The United States Department of Transportation

Strategic Spectrum Plan

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The United States Department of Transportation Strategic Spectrum Plan

Executive Summary
The United States Department of Transportation (DOT) occupies a leadership role in the global transportation network. The people of DOT are dedicated to improving transportation in the United States and around the world by making it safer, simpler, and smarter. Safer–because we will place a greater emphasis than ever before on saving lives and reducing accidents. Simpler–because we will consolidate and streamline our programs. And smarter–because we will focus on efficiency, achieving results, and increasing accountability.

DOT's mission, as stated in Section 101 of Title 49, United States Code, is as follows:

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.

In support of the DOT's mission, this first issue of the United States Department of Transportation Strategic Spectrum Plan (SSP) combines several key issues with an overview of present conditions and with a vision for our future. Spectrum is a finite resource that provides for systems and operations that provide for DOT services to the American public.

Each DOT administration that uses spectrum has contributed to this plan. This spectrum plan is a living document that will be revised as needed, to articulate the spectrum requirements and efficiencies needed in supporting the DOT SSP.

The Office of the Secretary commends the contributors to this plan, representing the DOT administrations listed below:

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

Vision Statement

The DOT provides transportation services both domestically and internationally. DOT's core mission emphasizes the national interest in safe and efficient transportation.

The Department of Transportation Act of 1966 calls for "...the development of transportation policies and programs that contribute to providing fast, safe, efficient, and convenient transportation at the lowest cost...."

Secretary Mineta has called for a safer, simpler, and smarter transportation system for the benefit of all Americans. The DOT will become more efficient and robust by integrating the services and systems used in aviation, automotive, rail, and sea transportation. The Department will seek out new spectrum efficient technologies, which are envisioned to allow DOT to move through the 21st century, building a spectrum efficient network of information and services to improve intermodal linkages.

DOT Strategic Spectrum Plan Supporting Goals Contained in the DOT Strategic Plan

Safety
Secretary Mineta's top priority is improving the safety of the Nation's transportation system. DOT will seek to ensure that the continued integrity of DOT spectrum supporting safety services is maintained.

Mobility
Congestion is clearly a growing threat to our economic well-being. Indeed, the U.S. Chamber of Commerce has said it is one of the biggest problems facing our economy today. Clearly, the time has come for more effective solutions. DOT is committed to a comprehensive approach to congestion relief that involves creativity and leadership in making needed improvements throughout the transportation system. Strategic expansion of our system capacity and other solutions are needed to address our growing mobility needs, and spectrum planning is vital in these processes. We will accelerate the application of technology to improve operations, while protecting the current vital spectrum used by incumbent services within the transportation sector.

Global Connectivity
Secretary Mineta's vision of the future acknowledges the vital importance of global connectivity in transportation. DOT will provide for continued GPS worldwide use in providing for civilian applications, including navigation for land, sea, and air. Spectrum preservation for this vital internationally recognized system is of utmost importance.

Security
We are dedicated to accomplishing our crucial transportation missions and will work to keep transportation operating safely and efficiently even during emergency situations. DOT will promote sharing spectrum with other government agencies and support for interoperability needed between Federal, State, and local first responders for homeland security and emergency preparedness matters. This includes support for continuity of government operations.

A Way Forward
DOT will seek to ensure the spectrum supporting current DOT technologies is utilized as necessary in providing for the safest transportation system in the world. We will also continue to seek to take advantage of new spectrum efficient technologies while 1) weighing budgetary implications and trade-offs associated with implementation, 2) analyzing transportation spectrum requirements and determining liability and costs related to commercialization of mission critical systems, and 3) considering spectrum as a resource and realizing the aggregate dollar value of DOT spectrum, and applying that value in cost benefit analysis studies as required, in providing for:

- Work with tribes, States, local governments, and other stakeholders to build safety into the transportation infrastructure and into operational procedures through research, planning, design, engineering, incentives, and incorporation of safety enhancing technologies.
- Mitigate the consequences of safety incidents through more effective response, technology, and coordination with private transportation providers and State and local government.
- Capitalize on secure, advanced technology in all modes of transportation to provide information to the public.

Increase the implementation of infrastructure and operational improvements focused on enhancing the ability of travelers to remain on the roadway, reducing the adverse consequences of roadway departure, improving intersection safety, and protecting pedestrians in the roadway environment.

DOT Spectrum Directives

DOT's policy is to establish systems that meet the needs of the public by facilitating efficient and safe transportation and supporting national security. The Secretary shall establish policy as necessary to guide and support activities involving multimodal implementation projects.

Use of the radio frequency spectrum is vital to the support of DOT programs, operations, and services to the traveling public. 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.

DOT recently updated its policy for using the radio frequency spectrum and for requesting funds for systems requiring radio frequency support. 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 spectrum guidance to all the DOT administrations. Each DOT operating administration shall issue the necessary directive 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, Section 33.

DOT 1120.32C, "Navigation and Positioning Coordination and Planning," establishes responsibilities and procedures to facilitate planning for certain DOT systems. It establishes a continuing management level body which serves as a DOT focal point for coordinating certain DOT programs and formulating associated DOT policies. References contained in this order are: 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 required to carry out its mission.

Conclusions

Americans have built a vast and highly productive network of transportation assets based on the strengths of individual modes–air, marine, highway, transit, and rail. Now, our challenge is to become architects of the future blending these separate constituencies into a single, fully coordinated system–one that connects and integrates the individual modes in a manner that is at once safe, economically efficient, equitable, and environmentally sound. Spectrum is a finite resource, the linchpin that will enable this to happen. The American people require the safest and the most efficient transportation system we can provide. The quality of our lives, the shape of our communities, and the productivity of our economy depend on our success in meeting this goal.

Federal Aviation Administration (FAA)

Executive Summary
Civil aviation is a critical element in the economic and social well-being of the United States. The following shows the aviation industry's annual contribution to our Nation's economy (according to a January 2003 study by the Campbell-Hill Aviation Group, Inc., showing aviation's economic benefits reach into every State and local economy, boosting gross domestic product (GDP), personal earnings, and creating jobs):

Economic Benefits of Aviation Nationally

- $903.5 billion in GDP–10% of the national economy
- $257.8 billion in personal earnings–6% of all earnings nationwide
- 11.2 million jobs–8% of national employment

(based on Calendar Year 2000 data)

FAA is responsible for providing the national airspace infrastructure to support this industry'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. FAA is charged with the responsibility of serving the public–the flying public–and this mission must be met 24 hours a day, 365 days a year. FAA also provides a service supporting National Security by providing air traffic control and vital information to all Defense Department and Law Enforcement aircraft operating within the National Airspace System (NAS) and at certain airports. FAA provides this same service plus aircraft interoperability coordination for the U.S. Forest Service in support of firefighting missions. By any measure, the United States has the safest aviation system in the world.

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. The White House Commission on Aviation Safety and Security, which released its final report on February 12, 1997, recognized the importance of radio spectrum to our Nation's air traffic control system when it directed FAA to develop a plan to ensure that "the FAA's spectrum needs during modernization are not compromised...." This SSP addresses that recommendation.

