized by ICAO to operate in the 108-118 MHz band. Thus, the possible implementation of LAAS installations by Canada and Mexico near the border areas in the 108-112 MHz sub-band could impact the present ILS localizer installations in the NAS.

As stated earlier, the FAA has been pursuing the full implementation of 50 kHz receivers, and new FM immunity requirements to be applied to ILS Localizer and VOR receivers.

A.8 Function of System – VOR System Elements

The function of the VHF VOR, which operates within the 108-118 MHz band segment, is to support terminal and enroute navigation, by providing point-to-point navigation and horizontal position location for aircraft.

B.8 Mission(s) and program(s) supported

The VOR is the principal terminal and enroute civil aviation navigation system in the NAS. Depending on the particular configuration, it can be used to provide 360-degree coverage over a radius of up to and beyond 130 miles. A single VOR receiver (in an aircraft) can be used to navigate an aircraft along any azimuth (or radial) extending to or from the location of the VOR. In addition, two VOR receivers (or one receiver sequentially tuned to two VOR signals) can be used to provide a horizontal location for the aircraft in the airspace. A single VOR receiver, used in conjunction with DME, can be used to determine the horizontal location of an aircraft at all times.

C.8 User community

United States commercial, business, and general aviation users, and foreign civil aircraft flying into and out of the United States. In addition, the user community includes aircraft from the DOD and other government agencies utilizing the NAS.

D.8 Geographical coverage (US&P, specified areas within US&P or outside US&P)

Coverage includes the United States and possessions, and adjacent oceanic areas extending to over 100 nautical miles from the shore in many locations. However, it should be noted that in Alaska and other geographic areas there are locations where it is impossible or very difficult to locate navigational aids (e.g., areas with extensive mountains, areas with no commercial power, etc.); in such areas VOR service may not be available.

E.8 Technical Parameters of System (bandwidth, frequencies, etc.)

VORs operate on channel spacing of 50 kHz. The VOR transmissions are comprised of both amplitude and frequency modulated signals. The emission bandwidth for VORs is 20.9 kHz.

F.8 Current use of new technologies and other efforts to improve spectrum efficiency

The FAA is continuing to pursue the transition to usage of 50 kHz VOR receivers. The protection of 100 kHz receivers has required the use of two sets of frequency assignment criteria, "interim" and "final". The less spectrum efficient "interim" criteria must still be applied to protect the 100 kHz channel assignments.

In the latter 1980s and 1990s, ICAO, with U.S. participation, worked extensively on the development of new FM immunity standards to help ensure that ILS localizer and VOR operations would be free from interference from FM broadcast stations. Those international standards have been in force for several years. However, the United States has not adopted these ICAO standards, and has filed an exception to the use of the new ICAO FM immunity standards. This action was taken as a result of recommendations made by the ARAC, which includes Government and industry representatives. In order not to require the equipage of new receivers in the large population of general aviation aircraft, at great cost, it was decided by the ARAC to continue to protect the older radio receivers by using the existing criteria. Thus, the FAA continues to protect radio receivers that do not satisfy the ICAO immunity requirements.

G.8 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

The spectrum used by the VOR systems is congested from a frequency assignment standpoint. In addition to VOR operations in the band, the new GPS LAAS capability is planned to operate in 112-118 MHz sub-band. Until there is a meaningful de-commissioning of VORs, it may be difficult to implement LAAS installations in this band beyond the present plan of 161 stations. Further compounding the problem, LAAS frequency assignments are being limited to below 117.2 MHz to protect the VHF A/G communications in the adjacent band (118-137 MHz) from LAAS emissions. Note that while it is the intention to implement LAAS in the NAS in the 112-118 MHz sub-band, this system capability has been standardized by ICAO to operate in the 108-118 MHz band. The possible implementation of LAAS installations by Canada and Mexico near the border areas, in the 108-112 MHz sub-band, could impact the present ILS localizer and VOR installations in the NAS. It should be noted that a few non-Federal Special (i.e., non-public use only) Category I (SCAT-1) precision approach GPS-aided systems have also been implemented in the 112-118 MHz band segment.

ICAO has also assigned the VHF Digital Link Mode 4 (VDL-4) capability to operate within the 118-137 MHz band, but operation is also allowed in the 108-118 MHz band. Because of the existing frequency assignment congestion, it would be very difficult, if not impossible, to find a channel for VDL-4 operations in the NAS. However, as a result of the Automatic Dependent Surveillance-Broadcast (ADS-B) link decision process, the FAA has decided not to implement VDL-4 in the NAS.

The FAA has also been looking at two other possible uses for the 112-118 MHz band segment: (1) there is such a pressure to find additional spectrum resources to satisfy the varied and large requirements for VHF A/G communication services (that presently operate in the 118-137 MHz band), that consideration has also been given to expanding some of the A/G communication services into the 112-118 MHz band, one possibility being to move the band edge down one or several MHz from the present 118 MHz band edge; and (2) the possible use of VOR channels (not VOR transmitters) for ground-to-aircraft (one way) broadcast services, such as AWOS or ASOS, the signals being received on the aircraft by VOR receivers.

In conclusion, there is no opportunity to share this spectrum with any other entity.

H.8 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

Due to the extensive usage of the frequency band used by the VOR system and the significant service distances involved with VOR operations, it is difficult to reuse frequencies and coordinate frequency usage with adjacent states (including specifically Canada and Mexico). However, established procedures with these states help to alleviate frequency coordination to the extent possible.

I.8 Whether system is used for COOP or COG activities

Not applicable.

J.8 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

Frequency assignment congestion is the number one spectrum management issue with both the ILS localizer and the VOR. This stems from the sizable number of systems that operate, or are planned to operate, in the 108-118 MHz band. As highlighted above, there are a number of systems that operate or are planned to operate in the band used by the VOR system. In addition, as also highlighted above, the FAA has considered the potential of using the 112-118 MHz portion for new VHF A/G communication services.

There is an RFI potential stemming from nearby (in frequency and location) high power FM broadcast stations operating in the adjacent 88-108 MHz band.
Since both the ILS localizer and VOR frequency bands begin at 108 MHz, the upper edge of the FM broadcast band, the presence of many high power FM stations adjacent in frequency to VOR and ILS localizer operations increases the chance of interference to these navigation services. Interference is due to two primary causes. Desensitization of the navigation receivers occurs due to the brute force power of high power FM stations operating near to the 108 MHz band edge. In addition, FM signals can mix in the front end of VOR and ILS localizer receivers, resulting in the generation of a new signal that falls within the channel bandwidth of the desired navigation signal, thereby potentially providing misleading guidance to the pilot.

It is very difficult to satisfy requests for ESV coverage for VOR operations. In particular, VOR coverage areas that might have been established by very careful engineering, perhaps with changes in the service volumes or frequencies of nearby navigational aids, are nearly impossible to expand using the ESV engineering criteria.

As highlighted above under the ILS localizer, the FAA has pursued the further implementation of 50 kHz receivers and the development of new ICAO FM immunity standards. The full implementation of both of these improvements could significantly increase the availability of spectrum for VOR operations, the full implementation of the LAAS, and possibly to realistically consider the implementation of other civil aviation services.

A.9 Function of System – Local Area Augmentation System (LAAS)

LAAS is a GPS Ground Based Augmentation System (GBAS) being developed by FAA. LAAS is expected to provide the required accuracy, availability, integrity, coverage, and continuity to initially support CAT-I precision approaches and eventually CAT-II and III precision approaches. Unlike current ILS, a single LAAS ground station may provide precision approach capability to all runway ends at an airport. LAAS will augment GPS by providing local differential corrections to users via a VHF data broadcast in the 112-118 MHz band. LAAS will allow suitably equipped aircraft to conduct precision approaches in the vicinity of LAAS-equipped airfields. LAAS will also allow suitably

equipped aircraft to conduct curved approaches, segmented approaches, and more efficient parallel runway and airport surface operations. CAT-I LAAS is being developed in cooperation with Airservices Australia, equipment manufacturers and users. The FAA completed the first system design approval in September of 2009. The FAA is conducting research and development for a CAT-III LAAS prototype by 2010 followed by design approval in 2012.
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B.9 Mission(s) and program(s) supported

The LAAS could, if fully implemented, serve as a primary civil aviation Category II/III precision landing system element in the NAS. Depending on the particular airport requirements, the LAAS will be configured to operate as a Category I, II or III precision approach and landing system.

C.9 User community

United States commercial, business, and general aviation users, and foreign civil aircraft flying into and out of the United States. In addition, the user community includes aircraft from the DOD and other government agencies utilizing the NAS.

D.9 Geographical coverage (US&P, specified areas within US&P or outside US&P)

Coverage includes hundreds of airports and surrounding airspace (to 25 miles distance from the airport) in the United States and possessions.

E.9 Technical Parameters of System (bandwidth, frequencies, etc.)

The LAAS operates in the 108-118 MHz band on channel spacing of 25 kHz. The transmissions from the ground system consist of a quadraphase-modulated signal. The signal consists of an 8-time slot, TDMA format. Only two time slots of the 8 available are anticipated to be required to provide service at an airport. Thus, spare time slots on the same RF channel are anticipated to be available for use at another airport.

While it is the intention to initially, implement LAAS in the NAS in the 112-118 MHz sub-band, this system capability has been standardized by ICAO to operate in the 108-118 MHz band. Thus, Canada and Mexico might operate in a broader band segment than that planned for the NAS.

F.9 Current use of new technologies and other efforts to improve spectrum efficiency

As a new system, the LAAS utilizes the most spectrum efficient signal possible, including the utilization of a spectrum efficient quadraphase modulation.

G.9 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

The 108-118 MHz band segment is already heavily congested, which makes it very difficult to even plan for the implementation of the LAAS. Therefore, there is no possibility for sharing this spectrum with other Federal agencies or non-Federal entities.

H.9 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

The possible implementation of LAAS installations by Canada and Mexico near the border areas, in the 108-112 MHz sub-band (see above), could severely impact the present ILS localizer installations in the NAS.

I.9 Whether system is used for COOP or COG activities

Not applicable.

J.9 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

When fully implemented, LAAS will be operational at all CAT III airports. Until there is a meaningful de-commissioning of at least some VORs, it may be difficult to implement LAAS installations in this band beyond the present plan. Further compounding the problem, LAAS frequency assignments are being limited to below 117.2 MHz to protect the VHF A/G communications in the adjacent band (118-137 MHz) from LAAS emissions.

A.10 Function of System – ILS Glideslope Related System Elements

The function of the ILS Glideslope, which operates within the 328.6-335.4 MHz band segment, is to provide vertical guidance to aircraft during the approach and landing (Categories I, II, and III) phases of the flight. There are approximately 1086 FAA and 269 non-FAA ILS Glideslope frequency assignments in this band.

B.10 Mission(s) and program(s) supported

The ILS Glideslope is a principal element of the ILS system (which also includes the ILS Localizer, see above), which is the primary civil aviation landing system in the NAS. Depending on the particular airport requirements, the ILS can be configured to operate as a Category I or Category II precision approach system, or a Category III precision landing system.

C.10 User community

United States commercial, business, and general aviation users, and foreign civil aircraft flying into and out of the United States. In addition, the user community includes aircraft from the DOD and other government agencies utilizing the NAS.

D.10 Geographical coverage (US&P, specified areas within US&P or outside US&P)

Coverage includes hundreds of airports and surrounding airspace (to 25 miles distance from the airport) in the United States and possessions.

E.10 Technical Parameters of System (bandwidth, frequencies, etc.)

ILS Glideslope systems operate on channel spacing of 150 kHz. The signals consist of 90 and 150 Hz tones. The emission bandwidth is 300 Hz.

F.10 Current use of new technologies and other efforts to improve spectrum efficiency

The focus on improving spectrum utilization efficiency for the ILS is on the Localizer (see above). In short, due to the very large number of aircraft installations, no changes are being pursued with regards to changes in the ILS Glideslope.

G.10 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

While not as severe as the ILS Localizer band segment, there is a fair amount of frequency assignment congestion in the ILS band segment. As such, there is no opportunity to share this spectrum with any other entity.

H.10 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

While it is difficult to reuse frequencies and coordinate frequency usage with adjacent states (including specifically Canada and Mexico), established procedures with these states help to alleviate frequency coordination to the extent possible.

I.10 Whether system is used for COOP or COG activities

Not applicable.

J.10 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

Except for the lack of potential interference from FM broadcast stations, a similar frequency congestion problem exists for the ILS Glideslope system as for localizers. Since the spectrum congestion is greater for ILS localizer operations, it is assumed that if an ILS localizer can be implemented, it will be possible to implement the associated Glideslope as well. No changes are contemplated to the ILS Glideslope system.

A.11 Function of System – Distance Measuring Equipment (DME)

The function of the DME system, which operates in the 960-1215 MHz band, is to provide (to the pilot) the distance from the tuned in DME ground station, which supports the navigation of the aircraft. DME systems are used in conjunction with VOR, ILS, and TACAN systems, as well as being used as stand-alone systems (for example, two DME systems can be used to determine the location of the aircraft).

B.11 Mission(s) and program(s) supported

The DME system is a primary civil aviation navigation system within the NAS. There are approximately 877 FAA and 157 non-FAA DME frequency assignments within the NAS.

C.11 User community

United States commercial, business, and general aviation users, and foreign civil aircraft flying into and out of the United States. In addition, the user community includes aircraft from the DOD and other government agencies utilizing the NAS.

D.11 Geographical coverage (US&P, specified areas within US&P or outside US&P)

Coverage includes the United States and possessions, and adjacent oceanic areas extending to over 100 nautical miles from the shore in many locations. However, it should be noted that in Alaska and other geographic areas there are locations where it is impossible or very difficult to locate navigational aids (e.g., areas with extensive mountains, areas with no commercial power, etc.); in such areas DME service may not be available

E.11 Technical Parameters of System (bandwidth, frequencies, etc.)

The DME operates in the 960-1027, 1033-1087, and 1093-1215 MHz sub-bands of the 960-1215 MHz band. It shares those sub-bands with the Tactical Air Navigation (TACAN). The DME channel spacing is 1 MHz, and the emission bandwidth is 650 kHz.

The frequency 1176.45 MHz has been selected as the third civil frequency (L5) for GPS. Location of GPS L5 in this protected ARNS band meets the needs of critical safety-of-life applications. However, the radionavigation satellite system (RNSS), such as GPS L5, takes on a secondary status with respect to DME and TACAN. The DoD's JTIDS/MIDS also operates in this band on a non-interference basis.

F.11 Current use of new technologies and other efforts to improve spectrum efficiency

Because of the high degree of frequency assignment congestion, the use of directional DME antennas in ILS installations has been introduced. The directivity of the antennas allows for a DME service to be implemented where it would otherwise not be allowed (the broader DME service coverage provided with a conventional omni-directional coverage antenna would cause interference to adjacent DME frequency assignments already implemented). However, the limited coverage provided by the directional antennas may lead to operational usage problems, stemming from, for example, the limited ATC routing that can be supported (and a loss of flexibility in changing ATC routing).

G.11 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

Due to the extensive usage of the 960 – 1215 MHz band for DME/TACAN services; the use of 1176.45 MHz for the third civil GPS frequency (L-5); the use of 978 MHz for the Universal Access Transceiver (UAT) system; and the DoD's JTIDS/MIDS service (on a secondary non-interference allocation), there is no opportunity for sharing this spectrum with any non-aviation entities. In addition, the DoD is expanding its use of IFF interrogators operating in the 1030 MHz frequency. The DoD use is driven by new interrogator development testing as well as training and operational homeland security related missions.

