

Linking the world

Radio-frequency assets are precious and omnipresent

By Eric Fetters-Walp

Frequency Management Services may be tiny—fewer than three dozen people—but its impact extends throughout Boeing and beyond.

Anything at Boeing that uses radio-frequency (RF) spectrum, from wireless microphones to the next generation of airplanes to satellites, is of concern to Shared Services Group's FMS. The team's tasks vary from the crucial role of representing Boeing on the international radiocommunication regulatory stage to the nitty-gritty of helping departments order the correct two-way radios.

"The rapid pace of technological change in Boeing heightens the company's need to strategically plan for and manage its RF assets and requirements, as well as to preserve and advance its competitive position," said John Herpy, leader of strategy and systems for FMS.

All of FMS' efforts are aimed at making sure Boeing protects a valuable asset—one that it needs to successfully operate and grow. "The company holds licenses to use radio spectrum with an estimated market value of at least \$20 billion, and its use could be put in jeopardy if Boeing doesn't operate it in compliance with U.S. and international regulations," said Mohamed El Amin, director of regulatory policy and international spectrum management. Located in London, he leads an international team that promotes and protects Boeing's spectrum interests around the globe.

As Mike Kato, senior manager of FMS, puts it: "We're involved just about everywhere. Spectrum is used on the factory floor, inside the products Boeing makes, on the launch pad and at flight-test ranges. But for all its importance to the company, the role of RF spectrum management is largely unknown."

Which is why FMS wants Boeing employees to know how it can help early on in the development and approval of anything that uses radio frequencies. Too often, the team's assistance in gaining needed regulatory authorizations for RF spectrum use is an afterthought, said Audrey Allison, director of FMS. "We could

PHOTO: SkyTerra test engineer James Tan (right) reviews data at the Boeing satellite production site in El Segundo, Calif., with Tim Cooper, electromagnetics technician in Frequency Management Services, to ensure a spacecraft's Ku-band antenna is compliant with FCC radio-frequency emission regulations.

PAUL PINNER/BOEING, GLADYS WICKERING/BOEING

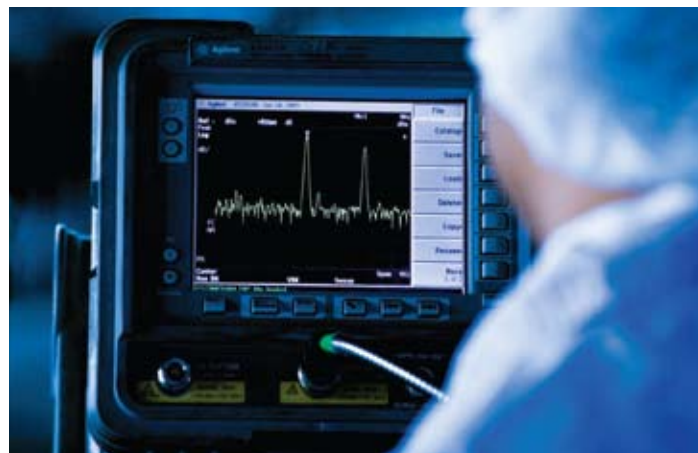


PHOTO: Frequency Management Services uses tools like the spectrum analyzer shown here as an integral part of the radio-frequency asset protection and regulatory compliance processes. PAUL PINNER/BOEING, GLADYS WICKERING/BOEING

be helping them at an earlier stage in their schedule, but we can't if we don't know who they are or what they need."

In the past five years, FMS has established a new Consolidated Frequency Management System, which has helped the team in authorizing the use of RF spectrum and equipment and ensuring the company's compliance in using that spectrum. With the processes to carry out those two missions in place, FMS is focused on its third mission: educating employees on the importance of RF at Boeing.

"We can gain a competitive advantage for the company if we create an environment of collaboration, education and strategic alignment," Herpy said. "We've already begun to see a shift in recognition of the importance of spectrum at Boeing."

