NTIA Spectrum News

Vol. 1, Issue 1 | *Published Aperiodically* | Fall,1999

Office of Spectrum Management

U.S. Department of Commerce • National Telecommunications and Information Administration • Washington, D.C.

Greetings to all spectrum managers and those with interests in the spectrum . . .

This is the first issue of a new aperiodic newsletter on spectrum management topics and related news. It is so new that we do not yet have a final title, but we are having a competition to name it. Please e-mail or postal mail your suggested title to the editor, and we will announce the title and the winner in the next issue.

We hope you enjoy the articles we have for you this quarter on current issues concerning the Global Positioning System (GPS), potential interference between radar systems and fixed wireless access networks, a new study of adjacent band interference recently taken up by NTIA, a short overview of telecommunications regulatory activities in Panama, and finally our gossip column bringing you up to date on activities of many spectrum managers around the world. We also welcome your suggestions for future articles, any articles you may wish to submit (especially on activities in your country and what is happening to you and other spectrum managers you know), and comments you have on the articles in this issue. With your permission, we may include your letter in a future issue.

By-the-way, you have our permission to reprint or otherwise use any or all of the material in this issue provided you indicate the source and, if possible send us a copy.

GPS – Moving Forward

What do a taxicab driver in Tokyo, a Swiss scientist measuring the rise in the height of the Alps, an engineer designing a communications network, a satellite measuring ocean temperatures to predict El Niño and a farmer planning crop irrigation have in common? They are all using the Global Positioning System (GPS) to get their jobs done. The GPS uses satellites to transmit very precise positioning signals to receivers on the earth. The GPS provides information that can be used for navigation and positioning using a very accurate time reference, the GPS master clock. The difference between the GPS reference time and the Coordinated Universal Time (UTC) of the U.S. Naval Observatory (USNO) is measured and this relationship is included in the GPS navigation message.

Gore Announces New GPS Initiative

U.S. Vice President Al Gore announced on January 25, 1999, a $400 million initiative that will modernize the GPS and will add two new civil signals to future GPS satellites, significantly enhancing the service provided to civil, commercial, and scientific users.

"The United States is proud to be a leader in the development of the Global Positioning System – a wonderful system that is benefitting our citizens and people around the world. This initiative represents a major milestone in the evolution of GPS as a global information utility, and will help us realize the full benefits of this technology in the next millennium," said Vice President Gore.

A civil signal will be at 1227.60 MHZ, and it will be available for general use in non-safety-critical applications. An additional signal will be on 1176.45 MHZ, and will meet the needs of critical safety-of-life applications. The latter frequency will be discussed at WRC-2000.

Figure 1. Illustration of GPS Satellite in Orbit. Courtesy of The Boeing Company.

How GPS Works

Each GPS satellite transmits data indicating its location and the current time. The GPS satellites synchronize operations so that these repeating signals are transmitted with the known relative time from each satellite. The signals, moving at the speed of light, arrive at a specific GPS receiver on earth at slightly different times because the satellites are at different distances from the receiver. The distance to the GPS satellites can be determined by calculating the amount of time it takes for their signals to reach the receiver. When the receiver has calculated the distance to at least four GPS satellites, it can calculate its position in three dimensions.

Determining Position

A GPS receiver "knows" the location of the satellites, because that information is included in the satellite transmissions. By determining the distance from the satellite, the receiver "knows" its location somewhere on the surface of an imaginary sphere centered at the satellite. It then determines the sizes of several spheres, one for each satellite in view. The receiver is located where these spheres intersect.

GPS Accuracy

A navigation receiver using only the GPS coarse-acquisition (C/A) signal is limited to a real-time computed accuracy of about 100 meters. Much higher accuracy can be obtained in several ways. One common method is Differential GPS, which requires an additional receiver fixed at a known location. Observations made by the stationary receiver are used to provide position corrections for the roving units, producing an accuracy better than 1 meter.

GPS Navigation in the Air

GPS offers an inexpensive and reliable supplement to existing navigation techniques for aircraft. Civil aircraft typically fly from one ground beacon, or way point, to another. With GPS, an aircraft's computers can be programmed to fly a direct route to a destination. The savings in fuel and time can be significant. GPS can simplify and improve the method of guiding planes to a safe landing, especially in poor weather. With advanced GPS systems, airplanes can be guided to touchdown even when visibility is poor.