H.11 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

Due to the extensive usage of the 960-1215 MHz frequency band and the significant service distances involved with DME operations, it is difficult to reuse frequencies and coordinate frequency usage with adjacent states (including specifically Canada and Mexico). However, established procedures with these states help to alleviate frequency coordination to the extent possible.

I.11 Whether system is used for COOP or COG activities

Not applicable.

J.11 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

There is extensive usage of the 960-1215 MHz band, as a consequence of the many DME and TACAN operations in this band, and two SSR channels centered at 1030 MHz and 1090 MHz (where 20 MHz and 11 MHz, respectively, are protected for these channels). As a result of the extensive usage, it is very difficult to implement new DME/TACAN operations in this band in some geographical areas. In addition, the new GPS civil signal (L5) and the Universal Access Transceiver (UAT) operate in this band and ADS-B broadcasts are planned for 1090 MHz.

As stated above, the DoD has an increasing requirement to operate on 1030 MHz and 1090 MHz for weapon system development, training, and operational homeland security missions. In addition, DOD Joint Tactical Information Distribution System/Multifunctional Information Distribution System (JTIDS/MIDS) operations are allowed in the 960-1215 MHz band on a non-interference basis. A memorandum of understanding (MOU) has been implemented between DOT and DOD that will allow greater technical and operational compatibility between civil aviation systems (e.g., DME, UAT, and L5) and JTIDS/MIDS. This MOU, among other things, requires JTIDS/MIDS to have the capability to inhibit transmissions on select frequencies in the 960-1215 MHz band, in order to protect future civil systems planned to operate below 1030 MHz. Also see F.11 above. DoD increases in operations on 1030 MHz as well as JTIDS contribute to the already challenging frequency congestion in the band.

A.12 Function of System – Tactical Air Navigation (TACAN) System

TACAN is the terminal and enroute navigation system used by the DOD, and is analogous in operation to the VOR with DME system used by civil aviation, in that it provides a heading for a radial extending our from the facility location and the distance from the facility (a DME function is built into the TACAN system).

B.12 Mission(s) and program(s) supported

The TACAN is the principal terminal and enroute navigation system used by DOD aircraft. Depending on the particular configuration, it can be used to provide coverage over a radius of up to and beyond 150 miles. The avionics (in the aircraft) consists of a receiver to obtain the azimuth information and a transponder to support the DME function.

C.12 User community

Primarily DOD aircraft. However, civil aviation does take advantage of the DME function of the TACAN system; a VOR may be co-sited with a TACAN at some locations, in which case a VOR with DME (VOR/DME) function can be obtained using the DME function of the TACAN system.

D.12 Geographical coverage (US&P, specified areas within US&P or outside US&P)

Coverage generally includes the United States and possessions, and adjacent oceanic areas extending to over 100 nautical miles from the shore in many locations. However, it should be noted that in Alaska and other geographic areas there are locations where it is impossible or very difficult to locate navigational aids (e.g., areas with extensive mountains, areas with no commercial power, etc.); in such areas a TACAN service may not be available.

E.12 Technical Parameters of System (bandwidth, frequencies, etc.)

TACAN operates in the 960-1027, 1033-1087, and 1093-1215 MHz sub-bands of the 960-1215 MHz ARNS frequency band. It shares those sub-bands with DME and GPS L5. The channel spacing is 1 MHz, and the emission bandwidth is 650 kHz.

F.12 Current use of new technologies and other efforts to improve spectrum efficiency

There are no known initiatives being undertaken to improve the spectrum efficiency of the TACAN system.

G.12 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

Due to the extensive usage of the 960 – 1215 MHz band for DME/TACAN services; the use of 1176.45 MHz for the third civil GPS frequency (L-5); the use of 978 MHz for the Universal Access Transceiver (UAT) system; and the DoD’s JTIDS/MIDS service (on a secondary non-interference allocation), there is no opportunity for further sharing this spectrum with any other entity.

H.12 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

Due to the extensive usage of the frequency band used by the TACAN system and the significant service distances involved with TACAN operations, it is difficult to reuse frequencies and coordinate frequency usage with adjacent states (including specifically Canada and Mexico). However, established procedures with these states help to alleviate frequency coordination to the extent possible.

I.12 Whether system is used for COOP or COG activities

Not applicable.

J.12 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

A complicating factor with making a TACAN frequency assignment is that many DME and TACAN operations are coupled (from a frequency channel usage standpoint) with VOR operations (since the DME is used with the VOR).

Another issue is that older TACAN antennas are either high band or low band with respect to the frequency range that they can support. Thus, flexibility is limited with these systems with regard to changing frequencies, which may be necessary to implement new systems.

In addition, as highlighted under the DME section, DOD JTIDS/MIDS operations are allowed in the 960-1215 MHz band on a non-interference basis. Particulars with regard to this aspect are discussed within the section on the DME.

No known actions are being taken to improve the TACAN system.

A.13 Function of System – Universal Access Transceiver (UAT)

The UAT system is specifically designed for ADS-B operation. An ADS-B-equipped aircraft determines its own position using GPS and periodically broadcasts this position and other relevant information using UAT to potential ground stations and other aircraft with ADS-B-in equipment. UAT is the first link to be certified for "radar-like" ATC services in the U.S. Since 2001, it has been providing 5 nm enroute separation (the same as radar) in Alaska. UAT users have access to ground-based aeronautical data and can receive reports from proximate traffic (FIS-B and TIS-B, which provides reports for proximate aircraft through a multilink gateway service that provides ADS-B reports for 1090ES equipped aircraft and non-ADS-B equipped Radar traffic.

B.13 Mission(s) and program(s) supported

In operation, the aircraft avionics transmits the aircraft's identification and position (based on GPS) once a second (which is received by other aircraft and ground stations). The aircraft avionics also receives similar data from other aircraft in the area equipped with the UAT. In addition, the UAT terminal also receives similar data from the ground system on aircraft in the area that are not equipped with the UAT capability. Thus, (1) the ground system obtains surveillance data from UAT equipped aircraft, which are not equipped with the 1030/1090 MHz SSR transponder capability, and (2) the UAT equipped aircraft obtain positional information concerning nearby aircraft (derived from UAT and ground system transmissions).

C.13 User community

The general aviation community.

D.13 Geographical coverage (US&P, specified areas within US&P or outside US&P)

Originally validated and implemented in Alaska, the geographical coverage has been expanding into broad geographic areas of the Continental United States portion of the NAS.

E.13 Technical Parameters of System (bandwidth, frequencies, etc.)

The UAT operates on a center frequency of 978 MHz, with a 2 MHz emission bandwidth.

F.13 Current use of new technologies and other efforts to improve spectrum efficiency

The UAT is a new system that is already spectrum efficient, since it only operates on a single channel.

G.13 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

The UAT only uses a single channel in the highly congested 960-1215 MHz band. As such, there is no possibility with sharing this spectrum with other Federal agencies and/or non-Federal entities.

H.13 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

The frequency channel used by the UAT is a DME and TACAN ramp test frequency in the United States (a survey has revealed that there are only a few (7) operational DMEs and TACANs in the world on 978 MHz). Therefore, it is not anticipated that there will be any problems with the operation of the UAT in border areas.

I.13 Whether system is used for COOP or COG activities

Not applicable.

J.13 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

Studies and tests have been conducted that indicate that there will be no mutual interference between ramp testers and UAT elements operating on this channel under the level of UAT operations assumed in the studies and testing. From an integrity standpoint, no potential for interference exists (each of the systems (UAT and DME) has significantly different pulse/data coding techniques). However, a mobile, non-aircraft UAT operational component might be developed which may have the potential to cause interference to DME ramp testing, and care will be needed in the placement of the ground-fixed portion of the UAT system to ensure that there will be no interference to DME ramp testing.

A.14 Function of System – Global Positioning System (GPS) Elements

The basic function of the GPS is to provide a position location determination capability for a mobile user. The GPS, used in conjunction with a broad range of computer automation, is the basis for the future satisfaction of a broad range of navigation and surveillance requirements (see below).

Wide Area Augmentation System (WAAS) provides increased navigation accuracy, availability, and integrity for aircraft navigation during departure, en route, arrival, and approach operations. WAAS consists of a network of GPS monitoring sites, processing facilities, and satellite earth stations, that provide correction & integrity messages to geostationary satellites, which broadcast this information to single frequency (L1-CA) user avionics. User avionics apply the corrections to accurately , accurately, an aircraft's 3-dimensional (3D) position in space. WAAS currently supports aviation navigation for en route through approaches equivalent to CAT-I and RNAV guided departures. FAA commissioned WAAS in 2003 and achieved the WAAS full level performance build in 2008 to meet service availability requirements.

B.14 Mission(s) and program(s) supported

The missions of the GPS system elements planned for and operating in the NAS include providing enroute, terminal, approach and landing, and surface movement navigation support. In addition, GPS also supports the provision of ADS within both the NAS (in the air and on the ground) and international airspace.

C.14 User community

United States commercial, business, and general aviation users, and foreign civil aircraft flying into and out of the United States. In addition, the user community includes aircraft from the DOD and other government agencies utilizing the NAS.

D.14 Geographical coverage (US&P, specified areas within US&P or outside US&P)

The GPS coverage is worldwide.

E.14 Technical Parameters of System (bandwidth, frequencies, etc.)

The GPS operates within the 1559-1610 MHz band, which will need to be protected in the future for the exclusive use of present and evolving future Radio Navigation Satellite Services and related aeronautical radio navigation system elements such as pseudolites. The GPS L1 civil aviation signal is transmitted in this band from satellites operating on a center frequency of 1575.42 MHz. While the pseudo random noise (PRN) coded signal is only transmitted at a 1 MHz bit rate, the protection of a significantly larger bandwidth is required to ensure adequate reception of the signal information and also to mitigate multipath interference. The associated WAAS satellites also transmit on the L1 signal format on the same center frequency 1575.42 MHz. It should be noted that GLONASS (the Russian satellite navigation system) also operates in the 1559-1610 MHz band.

Ground-based pseudolites, also transmitting on the L1 frequency, but with a pulsed, wideband format to preclude interference (near-far problem), may be a system component in GPS-aided approach and landing systems in a future architecture.

A new worldwide frequency allocation was obtained at the 2000 World Radiocommunication Conference to support the new L5 GPS civil aviation signal. L5 will be included in the new generation of the GPS, in addition to the present L1 civil signal, with initial operational capability (IOC) scheduled for 2013. L5 is planned to operate in the TACAN/DME band at a center frequency of 1176.45 MHz (it should be noted that L1 transmits at a 1 MHz bit rate, while the new L5 signal will transmit at a 10 MHz bit rate).

F.14 Current use of new technologies and other efforts to improve spectrum efficiency

The design of the civil GPS signals, L1 and L5, are very spectrum efficient, and are non-saturating, from the standpoint of the number of system users. The latest state of the art technology has been used to implement the GPS system elements.

G.14 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

The GPS capability is already being shared by a large number of Federal agencies and non-Federal entities.

H.14 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

The only problem area foreseen is that of the potential for RFI. A continuing dialogue must be maintained with other countries to ensure that the GPS system elements can continue to operate in an RFI free environment.

I.14 Whether system is used for COOP or COG activities

Not applicable.

J.14 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

Europe is designing a new satellite navigation system called Galileo, which will operate in the 1559-1610 MHz band. A binary offset code transmission format, which would interleave with the GPS signals in the same band, has been proposed. This evolving design will have to be reviewed carefully to ensure that there will be no interference to GPS.

Co-frequency (and nearby frequency) transmissions from ground DME transponders and the JTIDS/MIDS were identified as having a potential to interfere with L5 signal reception on aircraft. Early investigation concluded that, depending upon the density of DME and TACAN implementation within a geographic area, DME and TACAN frequency assignments on the center frequency and up to 9 MHz on either side of 1176.45 MHz might need to be re-engineered to protect L5 reception in aircraft at high altitude.

In order to make the GPS L5 civil signal more tolerant of interference, including allowing it to operate in areas with a low implementation density of DMEs and TACANs without requiring any DME and TACAN frequency assignment changes, the L5 signal had been planned to be 6 dB higher in power than the present L1 GPS signal. However, the present design provides for only a signal level 5.1 dB above the present L1 signal (i.e., 0.9 dB weaker than planned), at least for the initial implementation of satellites. This will impact the ability of the signal to coexist in its intended environment.

Based on the present L5 system design characteristics, FAA Air Traffic Organization Technical Operations Services (ATO-W) ATC Spectrum Engineering Services conducted a study (Ref. 2) to determine what changes might need to be made to the DME and TACAN frequency assignments to protect L5. It was determined that the protection of L5 might require up to 70 DME and TACAN frequency assignments to be moved out of the band segment in which L5 would operate. Subsequently, in 2004, the results of a refined analysis by RTCA, Incorporated (RTCA) determined that it would be possible to lower the L5 signal acquisition threshold, thereby eliminating the need to move DME and TACAN frequency assignments to protect future L5 operations (Ref. 3). An additional study has been done to refine the model, which predicts potential interference from GPS L5 to DME/TACAN. This study resulted in a significant reduction in the predicted interference effect, to the point where GPS L5 can live with any DME/TACAN scenario in the U.S. and no DME/TACAN would have to be re-assigned. To keep the situation from deteriorating in the future, no new DME/TACAN assignments will be made within the L5 frequency band (±12 MHz of 1176.45 MHz) in DME/TACAN congested areas.

In addition to the above challenges, the FAA is actively involved with other federal agencies and has representatives on interagency organizations, such as the Purposeful Interference Resolution Team (PIRT) to resolve a growing and concerning trend in purposeful interruptions to the GPS signal.

A.15 Function of System – Microwave Landing System (MLS)

The function of the MLS is to support the provision of straight-in and curved approach, and precision landing system services at airports.

B.15 Mission(s) and program(s) supported

The FAA had previously planned a broad implementation of MLS, thereby freeing up spectrum in the 108-112 MHz band segment by alleviating the need for as many ILS systems. However, the FAA decided in the mid-1990s not to implement MLS in favor of new services supported by GPS.

There are still a small number of civil MLS systems in the NAS, and a sizable number of DOD operational MLS systems, which operate in the ICAO standardized band segment of 5030-5091 MHz. The DOD implementation consists of approximately 50 DOD MLS systems (approximately 35 Mobile MLSs (MMLS) and 15 Fixed Base MLSs (FBMLS)). A small number of FAA-owned FBMLSs are also being used by the DOD. Additional DOD MMLSs may also be implemented. These systems must be protected for operational usage. .

C.15 User community

United States commercial, business, and general aviation users, and foreign civil aircraft flying into and out of the United States. In addition, the user community includes DOD aircraft utilizing the NAS. In practice, due to the decision not to seek a full implementation of the MLS, the number of users is limited mostly to some segments of the commercial and DOD aircraft fleets.

D.15 Geographical coverage (US&P, specified areas within US&P or outside US&P)

Coverage includes airports and surrounding airspace (to 25 miles distance from the airport) in the United States and possessions where the limited MLSs have been implemented.

E.15 Technical Parameters of System (bandwidth, frequencies, etc.)

The MLS operates in the 5031-5097.7 MHz band. The channel spacing is 600 kHz, and the emission bandwidth of each channel is 150 kHz.

F.15 Current use of new technologies and other efforts to improve spectrum efficiency

No new improvements in the MLS are foreseen at this time.

G.15 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

Because of the demand for the use of the 5030-5150 MHz band segment (see also Section III, N.15 below) by civil aviation for aeronautical radio navigation systems and safety communication services, no sharing with other Federal agencies and/or non-Federal entities is considered viable.