Allison said she hopes increased awareness of FMS' missions will lead product teams to consider any RF spectrum issues early on in development. For example, it has worked extensively with the engineering teams on the new 787 Dreamliner, which incorporates a range of wireless-enabled devices not present on previous airplanes, including a wireless system designed

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— John Herpy, FMS strategy and systems lead

to support a range of maintenance activities.

In that case, FMS got involved early in the process. That doesn't always happen, which can lead to delays. “If we have to get an authorization quickly, it's not easy, because the regulatory process can move at a glacial pace,” Allison said. Moreover, new technologies Boeing develops may require new spectrum allocations, equipment standards and associated regulatory requirements in common around the world.

FMS' work to raise RF spectrum compliance within Boeing includes its establishment four years ago of the Spectrum Governance Council, which serves as an internal governing and strategy body and includes representatives of all the business units. Outside the company, the team takes an active role in the International Telecommunication Union and its periodic World Radiocommunication Conferences, where global spectrum regulations are discussed and decided. At the last conference two years ago, Allison and other Boeing representatives sought additional spectrum for flight-test operations and unmanned aerial vehicles while improving regulations for satellite systems and defending satellite spectrum from reallocation for other uses.

Regulatory issues in the halls of government or at international conferences may not immediately affect most Boeing employees, but RF compliance is something that everyone should consider. Compliance is everyone's responsibility, said Kato, adding that everyday office items, such as microwave ovens and wireless headsets, can cause interference with Boeing's wireless communications network and essential factory floor operations. Employees should consult the FMS informational Web site at <http://cfms.web.boeing.com> on the Boeing intranet when they have questions, he said.

“Spectrum is such an essential element of what Boeing is doing,” Allison added. “As technology continues to evolve in this direction, access to spectrum is becoming ever more central to our ability to grow and remain competitive.” ■

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PHOTO: Joe Cramer, U.S. regional director for regulatory policy and international spectrum management, is shown at the World Radiocommunication Conference in Geneva in 2007. Boeing plays an active role at such conferences to preserve its capability to obtain needed spectrum resources to support current and future products operating around the globe. **STAN JENKINS/BOEING**

Managing the invisible risk



More and more, wireless technologies are integrating not only into our personal devices but into Boeing facilities, systems and products. As that demand increases, keeping track of the myriad resulting radio waves would seem impossible. Yet, for production environments that rely on wireless, such as the 787 Program, it has become mission critical.

While unseen, the radio waves emitted from the many wireless devices, systems and products in use today clutter the space around us like a busy interstate. And any of those waves in the radio-frequency (RF) spectrum can unintentionally interrupt or be intercepted by devices operating on the same frequency, causing significant issues such as corruption of digitally transmitted data, especially in critical production areas. This type of harmful interference can be avoided with careful coordination with the Frequency Management Services group of Shared Services.

The Federal Communications Commission governs all such RF devices, including those operating in the popular 900 MHz, 2.4 GHz and 5.7 GHz bands. However, many wireless devices currently in use across Boeing operate in what is called the “unlicensed spectrum”—frequencies that are not regulated by the FCC and do not have a licensing requirement.

That keeps Boeing's Unlicensed Radio Operations Committee (UROC) worried—and busy. Frequency Management Services' Spectrum Governance Council chartered the UROC Spectrum Coordinating Committee in 2007. Its job is to reduce risk by identifying the many unlicensed wireless devices and frequencies in use on Boeing property and bring them into compliance.

Last year, UROC's work became a little easier with the introduction of spectrum analyzers. With readouts resembling those of a Star Trek “tricorder,” these devices allow technicians to see and analyze the various signals using the unlicensed spectrum. The capability has enabled better spectrum management decisions, reducing risk and improving efficiency along the way.

The UROC team continues to monitor and identify unlicensed wireless technologies and bring them into compliance.