Although many new and enhanced aviation systems will be implemented in future years, most of the modernized system's spectrum requirements can be satisfied by utilizing existing aeronautical frequency bands, due to the FAA and the aviation industry's commitment to the use of spectrum-conserving new technologies.

FAA enables aircraft to safely operate by utilizing spectrum to support four main functions:

1) Direct communications between air traffic controllers and pilots throughout the country and in areas over the oceans to enable controllers to guide the movement of large numbers of aircraft on the ground and while in the airspace. Some systems can

only reach aircraft when they are flying over land areas; others can reach aircraft when they are flying over the oceans and remote areas of the world.

2) Broadcast of navigation data from ground stations located throughout the country so that pilots can determine their current position and are able to follow the roads or air routes developed in the sky for their use. Different types of ground stations are also used to guide aircraft to the runway while performing landings at major airports.

3) Ability for controllers to actually see and follow the progress of aircraft in the airspace and on the ground (surveillance) by detection through the use of primary and secondary radar systems, so that the controllers may issue instructions to pilots (using the communications system in operation for that airspace).

4) The dissemination of critical data, largely between ground stations and controllers, to enable the timely delivery of the information being gathered, such as the receipt of communications messages from pilots, as well as the transmission of the radar pictures being generated, through the use of various communications links.

In summary, as air travel increases and technology evolves, ever-increasing demands will continue to be placed on the spectrum allocated to serve aviation functions. In addition to these and other factors described within this report, the need to ensure that aircraft can communicate, navigate, and be tracked by air traffic controllers everywhere leads to a direct requirement to utilize the same spectrum for safety systems on a worldwide basis. Therefore, it is necessary to utilize frequency bands, which are allocated consistently around the world for the development of civil aviation radio standards within the United Nations' International Civil Aviation Organization. Such international standardization also ensures that safety systems will not be subject to harmful radio frequency interference, which could lead to life threatening outages of the systems pilots are using while in flight.

Although these and many other forces lead to the continuing need to utilize the existing spectrum (to ensure global interoperability and reduce the potential for harmful interference) and use it in new ways (to enable the introduction of new systems), the aviation community has been developing all future systems using the currently allocated spectrum. This is largely achieved through the use of highly spectrum efficient techniques, such as time division multiple access schemes to increase the overall number of channels for the next generation communications system. FAA's leadership role in international spectrum engineering and management helps ensure that new systems can operate within the same international bands as the older systems they replace.

While many new systems are planned for a modernized NAS, an analysis has identified over 7000 MHz of spectrum that is not expected to be used for the modernized air traffic control system. Table 1-5 in Appendix A lists the specific bands that are not required. In general, these bands are not currently allocated on a worldwide basis and are mostly in the higher frequency ranges. Eventual use of these bands by private industry will support U.S. efforts to maintain a leading role in the development and exploitation of technologically advanced systems that operate within these higher frequency ranges.

The bands that will be required, along with a description of systems that are planned to be implemented using those bands, can be found in Tables 1-1, 1-2, 1-3, and 1-4 in Appendix A within the report. Upon review, it is clear that these bands are largely those which are allocated and coordinated on a worldwide basis for civil aviation use. Furthermore, these bands operate within various regions of the spectrum where the propagation characteristics support the functions being served (weather radars are placed in bands that permit proper transmission in adverse weather conditions). Retention of these bands will ensure that aviation systems can be used interoperably around the world and that they can continue to perform their critical safety functions.

FAA Office of Commercial Space Transportation (AST)

AST Mission

To ensure protection of the public, property, and the national security and foreign policy interests of the United States, in the event of a commercial launch or reentry activity, and to encourage, facilitate, and promote U.S. commercial space transportation.

AST Vision

To be recognized and respected as the world's foremost authority on commercial space transportation safety and market assessments.

The availability of radio spectrum is critical to commercial space industry for many telecommunications services, ranging from air and space traffic control, communications and telemetry to radionavigation. Moreover, spectrum availability is one of the primary drivers in space system architectural design, with cost implications. Thus in order to safeguard the interests of this industry segment, AST looks to future frequency allocations for future Expendable and Reusable Launch Vehicles (RLV) communications, telemetry, and surveillance, among other applications.

Table 1-4 in Appendix A shows the existing allocations that will continue to be needed for commercial space launch activity support and telemetry and should be retained.

Presently the FAA Commercial Space Transportation Safety Office conducts telemetry in 2200-2290 MHz bands in general, which is allocated to U.S. Department of Defense (DoD). The Secretary of DoD determined that private use of this spectrum by commercial entities will be detrimental to national security interests. Under a 1989 compromise agreement commercial space launch operators were directed to shift to 2310-2390 MHz band or request waivers, which is what they are operating under presently. Moreover, since the broadcast satellite service is also implemented in the 2310-2360 MHz band only three frequencies remain in the 2360-2390 MHz space to support commercial space launch operations. In order to support planned modifications and future operations, commercial space launch fleet may need as many as 16 more channels in this band.

Some frequencies that are envisioned to be used in the future for emerging applications are also requested. "The Radio Frequency Blackout During Reentry" study,[1] conducted for AST, concluded that frequencies < 10 GHz would suffice for direct communications through plasma shields to avoid RLV communication blackout conditions. Some of the frequencies that have not been identified for use by the Modernized Air Traffic Control System are in this band, such as 3.5-3.65 GHz and 4.4-4.5 GHz bands. The recommendation is to retain these frequencies, as these might be amenable to reentry vehicle communications, considering radio frequency blackout constraints.

Reference: "Radio Frequency Blackout During Reentry," Report no. ATR-2005(5160)-1; Study conducted for Office of Commercial Space Transportation, FAA by Aerospace Corp., El Segundo, Calif 90245; 31 March 2005.

Federal Highway Administration (FHWA)

Spectrum resources are vital to FHWA in providing for the 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, we provide financial and technical support to them for constructing, improving, and preserving America's highway system. Our 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.

Our Vision...

Improving Transportation for a Strong America

Our Mission...

Enhancing Mobility Through Innovation, Leadership, and Public Service

Our Strategic Goals...

At FHWA, we aggressively pursue our vision and mission by focusing on six strategic goals:

- *Safety*–Continually improve highway safety.
- *Mobility and Productivity*–Preserve, improve, and expand the Nation's highway transportation system while simultaneously enhancing the operation of the existing highway system and intermodal connectors.
- *Global Connectivity*–Promote and facilitate a more efficient domestic and global transportation system that enables economic growth.
- *Environment*–Protect and enhance the natural environment and communities affected by highway transportation.
- *National Homeland Security*–Improve highway security and support national defense mobility.
- *Organizational Excellence*–Advance FHWA's ability to manage for results and innovation.