H.15 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

No problem areas have surfaced regarding spectrum coordination in border areas or outside the US&P.

I.15 Whether system is used for COOP or COG activities

Not applicable.

J.15 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

Up to the present time no problems have surfaced with regard to obtaining suitable spectrum to make frequency assignments, or stemming from RF interference.

A.16 Function of System – ATCRBS/SSR Related System Elements

The function of ATC Radar Beacon System/Secondary Surveillance Radar (ATCRBS/SSR) is to obtain the horizontal position and altitude of an aircraft (actually, the SSR function provides the slant range and bearing to the aircraft from the ground station). In operation, the aircraft receives a ground signal and applies a fixed delay before re-transmitting it back to the ground station, thereby allowing the ground station to calculate the slant range. The bearing to the aircraft is provided through the use of the narrow beam capability of the SSR antenna. The altitude is provided by an ADS function, by having the aircraft avionics send an encoded data message of the altimeter readout to the ground. A significant amount of computer processing and display capability allows the aircraft data to be provided effectively to the air traffic controller. In summary, the ATCRBS/SSR provides aircraft position, identification, and altitude via an ADS data link function (Mode C). In addition, an A/G data link communications function is also included.

B.16 Mission(s) and program(s) supported

Typically, the pilot is issued an airspace clearance via A/G communications to fly a specific route and altitude profile. Surveillance provides the capability to verify the actual position of the aircraft within the NAS. This allows the air traffic controller to check on the progress of the aircraft to help ensure, inter alia, that the aircraft is following the clearance instructions and not deviating into a potentially dangerous situation.

Surveillance is also an important function to the DHS and the DOD.

C.16 User community

United States commercial, business, and general aviation users, and foreign civil aircraft flying into and out of the United States. In addition, the user community includes DOD aircraft utilizing the NAS.

D.16 Geographical coverage (US&P, specified areas within US&P or outside US&P)

Coverage includes the United States and possessions, and adjacent oceanic areas extending to over 200 nautical miles from the shore in many locations. However, it should be noted that in Alaska and other geographic areas there are locations where it is impossible or very difficult to locate navigational aids (e.g., areas with extensive mountains, areas with no commercial power, etc.); in such areas SSR service may not be available.

E.16 Technical Parameters of System (bandwidth, frequencies, etc.)

The ATCRBS/SSR operates on two channels, at 1030 MHz and 1090 MHz (each frequency is the center frequency of a bandwidth of up to 21.5 MHz).

F.16 Current use of new technologies and other efforts to improve spectrum efficiency

See J.16 and Section III, N.16 below.

G.16 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

Due to the already significant spectrum usage congestion in the channels being used for ATCRBS/SSR elements, there is no possibility for sharing with other Federal agencies and/or non-Federal entities.

H.16 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

Established procedures help to alleviate frequency usage coordination problems to the extent possible.

I.16 Whether system is used for COOP or COG activities

Not applicable.

J.16 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

There are a relatively large number of present and new surveillance functions to be satisfied on the frequencies 1030 MHz and 1090 MHz. Specifically, the following systems and functions operate on these frequencies: (1) ATCRBS/SSR (including SSR Mode Select (Mode-S)), (2) Multilateration Systems (including aircraft/vehicle identification for ASDE), (3) Traffic Alert and Collision Avoidance System (TCAS), (4) Precision Runway Monitor (PRM), (5) SSR Mode-S based ADS-B, (6) Transponder Landing System (TLS), and (7) Remote Beacon Performance Monitors (RBPM).

1030 MHz is the frequency used by ground SSR facilities to interrogate aircraft transponders. Aircraft, upon receiving an interrogation on 1030 MHz, respond on 1090 MHz. There are approximately 1811 frequency assignments on these frequencies, of which 1271 are FAA and the remainder are DOD. To keep these systems from interfering with each other, such measures as different pulse repetition rates (PRRs) and limiting the transmit power of the interrogator based on the surveillance range (including the TCAS power management algorithms) are utilized. Channel occupancy is the principal problem on the 1030/1090 MHz frequencies. An aircraft beacon transponder is limited in the number of interrogations it can process before saturation occurs, after which it can no longer reply effectively. Furthermore, a ground facility can also only receive so many responses on 1090 MHz before it too becomes saturated and can no longer track all of the responses.

Two actions that are underway to relieve congestion on 1030/1090 MHz are the implementation of Mode-S and Monopulse SSR systems. Both of these systems require fewer interrogations. This results in a reduction in transponder occupancy time, thus allowing the aircraft to be able to respond to a larger number of interrogators. Consequently, there are not as many responses on 1090 MHz that the ground facilities need to process. Thus, these system improvements achieve an enhanced level of spectrum utilization efficiency over the traditional ATCRBS.

Additionally, the FAA senior leadership has recognized the risk that frequency congestion poses to the future integrity of the 1030/1090 MHz frequency pair as the amount of air traffic grows. In response, a program office is being established to develop and implement initiatives to preserve the performance of 1030/1090 MHz dependent systems.

Regarding SSR Mode-S site identification codes, presently, aircraft have 16 SSR Mode-S ground site identification (ID) codes, while the ground system can have 64 ID codes. In some geographic areas a large number of SSR Mode-S ground sites can be in communication with an aircraft, making the 16 ID codes on the aircraft insufficient to ensure a unique identification of the ground sites. Two new ID address bits have been added through standardization action by ICAO to increase the aircraft ID codes to 64; however, it will take some years for a full aircraft implementation of this new capability. In the meantime, several actions are being taken to help alleviate this situation, as highlighted below. The complexity of this issue is increased by the need to ensure compatibility with Canadian systems operating close enough geographically with NAS system elements to be impacted by constraints imposed by the frequency assignment criteria. The anticipated DOD conversion to Mode-S will only exacerbate the existing shortage of Mode-S site ID codes.

In particular, two actions are being taken to help alleviate the Mode-S aircraft ID issue during the near term. The ATC Beacon Interrogator 6 (ATCBI-6) program contract has been modified to allow sector ID codes to be related to a sector of the airspace. In addition, two separate “frame tables” for each Mode-S ID code have been created, with the ID codes being associated with a specific pulse repetition frequency (PRF). Even with these actions, however, there may be geographic areas where there are not enough Mode-S site IDs to prevent interference between systems.

Meetings are currently being held among the FAA William J. Hughes Technical Center, ATO-W Spectrum Engineering Services, the various FAA program offices with an interest in Mode-S, and Canada to devise a solution to this potential future crisis. Solutions being examined include linking radar systems together to create a mosaic system so that Mode-S site ID codes can be shared or initiating action to permit the use of the full set of 64 site ID codes that are potentially available. All potential solutions require substantial funding, however, which is another obstacle in today's austere funding environment.

The DOD use of SSR Mode 4 impacts the operational capability of NAS SSR functions by limiting the civil transponder capability to reply to ATC interrogations from the ground system. As a consequence, the DOD is upgrading to an SSR Mode 5 operational mode that will significantly reduce the impact to civil transponder operations. However, Mode 5 will not be fully operational until the year 2020. To help expedite the transition to Mode 5, the DOD has issued a directive that requires all future transponder replacements to be Mode 5 capable. In the meantime, a memorandum of understanding between the FAA and DOD has been developed to establish coordination procedures to reduce the impact of Mode 4 operations to the NAS.

A.17 Function of System – Air Route Surveillance Radar (ARSR)

The function of the ARSR is to provide primary radar surveillance coverage for enroute airspace, that is, outside the terminal areas (around airports). As a primary radar, a ground signal is reflected from the aircraft and received back at the ground station. Ground signal processing determines the slant range to the aircraft, while the narrow beam of the ground station radar antenna allows the ground station to determine the azimuth to the aircraft, relative to the ground station.

B.17 Mission(s) and program(s) supported

The ARSR supports the overall aircraft surveillance function, by providing an Independent Surveillance (i.e., with no cooperation from the aircraft) aircraft position input.

This service is provided in addition to the secondary radar service provided by SSR systems operating on 1030/1090 MHz (See also B.16 above).

C.17 User community

United States commercial, business, and general aviation users, and foreign civil aircraft flying into and out of the United States. In addition, the user community includes DOD aircraft utilizing the NAS.

D.17 Geographical coverage (US&P, specified areas within US&P or outside US&P)

Coverage includes the United States and possessions, and adjacent oceanic areas extending to over 200 nautical miles from the shore in many locations. However, it should be noted that in Alaska and other geographic areas there are locations where it is impossible or very difficult to locate navigational aids (e.g., areas with extensive mountains, areas with no commercial power, etc.); in such areas ARSR service may not be available.

E.17 Technical Parameters of System (bandwidth, frequencies, etc.)

Most ARSR systems (primary radars) operate in the 1240-1370 MHz portion of the 1215-1390 MHz band (which is allocated to the Aeronautical Radio Navigation Service) to support the NAS enroute aircraft surveillance function (some joint use FAA/DOD radars supporting the NAS operate across the entire 1215-1390 MHz band).

There are a total of 127 ARSR systems that are jointly operated by the FAA and the DOD, in support of the NAS and by the DOD for surveillance functions, respectively. An additional four ARSR systems are used for training by the FAA and DOD. Each ARSR requires at least two channels to operate (for frequency diversity), with each channel requiring up to 10 MHz bandwidth (measured at –20dB points).

F.17 Current use of new technologies and other efforts to improve spectrum efficiency

The FAA has implemented new filtering on many ARSR radars. See J.17 below. The FAA and DOD have also initiated a Service Life Extension Program (SLEP) to improve the performance and maintainability of 68 of the oldest ARSR systems deployed throughout the US&P. Although the SLEP does not decrease the amount of bandwidth required, the SLEP dramatically improves the performance of these radar systems while containing the emissions to nearly the same bandwidth.

G.17 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

The bands used by ARSRs are already congested from a frequency usage standpoint. Therefore, the FAA does not foresee any possibility for sharing the spectrum with other Federal agencies and/or non-Federal entities.

H.17 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

Established procedures help to alleviate frequency usage coordination problems to the extent possible.

I.17 Whether system is used for COOP or COG activities

Not applicable.

J.17 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

Frequency assignment congestion is a primary issue, stemming from a loss of spectrum and pressures to accommodate the operation of other systems in the 1215-1390 MHz band. This and other issues concerning present and future operations are highlighted in the following paragraphs.

As a part of the Omnibus Budget Reconciliation Act of 1993 (OBRA-93, which sought to transfer 200 MHz from Government frequency allocations, to be used for future commercial radio frequency devices), the 1390-1400 MHz portion of the band was lost for radar system usage. The FAA has completed modifications to FAA enroute radar systems to deal with the impacts of this loss of spectrum. It required the installation of costly filters on NAS ARSR systems: transmit filters on

ARSR-1 and 2 systems, and receive filters on ARSR-4 systems. On the positive side, the filters helped resolve a long-standing ARSR-4 interference issue from UHF TV stations, and on the ARSR-1s and 2s, the new “absorptive” filters helped eliminate previous problems caused by “reflective” filters. It is too early to know the possible impacts of new commercial radio frequency devices in 1390-1400 MHz; however, ATO-W is coordinating with other Government agencies on this issue and must remain alert to ensure protection of ARSR services.

The new frequency allocation to allow Radionavigation Satellite Service (RNSS), as a co-primary service, in the band segment 1215-1300 MHz will add additional sharing pressures on the operation of ARSR systems. The GPS DOD signal (L2) is at a center frequency of 1227.6 MHz, with a bandwidth of approximately 20 MHz, which is outside the operating frequency ranges of most ARSR systems. However, GLONASS has a signal centered at approximately 1250 MHz, and the new European Galileo and Chinese COMPASS satellite navigation system designs are proposing to operate in the vicinity of 1260-1300 MHz (within the new RNSS allocation); such operations would be within the operating frequency ranges of most ARSR systems. The additional signals from Galileo may be a problem for, in particular, the ARSR-4 systems, since they have more sensitive receiver systems (to allow coverage out to 250 nautical miles, to detect smaller targets, and to have a higher probability of detection than other ARSR systems). The FAA is participating in studies and domestic and international forums to address this issue. Action will be taken, as may be necessary, to eliminate any potential for interference to ARSR systems (this may include the need to develop and adopt additional mitigation techniques as a last resort).

DOD mobile point-to-point communications systems operate in the frequency band segment 1350-1390 MHz on a co-primary basis. In addition, the DOD operates some A/G data link communications in this band segment to support the tracking of aircraft on military ranges. DOD fixed, mobile, and airborne operations are being relocated from the 1390-1400 MHz and 1427-1435 MHz bands into the 1350-1390 MHz band. Such communications have the potential to interfere with and pose operational constraints to ARSR system operations. On going coordination is required to ensure that unacceptable NAS service restrictions are not imposed by DOD operations.

Amateur radio service operations are allowed in the 1290-1300 MHz band segment on a secondary (radio frequency spectrum allocation) basis. This allocation basis gives regulatory protection to ARSR operations from amateur radio service operations. Ongoing coordination and analysis is necessary to ensure continued interference-free service.

An on-going review of the NTIA Radar Spectrum Engineering Criteria (RSEC) is being conducted within Working Group 1 (WG-1) of the Technical Subcommittee, of the Interdepartment Radio Advisory Committee. The aim of WG-1 is to tighten the design criteria and thereby help relieve frequency assignment congestion. While supporting this effort, ATO-W must continue to ensure that any revisions to the criteria do not unduly restrict the design and future operations of ARSR systems.

A.18 Function of System – Airport Surveillance Radar (ASR)

The function of the ASR is to provide primary radar surveillance coverage for terminal airspace areas (around airports). As a primary radar, a ground signal is reflected from the aircraft and received back at the ground station. Ground signal processing determines the slant range to the aircraft, while the narrow beam of the ground station radar antenna allows the ground station to determine the azimuth to the aircraft, relative to the ground station.

B.18 Mission(s) and program(s) supported

The ASR supports the overall aircraft surveillance function, by providing an Independent Surveillance (i.e., with no cooperation from the aircraft) aircraft position input.

This service is provided in addition to the secondary radar service provided by SSR systems operating on 1030/1090 MHz (See also B.16 above).

C.18 User community

United States commercial, business, and general aviation users, and foreign civil aircraft flying into and out of the United States. In addition, the user community includes DOD aircraft utilizing the NAS.

D.18 Geographical coverage (US&P, specified areas within US&P or outside US&P)

Coverage includes terminal areas in the United States and possessions, extending up to 60 nautical miles from the ground facility.

E.18 Technical Parameters of System (bandwidth, frequencies, etc.)

Each ASR (ASR-7s, 8s, 9s, and 11s) requires two channels to operate (for frequency diversity), with each channel requiring up to 10 MHz bandwidth (measured at –20dB points). The new ASR-11s that are being implemented to replace ASR-7s and 8s require a narrower bandwidth per channel (5.6 MHz at –20dB); however, during the 4 to 6 month implementation transition period, both the old radar (an ASR-7 or 8) and the new ASR-11 are required to operate simultaneously.

F.18 Current use of new technologies and other efforts to improve spectrum efficiency

See E.18 above.

G.18 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

This band is already being shared with other Federal agencies, and there are a number of non-Federal systems. The FAA does not see any way that this band can be shared with other Federal agencies or non-Federal entities for additional functions.

H.18 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

Established procedures help to alleviate frequency usage coordination problems to the extent possible.

I.18 Whether system is used for COOP or COG activities

Not applicable.