— Kenn Johnson

All on the same wavelength

More than 50 years of radio-frequency spectrum use at Boeing

When one thinks of the contributions made by Boeing to the advancement of flight and aerospace technology, one of the last things that may come to mind are radios and radio frequencies. Yet the development of secure air-to-ground communications and the management of radio frequencies are a critical part of aerospace technology—especially considering the rapid expansion of new technologies aboard defense, space and commercial platforms and our reliance on wireless communications in today's society.

Indeed, management of the airwaves is one more field in which Boeing has been a pioneer and continues to lead the way for the aerospace industry.

Radio communication in airplanes began around the time of World War I. Early ground-to-air communication was unreliable and greatly affected by engine noise and other interference. Also, early communication systems relied on wireless telegraphs that required a radio operator—hardly an option for a single-crew mail plane.

In 1927, William Boeing was starting his own airline, Boeing Air Transport. He quickly saw the need for reliable ground-to-air communication to increase safety and improve airline efficiency.

Fortunately for Boeing a close friend, Thorpe Hiscock, was an avid radio enthusiast. During a dinner conversation with Boeing, Hiscock described his belief that a reliable and practical system of radio communications could be developed for Boeing's new airline.

Boeing hired Hiscock as the communications engineer for Boeing Air Transport and put him to work on his theory. His work would lead him to be recognized as the inventor of reliable aircraft radios.

In 1928, Hiscock and fellow Boeing engineers packed radio



PHOTO: Thorpe Hiscock developed a reliable and practical system of radio communications for Boeing Air Transport in 1928.

BOEING ARCHIVES



PHOTO: Atop the Boeing Flight Test hangar at Boeing Field in Seattle, Boeing Flight Test Radio employees support B-52 flight test operations in 1955. BOEING ARCHIVES

equipment into a truck and went cross-country testing different wavelengths and power settings to discover what would be most effective for short-wave reception and most useful for airline operations. Hiscock then loaded his radio equipment into a Boeing Model 40B and discovered how to shield the radio from interference on board the plane, especially from the engine's ignition system.

Hiscock worked through a number of challenges, but finally returned to Boeing with an announcement of success. The company took out patents on the radio equipment and enlisted Western Electric to manufacture radio sets for its airplanes.

Other fledgling airlines followed Boeing Air Transport in setting up a cross-country system of radio communications. It soon became evident that coordination was needed to avoid duplication of ground equipment and labor. There also was a need for some form of central administration to oversee the use of the limited number of frequencies that had been made available to airlines through the Federal Radio Commission (known as the Federal Communications Commission today). In order to accomplish these tasks, the FRC chartered Aeronautical



PHOTO: Boeing Air Transport pilot Eddie Allen with the Model 40B used by Thorp Hiscock during the successful test of two-way, ground-to-air radio communications. **BOEING ARCHIVES**

Radio Incorporated (known as ARINC today) with Boeing's own Thorpe Hiscock as one of the agency's directors, and Boeing one of the stockholders.

The current Boeing organization that manages the airwaves for the company—Frequency Management Services—traces its beginning to a memo dated April 18, 1948. It gave responsibility to coordinate the company's radio work to the Flight Test Equipment Group in order to avoid "the splendid confusion which seems to accompany radio installation and operations" at Boeing.

The group's original charter was to provide ground-to-air communications for flight-test and production aircraft, remote station operation and flight-plan filing, as well as flight-test monitoring and data transmission. The group was also responsible for coordinating station and operator licensing and frequency allocation.

In 1950, the Boeing radio organization was consolidated at the Hangar 1 tower at North Boeing Field in Seattle. In 1954, it was moved to a tower atop the then-new B-52 hangar at the field, 92 feet (28 meters) and 132 steps above the flight-test apron.

The facility, with its array of radio equipment, allowed engineers to collect flight data telemetry that greatly increased the efficiency of flight testing for the B-52 program and all Boeing commercial jet flight-test programs that followed.