USDOT Strategic Spectrum Communications Issues that Impact Intelligent Transportation Systems (ITS)

Spectrum is a key enabler for the dissemination of intelligence. DOT's ITS program is based on the fundamental principle of intelligent vehicles and intelligent infrastructure and the creation of an intelligent transportation system through integration with and between these two components. The Federal ITS program supports the overall advancement of ITS through investments in major initiatives, exploratory studies, and a crosscutting core program. Increasingly, the Federal investments will be directed at targets of opportunity (major initiatives) that have the potential for significant payoff in improving safety, mobility, and 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. DOT will use exploratory studies to examine other as yet unexamined or unsolved opportunities for applying ITS technologies to significant transportation problems. DOT will also support a crosscutting core program–architecture, standards, learning, evaluation, and technical assistance–that fosters the widespread deployment of ITS.

The following are spectrum and/or wireless communications issues that have the potential to impact ITS and therefore are of interest to the ITS Joint Program Office at DOT.

Very High Frequency (VHF)

Highway Advisory Radio: Currently used in various, low-tech forms by state Departments of Transportation to convey traffic and travel information.

VHF 220 MHz

FHWA has been assigned five narrowband frequency pairs on a nationwide basis; these will support nationwide compatibility of ITS by providing universal channels for advisory, hailing, and other applications. Testing is underway.

Cellular Telephony

Wireless E911: Implementation of this service will greatly facilitate deployment of the Emergency Notification and Personal Security user service. Comments have been submitted by ITS America and DOT during this rulemaking process.

902–928 MHz

Dedicated Short Range Communications (DSRC) protocols: The Department is facilitating meetings among current vendors and users of DSRC in the Location and Monitoring Service band to try to achieve industry consensus on nationwide compatibility of protocols and operating procedures, in anticipation of future spectrum opportunities. DOT does not necessarily advocate long-term use of this band for DSRC due to increasing congestion and unlicensed use.

5850–5925 MHz

DSRC: A new spectrum allocation to allow proliferation of all envisioned ITS user services that utilize DSRC.

What is DSRC?

DSRC allows high-speed communications between vehicles and the roadside or between vehicles for ITS; 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
- Transit or emergency vehicle signal priority
- Electronic parking payments
- Commercial vehicle clearance and safety inspections
- In-vehicle signing
- Rollover warning
- Probe data collection
- Highway-rail intersection warning

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 Federal Communications Commission's (FCC) allocated 5.9 GHz spectrum for DSRC permits much higher data-transmission rates than the lower frequency 915 MHz band and provides 75 megahertz of spectrum for DSRC applications. 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

The American Society of Testing Materials (ASTM) 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 and public sectors.

Since the FCC allocated the 5.9 GHz band for DSRC in October 1999, the ASTM standards committee has been working on the standards for this new service. ASTM approved the first new DSRC standard, 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. The committee is currently working on DSRC standards for the upper OSI layers in cooperation with IEEE.

11, 23, 31 GHz

Wireless communication for traffic surveillance and signal control: Recent 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.

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 DOT/National Highway Traffic Safety Administration (NHTSA) on these systems has been ongoing for some years.

ITS Supporting Public Safety

In 2004 the ITS Management Council, chaired by the Deputy Secretary of Transportation with principals-only membership, including the DOT Under Secretary for Transportation Policy, the Assistant Secretary for Transportation Policy and Intermodalism, DOT's Chief Information Officer, Administrators of FHWA, the Federal Motor Carrier Safety Administration (FMCSA), the Federal Transit Administration, NHTSA, the Research and Innovative Technology Administration, the Federal Railroad Administration (FRA), and the Maritime Administration (MARAD), reorganized the functions of the ITS program to focus on nine particular high pay-off areas. Each new area has decision points at which management will evaluate progress. Each new major initiative is multimodal, public-private sector involved, and aims to improve safety, mobility, and/or productivity.

As highway deaths continue to rise (43,000 in 2003) and growing traffic congestion robs Americans of time and money, the DOT's ITS program is launching a new generation of initiatives aimed at improving transportation safety, relieving congestion, and enhancing productivity. These nine initiatives are listed below:

- Cooperative Intersection Collision Avoidance Systems
- Electronic Freight Manifest
- Emergency Transportation Operations
- Integrated Corridor Management Systems
- Integrated Vehicle Based Safety Systems
- Mobility Services for All Americans
- Nationwide Surface Transportation Weather Observing and Forecasting System
- Next Generation 9-1-1
- Vehicle Infrastructure Integration (VII)

A number of navigation policy issues are of interest to ITS, namely:

- Potential expansion of public DGPS capability: Could provide navigation systems with further levels of accuracy; not typically needed by existing services, but of possible value to public safety agencies that rely on accurate positioning to respond to certain incidents; possibilities are currently being assessed.

- Global Positioning System (GPS) Next Generation (L5 frequency): Offers similar potential; ITS user requirements should be considered, and the ITS Joint Program Office (JPO) has been a party to these discussions among DOT and DoD.

- Federal Radionavigation Plan: The ITS JPO participates in this biennial DOT/DoD effort to ensure that requirements analysis accounts for surface transportation users.

In addition, a number of wireline telecommunications issues are of interest to ITS, namely:

- 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 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 a healthy economy for several years are all a part of this 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 some 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 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 will undoubtedly 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 the transportation plan. This requires analysis of geographic and information requirements. Where should the output from video cameras go–to the TMC, maintenance shops, or emergency services providers? Is full-motion needed, or would stop-action, single frames suffice? This type of question must be asked for every piece of information to be exchanged among people, systems, and agencies.

This analysis could feed into the regional architecture for transportation information exchange. In turn, the regional architecture, to be prepared by every State and metropolitan region over the next couple of years, provides the basis for defining the detailed requirements for telecommunications services needed to implement the transportation plan.

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 provided in the area.

Evaluate New Alternatives

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

Leasing obviously brings its own set of problems; it is no panacea, pros and cons exist. The rapid pace of technological change and the competitive market compel communications companies to keep their networks up-to-date and competitive.

The most difficult task in the evaluation of alternative telecommunications strategies is not the comparison of leased versus owned infrastructure but rather determining the communications requirements.

The Wireless Revolution

Several years ago, FCC authorized the use of new segments of the radio frequency spectrum for a variety of services. Two regions of the spectrum are of particular importance: the 2400 MHz and the 5000 MHz unlicensed bands. The technical details are less important than the equipment and services now available in these bands.

Four aspects of this development are important for transportation agencies:

1. These bands can support wideband 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. These bands are approved for license-free operation (no FCC license required). This significantly reduces recurring costs.

The new broadband wireless technologies can support point-to-point and point-to-multipoint architectures. An example of the former is center-to-center communications, and an example of the latter 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.

Conclusions

New options are available for virtually every transportation-related telecommunications application. However, to get the most for your telecommunications dollars, you must carefully evaluate these alternatives. Take the time to understand and define all of your telecommunications requirements and hire a competent telecommunications expert who knows the services available in your area and is capable of evaluating these various alternatives for your application. The result will be an entirely new set of implementation options, which may provide for a significantly cheaper telecommunications network.