J.18 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

The primary issue with the 2700-2900 MHz band is frequency congestion. Both ASR and NEXRAD operations are in this band. The FAA operates 277 ASRs in this band and there are also DOD, NASA, and non-federal ASRs. In addition, the FAA, U.S. Air Force, and the National Oceanic and Atmospheric Administration operate 206 NEXRADs in this band, which provide weather support for the NAS. Due to frequency congestion, the frequency band for NEXRAD systems has been expanded to 3000 MHz. The FAA is currently studying whether additional spectrum for ASR and NEXRAD radars operating in the 2700-3000 MHz band would be needed in the future.

The most stringent RSEC requirements are applicable to radars operating in this band. ATO-W is working within the NTIA process to help ensure that any future revisions to the RSEC will have the least possible impact on present and future NAS operations within the 2700-3000 MHz band. Recently, several DOD tactical systems that do not satisfy the RSEC have been developed for operation in this band. The FAA is working with DOD to ensure that these systems will be retrofitted to bring them into compliance.

A.19 Function of System – Next Generation (Weather) Radar (NEXRAD)

The function of the NEXRAD is to provide weather information out to 250 NM and feed that information to ATC for use in routing aircraft around dangerous weather conditions and making other critical NAS decisions.

B.19 Mission(s) and program(s) supported

The function of the NEXRAD systems are to provide weather support for the NAS to aid ATC in making critical flight routing decisions.

C.19 User community

All civil aviation and other users benefit from the systematic implementation of the NEXRAD system.

D.19 Geographical coverage (US&P, specified areas within US&P or outside US&P)

The NOAA maintains most NEXRAD systems within the CONUS while the FAA maintains those NEXRAD systems in Hawaii, Alaska, and Possessions. The network of NEXRAD systems provide coverage for the US&P.

E.19 Technical Parameters of System (bandwidth, frequencies, etc.)

The FAA, U.S. Air Force, and the National Oceanic and Atmospheric Administration operate 206 NEXRADs in the 2700-3000 MHz band. Each system uses two frequencies, the bandwidth of each system at the –20 dB point is 4.6 MHz, and the peak power output is 750 kW into 46 dB gain antenna, rotating antenna.

F.19 Current use of new technologies and other efforts to improve spectrum efficiency

Since these are modern radar systems, there are presently no new activities being undertaken to improve spectrum efficiency.

G.19 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

There is already significant sharing in this band, which includes sharing the NEXRAD data with NOAA, the DoD, DHS, and the FAA. It is not foreseen that there will be an opportunity to have further sharing.

H.19 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

Established procedures help to alleviate frequency usage coordination problems to the extent possible.

I.19 Whether system is used for COOP or COG activities

Not applicable.

J.19 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

See J.18 above.

A.20 Function of System – Terminal Doppler Weather Radar (TDWR)

The function of the TDWR is to provide weather information to terminal ATC. In addition to standard weather information, wind sheer information is obtained from the TDWR for 40 NM around terminal air space.

B.20 Mission(s) and program(s) supported

The TDWR supports air traffic control within the terminal airspace around major airports.

C.20 User community

The entire civil aviation community, and DOD aircraft, that operate into and out of TDWR equipped airports take advantage of this weather radar capability.

D.20 Geographical coverage (US&P, specified areas within US&P or outside US&P)

A system of 48 TDWRs provides weather radar coverage within 40 NM around many of the larger airports in the NAS

E.20 Technical Parameters of System (bandwidth, frequencies, etc.)

TDWRs operate in the 5600-5650 MHz band segment. The –20 dB bandwidth is 3.26 MHz and the peak transmit power is 250 kW into a 50 dB gain rotating antenna.

F.20 Current use of new technologies and other efforts to improve spectrum efficiency

The systems operating in, and planned to operate in, the 5600-5650 MHz band are already spectrum efficient. Therefore, no new improvement efforts are foreseen at this time.

G.20 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

The 5600-5650 MHz band segment is already being shared, see J.20 below.

H.20 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

Established procedures help to alleviate frequency usage coordination problems to the extent possible.

I.20 Whether system is used for COOP or COG activities

Not applicable.

J.20 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

The most significant problem with the implementation and operation of TDWRs is that commercial TV stations desire to implement their own weather radars in this band. In addition to proposing placement of these radars in or near major cities, where TDWRs already operate, these radars have much less stringent specifications than NAS systems. This results in a significant workload in reviewing proposed system implementations and in communicating with industry regarding why their radars cannot be implemented at the requested location and with the proposed specifications.

A.21 Function of System – Airport Surface Detection Equipment (ASDE)

The function of ASDE radar systems is to provide air traffic controllers positional information of aircraft on the airport surface and out to 3 NM from the airport, independent of the weather conditions.

B.21 Mission(s) and program(s) supported

The mission of ASDE radar systems is to improve the safety and efficiency of moving aircraft on the airport surface following the landing phase, and prior to the takeoff phase.

C.21 User community

All civil and DOD aircraft that operate at the airports serviced by ASDE-X and ASDE-3 radar systems.

D.21 Geographical coverage (US&P, specified areas within US&P or outside US&P)

At each airport, the runways, taxiways, and other surface areas where aircraft movements take place. The total coverage includes all the airports serviced by ASDE-X and ASDE-3 radar systems.

E.21 Technical Parameters of System (bandwidth, frequencies, etc.)

ASDE-X operates in the 9-9.2 GHz band segment. There are currently 35 ASDE-Xs in the NAS. There are two versions of the surface movement radar (SMR) component of the ASDE-X: one operates on 4 frequencies with a bandwidth of up to 70 MHz, and transmits 70 watts of peak power into a 35 dB gain, rotating antenna. The other version, the surface movement radar improved (SMRi), operates on 16 frequencies spread across the 9-9.2 GHz band, uses up to 208 MHz of bandwidth, and transmits up to 155 watts into a 38 dB gain rotating antenna. The ASDE-3 operates on 16 frequencies spread across the 15.7-16.2 GHz band, each frequency using 28 MHz of bandwidth, and transmits 3 kW of power into a 44 dB gain, rotating antenna. All ASDE systems frequency hop across those frequencies in the hop set and occupy the total frequency band in which they operate. Transmission on select frequencies can be inhibited, but significant performance degradation is the result.

F.21 Current use of new technologies and other efforts to improve spectrum efficiency
Spectrum efficient designs are presently being used for ASDE-X system elements. No new initiatives are contemplated.

To satisfy the performance specifications in this high of a frequency band requires relatively large frequency bandwidths. Trials on the new SMRi with filters and other modifications are currently being pursued to improve the spectrum utilization efficiency.

G.21 Sharing of system/spectrum with other Federal agencies and/or non-Federal entities

There is already considerable sharing with other Federal agencies in the 9-9.2 GHz band segment. The frequency band is used extensively by the DOD for precision approach radar systems. Additionally, the radiolocation service was upgraded to co-primary allocation at the WRC-2007, which will encourage the development of other DOD radar systems in the 9-9.2 GHz band. No sharing with non-Federal entities is contemplated, although airlines and other non-federal FAA customers receive data feeds from the ASDE radar systems.

H.21 For spectrum-supported systems used in border areas or outside US&P, spectrum management challenges and actions to address such challenges

Established procedures help to alleviate frequency usage coordination problems to the extent possible.

I.21 Whether system is used for COOP or COG activities

Not applicable.

J.21 Description of challenges in implementing or operating spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, RF interference and others. Describe actions the agency is taking to address such challenges.

The primary issue regarding the operation of ASDE-X is ensuring compatibility with existing DOD precision approach radars (PARs). A study was conducted resulting in a conclusion that compatibility between the SMR or SMRi and PARs was essentially a “non-issue” under the current deployment plan to implement ASDE-Xs . If additional ASDE-Xs are planned to be implemented (beyond the current plan), compatibility with PARs might be a far more serious issue.

At the relatively high frequencies used by both the ASDE-X and ASDE-3 systems, there is a large signal attenuation due to rain and problems with multipath. This especially limits the functional capability of the ASDE-3 system that operates in the higher 15.7-16.2 GHz band. The new SMRi is an attempt to overcome this challenge.

III. Future Spectrum Requirements (Changes since 2007 Agency Plan submission) for Federal agency systems using Federal-agency or shared spectrum allocations

A.1 Function of System – VHF Air-Ground Communications

The A/G safety communications element (Air Traffic Service (ATS) communications) is provided in the NAS through the use of very high frequency (VHF) spectrum resources within the 118-137 MHz band. By 2018, the FAA's air-ground communications system will be comprised of a mixture of the currently used voice communications and data communications. Data communications will increase efficiency by providing routine and strategic information to the pilot and automating certain routine tasks for both the pilot and controller. Controllers can focus on providing more preferred and direct routes and altitudes, which will save both fuel and time. A decreased number of voice communications also will reduce radio frequency congestion and eliminate verbal miscommunication—a great safety improvement that will reduce operational errors. Providing changes to radio frequencies and other information, such as local barometric pressure required for weather advisories, through the means of a data communications link can also greatly reduce errors. When weather impacts numerous flights, clearances for data communications capable aircraft can be sent all at once, increasing controller and operator efficiency.

B.1 Mission(s) and program(s) supported

The NEXCOM program replaces and modernizes the aging and obsolete NAS air-to-ground (A/G) analog radios. Replacing the radios is part of a larger program to eliminate existing NAS limitations that will affect the air traffic system's capability to manage effectively, the projected U.S. air traffic requirements of the future. These limitations include FAA very high frequency (VHF) radio frequency spectrum saturation, inadequate A/G radio equipment maintainability and reliability, and lack of A/G information security and communications control. NEXCOM's new radio technologies support the FAA's goal of Greater Capacity by making more efficient use of existing spectrum. Furthermore, replacing very old radios and their higher failure rates with newer radios will reduce the future growth rate of O&M costs.

The NEXCOM program was re-baselined in December, 2005. NEXCOM will be implemented in two segments, 1a and 2. Segment 1a addresses the high- and ultrahigh-sector air traffic voice channels for aircraft flying en route above 24,000 feet. Only Segment 1a has been approved to date. Segment 1a will replace all en route radios with Multimode Digital Radios (MDRs) by 2013. The first installation was in 2004. The program has been designed for growth and flexibility. The MDRs can emulate the existing analog protocol, thus facilitating transition, or they can operate in the more efficient 8.33 kHz (DSB-AM) voice mode currently in use in Europe, or with additional expenditures in a later phase they can operate in the VDL-3 mode especially designed for Air Traffic Control or VDL-2 mode originally designed for AOC.. The VDL mode provides integrated data and voice. If needed the 8.33 kHz voice-only mode provides the spectrum needed for a stand-alone data communications system .

Segment 2 will implement new radios that will service the high-density terminal areas and the flight service operations.

C.1 User community

See Section II, C.1 above.

D.1 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.1 above.

E.1 Technical Parameters of System (bandwidth, frequencies, etc.)

Data communications will operate in the 136.000 to 136.475 MHz band with the bandwidth of 14 KHz. To accommodate the data communications requirement, no new assignments for voice ATS will be made in the 136.000 to 136.475 MHz band. By 2018, voice communications may likely be operating on 8.33 KHz channel spacing instead of the currently used 25 KHz channel spacing.

F.1 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.1 above.

G.1 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.1 above.

H.1 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See Section II, F.1 and J.1 above.

I.1 Is use of commercial systems being considered as an alternative?

No.

J.1 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H1 above.

K.1 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.1 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.1 above.

M.1 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

According to the FAA's JPDO Concept of Operations for the NextGen, one of the key transformations for the NextGen is to allow the flight crew to change airspace sector configuration dynamically so that maximum flexibility is possible. This dynamic sector reconfiguration concept may require a significant amount of additional VHF spectrum.

There is an ongoing dialogue within the ICAO to ensure that future A/G communication requirements will be met. As time progresses, U.S. strategies, positions, and proposals will be needed to ensure that U.S. ATS and AOC A/G spectrum requirements will be satisfied in the most spectrum and cost efficient manner.

N.1 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

The implementation of an A/G data link system will require spectral resources that will be taken from the current ATS A/G communications pool of frequencies. The plan is to sub-band the existing ATS frequencies to accommodate both voice and data link. Although it is projected that the data link system will provide spectrum relief in the future, it is not anticipated that there will be a reduction in the need to support new voice requirements until sometime further in the future (approximately, the late-2020 time-frame). Therefore, in the immediate future, it is anticipated that voice communication requirements will continue to grow at a steady rate with a reduced number of frequency channels. Based on this, it is expected that, in order to accommodate the new data link system, additional spectrum and/or the adoption of 8.33 kHz (voice) may be required.

O.1 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

The ability to satisfy the FAA mission would be compromised. The data link communications system is an integral part of the Next Generation Air Transportation System, which has been developed to facilitate the reduction of flight delays, the increase of air traffic capacity, and the increase of flight safety. If this system were not implemented, due to the lack of spectrum, there would be an adverse impact on the national air transportation system, including major impacts on personal, business, and government transportation, and the national commerce as well.

A.2 Function of System – UHF Air-Ground Voice Communications

See Section II, A.2 above.

B.2 Mission(s) and program(s) supported

See Section II, B.2 above.

C.2 User community

See Section II, C.2 above.

D.2 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.2 above.

E.2 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.2 above.

F.2 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.2 and B.2 above.

G.2 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

Not applicable. This band is controlled by DOD.

H.2 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See Section II, F.2 above.

I.2 Is use of commercial systems being considered as an alternative?

Not applicable. This band is controlled by DOD.

J.2 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.2 above.

K.2 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.2 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.2 above.

M.2 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

Future plans for the FAA's usage in the UHF/AM band are uncertain, since DOD not only controls it, but there have been a few proposals to reallocate portions to accommodate new military systems. In addition, many of the VHF/AM future plans may have a parallel effect upon UHF/AM.

N.2 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

Continue in current configuration.

O.2 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

The ability for the FAA to continue its service for the DoD mission would be compromised.

A.3 Function of System – HF Air-Ground Voice Communications

See Section II, A.3 above.

B.3 Mission(s) and program(s) supported

See Section II, B.3 above.

C.3 User community

See Section II, C.3 above.

D.3 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.3 above.

E.3 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.3 above.

F.3 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.3 and B.3 above.

G.3 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.3 above.

H.3 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See Section II, F.3 above.

I.3 Is use of commercial systems being considered as an alternative?

The AM(R)S provided by aeronautical stations is a contracted service. RCOM emergency use requires it to be a government owned network.

J.3 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.3 above.

K.3 Identify systems, which may be used for COOP or COG activities

See Section II, I.3 above.

L.3 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.3 above.

M.3 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

The FAA plans HF-long-range air to ground datalink communications in the oceanic and Alaskan airspace in the 2.85-22 MHz band. It is estimated that an additional 180 kHz of spectrum is necessary in this band associated with sixty new channels for a planned oceanic air-to-ground datalink.

N.3 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

The RCOM is expected to be scaled down from over 40 stations to approximately 15 HF stations. This, however, will not reduce the number of frequencies required.

O.3 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

The HF AM(R)S remains as the backbone air-ground communications capability for oceanic and other remote areas (where VHF air-ground communications cannot be provided). Therefore, if this service could not be provided, no systematic oceanic air traffic control service could be provided. Major service areas for the U.S. and the FAA include the North Atlantic, the Pacific, and Caribbean areas.

The RCOM is required to provide essential backup communications for the FAA. Therefore, a loss of this service would severely impact the capability to ensure that FAA services could be provided during times of emergency.

A.4 Function of System – Satellite (AMS(R)S) Communications

See Section II, A.4 above.

B.4 Mission(s) and program(s) supported

See Section II, B.4 above.

C.4 User community

See Section II, C.4 above.

D.4 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.4 above.

E.4 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.4 above.

F.4 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.4 and B.4 above.