In 1984, the Frequency Management organization was officially separated from the Flight Test Radio Group. Today, its challenges include dealing with an exponential increase in the demand for use of the radio-frequency spectrum, along with greater complexity and variety of products and services that depend on control of the airwaves. It also is responsible for the complex political negotiations with international partners, competitors and regulators necessary to secure unfettered global spectrum access that allows Boeing products and operations to perform with precision as they span the globe and reach into space.

— Mike Lombardi

Making waves



787 Dreamliner boasts newest wireless technologies

More than 90 years after radios first flew aboard airplanes to allow air-to-ground communications, radio-enabled technology performs a wide array of functions on modern jetliners.

That's truer than ever on Boeing's newest model, and Commercial Airplanes and Frequency Management Services have worked closely together as the 787 Dreamliner has taken shape. The Boeing 787 Dreamliner offers an innovative wireless maintenance system that allows airline crews to run tests between flights and determine what maintenance is needed while moving around the airplane. The same wireless network is used to provide access to the maintenance documents/manuals and to support airline, aircraft, crew and ramp activities.

"FMS expertise has been invaluable to the Onboard Wireless Integration team and the Systems groups and suppliers we support," said Milad Moss, senior project manager at the Cabin and Network Systems Technology Center in Everett, Wash.

"BCA relied heavily on FMS to help develop an action plan that would enable us to access the required spectrum to support a variety of wireless airplane applications," Moss said.

To implement the action plan, FMS worked with regulatory agencies all over the world. In parts of the globe where spectrum rules are incompatible with Commercial Airplanes' requirements, the FMS team is working to modify those rules.

"As wireless technologies continue to evolve, and the aviation industry demands more wireless systems installed on board aircraft, there will be more opportunities and need for FMS support of [Commercial Airplanes'] projects," she said.

— Eric Fetters-Walp

PHOTO: Milad Moss, senior project manager at the Cabin and Network Systems Technology Center in Everett, Wash., worked with Frequency Management Services on the wireless systems installed in the 787 Dreamliner, seen in the background. **GAIL HANUSA/BOEING**

Defending the peace with wireless

FMS provides critical support to IDS programs

The watchful eyes and ears of Boeing-built defense satellites and unmanned aerial vehicles would be useless without radio-frequency (RF) spectrum.

Just to operate Integrated Defense Systems' Boeing Broadband SatCom Network, Frequency Management Services maintains 175 spectrum authorizations. Without spectrum licenses, those satellites would be of little value, said Mike Turner, program manager for the Boeing Broadband SatCom Network.

"Our competitive advantages include expert operations personnel, superior engineering talent and a Frequency Management team that ensures we have licenses to operate around the globe," Turner said. "The ongoing work that FMS does to ensure we maintain our operating licenses and to elevate the status of our frequency allocation helps to protect our current service and provides opportunities for Boeing to expand our broadband communication capabilities."

A wide array of sophisticated IDS aircraft and products use RF spectrum for communications, navigation and targeting. For example, FMS supports ScanEagle—an unmanned intelligence, surveillance and reconnaissance system operated by the U.S. Navy and others—by working with Insitu, a wholly owned Boeing subsidiary. (See related story on unmanned aerial systems, Page 14).

"The FMS team plays a business-critical role in furnishing licenses, advice and regulatory compliance material that not only enables Boeing's [unmanned aerial systems] to be operated effectively and efficiently but also helps avoid costly penalties for any transgression of these sometimes very vague and complicated laws," said Jed Sturman, director, Unmanned Airborne Systems Policy & Regulatory Compliance, Phantom Works, IDS.

FMS employees help provide the required access and authorization to operate in RF spectrum used for the ScanEagle's command and control capabilities and to downlink data from multiple onboard sensors, wherever the ScanEagle is operated. Additionally, FMS helps secure the approval and compliance of onboard equipment and the authorization to radiate wireless signals within the continental United States.