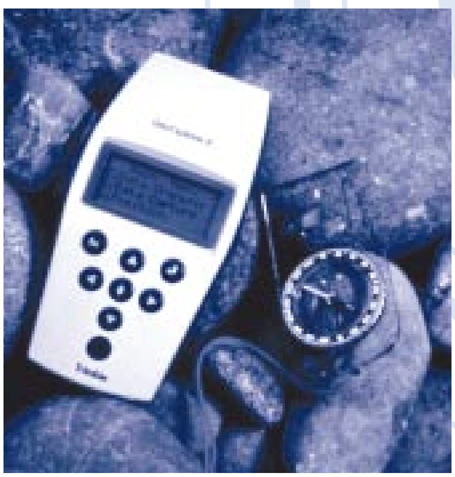

Figure 2. Small GPS Receiver. Courtesy of Trimble.

Other GPS Uses

GPS has improved efficient routing of vessels and enhanced safety at sea by making it possible to report a precise position to rescuers when disaster strikes. GPS improves efficiency on land as well. Delivery trucks can receive GPS signals and instantly transmit their position to a central dispatcher. Police and fire departments can use GPS to dispatch their vehicles efficiently, reducing response time. GPS helps motorists find their way by determining their location; this information can then be shown along with the intended route on dashboard displays. Railroads are using GPS technology to locate trains and control their movements. Surveyors and map makers use GPS for precision positioning. Forestry, mineral exploration, and wildlife habitat management all use GPS to precisely define positions of important assets and to identify changes. GPS has evolved into the primary worldwide system for the distribution of Precise Time and Time Interval (PTTI) information. This accurate timing is used by many telecommunications systems. Furthermore, GPS signals are used for time transfer between standard reference clocks with an accuracy better than 10 nanoseconds.

GPS as a Component of the GNSS

GPS operates in the band 1559-1610 MHZ allocated to the Radio Navigation Satellite Service (RNSS) and the Aeronautical Radio Navigation Service (ARNS). An objective of the United States, as well as the International Civil Aviation Organization (ICAO), is the implementation of a global navigation satellite system (GNSS) that can support aeronautical safety in all phases of flight. A principal component of GNSS is GPS, providing worldwide coverage, free-of-charge. Systems that augment GPS in critical applications are being developed. Some of these systems are planned to operate on frequencies in the 1559-1610 MHZ band.

GPS ISSUES AT THE ITU WRC-2000

Several issues related to GPS will be addressed at the upcoming World Radiocommunication Conference (WRC) of the International Telecommunication Union (ITU):

Agenda Item 1.9: WRC-97 adopted Resolution 220 in response to a proposal to add an allocation to the 1559-1567 MHZ band for the Mobile-Satellite Service (MSS). ITU-R working party WP8D was tasked to determine if sharing between Mobile-Satellite Service (MSS) and ARNS/RNSS is feasible. Studies have been completed to determine interference protection requirements of a broad range of GPS radionavigation satellite services and applications including proposed system modernizations. The conclusions from these studies as reported in the draft WRC Conference Preparatory Meeting (CPM) text is that it is not feasible to share the 1559-1567 MHZ band with the MSS.

Agenda Item 1.15.1: Additional civil frequencies for RNSS will greatly enhance the accuracy, reliability and robustness of the civil GPS by enabling more effective corrections to be made for the time delay effects of the ionosphere on the signals from space. GPS currently provides signals that are used for Radio Navigation on two frequencies, one of which is available for civil applications. Additional civil signals, that are widely separated in frequency, will allow receivers to measure the time of arrival for two signals that have passed through the ionosphere and correct for the delay introduced by passage from space to earth. This will result in improved accuracy in the navigation solution to support operations requiring increased precision. The protected civil signal will provide increased signal robustness that will help protect safety-critical users from the effects of radio frequency interference. ICAO has stated the requirement for an additional civil signal on GPS to support GNSS requirements and for space-based augmentation systems.

The United States has identified a second new civil signal at 1227.6 MHZ and a third civil signal at 1176.45 MHZ to support GNSS developments. The third signal is proposed to be an international civil aviation safety-of-life service signal with a required bandwidth on the order of 24 MHZ. Technical studies evaluating the compatibility between existing operational ARNS systems and the proposed GPS signal at 1176.45 MHZ have been conducted by the United States.

Agenda Item 1.15.2: GPS receivers operating on both 1575.42 and 1227.6 MHZ are used for accurately positioning commercial and scientific spacecraft. However, the present allocation for the RNSS does not afford protection for these signals. WRC-2000 is to consider the addition of the space-to-space direction to the RNSS allocations in the 1215-1260 and 1559-1610 MHZ bands. Over the past seven years, more than 90 GPS receivers have been flown in space by 20 different countries with no identified cases of interference. Sharing studies have been performed showing that the addition of the space-to-space direction to the RNSS allocation is acceptable.