G.4 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.4 above.

H.4 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See Section II, F.4 above.

I.4 Is use of commercial systems being considered as an alternative?

Not applicable.

J.4 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.4 above.

K.4 Identify systems, which may be used for COOP or COG activities

See Section II, I.4 above.

L.4 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.4 above.

M.4 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

It is possible that the FAA may consider this band for future use of aviation-related data links for air traffic control.

N.4 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

Not applicable.

O.4 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

International (oceanic) air traffic control would be expected to be significantly impacted, since a growing number of aircraft utilize AMS(R)S for ATC communications and ADS position reporting.

A.5 Function of System – Support Communications

The current support communications systems as described in Section II, A.5 above will continue to be used in the future. In addition a number of additional support communications are planned to be used within the NAS. For example, NextGen requires the deployment of new advanced sensors at airports in order to detect the varying conditions that may affect flight operations and wake vortices. Another example is a proposal to deploy wireless headsets for air traffic controllers. Since the headsets are a critical part of the FAA's air traffic communications system, commercially available unlicensed wireless headsets will not be used. FAA's wireless headsets will operate within properly allocated bands.

B.5 Mission(s) and program(s) supported

See Section II, B.5 above.

C.5 User community

See Section II, C.5 above.

D.5 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.5 above.

E.5 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.5 above. For the proposed wireless headsets, Federal/non-Federal shared Fixed/Mobile spectrum bands (e.g. 36 – 38.5 GHz) are being considered along with low power operation and very short range.

F.5 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.5 and B.5 above.

G.5 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

For the proposed wireless headsets, Federal/non-Federal shared Fixed and Mobile spectrum bands (e.g. 36 – 38.5 GHz) are being considered.

H.5 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See Section II, F.5 above.

I.5 Is use of commercial systems being considered as an alternative?

No, although the FAA will use a managed service thru the FAA Telecommunications Infrastructure office in conjunction with Harris Corporation for some radar microwave links.

J.5 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.5 above.

K.5 Identify systems, which may be used for COOP or COG activities

See Section II, I.5 above.

L.5 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.5 above.

M.5 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

Not applicable, since these systems are domestic in nature and do not interface directly with aircraft; therefore, no international standardization is required.

N.5 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

A planned relocation of 120 FAA systems out of the 1710-1755 MHz band to other bands or Telco is planned to be completed by 2010.

A planned replacement of existing RCL backbone microwave system with newer radios, which comply with the proposed NTIA channel plan for 7.125-8.5 GHz is also being pursued subject to the availability of funds as required by U.S. law.

O.5 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

Interoperability and interconnectivity between FAA facilities would be severely compromised, therefore significantly impacting the whole air traffic control system.

A.6 Function of System – NDB System

See Section II, A.6.

B.6 Mission(s) and program(s) supported

See Section II, B.6 above.

C.6 User community

See Section II, C.6 above.

D.6B Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.6 above.

E.6 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.6 above.

F.6 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.6 above.

G.6 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.6 above.

H.6 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

No new efforts are planned to improve the spectrum efficiency of the NDB systems.

I.6 Is use of commercial systems being considered as an alternative?

No

J.6 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.6 above.

K.6 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.6 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.6 above.

M.6 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

There are presently no new requirements that would require new international coordination.

N.6 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

There are approximately 2098 NDB frequency assignments, of which the majority, 1386, are non-FAA assignments. Many of the FAA supported NDBs have been operational for many years. While these systems continue to age, the potential of new systems, in particular GPS, have led planners to believe that in the very near future NDBs may be able to be decommissioned. However, based on the number of frequency assignment requests, in particular non-Federal, there is a continuing need for the present system of navigational aids (in particular, NDBs are needed in Alaska to provide weather information, in addition to the navigation capability).

While the future requirement for NDBs is anticipated to be mostly for non-Federal systems, some new ILS installations may have compass locator beacons associated with outer markers beacons (known as LOMs, an NDB service) associated with them. A planned phase-out of the aeronautical NDB system is expected to begin in the time period leading up to 2010 (Ref. 1). However, most NDBs that define low-frequency airways in Alaska or serve international gateways and certain offshore areas like the Gulf of Mexico will be retained (Ref 1). Consistent with this planned phase-out, the FAA has already decommissioned a number of Federal NDBs. The FAA's goal is to reduce the number of Federal NDBs to the minimum number possible. FAA has begun decommissioning stand-alone NDBs as users equip with GPS. NDBs used as compass locators, or as other required fixes for ILS approaches (e.g., initial approach fix, missed approach holding), where no equivalent ground-based means are available, may need to be maintained until the underlying ILS is phased out. Most NDBs that define low frequency airways in Alaska or serve international gateways and certain offshore areas like the Gulf of Mexico will be retained. In summary, a significant future NDB requirement is not expected, and, thus, it is considered that there will be sufficient spectrum resources available to satisfy any new NDB requirements.

O.6 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

The ability to satisfy the FAA mission would be compromised in Alaska and certain offshore areas.

A.7 Function of System – ILS Localizer Related System Elements

See Section II, A.7 above.

B.7 Mission(s) and program(s) supported

See Section II, B.7 above.

C.7 User community

See Section II, C.7 above.

D.7 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.7 above.

E.7 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.7 above.

F.7 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.7 above.

G.7 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.7 above

H.7 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems
None at this time

I.7 Is use of commercial systems being considered as an alternative?

There are a sizable number of non-Federal ILS systems in operation (see below). However, no consideration is being given to use commercial ILS systems as an alternative method for satisfying the precision approach/landing system requirement for the NAS.

J.7 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.7 above.

K.7 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.7 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.7 above.

M.7 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

While there are anticipated to be additional spectrum requirements related to ILS systems, it is not anticipated that any new action will be required in international forums.

N.7 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

There are approximately 1213 FAA and 392 non-FAA ILS localizer frequency assignments in this band. As the GPS-based augmentation systems (WAAS and LAAS) are

integrated into the NAS, and user equipage and acceptance grows, the number of CAT-I ILS may be reduced. FAA does not anticipate phasing out any CAT-II or III ILS systems until LAAS is able to deliver equivalent service and GPS vulnerability concerns are addressed. A reduction in the number of CAT-II/III ILS may then be considered. Until LAAS systems are available, new and upgrade CAT-II and III precision approach requirements will continue to be met with ILS.

It is judged that there will be sufficient spectrum resources available to make the remaining frequency assignments for the 2009 requirements. Spectrum resources are expected to be available to implement some additional ILS systems in lower traffic density areas of CONUS. However, it would be very difficult to make further ILS frequency assignments in some high traffic density areas, such as the New York City area. It is expected that there will be additional ILS implementation requirements for the years after FY-2009. This stems from the history of new ILS frequency assignments over the years. There have been a significant number of new frequency assignments each year since 1994 (including FAA, DOD, and other Government and non-Government requirements). According to the current NAS Capital Investment Plan, the ILS localizer requirements for new installations are a total of 23 during 2009 to 2013.

If the historical requirement for new ILS (with DME) systems continues at the present rate, the frequency requirements for them may not be able to be satisfied at many locations. Thus, action needs to be taken at the earliest possible date if the life of the ILS system is to be extended. Based on the expected growth of GPS-based capabilities, some relief may be on the horizon, with the planned phase out of ILS Category I systems beginning in the 2015 time period (Ref. 1).

O.7 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

The ability to satisfy the FAA mission would be compromised. This would be exhibited through an adverse impact on the national air transportation system, including major impacts on personal, business, and government transportation, and the national commerce as well.

A.8 Function of System – VOR System Elements

See Section II, A.8 above.

B.8 Mission(s) and program(s) supported

See Section II, B.8 above.

C.8 User community

See Section II, C.8 above.

D.8 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.8 above.

E.8 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.8 above.

F.8 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.8 above.

G.8 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.8 above.

H.8 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

None at this time

I.8 Is use of commercial systems being considered as an alternative?

There are a sizable number of non-Federal VOR systems in operation (see below). However, no consideration is being given to use commercial VOR systems as an alternative method for satisfying the navigation requirements being satisfied by the VOR system in the NAS.

J.8 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.8 above.

K.8 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.8 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.8 above.

M.8 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

While there are anticipated to be some additional spectrum requirements related to VOR systems, it is not anticipated that any new action will be required in international forums. As stated in earlier sections, 50 kHz receivers exist, as well as more stringent receiver filtering, both of which would support the availability of additional channels.

N.8 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

There are approximately 979 FAA and 112 non-FAA VOR frequency assignments in the 108-118 MHz band. In addition, possible new systems include the LAAS, and the possible future implementation of VHF A/G communications in the 112-118 MHz portion of the band (see above). The SBAS, which is the WAAS (Wide Area Augmentation System), is another alternative for en route navigation. The WAAS provides corrections and satellite reliability information to GPS receivers properly equipped, and the augmented signal can be translated into a precise geographic position. As the transition to SBAS navigation occurs, FAA will decide whether half the VORs can be decommissioned and during 2015 whether virtually all VORs could be decommissioned.

It is projected that there will be very few new VOR requirements. The new requirements will include some service upgrades (i.e., an increase in service volumes). Even so, there may not be sufficient spectrum to satisfy new VOR requirements, especially for implementation in high traffic density areas. Based on the implementation and use of GPS-based system capabilities, a planned phase out of the VOR system is expected to begin in the 2010 time period (Ref. 1).

Designated frequencies have been established for normal ramp testing of VOR receivers at 108.00 MHz and 108.05 MHz. Since many FM broadcast stations operate in close geographic proximity to the test stations, the FAA has had to provide test frequencies from operational channels higher in the band to avoid the potential for interference to the test facilities from the FM stations. Careful coordination is required to ensure that these non-typical test frequencies do not cause interference to operational VOR services.

O.8 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

The ability to satisfy the FAA mission would be compromised. This would be exhibited through an adverse impact on the national air transportation system, including major impacts on personal, business, and government transportation, and the national commerce as well.

A.9 Function of System – Local Area Augmentation System (LAAS)

LAAS is a GBAS being developed by FAA. LAAS is expected to provide the required accuracy, availability, integrity, coverage, and continuity to initially support CAT-I precision approaches and eventually CAT-II and III precision approaches. Unlike current ILS, a single LAAS ground station may provide precision approach capability to all runway ends at an airport. LAAS will augment GPS by providing local differential corrections to users via a VHF data broadcast. LAAS will allow suitably equipped aircraft to conduct precision approaches in the vicinity of LAAS-equipped airfields. LAAS will also allow suitably equipped aircraft to conduct curved approaches, segmented approaches, and more efficient parallel runway and surface operations. The FAA is conducting research and development for a CAT-III LAAS prototype by 2010 followed by design approval in 2012.

B.9 Mission(s) and program(s) supported

See Section II, B.9 above.

C.9 User community

See Section II, C.9 above.

D.9 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.9 above

E.9 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.9 above.

F.9 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.9 above.

G.9 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.9 above.

H.9 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See Section II, F.9 above.

I.9 Is use of commercial systems being considered as an alternative?

It is possible that some LAAS installations might be non-Federal systems.

J.9 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.9 above.

K.9 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.9 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.9 above.

M.9 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

There are presently no known new requirements that might result in an initiative in the ICAO forum.

N.9 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

Spectrum engineering carried out to date has identified sufficient spectrum resources above 112 MHz to satisfy these requirements based on the following assumptions: (1) only one transmitter at one site, using two time slots of the eight time slots available on a single 25 kHz frequency channel, would be required at each airport; and (2) a service altitude and distance no greater than 20,000 feet and 23 NM, respectively. If a larger coverage area, or additional transmitters and/or additional time slots would be needed to satisfy the navigation requirements for any of the airports analyzed, then the results of the analysis may not be valid.

It is expected that no new installations of the non-Federal SCAT-1 precision approach GPS-aided system in the future.

O.9 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

LAAS installation requirements are intended to satisfy new requirements, and potentially begin to replace ILS installations. As such, the ability to satisfy the FAA mission would be compromised if spectrum is not available to satisfy LAAS requirements. This would be exhibited through an adverse impact on the national air transportation system, including major impacts on personal, business, and government transportation, and the national commerce as well.

A.10 Function of System – ILS Glideslope Related Elements

See Section II, A.10 above.

B.10 Mission(s) and program(s) supported

See Section II, B.10 above.

C.10 User community

See Section II, C.10 above.

D.10 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.10 above.

E.10 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.10 above.

F.10 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.10 and B.10 above.

G.10 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.10 above.

H.10 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See Section II, F.10 above.

I.10 Is use of commercial systems being considered as an alternative?

There are a sizable number of non-Federal ILS systems in operation. However, no consideration is being given to use commercial ILS systems as an alternative method for satisfying the precision approach/landing system requirement for the NAS.

J.10 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.10 above.

K.10 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.10 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.10 above.

M.10 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

There are presently no plans for seeking to initiate an activity within an international forum, such as ICAO, to change the ILS Glideslope system element.

N.10 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

Substantial amounts of spectrum in this band will continue to be needed to operate CAT-II and III ILS glide slope subsystems even after CAT-I ILS have been decommissioned.

O.10 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

The ability to satisfy the FAA mission would be compromised. This would be exhibited through an adverse impact on the national air transportation system, including major impacts on personal, business, and government transportation, and the national commerce as well.

A.11 Function of System – Distance Measuring Equipment (DME)

See Section II, A.11

B.11 Mission(s) and program(s) supported

See Section II, B.11 above.

C.11 User community

See Section II, C.11 above.

D.11 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.11 above.

E.11 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.11 above.

F.11 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.11 above.

G.11 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.11 above.

H.11 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See Section II, F.11 above.

I.11 Is use of commercial systems being considered as an alternative?

As outlined above, there are 157 non-FAA DME frequency assignments within the NAS, thereby reflecting that there are a considerable number of commercial DME systems (there are 877 FAA systems). However, there is no plan to seek the utilization of commercial systems to satisfy the very large DME functional requirements in the NAS.

J.11 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.11 above.

K.11 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.11 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, F.11 and J.11 above.

M.11 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

There are presently no new proposals planned to be presented to an international forum (such as ICAO).

N.11 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

There is no plan to phase out the DME system within the next 10 years (See Ref. 1). As stated in Ref. 1, The FAA plans to sustain existing DME service to support enroute navigation, and to install additional low-power DMEs to support ILS precision approaches as recommended by the Commercial Aviation Safety Team. The FAA may also need to expand the DME network to provide a redundant RNAV capability for terminal area operations at major airports and to provide continuous coverage for RNAV operations at enroute altitudes.

Low Power DME (LPDME) will replace ILS marker beacons at existing and newly established Category I ILS locations. High Power DME (HPDME) will be used to support RNAV procedures that are used as a backup to satellite navigation. To support the Commercial Aviation Safety Team (CAST) recommendations, the DME program is procuring and installing DME systems at recommended sites. These systems will support the reduction of controlled-flight-into-terrain (CFIT) accidents at the most vulnerable locations in the NAS. There are 451 identified CAST DME sites. However, the FAA recommends installing DME at 177 locations. This number would cover 80 percent of all operations. For safety reasons, the industry wants to discontinue using step-down or “dive-and-drive” non-precision approach procedures, in which the pilot descends to the minimum allowable altitude to try to see the runway. Using DME minimizes the need to do this. To support RNAV requirements a minimum of 100 new HPDMEs will be required. An additional 150 HPDMEs will be required to replace the first generation 20 year old solid state DME technology collocated with VOR. These HPDMEs will support the planned reduction of VORs. These HPDMEs will be stand-alone thus reducing maintenance cost. The remaining 250 HPDMEs will need to be replaced within 15 years due to their age and supportability costs.