Federal Railroad Administration (FRA)

High-Speed Ground Transportation

Spectrum plays a major role in providing for enhancements to the U.S. rail systems. As directed by the High-Speed Ground Transportation Act of 1965 and follow-on legislation, FRA has sponsored the development of high-speed ground transportation (HSGT). HSGT is a family of transportation options that address long-term passenger transport needs in heavily populated corridors. With the successful completion of the original phases of the Northeast Corridor (NEC) Transportation Project, including continuous electrification between Washington, New York, and Boston, efforts have expanded beyond the NEC main line to HSGT options in other corridors.

What is HSGT?

HSGT is self-guided intercity passenger ground transportation that is time-competitive with air and/or autos on a door-to-door basis for trips in the approximate range of 100 to 500 miles. This is a market-based, not a speed-based definition: it recognizes that the opportunities and requirements for HSGT differ markedly among different pairs of cities.

What is a corridor?

A corridor is a natural grouping of metropolitan areas and markets that, by their proximity and configuration, lend themselves to efficient service by ground transport.

What are the potential benefits of HSGT?

Supporters of HSGT point to the long-term growth in America's population, income, travel demand, and congestion in intercity transportation by air and auto. Traditional remedies, such as the expansion of airports and highways, have involved increasing environmental and dollar costs and public opposition in affected communities. HSGT can offer such social, economic, and environmental benefits as energy savings, emission reductions, and maximized use of existing facilities. A discussion of these possibilities is in FRA's 1997 report, *High-Speed Ground Transportation for America*. Since that report was published, the events of September 11, 2001, have temporarily mitigated air traffic congestion and emphasized to some observers the possibility that HSGT (together with other passenger rail services) might function as an alternative mode of quality public transportation in the event of future disruptions to the air and highway networks, as well as under more normal circumstances.

FRA Research & Development

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 the safety regulatory processes, to railroad suppliers, to railroads involved in the transportation of freight, to intercity and commuter passengers, to railroad employees, and to labor organizations.

The following ongoing research and development 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 FRA 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. ITS for highways and mass transit are based on these technologies, as are the new 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. 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, as well as into planning and scheduling systems. The new 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)

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. The National Transportation Safety Board has named PTC as one of its most-wanted initiatives for national transportation safety. PTC systems are comprised of digital data link communications networks, continuous and accurate positioning systems, such as the Nationwide Differential Global Positioning System (NDGPS), onboard 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.

High Accuracy (HA) NDGPS

FRA, in cooperation with FHWA, National Oceanic and Atmospheric Administration. and the U.S. Coast Guard is developing a new signal that will be added to NDGPS. From FRA's perspective, this will provide for the follow accuracy requirements:

- PTC–1 meter
- Rail Defect Location–30 centimeters
- Automated Track Surveying–10 centimeters
- Surveying and Scientific Applications–1 centimeter

Other agencies have similar accuracy requirements for: precision farming, highway lane keeping, construction, machinery control, and aerial mapping. Prototype HA NDGPS sites are currently providing 15-centimeter accuracy 150 miles from the reference station. This is significant because it proves that a high accuracy system can be deployed nationwide without the need to build a lot of additional reference stations. With the additional ongoing research and development and the addition of the new GPS civil signals on L1, L2, and L5, better accuracies and better convergence times to those higher accuracies are anticipated. The HA NDGPS signal will also improve the integrity and service availability needed for safety of life systems like PTC.

Currently, 50 other countries operate systems that are compatible with our NDGPS system. It is important that these countries also have the opportunity to upgrade their systems. Thus, the final signal standard will be coordinated internationally. Currently we plan to use frequencies in 415 KHz to 495 KHz band and a GMSK modulation format.

Maritime Administration (MARAD)

MARAD, the U.S. Coast Guard, and ten other Federal agencies, in partnership with non-Federal stakeholders, inaugurated a program to improve the marine portion of the national transportation system. The MTS initiative is a program to ensure a safe and environmentally sound world-class marine transportation system that improves the global competitiveness and national security of the United States.

MTS National Task Force

Congress directed the Secretary of Transportation to form a Task Force to assess the adequacy of the Nation's marine transportation system to operate in a safe, efficient, secure and environmentally sound manner.

The MTS Task Force was composed of industry associations, shipper groups, and other stakeholders. Through cooperative efforts between Government and private sector partners, the MTS assessment was completed and transmitted to Congress on September 9, 1999.

Implementation of MTS Recommendations

The Congressional report, An Assessment of the U.S. Marine Transportation System, was the culmination of two years of unprecedented dialogue between the public and private sector to address issues in the MTS. Three key recommendations of the report have been implemented.

- In April 2000, the Marine Transportation System National Advisory Council (MTSNAC) was established by the Secretary of Transportation with the Maritime Administration as the designated sponsor. The MTSNAC consists of 30 industry leaders representing every element of our MTS. The purpose of the MTSNAC is to advise the Secretary of Transportation on issues, policies, plans, and funding solutions needed to ensure that the U.S. MTS is capable of responding to the projected trade increases. The MTSNAC has held two meetings and has identified public awareness as its top priority. The MTSNAC has also established five Council teams: Awareness, Infrastructure, Safety and Environment, Information Technology, and Research and Development. For further information on the MTSNAC, you can visit the MTSNAC website at http://www.mtsnac.org/.

- A new Interagency Committee for the Marine Transportation System (ICMTS) was also established. This Committee served as the national coordinating body for all Federal agencies responsible for one or more aspects of the MTS. 17 federal agencies signed a Memorandum of Understanding for the ICMTS.

- Discuss the state of the art in technology and techniques related to MTS.

As a result of recommendations of the U.S. Commission on Ocean Policy, President Bush issued his U.S. Ocean Action Plan, on December 17, 2004. This Ocean Action Plan recognized the importance of improving the Marine Transportation System (MTS), and directed the creation of a cabinet-level Interagency Committee on the Marine Transportation System, named the Committee on the Marine Transportation System (CMTS), which succeeded the former ICMTS. The CMTS is chaired by the Secretary of Transportation.

Several agencies, including the Department of Transportation, the Department of Homeland Security, the Department of Defense, the Department of Commerce, the Department of Agriculture, and the Department of the Interior, worked over a period of several months to develop a charter and concepts for operation for the CMTS. The CMTS met for the first time in July of 2005 to finalize the charter and discuss national issues that should be addressed by the Committee.

The CMTS will provide major benefits to both the nation and the ten cabinet level departments by addressing critical issues that individual Agencies have not been able to affect. Previous interagency efforts did not produce the results necessary because of a need to engage senior leadership. This CMTS has the commitment from the most senior leadership of the ten cabinet level departments that have responsibility for the Nation's MTS.

Spectrum Supporting MARAD Initiatives

GMDSS (Global Maritime Distress and Safety System) and VHF (Very High Frequency) radiotelephone are integral components of the worldwide marine radio communications system. Nearly six million U.S. and Canadian recreational sail- and powerboats carry VHF radios.