PHOTO: Jim McClanahan, Insitu production shop team lead, secures the engine fairing on a ScanEagle, one of many Boeing programs that rely on radio-frequency spectrum. **DOUG CANTWELL/BOEING**



PHOTO: Frequency Management Services supports the F/A-18 Super Hornet Program, which uses radio-frequency spectrum for testing. **RICHARD RAU/BOEING**

“Given the finite nature of available RF spectrum, the FMS team does a superb job in providing technical, regulatory and licensing support and advice that assures this connectivity is, wherever possible, available at the right time, in the right form,” Sturman added.

The Boeing-built F/A-18 and F-15 jet fighters aren’t controlled via radio-transmitted commands like an unmanned aerial vehicle, of course, but RF spectrum is just as crucial to them, said Ron Ridderbos, senior manager of electrophysics at the IDS site in St. Louis. In addition to the numerous systems on board the F/A-18 and F-15 that use RF spectrum, much of the testing done in St. Louis to support delivery of these jets to customers involves RF spectrum. Coordination between FMS and IDS has improved in recent years, Ridderbos said.

“An effort has been made to involve FMS personnel in the avionics development process earlier so that there is a better understanding of requirements and future needs,” he said.

“FMS personnel also have been working more closely with the programs by participating in key program meetings. As this focus on partnership between FMS and the programs has evolved, there has been a better understanding of spectrum requirements and the authorization process by program engineers.”

As with Boeing’s other business units, the coordination of RF spectrum authorizations has become increasingly important for IDS with incorporation of new technologies into its products. “The spectrum available to us and our hardware manufacturers continues to shrink, making effective spectrum management critical,” Ridderbos said.

– Eric Fetters-Walp

Advantage: Wireless

Strategic use of wireless communications throughout company is critical to success



PHOTO: Sudhakar Shetty, Senior Technical Fellow for Airplane Systems, supports spectrum management. GAIL HANUSA/BOEING

applied internally to productivity improvement initiatives, environmental monitoring, intelligent tooling and factory floor communications, and in the products we sell and maintain for our customers,” said James Farricker, Senior Technical Fellow and chief engineer for the Boeing Information Technology Computing & Network Organization. “Spectrum management is key to our ability to be able to provide Boeing a competitive advantage.”

An important requirement for most of Boeing’s electronic

Boeing’s wireless computing networks, laser alignment systems for airplane production and emerging uses for radio-frequency (RF) identification tags all have something in common.

They use RF spectrum—meaning Shared Services Group Frequency Management Services has assisted with them.

“Wireless communications have become pervasive throughout Boeing, being

equipment—from radios to sensors to target acquisition systems—is that components successfully link to one another to function, Faye Francy said. She leads the Networked Systems Technology Domain, one of eight companywide technology groupings in Boeing’s Enterprise Technology Strategy, designed to better integrate and focus Boeing’s technology investments. Most of the time, that requires using radio frequencies without significant interference. FMS works to make sure that’s possible, she said.

“The Networked Systems domain team has identified spectrum access and optimization as a critical capability for the enterprise, and we are collaborating with the FMS spectrum planning team to ensure we are investing in the right areas to protect the future,” Francy said.

Farricker said the FMS team has supported a long list of projects in recent years, from coordinating the use of new 787 testing tools to planning for the introduction of autonomous guided vehicles in the 737 wing factory in Renton, Wash. In such cases, FMS helped early on to identify potential RF conflicts and interference problems. FMS also has helped various groups collaborate in deploying wireless systems throughout Boeing, he said.

Sudhakar Shetty, Senior Technical Fellow at Commercial Airplanes’ Airplane Systems, said collaboration with FMS will further increase as wireless communications technology finds more applications across Boeing and its products.

“FMS is uniquely qualified to effectively address this issue at the corporate level to ensure a ‘One Boeing’ solution without duplications,” said Shetty, who leads Commercial Airplanes’ global network and wireless research strategies and technologies.