A new program has been initiated to implement DME-DME RNAV routes (including quick (Q) routes for enroute operations, and standard arrival (STAR) and standard instrument departure (SID) routes for terminal operations). These initiatives consist of expanding the Frequency Protected Service Volumes (FPSVs) of current installations to support the new operations.

Currently, there are also 24 DME NAS channels being used by the DOD for air-air refueling. While the DOD has indicated that these DME channels are presently needed to support the air-air refueling function, the potential for regaining at least some of these channels in the future for NAS operations should be investigated.

O.11 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

The ability to satisfy the FAA mission would be compromised. This would be exhibited through an adverse impact on the national air transportation system, including major impacts on personal, business, and government transportation, and the national commerce as well.

A.12 Function of System – Tactical Air Navigation (TACAN)

See Section II, A.12 above

B.12 Mission(s) and program(s) supported

See Section II, B.12 above.

C.12 User community

See Section II, C.12 above.

D.12 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.12 above.

E.12 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.12 above.

F.12 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.12 and B.12 above.

G.12 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.12 above.

H.12 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See Section II, F.12 above.

I.12 Is use of commercial systems being considered as an alternative?

No consideration is being given to use commercial TACAN systems as an alternative method for satisfying the navigation requirements being satisfied by the TACAN system for DOD users and civil aviation users of the DME function of the TACAN system in the NAS.

J.12 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.12 above.

K.12 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.12 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.12 above.

M.12 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

No new requirements are known which might require the development of new inputs into such international forums as the ICAO or the ITU.

N.12 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

The DoD requirement for land-based TACAN will continue until military aircraft are properly equipped with GPS; GPS PPS receivers are certified for all operations in both national and international controlled airspace; and the GPS support infrastructure including published procedures, charting, etc., is in place. A phase down of TACAN systems is planned for a future date, yet to be determined. Sea-based TACAN will continue in use until a replacement system is successfully deployed. The USN, USCG, and Military Sealift Command (MSC) operate several hundred sea-based TACAN stations.

It is projected that there will be very few new TACAN requirements. Sufficient spectrum should be available to satisfy any new TACAN requirements.

O.12 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

The ability to satisfy the FAA mission would be compromised. This would be exhibited through an adverse impact on the national air transportation system, including major impacts on personal, business, and government transportation, and the national commerce as well. In addition, the satisfaction of DOD navigation requirements would be severely compromised.

A.13 Function of System – Universal Access Transceiver (UAT)

See Section II, A.13

B.13 Mission(s) and program(s) supported

See Section II, B.13.

C.13 User community

See Section II, C.13.

D.13 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.13.

E.13 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.13.

F.13 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.13 and B.13.

G.13 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.13.

H.13 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See Section II, F.13.

I.13 Is use of commercial systems being considered as an alternative?

A large part of the UAT system consists of avionics, which are procured by the aircraft owners and, therefore, are commercial system elements by definition. It is not anticipated that the ground system elements will be commercial systems, stemming from, in part, the sensitivity of the aircraft positional data involved in the system operation.

J.13 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.13.

K.13 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.13 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.13.

M.13 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

ICAO SARPs for the UAT have been developed and approved. Thus, no additional actions are foreseen at this time regarding the UAT system design.

N.13 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

The UAT system implementation, taking into account both the ground and aircraft system elements, is continuing to expand. However, at this time, there is no foreseen need for additional spectrum to operate the UAT system.

O.13 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

The surveillance data received by both the ground system and the aircraft, stemming from the operation of the UAT system, is invaluable to the operation of the NAS. Any discontinuance of UAT operations would leave the NAS lacking in the surveillance data required to operate a safe and efficient national airspace system.

A.14 Function of System – Global Positioning System (GPS) System Elements

See Section II, A.14

B.14 Mission(s) and program(s) supported

See Section II, B.14

C.14 User community

See Section II, C.14.

D.14 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.14.

E.14 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.14.

F.14 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.14 and B.14.

G.14 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.14.

H.14 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See Section II, F.14

I.14 Is use of commercial systems being considered as an alternative?

A large portion of the GPS is comprised of avionics, which are commercial systems. Because of a number of factors, including the integrity of the ground system elements, it is not expected that the ground system elements will be commercial systems.

J.14 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.14.

K.14 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.14 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.14.

M.14 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

No new initiatives in international forums are foreseen.

N.14 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

GPS will be the primary Federally provided radionavigation system for the foreseeable future. GPS will be augmented and improved to satisfy future civil and military requirements for accuracy, availability, continuity, coverage, and integrity. WAAS will be modified to utilize the L5 signal provided by modernized GPS satellites, in lieu of the current semi-codeless L2 signal being utilized to determine ionospheric corrections. New dual-frequency WAAS avionics using L1 and L5 will improve the availability of Localizer Performance with Vertical Guidance (LPV) services.

No future spectrum requirement problems are foreseen regarding the GPS L1 and L5 civil signals, since they are worldwide, non-saturating (i.e., the number of users does not have any impact on the spectrum required for the service). Thus, they do not require any further frequency assignments. Likewise, the WAAS satellites operate on the same L1 frequency assignment as GPS, and, therefore, no future requirement issue is foreseen.

The GPS elements are expanding, but there is expected to be no impact on spectrum requirements.

The final report of the President's Commission on Critical Infrastructure Protection concluded that GPS services and applications are susceptible to various types of RFI, and that the effects of these vulnerabilities on civilian transportation applications should be studied in detail.

Because of the unique requirements of aviation, FAA will continue to develop enhanced interference detection and locating capabilities to help mitigate the impacts of RFI on present and future National Airspace System (NAS) systems.

O.14 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

The ability to satisfy the FAA mission would be severely compromised. This would be exhibited through an adverse impact on the national air transportation system, including major impacts on personal, business, and government transportation, and the national commerce as well.

A.15 Function of System – Microwave Landing System (MLS) Elements

See Section II, A.15

B.15 Mission(s) and program(s) supported

See Section II, B.15.

C.15 User community

See Section II, C.15.

D.15 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.15.

E.15 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.15.

F.15 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.15 and B.15.

G.15 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.15.

H.15 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See Section II, F.15.

I.15 Is use of commercial systems being considered as an alternative?

Airborne elements of the MLS largely consist of commercial system components. It is not anticipated that commercial ground system elements will be considered as an alternative to Government provided systems in the NAS.

J.15 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.15.

K.15 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.15 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.15.

M.15 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

No new U.S. proposals, etc. are anticipated with regard to the MLS. However, as noted below in Section N.15, new communications with ICAO are expected to be forthcoming regarding new uses of the 5030-5150 MHz band segment.

N.15 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

While the present MLS operational systems must be protected, there are presently no plans for the implementation of new MLS systems in the NAS. A planned phase-out of the MLS system is expected to begin in the post 2010 time period (see Ref. 1).

However there is a potential new requirement for an airport wireless local area network, which would operate in the broader 5091-5150 MHz band, and would include both aircraft-ground (within 2 nmi, during landing and departure) and ground-ground communication links. It will eliminate some of the existing costly cable runs between various airport facilities. At the request of the FAA, the RTCA established a special committee to develop standards for this network (the Airport Wireless Surface Communications System (AWSCS)) which would operate in the 5091-5150 MHz and potentially the 5000-5091 MHz as well. The FAA is also considering the band allocated to the aeronautical radionavigation service and reserved for MLS for future Unmanned Aircraft System (UAS) functions. The International Air Transport Association (IATA) has developed a system concept that would operate within the 5000-5150 MHz band. Therefore, the entire 5000-5150 MHz band needs to be protected for future ARNS usage.

The FAA is also facing a future crisis in the lack of adequate spectrum to satisfy the continuing need for point-to-point and point-to-multipoint communication links for transferring air traffic control related information. Thus, the FAA is developing a proposal to use a portion of the 5090-5150 MHz band to satisfy such future fixed communications needs. A channel design structure similar to that of the 900 MHz band is being considered.

O.15 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

If sufficient spectrum was not available to operate the present MLS implementation, there would be a limited capability to satisfy, in particular, Category II and III precision landing requirements at several of the large international airports.

A.16 Function of System – ATCRBS/SSR Related System Elements

See Section II, A.

B.16 Mission(s) and program(s) supported

See Section II, B.16.

C.16 User community

See Section II, C.16.

D.16 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.16.

E.16 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.16

F.16 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.16 and B.16.

G.16 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.16.

H.16 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See N.16 below and Section II, J.16.

I.16 Is use of commercial systems being considered as an alternative?

Avionics components for the ATCRBS/SSR are obtained as commercial system elements. However, it is anticipated that the ATCRBS/SSR ground system for the NAS will continue to be provided as a Federal system.

J.16 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.16.

K.16 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.16 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.16.

M.16 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

No new U.S. proposals to the ICAO, etc. are foreseen at the present time regarding the use of ATCRBS/SSR.

N.16 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

The FAA Runway Incursion Reduction and the Safe Flight 21 Programs have introduced several new technologies that use 1030/1090 MHz. The use of multilateration in conjunction with the ASDE-3 and ASDE-X programs to provide aircraft identification for surface surveillance will have the biggest impact on the capacity of the 1030/1090 MHz frequency pair. Multilateration has the potential to be implemented at 79 airports initially, and possibly many more airports will be identified to receive this capability in future years.

To improve surface surveillance, experimentation using 1030/1090 MHz to track vehicles operating on the runway movement area is being conducted. If this function proves beneficial, such a vehicle tracking capability could be added at airports equipped for multilateration. Studies have been initiated to determine the feasibility of expanding the vehicle tracking capability to the "airplane side of the airport" (e.g., ramp areas and de-icing stations).

ADS-B is an additional 1030/1090 MHz function being implemented for use by the civil aviation community. The Volpe National Transportation Systems Center was contracted by the FAA to conduct studies to ensure that 1030/1090 MHz would have the capacity to accommodate these additional functions without negatively affecting the performance of existing functions. These studies assumed the implementation of ongoing system improvements and a forecast of future traffic. The impact of adding multilateration, including ground vehicle tracking, and ADS-B was an approximate 3% reduction in current ATCRBS “round-reliability” performance. FAA Air Traffic Organization Enroute and Oceanic Services (ATO-E) and FAA Air Traffic Organization Terminal Services (ATO-T) chose to accept this negligible degradation so that the benefits of the new system functions can be realized. Area multilateration was tested in Memphis, Tennessee; and over the Gulf of Mexico. It is also being tested at the Patuxent Naval Air Station. In addition, it is planned that a small number of PRM and TLS systems will be implemented.

O.16 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

The ability to satisfy the FAA mission would be severely compromised. This would be exhibited through an adverse impact on the national air transportation system, including major impacts on personal, business, and government transportation, and the national commerce as well.

A.17 Function of System – Air Route Surveillance Radar (ARSR)

See Section II, A17

B.17 Mission(s) and program(s) supported

See Section II, B.17.

C.17 User community

See Section II, C.17.

D.17 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.17.

E.17 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.17.

F.17 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.17 and B.17.

G.17 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.17.

H.17 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See Section II, F.17.

I.17 Is use of commercial systems being considered as an alternative?

The FAA does not foresee that commercial systems will be considered as an alternative for providing the ARSR service.

J.17 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.17.

K.17 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.17 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.17 above.

M.17 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

No new requirements are anticipated at this time.

N.17 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

The DOD has assumed primary responsibility for the operation and maintenance of ARSR systems. An arrangement has been made with the Office of Management and Budget for the DOD to fund the operation and maintenance of ARSR facilities by reimbursing the FAA for technician and engineering support to those facilities. FAA personnel will continue to provide nearly all maintenance and engineering support to ARSR facilities, and the FAA is still responsible for protecting the radio frequency spectrum used by these long range radar systems. Although the FAA primarily depends on co-operative SSR data for en-route air traffic control services, it recognizes the benefits of the non-cooperative primary radar service and therefore, continues to receive and use the ARSR data at all Air Route Traffic Control Centers (ARTCC).

At the present time no future requirements are predicted for additional ARSR systems for the NAS; however, a service life extension program has been initiated to upgrade the ARSR systems that service the interior of the United States.

O.17 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

From the broad U.S. perspective, the primary function of ARSR systems is national security. However, the FAA still finds the ARSR data valuable (See N.17 above).

A.18 Function of System – Airport Surveillance Radar (ASR)

See Section II, A..18

B.18 Mission(s) and program(s) supported

See Section II, B.18.

C.18 User community

See Section II, C.18.

D.18 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.18.

E.18 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.18.

F.18 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.18 and B.18.

G.18 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.18.

H.18 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See Section II, E.18.

I.18 Is use of commercial systems being considered as an alternative?

The FAA does not now see a possibility for using commercial systems to satisfy the NAS ASR functions.

J.18 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.18.

K.18 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.18 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.18.

M.18 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

No new initiatives are foreseen.

N.18 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

O.18 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

The lack of ASR services would essentially leave terminal air traffic control blind to aircraft that might not have an SSR capability (e.g., general aviation aircraft) or might have a failed SSR transponder. Thus, ASR coverage is necessary to ensure that all aircraft can be seen in this busy airspace environment. In summary, a severe degradation of safety would result in terminal airspace without the availability of ASR.

A.19 Function of System – Next Generation (Weather) Radar (NEXRAD)

See Section II, A.19 above.

B.19 Mission(s) and program(s) supported

See Section II, B.19 above.

C.19 User community

See Section II, C.19 above.

D.19 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.19 above.

E.19 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.19 above.

F.19 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.19 and B.19 above.

G.19 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.19 above.

H.19 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See Section II, F.19 above.

I.19 Is use of commercial systems being considered as an alternative?

Both the ASR and NEXRAD systems operating in the 2700-3000 MHz band are Federal systems. It is not expected that commercial systems will be employed to satisfy these requirements.

J.19 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.19 above.

K.19 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.19 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.18 above.

M.19 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

No new or planned spectrum requirements that may require international attention are foreseen at the present time.

N.19 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

Future requirements for additional ASR and NEXRAD radars for the NAS that operate within the 2700-3000 MHz band are under study and the FAA may need the 3500-3650 MHz band for future radar expansions.

O.19 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

The services provided by the NEXRAD weather radar system are invaluable to NAS operations. Clearly, any impact on the current and planned operation of this system would be highly detrimental to the capacity and safety of the civil aviation system, severely impacting air commerce and the air transport of passengers.

A.20 Function of System – Terminal Doppler Weather Radar (TDWR)

See Section II, A.20 above.

B.20 Mission(s) and program(s) supported

See Section II, B.20 above.

C.20 User community

See Section II, C.20 above.

D.20 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.20 above.

E.20 Technical Parameters of System (bandwidth, frequencies, etc.)
See Section II, E.20 above.

F.20 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.20 and B.20 above.

G.20 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.20 above.

H.20 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See Section II, F.20 above.

I.20 Is use of commercial systems being considered as an alternative?

No, commercial systems are not being considered to satisfy NAS TDWR requirements.

J.20 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.20 above.

K.20 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.20 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.20 above.

M.20 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

No new requirements outside the 5600-5650 MHz band segment are contemplated at this time, therefore no new initiatives in international forums are foreseen.

N.20 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

The FAA has a number of service life extension programs. The existing TDWRs will continue to operate..

O.20 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

The services provided by the TDWR weather radar system are invaluable to NAS operations. Clearly, any impact on the current and planned operation of this system would be highly detrimental to the capacity and safety of the civil aviation system, severely impacting air commerce and the air transport of passengers.

A.21 Function of System – Airport Surface Detection Equipment (ASDE)

See Section II, A.21

B.21 Mission(s) and program(s) supported

See Section II, B.21 above.