MARAD Use of Ports and Coastal Regions

Port Coastal Region
Akognak, AK Pacific Northwest
Albany, NY North Atlantic
Anacortes, WA Pacific Northwest
Anchorage, AK Pacific Northwest
Annapolis Anch., MD North Atlantic
Baltimore, MD North Atlantic
Barbers Point, HI Pacific Southwest
Beaumont, TX U.S. Gulf
Bellingham, WA Pacific Northwest
Boston, MA North Atlantic
Brayton Point, RI North Atlantic
Bremerton, WA Pacific Northwest
Bridgeport, CT North Atlantic
Brownsville, TX U.S. Gulf
Brunswick, GA South Atlantic
Buchanan, NY North Atlantic
Bucksport, ME North Atlantic
Camden, ME North Atlantic
Cantrel Field, LA U.S. Gulf
Ceiba, PR Puerto Rico
Cementon, NY North Atlantic
Charleston, SC South Atlantic
Cherry Point, WA Pacific Northwest
Claymont, DE North Atlantic
Columbia River Ports, OR Pacific Northwest
Coos Bay, OR Pacific Northwest
Corpus Christi, TX U.S. Gulf
Lightering Area, TX U.S. Gulf
Cove Point, MD North Atlantic
Davisville, RI North Atlantic
Drift River Terminal, AK Pacific Northwest
Dutch Harbor, AK Pacific Northwest
Eastport, ME North Atlantic
Edmonds, WA Pacific Northwest
El Segundo, CA Pacific Southwest
Everett, WA Pacific Northwest
Fall River, MA North Atlantic
Fernandina, FL South Atlantic
Ferndale, WA Pacific Northwest
Fort Lauderdale, Fl South Atlantic
Freeport, TX U.S. Gulf
Lightering Area, TX U.S. Gulf
Galveston, TX U.S. Gulf
Lightering Area, TX U.S. Gulf
Georgetown, SC South Atlantic
Groton, CT North Atlantic
Guayama, PR Puerto Rico
Guayanilla, PR Puerto Rico
Gulfport, MS U.S. Gulf
Hilo, HI Pacific Southwest
Homer, AK Pacific Northwest
Honolulu, HI Pacific Southwest
Houston, TX U.S. Gulf
Hydaburg, AK Pacific Northwest
Ingleside, TX U.S. Gulf
Jacksonville, FL South Atlantic
Juneau, AK Pacific Northwest
Kahului, HI Pacific Southwest
Kake, AK Pacific Northwest
Kawaihae, HI Pacific Southwest
Kenai, AK Pacific Northwest
Ketchikan, AK Pacific Northwest
Key West, FL U.S. Gulf
Kivalina, AK Pacific Northwest
Kodiak, AK Pacific Northwest
L.A./Long Beach, CA Pacific Southwest
Las Mareas, PR Puerto Rico
LOOP Terminal, LA U.S. Gulf
Manchester, WA Pacific Northwest
March Point, WA Pacific Northwest
Mayaguez, PR Puerto Rico
Miami, FL South Atlantic
Mobile, AL U.S. Gulf
Montauk, NY North Atlantic
Lightering Area North Atlantic
Morehead City, NC South Atlantic
Nawiliwili, HI Pacific Southwest
New Haven, CT North Atlantic
New London, CT North Atlantic
New Orleans, LA U.S. Gulf
New York, NY North Atlantic
Nikiski, AK Pacific Northwest
Northport, NY North Atlantic
Northville, NY North Atlantic
Olympia, WA Pacific Northwest
Palm Beach, FL South Atlantic
Panama City, FL U.S. Gulf
Pascagoula, MS U.S. Gulf
Lightering Area, MS U.S. Gulf
Pensacola, FL U.S. Gulf
Philadelphia, PA North Atlantic
Piney Point, MD North Atlantic
Point Comfort, TX U.S. Gulf
Point Wells, WA Pacific Northwest
Ponce, PR Puerto Rico
Port Angeles, WA Pacific Northwest
Port Arthur, TX U.S. Gulf
Port Canaveral, FL South Atlantic
Port Everglades, FL South Atlantic
Port Hueneme, CA Pacific Southwest
Port Manatee, FL U.S. Gulf
Port Royal, SC South Atlantic
Port Townsend, WA Pacific Northwest
Portland, ME North Atlantic
Portsmouth, NH North Atlantic
Providence, RI North Atlantic
Ravena, NY North Atlantic
Roseton, NY North Atlantic
S. Sabine Light. Area, TX U.S. Gulf
S. Calif. Light. Area, CA Pacific Southwest
Sabine, TX U.S. Gulf
Salem, MA North Atlantic
San Diego, CA Pacific Southwest
San Francisco, CA Pacific Southwest
San Juan, PR Puerto Rico
Sandwich, MA North Atlantic
Sandy Point, ME North Atlantic
Savannah, GA South Atlantic
Searsport, ME North Atlantic
Seattle, WA Pacific Northwest
Skagway, AK Pacific Northwest
Somerset, MA North Atlantic
Stony Point, NY North Atlantic
Tacoma, WA Pacific Northwest
Tampa, FL U.S. Gulf
Texas City, TX U.S. Gulf
Valdez, AK Pacific Northwest
Virginia Ports, VA South Atlantic
West Palm Beach, FL South Atlantic
Westport, WA Pacific Northwest
Wilmington, CA Pacific Southwest
Wilmington, NC South Atlantic
Yabucoa, PR Puerto Rico

Saint Lawrence Seaway Development Corporation (SLSDC) Spectrum Requirements

The St. Lawrence Seaway

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 intergovernment 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 Montreal and Lake Erie. 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 & Waterways Safety Act.[1]

The Seaway Automatic Identification System (AIS)

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 St. Lambert, Quebec, to Long Point Ontario (Mid-Lake Erie), effective at the beginning of the 2003 Navigation Season[2].

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

[1] *See* 33 U.S.C. §§ 1223-27, 1231, 1232.
[2] *See* 33 C.F.R.§ 401.20; 68 Fed.Reg. 9549 (February 28, 2003).

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[3], 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.[4]

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.[5]

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. In the event it becomes necessary, security information about HIVs could be transmitted through AIS rather than communicated via voice radio transmissions, which are more susceptible to interception.

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[3]ITU-R Recommendation M.1371-1: 2000, TECHNICAL CHARACTERISTICS FOR A UNIVERSAL SHIPBORNE AUTOMATIC IDENTIFICATION SYSTEM USING TIME DIVISION MUTLIPLE ACCESS IN THE MARITIME MOBILE BAND. The International Telecommunications Union Sector for Radiocommunications formally adopted this standard in August 2001. This is the standard that defines in detail how the AIS works and as such is the primary AIS standard.

See also International Maritime Organization Resolution MSC 74(69), Annex 3, RECOMMENDATION ON PERFORMANCE STANDARDS FOR AN UNIVERSAL SHIPBORNE AUTOMATIC IDENTIFICATION SYSTEM (AIS). This standard defines the basic performance requirements for AIS equipment and was used by International Telecommunications Union and IEC in developing technical and test standards.