GPS on the Internet

Here are a few Internet world wide web sites on the GPS:

http://www.gpsworld.com
http://www.navcen.uscg.mil/gps/default.htm
http://www.nasm.edu/gps/intro.html
http://www.gps.faa.gov
http://www.ntiacsd.ntia.doc.gov/gps/

Good News and Bad News for Fixed Wireless Access and Radar Sharing

Fixed Wireless Access (FWA) communications systems offer access to the public switched telephone networks and higher bandwidth services in areas where the cost and technical difficulties of implementing traditional wireline service are prohibitive, especially in developing nations. However, there are risks of serious interference if FWA systems operate in bands where radars are also allocated and may be operating. These risks should be considered before a decision to implement FWA in radar bands is made.

When identifying spectrum for national applications of FWA, radiolocation frequency bands are often chosen as a starting point because radars are generally deployed in fewer numbers than some other radio systems. In fact, some types of radars are not deployed at all by many national administrations. While administrations determine their national radio spectrum requirements, some radar activities may be dictated by circumstances beyond national spectrum planning and control. These include emergency or security operations including those in neighboring nations. This creates a potentially unresolvable conflict of priorities between public telecommunications and immediate security or safety concerns when co-frequency, co-coverage operations become necessary.

Radar technology has proved to be invaluable because radars can monitor larger volumes of space and provide more accurate range and bearing information than a person's eyesight, especially during poor weather. The widespread dependence on these systems means that they may be deployed anywhere in the world whenever a contingency or disaster occurs. Because of the high power and mobility of these systems, and the requirement to operate them in unpredictable situations, instances are bound to occur where radar signals cross national borders and cause interference to public systems.

Radars are also becoming widely used in today's civilian world, providing significant economic and environmental benefits. They perform many surveillance tasks in areas such as construction, space rendezvous, and law enforcement. Among the largest civilian uses of radars are air and sea traffic control and weather forecasting. Airport surveillance and weather tracking radars are located at all major airports; and each commercial aircraft and ocean-going ship utilizes radar for collision avoidance and/or navigation. Air traffic control radars monitor air traffic to ensure safe separation and proper take-off and landing flow many miles from the airport, and also monitor traffic flow between airports.

Many harbors and ports also operate radars to assist with vessel traffic control. Weather radars are designed to detect severe weather such as violent thunderstorms and to calculate the speed and direction of motion to aid in timely warnings to the population. These radars also provide precipitation measurements to assist in flood forecasting. Satellites also use radars to assist in weather forecasting. A newer use of radars is Earth sensing. These radars use ground-penetrating frequencies in the 10's of MHZ to 1 GHz range to find buried mineral deposits and other useful materials. They can also locate buried storage tanks and drums, caves, sinkholes and mines. Radars utilizing frequencies in the lower end of the frequency range can examine subsurface at great depths, while radars using the higher frequencies map the near surface in great detail.

The sharing problems are the bad news. The good news is that other non-radiolocation bands are available for FWA applications and some manufacturers are working closely with radar users to design FWA systems that are not susceptible to radar interference. The ITU is working on a Recommendation on preferred frequency bands for FWA that will include the necessary sharing information to ensure a successful FWA installation. Recognizing the seriousness of interference to public networks and the possibility that radar users may not be able to restrict radar operations to prevent or alleviate interference, before identifying national spectrum for FWA or public mobile systems, administrations should look to the ITU evaluation of the potential for interference from radar systems.

Spotlight on Panama

This part will spotlight the spectrum management of a different nation in each issue.

The Republic of Panama modernized its spectrum management process by first enacting Law 31 in February 1996. Law 31 established a new regulatory office, the Ente Regulador de los Servicios Publicos, that was to regulate telecommunications, electricity and water. Previously, telecommunications regulation was in the Ministry of Government and Justice, a very large organization that did many things, such as registering automobiles and issuing auto license plates. The old spectrum management office was very small and understaffed, and unable to keep up with the many demands for new frequency assignments in a timely manner.

José Guanti was appointed as the first Director of Telecommunications in the Ente Regulador. Guanti has an engineering background and has extensive experience in telecommunications, having been the chief executive of a satellite communications company. On taking office, he immediately recognized that the spectrum management office and procedures needed to be modernized to meet the many demands that Panama needed to move its infrastructure into the 21st century. The person that Guanti hired to direct the new office of spectrum management was Edmundo De Gracia, a dynamic and forward-looking leader with extensive experience in telecommunications.

De Gracia hired a small staff of computer-literate engineers, and he recognized that some training was necessary before any major new steps were taken. In October 1996, NTIA's Office of Spectrum Management presented a one-week seminar to De Gracia and his staff. Among the topics covered were establishing a spectrum management organization, frequency assignment procedures and coordination, data base frequency assignment record keeping, spectrum planning, and monitoring and measurements.