– Eric Fetters-Walp

Up and running

Radio system keeps production lines and services operating smoothly



PHOTO: Glenn McEachron, manager of Northwest Radio Services, leads a team that ensures that mission-critical mobile radio communications are online 24/7. ALAN MARTS/BOEING

Glenn McEachron oversees a communications system used by thousands of Boeing employees every day, from firefighters to crane operators sitting hundreds of feet above the Everett, Wash., production floor.

If the radio system were to fail, critical functions across Boeing's Puget Sound-area sites would be disrupted.

"It would actually interrupt airplane production, in addition to things like fire and security and flight-line testing," said McEachron, manager of Boeing's Northwest Radio Services.

McEachron's team, part of Shared Services Group, operates the company's portable and mobile radio network within a 90-mile (145-kilometer) stretch of the Puget Sound region. In that area alone there are 10,000 employee radios using 40 different frequencies to communicate. Northwest Radio Services also assists similar radio networks at other Boeing sites within the United States.

To ensure these systems keep operating effectively and lawfully, the team relies upon Frequency Management Services. "They make it easy for us. They take it upon themselves to renew our licenses and authorize the use of our entire radio system," McEachron said.

FMS currently is helping Northwest Radio Services switch its communications to new frequencies to reduce potential interference with emergency services frequencies. It is a major task that includes physically reprogramming thousands of radios and making sure the transition is performed in compliance with Federal Communications Commission regulations.

FMS plays a key role in ensuring the availability of our Northwest Radio Services' communications network, McEachron said. "They really provide a great deal of education on how to use our radios and frequencies lawfully and compliantly and how to operate without interfering with our communications. We depend on them tremendously."

— Eric Fetters-Walp

Glossary

Frequency Management Services deals with the technical world of radio-frequency (RF) signals and their regulation, which has a jargon all its own. Here are a few of the terms that Boeing employees interacting with FMS need to know:

Authority to Radiate: The government document that grants Boeing the permissions needed to legally radiate an RF signal. This permission is then managed by FMS, which provides an authorization memorandum to the specific user.

Compliance assessment: The process used by FMS to conduct RF spectrum assessments of Boeing sites and RF operations to evaluate regulatory compliance; assess compliance risks and recommend remedies and other corrective actions; and communicate regulations, standards and procedures to Boeing RF users.

Electromagnetic interference: "Harmful interference" and/or interference caused by devices that, intentionally or unintentionally, radiate electromagnetic energy that interrupts, obstructs, or otherwise degrades or limits the effective performance of telecommunications equipment or other electronic equipment within or adjacent to Boeing facilities.

Federal Communications Commission: An independent U.S. government agency reporting directly to Congress. The FCC is responsible for regulating the use of frequencies assigned to nonfederal government users.

International Telecommunication Union: The United Nations agency that coordinates global use of the RF and satellite orbits and establishes worldwide standards for communications systems.

License: The legal permission to radiate RF signals in free space.

National Telecommunications and Information Administration: Part of the U.S. Department of Commerce. NTIA is the U.S. president's principal adviser on telecommunications and information policy issues. It also is responsible for managing the use of U.S. government frequencies.

Radio-frequency spectrum: The portion of the electromagnetic spectrum between 9 kilohertz (kHz) and 400 gigahertz (GHz).

Radio-frequency device or equipment: A term used to describe any device, equipment or system component that's designed to intentionally transmit or receive electromagnetic energy. Although the term specifies "radio," it also includes radar, navigational aids, telemetry, video and other types of electronic equipment used in private, commercial and military communications systems. Typically, all such equipment used at Boeing must be cleared by FMS.

Regulatory compliance: This refers to fulfilling all the legal requirements that govern the use of RF spectrum and all the requirements outlined in Boeing procedures, specifically PRO-3271.