C.21 User community

See Section II, C.21 above.

D.21 Geographical coverage (US&P, specified areas within US&P or outside US&P)

See Section II, D.21 above.

E.21 Technical Parameters of System (bandwidth, frequencies, etc.)

See Section II, E.21 above.

F.21 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section II, A.21 and B.21 above.

G.21 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

See Section II, G.21 above.

H.21 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

See Section II, F.21 above.

I.21 Is use of commercial systems being considered as an alternative?

No, commercial systems are not being considered to satisfy ASDE requirements for the NAS.

J.21 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

See Section II, H.21 above.

K.21 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.21 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

See Section II, J.21 above.

M.21 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

No new initiatives in international forums are foreseen as being needed at this time.

N.21 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

Ten (10) additional ASDE-X systems will be installed by 2013. FAA is testing a new system, the Low Cost Ground Surveillance (LCGS) system operating the 9.0-9.2 GHz band, and it may be deployed in 2010. LCGS would be used at small to medium-sized airports to increase the number of airports that use sophisticated detection system to show the location of aircraft and other vehicles near the runways and taxiways on tower displays, which would enhance to reduce runway incursions. In addition, the FAA is investigating development and use of Synthetic Vision System (SVS) in the bands 34.7-35.2 GHz and 92-100 GHz for precision landing guidance in low-visibility conditions. RTCA Special Committee SC-213 is currently developing Minimum Aviation System Performance Standards (MASPS) level guidance for SVS.

No future requirements are predicted for ASDE-3 systems. See Section II, J.21.

O.21 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

The service provided by the ASDE radar system is invaluable to the safety and efficiency of NAS ground system operations. Clearly, any impact on the current and planned operation of this system would be highly detrimental to operation of those airports where ASDE operates, or is planned to operate. Since these airports handle a heavy load of traffic, the civil air transport system would be severely impacted, affecting both air freight and passengers.

A.22 Function of System - Automated Dependant Surveillance – Broadcast (ADS-B)

The function of ADS-B is to determine aircraft position and to broadcast the position information to ground stations and other aircraft.

B.22 Mission(s) and program(s) supported

ADS-B will be one of the critical elements of the FAA's NextGen Plan to transition from ground-based surveillance systems to satellite-based surveillance systems. An ADS-B-equipped aircraft determines its own position (longitude, latitude, altitude, and time) using GPS and periodically broadcasts this position and other relevant flight information (such as identification, indication of climb or descent angle, velocity, next waypoint etc.) to potential ground stations and other aircraft with ADS-B equipment. ADS-B is used over two different data link technologies, Mode-S Extended Squitter (1090 ES) and Universal Access Transceiver (978 MHz UAT), The FAA will extend the ADS-B capability by installing ADS-B ground equipment across the entire U.S. by 2013 (794 ground stations). This will allow pilots of equipped aircraft to see airborne traffic, weather conditions, and flight-restricted areas on their cockpit displays.

Furthermore, ADS-B will provide surveillance to areas that currently do not have radar coverage, including the Gulf of Mexico. The Traffic Information System (TIS-B), which broadcasts over ADS-B transmitters, can provide surveillance data about both ADS-B and non-ADS-B equipped aircraft, providing a more complete "picture" of nearby air traffic. Flight Information Services (FIS-B) provide ground-to-air broadcast of non-air traffic control advisory information, which provides users valuable, near real-time information to operate safely and efficiently. FIS-B products include graphical and textual weather reports and forecasts, Special Use Airspace Information, Notices to Airmen, and other aeronautical information.

The nationwide implementation of ADS-B will enable a once-per-second transmission of location and other flight information from the aircraft to replace or supplement the transponder response or passive reflected energy from radars. The advantage of ADS-B is that it has a faster update rate (1 second versus 5 seconds for a radar), and the accuracy remains constant regardless of the distance from the aircraft to the receiving site, unlike radar technology where accuracy declines with distance.

C.22 User community

United States commercial, business, and general aviation users, and foreign civil aircraft flying into and out of the United States. In addition, the user community includes DOD aircraft utilizing the NAS.

D.22 Geographical coverage (US&P, specified areas within US&P or outside US&P)

The coverage is the entire US&P.

E.22 Technical Parameters of System (bandwidth, frequencies, etc.)

ADS-B receives the GPS L1 signal on 1575.42 MHz and broadcasts aircraft position on either 1090 MHz (mostly commercial transport aircraft) or 978 MHz (general aviation aircraft). ADS-B ground stations operate on 1090 MHz.

F.22 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section A.22 above.

G.22 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

Yes.

H.22 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

Being investigated.

I.22 Is use of commercial systems being considered as an alternative?

All the airborne ADS-B equipment are commercial systems. Some of the ADS-B ground systems will be Non-Federal systems.

J.22 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

None

K.22 Identify systems, which may be used for COOP or COG activities

None

L.22 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

Equipage of ADS-B on board aircraft must be done in order to have a fully successful transition to the satellite based surveillance.

M.22 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

None at this time

N.22 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

The Segment 1 of the ADS-B program, which is scheduled to be completed by 2010, provides 3 and 5-mile separation standards using ADS-B as a surveillance source. The areas that Segment 1 will focus on are: Gulf of Mexico (Communications, Weather, and Surveillance); Louisville, KY (Surveillance/TIS-B/FIS-B); Philadelphia, PA (Surveillance/TIS-B/FIS-B); Southeast Alaska, Juneau Area (Surveillance/TIS-B/FIS-B and Wide Area Multilateration); and Expansion of Broadcast Services – East Coast, Midwest to North Dakota, Western Arizona through California and Oregon, (TIS-B/FIS-B). Segment 2 of the program is expected to begin in FY 2009 and the schedule for deployment of services for the remainder of the NAS will be developed jointly by the FAA and the service provider, ITT, based on a roadmap that will provide for maximum operational benefit and based on the potential for early equipage and a select pocket of users that will optimize the user and government benefits. All 794 ADS-B ground stations will be deployed by 2013.

A.23 Function of System – Unmanned Aircraft System (UAS)

A UAS is an aircraft that is flown without a pilot–in-command onboard and is controlled from another location (ground, another aircraft, space) or programmed and fully autonomous. The UAS includes the aircraft, control system, and operator.

B.23 Mission(s) and program(s) supported

UAS operations are some of the most demanding operations in NextGen. UAS operations include scheduled and on-demand flights for a variety of civil, military, and state missions.
Because of the range of operational uses, UAS operators may require access to all NextGen airspace. UASs are expected to fly in trajectory-based airspace. The UAS operators are capable of conducting the procedures required for the airspace and must achieve the same target level of safety against collisions as manned aircraft. Because UASs may also operate in airspace in which cooperative surveillance may not be required, they have the responsibility for sensing and avoiding other aircraft. This may include responsibility for separating from aircraft that do not have cooperative surveillance in some airspace.

C.23 User community

United States commercial, business, and general aviation users, and foreign civil aircraft flying into and out of the United States. In addition, the user community includes DOD aircraft utilizing the NAS.

D.23 Geographical coverage (US&P, specified areas within US&P or outside US&P)

The coverage is the entire US&P.

E.23 Technical Parameters of System (bandwidth, frequencies, etc.)

Detailed spectrum requirements for UAS have not been identified yet. However, it is expected that considerably large amount of spectrum would be needed for UAS. Based on the studies performed to date, the total UAS bandwidth requirements are 28 MHz if line-of-sight systems are used; 49 MHz if satellite spot-beam used; and 56 MHz if satellite regional-beam used. RTCA Special Committee SC-203 is currently developing the Minimum Aviation System Performance Standards (MASPS) for UAS.

F.23 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section A.23 above.

G.23 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

Yes.

H.23 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

Being investigated.

I.23 Is use of commercial systems being considered as an alternative?

Being investigated

J.23 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

Being investigated

K.23 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.23 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

Being investigated.

M.23 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

Being investigated.

N.23 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

The FAA's Flight Pan for 2007-2011 calls for development of policies, procedures, and approval processes to enable operation of Unmanned Aircraft Systems (UASs). One of the FAA's research program is to conduct field evaluation of detect, sense, and avoid technology; command, control, and communications technologies; and flight termination procedures for UAS.

O.23 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

UAS operations would continue to be supported outside the NAS.

A.24 Function of System – Airport Wireless Local Area Network

Airport wireless local area network will operate in the broader 5091-5150 MHz, and perhaps 5000-5030 MHz bands to provide wireless paths at some airports for both aircraft-ground (within 2 nmi during landings and departure) and ground-ground communications links.

B.24 Mission(s) and program(s) supported

Airport wireless local area network will eliminate some existing costly cable runs between various airport facilities (e.g. interconnections of ASDE-X sensors) thereby reducing the operating cost as well as to provide more efficient communications capabilities at airport.

C.24 User community

United States commercial, business, and general aviation users, and foreign civil aircraft flying into and out of the United States. In addition, the user community includes DOD aircraft utilizing the NAS.

D.24 Geographical coverage (US&P, specified areas within US&P or outside US&P)

The coverage is the entire US&P.

E.24 Technical Parameters of System (bandwidth, frequencies, etc.)

Airport wireless local area network will operate in 5091-5150 MHz and perhaps in 5000-5030 MHz.

F.23 Descriptions of agency functionalities (day-to-day operations, scenario-driven, new functionalities), new functionalities), to be supported by spectrum-dependent systems (such as mobile broadband applications)

See Section A.24 above.

G.24 Is consideration being given to sharing of system/spectrum with other Federal agencies and/or non-Federal entities?

Yes.

H.24 Planned use of new technologies and other efforts to improve spectrum efficiency in these systems

Being investigated and developed.

I.24 Is use of commercial systems being considered as an alternative?

Being investigated

J.24 For spectrum-supported systems used in border areas or outside US&P, anticipated spectrum management challenges and planned actions to address such challenges

Being investigated

K.24 Identify systems, which may be used for COOP or COG activities

Not applicable.

L.24 Description of challenges in implementing or operating future spectrum-dependent systems, such as difficulties in obtaining suitable frequency assignments or sufficient bandwidth, frequency band and/or geographic congestion problems, or potential RF interference. Describe actions the agency is taking to address such challenges.

Being investigated.

M.24 Identify new and/or planned additional spectrum requirements may require consideration of development of U.S. proposals, positions, and strategies within regional and international regulatory and standard-setting entities.

Being investigated and considered.

N.24 Future (5-10 year) plans for system(s), e.g., are systems expected to continue as currently planned (scale-wise, spectrum use, etc.) expand, contract, planned for phase-out, and the resulting impact on spectrum requirements for these systems.

At the request of the FAA, the RTCA established a special committee to develop standards for the airport wireless local area network (tentatively termed the Aeronautical Mobile Airport Communications System (AeroMACS)) which would operate in the 5091-5150 MHz band and potentially portions of the 5000-5091 MHz band as well.

O.24 Impact on ability to meet agency missions if spectrum is not available for these planned future systems.

Future airport communications requirements may not be satisfied.

IV. Current use of Commercial Spectrum-Dependent Licensed Systems (Changes since September 2007 Agency Plan submission)

A. Challenges or obstacles to using commercial systems such as cost, procurement, administrative, and uncertainty as to future availability of commercial system

A primary concern with regard to utilizing commercial systems is the lack of frequency protection assurance. It is usually not possible to obtain a guarantee of interference free service.

B. Trends with respect to use (increase, decrease, anticipated future use)

The trend is increased use, due in part to the possible implementation of the Next Generation Air Transportation System.

C. Systems used

ARINC for oceanic HF air-ground voice communications and VHF air-ground data link communications; leased satellite communications (for interfacility links) in the Alaskan NAS Interfacility Communications System (ANICS) and the FAA Telecommunications Satellite System (FAATSAT); and satellite phone communications (for emergency and backup) using the Mobile Satellite Ventures (MSV) system.

D. Frequency bands and bandwidth

For ARINC HF communications, see Section II. ARINC VHF data link communications uses a bandwidth of 25 kHz per channel. ANICS utilizes the 5925-6425 MHz for the uplink and 3700-4200 MHz for the downlink, with bandwidths of 50 kHz up to 400 MHz. The FAATSAT operates in 14.0-14.5 GHz for the uplink and 11.7-12.2 GHz for the downlink and operates over various bandwidth channels.

E. Agency Function(s), program(s) and missions supported by commercial systems

ARINC services are utilized to provide HF oceanic air-ground voice communications and VHF air-ground data link communications; ANICS and the FAATSAT are used for inter-facility communications; and the MSV satellite phone service is used for emergency/backup communications.

F. Identify systems used for COOP, COG, emergency communications etc.

The MSV satellite phone service is used with FAA owned ground stations for emergency/backup communications.

G. Lessons learned/best practices in using commercial spectrum-dependent systems

There have been problems in gaining authorization from the NTIA or FCC to obtain proper licenses, there is limited flexibility in obtaining or modifying licenses, and there are significant problems with obtaining interference free service guarantees.

V. Future Planned or Anticipated Use of Commercial Spectrum-Dependent Licensed Systems

A. Challenges or obstacles to using commercial systems such as cost, procurement, administrative problems, and uncertainty as to future availability of commercial system

See A, Section IV above.

B. Trends with respect to use (increase, decrease, anticipated future use)

See B, Section IV above.

C. Systems used

See C, Section IV above. In addition, it is expected that the Next Generation Air Transportation System will begin to be implemented in the next several decades, of which some system elements may be commercial spectrum-dependent in nature.

D. Frequency bands and bandwidth

See D, Section IV above.

E. Agency Function(s) and missions supported by commercial systems

See E, Section IV above.

F. Identify systems used for COOP, COG or emergency communications etc.

See F, Section IV above.

G. Lessons learned/best practices in using commercial spectrum-dependent systems

See G, Section IV above.

VI. Agency Current and Anticipated Use of Unlicensed Systems and Devices

A. Challenges and/or concerns (safety of life, congestion, etc.)

The FAA does not allow the use of unlicensed systems or devices for safety of life services due to the potential for interference and the lack of any protection from interference. The FAA may consider unlicensed systems or devices for non-safety of life services, such as administrative services. Since there is a trend to an increased use of unlicensed systems and devices, the challenge of FAA spectrum management is to have adequate resources to review proposals for such usage to ensure that there will be no interference to civil aviation safety of life services.

B. Trends over past five years in use of unlicensed systems and devices (increasing, decreasing)

Increasing.

C. Types of unlicensed systems and devices utilized

Wireless cameras, cell phones, equipment status.

D. Frequency bands of unlicensed systems and devices utilized

2.4 GHz and 5.8 GHz.

D.1. Function of devices, agency functions supported and missions supported by use of unlicensed devices

Administrative, physical security, remote monitoring.

D.2. Future plans, current evaluation of, and expected use of unlicensed systems and devices

A new future requirement for wireless headsets to be used by air traffics controllers is being investigated. All currently available commercial wireless headsets are unlicensed devices and would not satisfy the FAA's safety requirement because of potential radio frequency interference. The FAA is currently investigating the possibility of developing licensed wireless headsets that would operate in property authorized bands. One potential band being considered is the fixed/mobile band 36-38.5 GHz.

D.3. Whether unlicensed systems or devices are used or planned for use for COOP, COG, emergency communications, and if so, what systems

None.

E. Lessons learned/best practices in using unlicensed systems and devices systems

Maximize usage of these systems and devices to the extent possible for administrative purposes.