[4] IEC 61993-2 Ed.1 MARITIME NAVIGATION AND RADIOCOMMUNICATION REQUIREMENTS–AUTOMATIC IDENTIFICATION SYSTEMS (AIS)–PART 2: CLASS ASHIPBORNE EQUIPMENT OF THE UNIVERSAL AUTOMATIC IDENTIFICATION SYSTEM (AIS)–OPERATIONAL AND PERFORMANCE REQUIREMENTS, METHODS OF TEST AND REQUIRED TEST RESULTS. IEC formally adopted this standard in November 2001.

[5] *See* 46 U.S.C. § 70114

Other SLSDC 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), and for hydrographic surveying operations. The Office of Maintenance utilizes various frequencies to maintain voice communications between work crews.

Future SLSDC Spectrum Needs

Projects/issues that would require the use of additional frequencies in the future could include the following:

- Microwave backup to provide redundancy for the radios used to communicate with vessels transiting the upper part of the river.
- Secure (i.e., encrypted voice) communications for use during national and/or international crises.
- Secure/encrypted communications for use by law enforcement vessels not using AIS.

Appendix A–FAA Spectrum Use

Table 1-1. Spectrum Needs for Pilot-to-Controller Communications in the Modernized Air Traffic Control System

Frequency Bands (MHz)	Future Civil Pilot/Controller Communications Applications	Remarks
2.85–22	• HF long-range air/ground (A/G) voice communications in oceanic and Alaskan airspace • HF datalink for oceanic A/G data communications	Continued use of internationally allocated bands in this range is essential for ATC communications in Alaskan and oceanic airspace. An additional 180 kHz of spectrum in this band associated with 60 separate new carrier frequencies are estimated to be necessary for the planned HF datalink.
112–117.975	• Integrated voice and data for pilot-to-controller communications	This band will also continue to support aeronautical radionavigation systems in addition to the planned communications application shown at left.
117.975–137	• Integrated voice and data for pilot-to-controller communications (NEXCOM) •Emergency communications (emergency locator transmitter satellite monitoring and homing)	The conversion of the existing VHF A/G radio system to its planned next-generation implementation will temporarily increase the already severe spectral congestion in this band, making it desirable to devote a portion of the 108–117.975 MHz band to the system.
960–1215	• Satellite-based integrated communications and surveillance system	These bands, currently allocated to aeronautical radionavigation, are needed for the potential communications application shown at the left (ATS and AOC), as well as for various future navigation and surveillance applications.
1545–1559; 1646.5–1660.5	• Space-to-earth and earth-to-space satellite links for integrated voice and data A/G communications	These bands will continue to be vital for existing and future safety-related aeronautical mobile communications applications (ATS and AOC). However, SATCOM has not yet been proven to be a viable means of pilot/controller communications in areas of high traffic density.
1610–1626.5	• Integrated voice and data A/G communications via satellite	Existing aviation allocations in this band may be utilized to provide future satellite-based ATS and AOC services. This band is shared with the mobile satellite service, and aeronautical use of the band would likely be by commercial vendor.
2483.5–2500	• Satellite links supporting ATS and/or AOC	This non-Government band is potentially useful for leased SATCOM applications.
5091–5250	• Feeder links supporting integrated voice and data A/G communications	This band is also allocated for aeronautical radionavigation use. This band is shared with commercial mobile satellite service feederlinks.

Table 1-2. Spectrum Needs for Aeronautical Radionavigation in the Modernized Air Traffic Control System

Bands (MHz)	Future Civil Aeronautical Radionavigation Applications	Remarks
0.190–0.435; 0.510–0.535	• Alaskan aeronautical NDB system for en route and nonprecision approach navigation	These bands may still be needed in Alaskan airspace even after the aeronautical NDB system has been fully decommissioned, by 2010, throughout the rest of the NAS.
74.8–75.2	• ILS marker beacons, until LAAS provides full modernized precision landing guidance capability	Since all ILS marker beacons operate on a single frequency, the need for this band will remain unchanged until complete ILS phase-out. No other aeronautical uses are envisioned for this band after ILS phase-out, which is expected no earlier than 2010.
108–117.975	• ILS localizers (until LAAS provides full modernized capability) • LAAS and/or SCAT-I precision landing guidance capability • Subset of existing VOR system to serve as a limited backup to GNSS	Currently devoted to ILS localizers and VOR, this band is potentially useful for the aeronautical radionavigation applications identified at the left, and also for certain new satellite communications applications (e.g., LAAS). ILS phase-out is expected no earlier than 2010.
328.6–335.4	• ILS glideslope (until LAAS provides full modernized capability) • LAAS may use this band	This band is currently dedicated to the ILS glideslope function. Its large installed base of airborne antennas makes it a potential band for LAAS. The beginning of ILS phase-out is expected no earlier than 2010.
960–1215	• Subset of existing DME system for use as backup to GPS • Second civil GPS link will use this band to improve accuracy and reliability of GPS worldwide navigation system	These bands are also under consideration for various future satellite-based pilot-to-controller communications and surveillance applications. A future GPS L5 signal will operate in this band.
1215–1260	• GPS L2 link, which will also be used by WAAS • GLONASS L2 link	This band is needed for satellite navigation systems and will continue to be used for that purpose, as well as for long-range surveillance.
1559–1610	• GPS L1 link and GLONASS • WAAS • LAAS pseudo-satellites • Future GNSS elements	This band is the sole radio spectrum allocated for satellite navigation systems and must continue to be reserved for the exclusive RNSS systems with ample protection for civil aviation use of RNSS systems.
4200–4400	• Radio altimeters	This band is needed to provide sufficient resolution to support precision landings.
5000–5250	• MLS • LAAS may use this band	Also needed for weather surveillance. MLS uses 5000-5150 MHz. The band segment 5090-5250 MHz is shared with mobile satellite service feederlinks.
34700–35200; 92000–100000	• Airborne enhanced vision systems for precision landing guidance in low-visibility conditions	Ongoing testing of this system will determine the system's reliability and weather immunity necessary to implement it. The 92000–100000 MHz band consists of a number of sub-bands that may be used by other types of systems. Selection of a final operating band from one of these sub-bands will be made based on system performance and compatibility with other users of this band.

Table 1-3. Spectrum Needs for Aeronautical Surveillance in the Modernized Air Traffic Control System

Bands (MHz)	Future Civil Aeronautical Surveillance Applications	Remarks
448–450	• Wind-profiler radars measuring winds aloft, up to 65,000 feet	This band will be needed by the wind profilers to be relocated from the 403–406 MHz band and for the National Weather Service network. Also, wind profilers will be used to measure the jet stream.
1030; 1090	• ATCRBS for identification and tracking of aircraft • TCAS for detection/prevention of imminent mid-air collisions • Precision Runway Monitor for monitoring aircraft on parallel runway approaches • ADS-B and SMGCS, for automatic position/velocity reporting, may operate here • TIS, for automatic uplinking of processed surveillance data to aircraft, may use these bands • ASDE, ASDE-X multilateration component	TCAS and other surveillance systems operating in or planned for these bands are particularly important to the continued safe functioning of the modernized air traffic control system.
960-1215	•Future generation of ADS-B, potential future generation SMGCS, and TIS	This band is also a primary candidate for future aeronautical surveillance and air route communications functions.
1215–1390	• Long-range surveillance radars for detection and tracking of aircraft •Range measuring datalink	Current military range measuring datalink, which is similar to the ADS-B function, may also be developed for civil use in this band. This band will remain essential for operating long-range surveillance radars.
2700–3000	• Terminal surveillance radars • Long-range weather radars	This band needed to support terminal airspace surveillance and long-range weather detection.
5150–5250	• Terminal weather radars	This is the expansion band for Terminal Weather Radars currently in the 5600–5650 MHz band.
5350-5470	• Airborne weather radars	
5600–5650	• Terminal weather radars	Expansion into 5150–5250 MHz band will be needed.
9000–9200	• Low cost ASDE-X, SMR, PAR	Shared with military radars, this band offers potential improvement of radar performance in rain.
9300-9500	• Airborne weather radars	
13250-13400	• Airborne Doppler weather radar	
15700–16200	• ASDEs for surveillance of airport surface traffic/low cost ASDE	Current (though not exclusive) access to this band will be necessary for continued ASDE operation.