The spectrum management office was off and running following the seminar. More computer-literate engineers and computer experts were hired, and new rules and procedures were established. Panama is one of the few countries to make its frequency assignment data base available via the Internet. The web site is:

continued on Page 4

Adjacent Band Interference – A Major New NTIA Initiative

Over the years, extensive radio regulations have been developed, at both the national and international levels, to assure that the various radio services can operate in the same environment without unacceptable levels of radio interference. Most of these regulations and procedures are focused on radio systems operating in the same allocated bands of frequencies. Recent years, however, have seen a dramatic increase in the number of problems and spectrum management issues involving adjacent band interference, *i.e.*, interference from a transmitter operating in one band to a receiver operating in an adjacent allocated band. These types of problems are expected to grow. Several fundamental factors that cause many of these issues include:

1) continuing rapid increases in overall spectrum use,
2) in some cases, conversion from analog to digital technology,
3) introduction of advanced, but sometimes more susceptible to interference, technologies in adjacent bands,
4) marketplace pressures for less expensive radio equipment,
5) reduction of previously available "guard bands", and
6) equipment manufacturer's lack of knowledge regarding radio equipment operating in adjacent bands.

Transmitter emission standards have been one of the traditional regulatory methods used to control adjacent band interference. Two task groups of the ITU-R, the former TG-1/3 and the current TG-1/5, have been very active in updating internationally-agreed transmitter unwanted emission limits. However, controlling transmitter emissions is only one part of the overall problem; receiver characteristics and other factors also play an important role. In general, many of the technical and regulatory aspects of adjacent band interference are not well defined.

Because of these growing concerns, NTIA has embarked on a major project to comprehensively examine adjacent band interference and to make appropriate recommendations. Specific tasks include:

1) establishing an automated data base of interference cases,
2) investigating the role that various voluntary and required spectrum standards play, including transmitter, receiver, and antenna standards,
3) developing new analysis and computer modeling approaches to the study and mitigation of adjacent band interference, including the effects of aggregate interference,
4) characterizing the radio environment in bands adjacent to key bands used for commercial and public safety communications systems, such as bands in which radars and other high powered emitters operate, and
5) identifying and studying newer technologies that provide increased immunity to various types of in-band and adjacent band interference.

The results of these studies will be published in formal NTIA reports and posted on the NTIA web site at <<www.ntia.doc.gov>>.

Spotlight on Panama

Continued from Page 3

<<www.enteregulador.gob.pa>>, and the easy access to frequency records accelerates the frequency selection process.

De Gracia has left the Ente Regulador to take a position with a cable television company. His successor is Roxana Sanjur, an attorney, who is fine-tuning the spectrum management process. Among other things, Sanjur is moving ahead to establish a small spectrum measurement and monitoring facility, primarily to fill the missing holes in the frequency assignment data base that resulted from lack of adequate staff and computers in the old office.

Sanjur is ably assisted by her key deputy Manuel Troitino, and special assistants Rigoberto Rodriguez and John Dennis. Rodriguez has the major responsibility of developing broadcasting regulations.

The rapid transition and modernization of the Panamanian spectrum management process can be used as a model for other nations wishing to do the same.

THE FCC MOVES TO A NEW BUILDING

The Federal Communications Commission (FCC) completed its move this May from eight headquarters buildings around 1919 M Street, its home for more than 30 years in Northwest Washington, DC, to a single new, 10-story building called Portals II, located across town in Southwest DC. This relocation allows the FCC to consolidate its headquarters and bureaus into a single location.

Where Are They Now?

Veterans of many years of international spectrum management often wonder how our former colleagues, and at times, our adversaries are doing. This part will present a few tidbits of such information.

- Richard "Dick" Parlow, USA, retired from his government position at NTIA and joined the Iridium satellite firm where he continues his international work.

- Bob Eldridge, Canada, former ITU CCIR Study Group 8 veteran, retired from British Columbia Telephone. Bob lives in Pemberton, British Columbia, where he is very active in amateur radio, specializing in telegraphy and the 160-meter band.

- Ed DuCharme, Canada, ex-Canadian official, lives in Kanata, Ontario, Canada where he is a consultant to Motorola and Iridium.

- Hal Kimball, USA, retired from NTIA and lives in Geneva where he consults on telecommunications.

- A. Prose Walker, USA, former chairman of ITU CCIR Study Group 10, is retired and living in Greece, NY.

- Bob Mayher, USA, Chairman of ITU-R Study Group 1, married Kathryn Gasparotti on June 19. Bob provides spectrum management consulting as Smile Associates.

Published by the National Telecommunications and Information Administration. We would greatly appreciate your comments. Please postal mail or e-mail them to Fred Matos, National Telecommunications and Information Administration, Room 6888, 14th and Constitution Ave. N.W., Washington, D.C. 20230; or e-mail to <<fmatos@ntia.doc.gov>>