VII. Evaluation of New Technologies for Potential Use in Federal Agency Spectrum-dependent Systems

A. New technologies being studied and evaluated

The FAA is evaluating another type of en-route surveillance radar called Wide Area Multilateration (WM/LAT) during 2007 and 2010 in Colorado. It operates on 1030/1090 MHz and uses triangulation to determine the location of an aircraft that cannot be detected by radar. In mountainous terrain. The line-of-sight transmission from a radar can be blocked by an intervening mountain between the radar and the aircraft. The WM/LAT system overcomes this problem, and will be implemented in Juneau, Alaska and other mountain regions if it proves to be successful.

The FAA is also planning to install a new radar system called CARSR operating on two pairs of frequencies separated by 5.18 MHz in the band 1240-1350 MHz. The CARSR includes a motor control unit that syncs all of the CARSR antennas to rotate and pass through true north at the same time thereby eliminating main beam to main beam coupling between CARSRs.

B. Expected impact of the use of new technologies on meeting communications requirements, e.g., providing more functionality, enhancing ability to support agency missions, facilitating sharing with other Federal agencies or non-Federal entities, and either increasing or decreasing spectrum requirements

The trend is to gain more functionality and satisfy the future, increased, requirements with a minimum amount of additional spectrum.

C. Challenges to implementing new technologies (e.g., legacy equipment, validation of new technologies, costs, budget, organizational support)

While legacy systems, validation of new technologies, costs for new system elements, and ensuring adequate resources to implement, operate, and maintain new system elements are all major challenges, a significant challenge will continue to be the very large number of aircraft (several hundred thousand) that are equipped with “the present system”, and the projected costs for, and time period to implement, new system elements in the aircraft.

VIII. Spectrum Management Organization and Integration with Agency Strategic Planning and Capital Planning

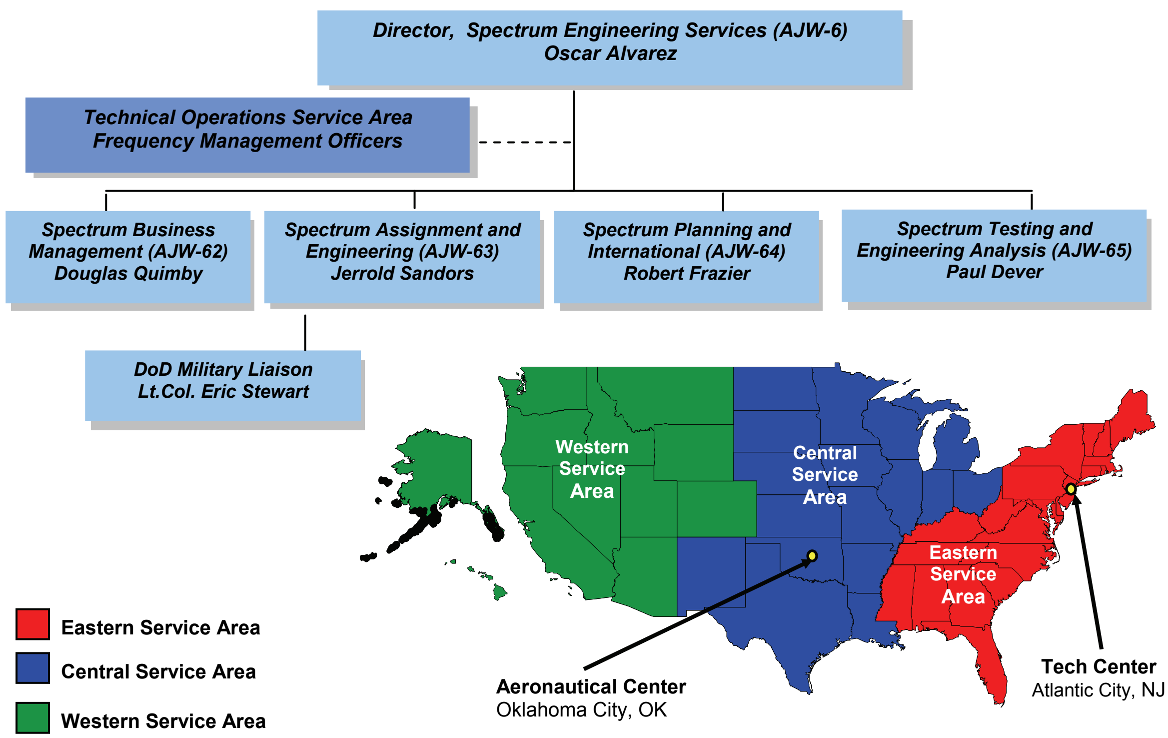
A. Organization chart showing where spectrum management function is located, key staff positions and reporting structure

The FAA Spectrum Engineering Services Organization, AJW-6, is located in the FAA organization as follows (starting at the top of the FAA organization):

FAA Administrator, FAA Deputy Administrator, Chief Operating Officer for Air Traffic Organization, Vice President for Technical Operations, and Director for Spectrum Engineering Services.

The Organizational chart for Spectrum Engineering Services is presented below:

Figure 4: Spectrum Engineering Services Organizational Chart



B. Flowchart showing strategic spectrum management activity within agency, and progress made with respect to formalizing strategic spectrum planning activities

As required by the FAA Acquisition Management System (AMS), spectrum review and certification is required for all programs seeking investment decisions by the agency's approval body, the Joint Resources Council (JRC), prior to investment approval. The AMS contains flowcharts for each phase of the decision making process. In particular, prior to the investment analysis readiness decision, spectrum requirements for the program need to be identified and incorporated into the preliminary requirements document and investment analysis plan. Prior to the final investment analysis decision, spectrum certification must be obtained from NTIA for systems that utilize radio frequencies. In both cases, the FAA Spectrum Engineering Services office performs the required analyses and confirms completion of these activities prior to the decision. (Reference: the JRC Readiness Criteria and Checklist, 8/16/07) .

The FAA AMS Requirements Document, Section 5.4, Spectrum Management, states:
Define requirements for spectrum management, including certification of radio spectrum availability. Ensure spectrum compatibility with the rest of the Enterprise Architecture.

C. Relationship of agency strategic spectrum management activity with preparation of system certification and frequency assignment requests

See response to B above. Spectrum certification is obtained by the agency from NTIA prior to approval of proposed investments, and, thus, prior to acquisition of systems or requests for particular frequency assignments.

D. How spectrum management is integrated with agency strategic planning and program planning activities and improved integration over past 3-5 years

See response to B above. The current JRC readiness process was updated in 2007 to ensure that spectrum considerations were incorporated into the JRC Readiness Criteria and Checklist.

E. How spectrum management is integrated with Agency Capital Planning, including flowchart of internal agency process utilized to comply with Office of Management and Budget (OMB) requirements and how this has changed over the past 3-5 years

The FAA AMS serves as the agency's capital planning process. The AMS is consistent with OMB requirements in Circular A-11. The AMS contains flowcharts for each phase of the decision making process. AMS policy, 1.1.3, Legal Basis for the Policy states:

The FAA developed the Acquisition Management System in response to Section 348 of Public Law 104-50. The AMS supersedes the Major Acquisition Policies and Procedures of the Department of Transportation and all other acquisition and procurement statutes and regulations, including the Federal Acquisition Regulation. Contracts awarded prior to April 1, 1996, remain under the Federal Acquisition Regulation until bilateral modification brings them under the Acquisition Management System. AMS policy takes precedence over all other FAA policy dealing with any aspect of lifecycle acquisition management and related disciplines. The AMS serves as the FAA's Capital Planning and Investment Control (CPIC) process.

F. Spectrum office contacts, to include staff, addresses, phone, fax and e-mail for questions relating to agency-specific plan

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FAA References

1. "2008 Federal Radionavigation Plan", the official source of radionavigation policy and planning for the Federal Government, published jointly by the Departments of Defense, Homeland Security, and Transportation, DOT-VNTSC-RITA-08-02/DOD-4650.5.

2. "Spectrum Management Study to Determine the Feasibility of Protecting the New GPS Civil Signal L5 From RFI", by ATO-W ATC Spectrum Engineering Services, September 2003.

3. "Assessment of Radio Frequency Interference Relevant to the GNSS L5/E5A Frequency Band, DO-292, by RTCA, Incorporated (prepared by Special Committee (SC) 159), July 29, 2004.

4. “FAA’s NextGen Implementation Plan 2009”

5. “FAA’s National Airspace System Capitol Investment Plan for Fiscal Years 2009 – 2013”

6. “2009-2013 FAA Flight Plan—Charting the Path for the Next Generation”

7. FAA’s “National Aviation Research Plan 2008” dated February 2008

8. FAA Joint Planning & Development Office “Concept of Operations for the Next Generation Air Transportation System-Version 2.0” dated 13 June 2007

Table of Acronyms

AAC	Aeronautical Administrative Communications
ADS	Automatic Dependent Surveillance
ADS-B	ADS-Broadcast
A/G	Air-Ground
ALE	Automatic Link Establishment
AIS	Automatic Identification System
AM(R)S	Aeronautical Mobile (Route) Service
AMS	FAA Acquisition Management System
AMS(R)S	Aeronautical Mobile Satellite (Route) Service
ANICS	Alaskan NAS Inter-facility Communications System
ANLE	Airport Network and Location Equipment
AOC	Aeronautical Operational Control
APC	Aeronautical Passenger Communications
ARAC	Aviation Rulemaking Advisory Committee
ARINC	Aeronautical Radio, Incorporated
ARNS	Aeronautical Radionavigation Service
ARSR	Air Route Surveillance Radar
ARTCC	Air Route Traffic Control Center
ASDE	Airport Surface Detection Equipment
ASOS	Automated Surface Observation System
ASR	Airport Surveillance Radar
AST	FAA Office of Commercial Space Transportation
ASTM	American Society of Testing and Materials
ATC	Air Traffic Control
ATC	Automatic Train Control
ATCBI	ATC Beacon Interrogator
ATCRBS	ATC Radar Beacon System
ATO-E	FAA Air Traffic Organization Enroute and Oceanic Services
ATO-T	FAA Air Traffic Organization Terminal Services
ATO-W	FAA Air Traffic Organization Technical Operations Services
ATS	Air Traffic Service
AWOS	Automated Weather Observation System
AWSCS	Airport Wireless Surface Communications System
CARSR	Common Air Route Surveillance Radar
CAST	Civil Aviation Safety Team
CB	Citizen Band
CIP	Capital Investment Plan
COG	Continuity of Government
CONUS	Continental United States
COOP	Continuity of Operations
CORS	Continuously Operating Reference Station
CY	Calendar Year
DHS	Department of Homeland Security
DOC	Department of Commerce
DOD	Department of Defense
DOT	Department of Transportation
DME	Distance Measuring Equipment
DSB-AM	Double Sideband-Amplitude Modulation
DSRC	Dedicated Short Range Communications Systems
eLoran	Enhanced Loran
ESV	Expanded Service Volume
EUROCONTROL	European Organization for the Safety of Air Navigation

FAA	Federal Aviation Administration
FAATSAT	FAA Telecommunications Satellite System
FCC	Federal Communications Commission
FBMLS	Fixed Base Microwave Landing System
FHWA	Federal Highway Administration
FIS-B	Flight Information Service- Broadcast
FISDL	Flight Information Service-Data Link
FM	Frequency Modulation
FMCSA	Federal Motor Carrier Safety Administration
FPSV	Frequency Protected Service Volume
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
FY	Fiscal Year
GLONASS	Russian Satellite Navigation System
GNSS	Global Navigation Satellite Service
GPS	Global Positioning System
HA_NDGPS	High Accuracy Nationwide Differential GPS
HAR	Highway Advisory Radio
HF	High Frequency
HFDL	HF Data Link
HIVs	High Interest Vehicles
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ID	Identification
IEEE	Institute of Electrical and Electronics Engineers
ILS	Instrument Landing System
IMO	International Maritime Organization
Inmarsat	International Maritime Satellite Organization
IOC	Initial Operational Capability
ITS	Intelligent Transportation Systems
ITS-JPO	Intelligent Transportation Systems Joint Program Office
ITU	International Telecommunications Union
JRC	FAA Joint Resources Council
JTIDS/MIDS	Joint Tactical Information Distribution System/Multifunctional Information Distribution System
LAAS	Local Area Augmentation System
LCGS	Low Cost Ground Surveillance
L1	GPS Civil Navigation Signal
L2	GPS DOD Signal
L5	GPS Civil Navigation Signal (Planned)
MAC	Media Access Layer
MARAD	Maritime Administration
MASAD	Multi-Service Access Devices
MASPS	Minimum Aviation System Performance Standards
MLS	Microwave Landing System
MMLS	Mobile MLS
Mode-S	SSR Mode Select
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MSV	Mobile Satellite Ventures
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NAVTEX	Navigation Telex Radio
NDB	Non-Directional Beacon
NDGPS	Nationwide Differential GPS
NEXCOM	Next Generation VHF Air-Ground Communications System

NEXRAD	Next Generation Weather Radar
NHTSA	National Highway Traffic Safety Administration
NM	Nautical Mile
NPA	Non-Precision Approach
NTIA	National Telecommunications and Information Administration
OBRA-93	Omnibus Budget Reconciliation Act of 1993
OEP	Operational Evolution Partnership
OIG	Office of the Inspector General
OMB	Office of Management and Budget
OPS	Office of Pipeline Safety
OST	Office of the Secretary of Transportation
PAR	Precision Approach Radar
PHMSA	Pipeline and Hazardous Materials Administration
PHY	Physical Layer
PNT	Positioning, Navigation and Timing
PRF	Pulse Repetition Frequency
PRM	Precision Runway Monitor
PRN	Pseudo Random Noise
PRR	Pulse Repetition Rate
PTC	Positive Train Control
RBPM	Radar Beacon Performance Monitors
RCOM	NAS Recovery Communications System
RD&D	Research, Development and Demonstration
RFI	Radio Frequency Interference
RITA	Research and Innovative Technology Administration
RNAV	Area Navigation
RNSS	Radionavigation Satellite Service
RSEC	NTIA Radar Spectrum Engineering Criteria
RTCA	RTCA, Incorporated (formerly the Radio Technical Commission for Aeronautics)
RTK	Real Time Kinematic
SAE	Society of Automotive Engineers
SARPs	ICAO Standards and Recommended Practices
SCAT-1	Special Category One System
SF GPR	Step Frequency Ground Penetrating Radar
SHARES	Shared Resources High Frequency Radio Program
SID	Standard Instrument Departure
SLEP	Service Life Extension Program
SLSDC	Saint Lawrence Seaway Development Corporation
SLSMC	Saint Lawrence Seaway Management Corporation
SMR	Surface Movement Radar
SMRi	SMR Improved
SSR	Secondary Surveillance Radar
STAR	Standard Arrival
SVS	Synthetic Vision System
TACAN	Tactical Air Navigation System
TCAS	Traffic Alert and Collision Avoidance System
TDMA	Time Division Multiple Access
TDWR	Terminal Doppler Weather Radar
TIS	Traveler’s Information Service
TIS-B	Traffic Information Service-Broadcast
TLS	Transponder Landing System
UAT	Universal Access Transceiver
UHF	Ultra High Frequency
UNAVCO	University NAVSTAR Consortium
U.S.	United States

USACE	US Army Corps of Engineers
USCG	United States Coast Guard
US&P	United States and Possessions
VDL	VHF Digital Link
VDL-2	VDL Mode 2
VDL-3	VDL Mode 3
VDL-4	VDL Mode 4
VHF	Very High Frequency
VOR	VHF Omnidirectional Range
VTS	Vessel Traffic Service
WAAS	Wide Area Augmentation System
WG-1	Working Group 1 (of the Technical Subcommittee of the NTIA Interdepartment Radio Advisory Committee)
WM/LAT	Wide Area Multilateration System