Table 1-4. Spectrum Needs for Critical Aviation Support Services in the Modernized Air Traffic Control System

Frequency Bands (MHz)	Future Civil Aeronautical Support Applications	Remarks
2–28	• Long-range NAS RCOM links	Existing allocations will continue to be needed by RCOM, which shares this band with many other users.
162.0125–174	• Short-range NAS C3 land mobile links • Control links for visual navaids • Datalinks for weather sensors	Existing allocations will continue to be required to meet the spectral needs of these services, which share this band with many non-FAA users. Action is currently being taken to narrowband emissions to comply with NTIA standards.
406–406.1	• Transmission of distress signals	This band will remain essential to these SAR systems.
406.1–420	• Low-capacity radio relays • Equipment status monitoring • Datalinks for weather sensors • Back-up indoor communications	Action is being taken to relieve spectral congestion in this band by 2006. Existing FAA spectrum in this band will continue to be required for ongoing and increasingly complex NAS support operations. Action is being taken to comply with new narrowband emission standards and the new U.S.–Mexico border zone sharing agreement by 2008.
420–450	• CSL flight termination links	Access to this band may be needed for command destruction of off-course unmanned launch vehicles.
932–935; 941–944	• LDRCL system connecting FAA sites to backbone network • Datalinks for weather sensors	Existing allocations will continue to be required to meet the spectral needs of these services, which share these bands with many non-FAA users.
960–1215	• ADL for A/G data transfer • A/G diagnostic downlink for flight performance monitoring • Possible control links for UAVs.	These bands, currently allocated to aeronautical radionavigation, are needed for the potential critical support applications shown at the left, as well as for various future communications and surveillance applications.
1544–1545; 1645.5-1646.5	• Satellite feederlinks for relaying of distress signals during SAR operations	This band will continue to be needed for SAR and other emergency functions.
1710–1850	• LDRCL	The 1710–1755 MHz sub-band has been vacated by the FAA.
2360–2390	• CSL operations support	Needed for launch vehicle telemetry.
2900–3100	• CSL operations support	Range safety radars need access to this band.
3700–4200	• ANICS space-to-earth links for Alaskan FAA facilities	The commercial vendor of this leased system will continue to need access to non-Government spectrum in this band.
5650–5850	• CSL operations support	CSL tracking radars need access to this band.
5925–6425	• ANICS earth-to-space links	Commercial vendor needs access to non-Government spectrum in band.
7125–8500	• LDRCL • RCL backbone network • TML	Existing allocations will continue to be required to meet the spectral needs of these services, which share this band with many non-FAA users.
9300–9400	• CSL operations support	Range safety radars need access to this band.
11700–12200	• FAATSAT space-to-earth links	The vendor of this leased system will continue to need access to non-Government spectrum in this band.
14000–14500	• FAATSAT earth-to-space links • TML (14400-14500 MHz)	The vendor of this leased system will continue to need access to non-Government spectrum in this band. FAA will continue to need access to this band to operate TML.
14500–15350	• TML	FAA will continue to need access to this band for TML.

21200–23600	• LDRCL	Existing allocations will continue to be required to meet the spectral needs of this service.

Table 1-5. Spectrum Which Has Not Been Identified for Continued Use by the Modernized Air Traffic Control System

Frequency Bands (MHz)	Current and Authorized Civil Aviation Uses	Remarks
0.009–0.014	• Omega worldwide radionavigation system	This band will not be required by civil aviation after Omega system termination.
0.090–0.110	• Loran-C long-range radionavigation system	This band will not be required by civil aviation if the Loran-C system is terminated.
0.190–0.435; 0.510–0.535	• Aeronautical NDB system for en route and non-precision approach navigation	Except in Alaska, where the aeronautical NDB system is projected to continue indefinitely, these bands will cease to be needed by civil aviation upon termination (scheduled for 2006) of the non-Alaskan segments of the system.
3500–3650	• Airport surveillance radars for target tracking in terminal airspace	No future civil aviation uses have been identified for this band. While no impact on the modernized air traffic control system is foreseen, loss of this band could limit future expansion of the airport surveillance radar system.
4400–4500	• High-capacity communications links between FAA ground facilities	No future civil aviation uses have been identified for this band.
15400–15700	• Aeronautical navigation systems	No future civil aviation uses have been identified for this band.
16200–17700	• Airport surface surveillance radars for detection and tracking of airport surface traffic	No future civil aviation uses have been identified for this band. The 15700-16200 MHz band, currently used by the ASDE-3, should be sufficient to satisfy projected requirements for airport surface surveillance.
24250–24650	• Ground radars for detection and tracking of airport surface traffic	This band became available for reallocation in 2000, assuming use by the FAA upon receiving necessary funding to acquire replacement radars operating in the 15700-16200 MHz band.
25250–27500	• High-capacity communications links between FAA ground facilities	No future civil aviation uses have been identified for this band.
36000–38600	• High-capacity communications links between FAA ground facilities	No future civil aviation uses have been identified for this band.

Appendix B–DOT Transportation Statistics

Aviation Transportation Statistics

Over 678 million (587 million domestic and 91 million international) passengers flew 324 billion air miles on U.S. commercial flights in 2003. This figure is expected to exceed 1 billion by 2015.

Over 17 million tons of freight and 880,000 tons of mail were transported by air in the United States during 2003. Freight alone is expected to exceed 28 million tons by 2015.

Over 4,000 large commercial and 211,000 general aviation aircraft operated in the United States during 2003. These fleets are expected to exceed 5,700 and 246,000 aircraft (respectively) by 2015.

U.S. civil aircraft will fly more than 50 million hours this year.

Approximately 2,000,000 passengers and 2.6 million bags screened each day.

General Aviation (GA) accounts for approximately 77 percent of all flights within the United States.

Over 90 percent of U.S.-registered aircraft are categorized as GA.

Sources: The Bureau of Transportation Statistics; the Federal Aviation Administration.

Highway Transportation Statistics

The highway mode consists of 3,801,849 miles of roads, 46,717 miles of interstate highway, and 114,700 miles of the National Highway System.

The Nation's highway infrastructure includes approximately 582,000 bridges over 20 feet of span.

The Nation's highway infrastructure includes about 350 tunnels over 100 meters in length.

In 2002. at the request of the American Association of State Highway and Transportation Officials, a National Cooperative Highway Research Program project (NCHRP 20-59, Task 5) estimated that it would cost $10.5 billion for a reasonable program to upgrade highway security measures over the 6-year period of the pending surface transportation bill reauthorization.

About 800,000 shipments of hazardous materials are made everyday in the United States–trucks transport 95 percent of these shipments.

Americans ship 73 percent of goods by truck, compared to 4 percent by rail, 3 percent by air, 2 percent by pipeline, and 1 percent by water.

Motor carriers haul 67.9 percent (or 8.9 million tons) of all freight transported in the United States.

90 percent of the U.S. food supply is transported by truck.

By the year 2015, the U.S. freight transportation industry will carry 17.4 billion tons of freight, generating $1.2 trillion in revenue, which represents a 71.2 percent increase over 2003 revenue of $701.9 billion.

Sources: American Trucking Trends 2003; National Result Carrier Fleet Count; Motor Carrier Management Information System; BTS Commodity Flow Survey 1997.

Passenger and Freight Rail Statistics

Amtrak operates more than 22,000 route miles of track and serves 24 million people annually at over 500 station stops; Amtrak's passenger-related revenues reach $1.4 billion.

Alaska Railroad operates on 611 miles of track, serves over 475,000 passengers, and has 11 station stops.

Freight Rail Statistics

In the United States, 64 percent of coal used for electric power, and 20 percent of chemicals are transported by rail. Freight rail assets include 170,000 miles of track, freight rail conveyances (rail cars and locomotives), rail yards, data facilities, employees, and passenger and commuter rail stations.

The Strategic Rail Corridor Network is made up of 30,000 miles of private track and connectors important to national defense.

Sources: Compiled from the Association of American Railroad's Railroad Facts 2002 Edition; the American Short Line and Regional Railroad Association's North American Short Line and Regional Railroads Profile of 2002, and Amtrak's 2003 Consolidated Financial Statement.

Maritime Transportation Statistics

Each year, over 95 percent (by volume) of U.S. trade enters or leaves through seaports, accounting for about 9 million containers; seaports account for 2 billion tons and more than $742 billion of domestic and international freight.

Over 25,000 miles of commercially navigable waterways serve more than 300 U.S. ports.

Approximately 3.3 billion barrels of oil are shipped by sea each year.

More than 5 million cruise ship passengers travel each year from U.S. ports.

Ferry systems transport 134 million passengers annually.

Waterways support 110,000 commercial fishing vessels, contributing $111 billion to State economies.

78 million Americans engage in recreational boating.

Some 8,100 foreign vessels make 50,000 U.S. port calls each year, and domestic and international trade is expected to double in next 20 years.

The U.S. inland navigation system consists of 12,000 miles of commercially navigable inland and coastal waterways. The total navigable inland waterways is 25,000 miles, including the Columbia-Snake River system, the Great Lakes-St. Lawrence Seaway, and other rivers, canal systems, and coastal waterways.

Over 90 percent of Operations Enduring Freedom and Iraqi Freedom cargo was moved by vessels.**

Sources: An Assessment of the U.S. Transportation System–A Report to Congress, September, 1999.

***USTRANSCOM 2003 Annual Command Report; U.S. Army Corps of Engineers, and the USDA Rural Business and Development Policy Branch of the Food and Rural Economics Division.*

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Appendix C–DOT Stakeholders

Aviation Stakeholder Associations and Organizations

- Air Carrier Association of America
- Airforwarders Association and the Air Courier Conference of America
- Air Line Pilots Association
- Air Transport Association
- Aircraft Electronics Association
- Aircraft Owners and Pilots Association
- Airports Council International – North America
- Airport Law Enforcement Agencies Network
- Allied Pilots Association
- American Association of Airport Executives
- American Pilots Association
- Association of Flight Attendants
- Cargo Airline Association
- Coalition of Airline Pilots Associations
- Experimental Aircraft Association
- General Aviation Manufacturers Association
- Helicopter Association International
- International al Air Transport Association
- International Council of Air Shows
- National Aeronautic Association
- National Agricultural Aviation Association
- National Air Carrier Association
- National Air Transportation Association
- National Aircraft Resale Association
- National Association of State Aviation Officials
- National Association of Flight Instructors
- National Business Aviation Association
- Professional Aviation Maintenance Association
- Regional Airline Association
- Small Aircraft Manufacturers Association
- Soaring Society of America
- United States Parachute Association
- University Aviation Association

Highway Stakeholder Associations and Organizations

- American Association of Motor Vehicle Administrators
- American Association of State Highway and Transportation Officials
- American Bus Association
- American Chemistry Council
- American Trucking Associations (and affiliated State associations)
- American Road and Transportation Builders Association
- Commercial Vehicle Safety Alliance
- Community Transportation Association of America
- International Bridge, Tunnel and Turnpike Association
- Motor Freight Carriers Association
- National Association for Pupil Transportation
- National Cargo Security Council
- National School Transportation Association
- National Tank Truck Carriers
- Owner-Operator Independent Drivers Association
- United Motorcoach Association

Rail Stakeholder Associations and Organizations

- Air Brake Association
- American Chemistry Council
- American Council of Railroad Women
- American Petroleum Institute
- American Public Transportation Association
- American Railcar Industries
- American Shortline and Regional Railroad Association American Train Dispatchers
- Amtrak
- Association of American Railroads
- Brotherhood of Locomotive and Trainman
- Brotherhood of Locomotive Engineers
- Brotherhood of Maintenance-of-Way Employees
- The Chlorine Institute
- The Fertilizer Institute
- Institute of Makers of Explosives
- International Brotherhood of Electrical Workers Union
- National Association of Chemical Distributors National Industrial Transportation League
- Northeastern Shippers
- Pulp and Paper Transportation League
- Railroad Insurance Group
- Railway Association of Canada
- Railway Progress Institute
- Railway Supply Institute
- Railway Tie Association
- Southeastern Shippers
- Transportation Communication Workers Union
- United Transportation Workers Union

Maritime Stakeholder Associations and Organizations	
American Association of Port Authorities	Maritime Institute for Research and Industrial Development
American Maritime Congress	Masters, Mates and Pilots
American Shipbuilding Association	National Association of Warehouse Employees
American Waterways Operators	National Defense Transportation Association
Inland Rivers Port and Terminals	National Industrial Transportation League
Intermodal Association of North America	National Maritime Union
International Council of Cruise Lines	Pacific Maritime Association
International Longshore Association	Sailors Union of the Pacific
International Longshoreman and Warehouse Union	Seafarers International Union
International Longshoreman's Association	Shipbuilders Council of America
International Organization of Masters, Mates and Pilots	Transportation Institute
Lake Carriers Association	Transportation Research Board
Marine Engineers' Beneficial Association	U.S. Chamber of Shipping
Marine Institute of Technology	World Shipping Council