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Agenda Item 3: Air Navigation Services
3.1 CNS/ATM

STATUS OF THE GLOBAL POSITIONING SYSTEM (GPS) AND ITS WIDE AND LOCAL AREA AUGMENTATION SYSTEMS FOR CIVIL AVIATION

(Presented by the United States of America)

SUMMARY

This information paper provides the most recent status of the United States Global Positioning (GPS) and updated GPS policy, as well as the Federal Aviation Administration's (FAA) Wide Area Augmentation System, or WAAS, and Local Area Augmentation System, or LAAS.

1. Introduction

1.1 Satellite navigation technology is already in use in the United States and around the world as a navigation aid for en route, oceanic and remote airspace, and non-precision approach operations. The U.S. Global Positioning System (GPS) provides this service as an integral part of the International Civil Aviation Organization's (ICAO) envisioned seamless Global Navigation Satellite System, or GNSS. The United States is also committed to the modernization of GPS to provide better service and increased benefits to all users.

1.2 The U.S. Federal Aviation Administration (FAA) is also relying on GPS to be the cornerstone of its future air navigation infrastructure within the U.S. National Airspace System (NAS). The FAA has already commissioned its Wide Area Augmentation System (WAAS) within the United States and continues its research and development of the Local Area Augmentation System (LAAS).

2. Discussion

Global Position System (GPS) Modernization

2.1 GPS has been available for peaceful, civil users worldwide for many years. The United States has, through its approved GPS policy guidance and offering of GPS to the International Civil Aviation Organization (ICAO) as a main component of the future GNSS infrastructure, committed to the continued modernization and improvement of GPS for all users worldwide. Basic U.S. principles related to GPS are as follows:

- No direct user fees for civil GPS services
- Open public signal structure for all civil services

- Global use of GPS time, geodesy, and signal standards
- Global compatibility and interoperability of future systems with GPS
- Protection of current radio navigation spectrum from disruption and interference
- Recognition of national and international security issues and protection against misuse

2.2 On December 15, 2004, the U.S. Government released the *U.S. Space-Based Positioning, Navigation, and Timing Policy*. This new policy continues the U.S. offer of GPS to the world aviation community. In very general and summarized terms, the policy directs the United States to provide GPS services on a continuous, worldwide basis, free of direct user fees for civil, commercial, and scientific uses; improve the performance of GPS services worldwide; and ensure that foreign GPS-based systems are interoperable with GPS and its augmentations.

2.3 In support of this, the United States continues to actively plan GPS modernization activities. The first enhancement will be the addition of a 2nd civil frequency (L2C). Although L2C is not in the Aeronautical Radionavigation Service (ARNS) protected band, it will provide benefits to many non-aviation civil users worldwide. The first GPS satellite with L2C is scheduled for launch in late 2005, with an expected full 24-satellite constellation projected to be available in 2012.

2.4 The 3rd civil GPS signal (L5) will be in an ARNS protected band and thus will provide many safety-of-life benefits to the worldwide civil aviation community. The first GPS satellite carrying the L5 signal is scheduled to be launched in 2007, with a 24-satellite constellation projected to be available by 2015.

2.5 Finally, the GPS III satellites will add an improved civil signal (L1C), which is expected to increase accuracy from 4.8m to 1.2m. GPS III is also evaluating integrity improvements and increased A/J power (+20 dB). Current projections have a full 24-satellite GPS III constellation available by 2021.

U.S. WAAS Program Status

2.6 The FAA officially commissioned the WAAS initial operating capability (IOC) on July 10, 2003 to support en route navigation, precision approach and departure operations, and terminal area and surface navigation. Since then, WAAS performance has consistently demonstrated 1-meter horizontal and 1.5 meter vertical accuracy. At commissioning, the FAA had published over 500 lateral navigation/vertical navigation (LNAV/VNAV)* approach procedures.

- * *LNAV/VNAV is an approach procedure with vertical guidance with nominal minimums of a 350' decision height, 1½-mile visibility, 556m horizontal alert limit (HAL), and 50m vertical alert limit (VAL).*

2.7 In September 2003, the FAA improved the precision approach capability provided by WAAS through terminal approach procedures (TERPS) optimization. This improvement took full advantage of the capabilities of the WAAS signal-in-space and provided a new approach procedure with vertical guidance called LPV*. LPV provides more lateral precision over LNAV/VNAV resulting in lower approach minima for most runways.

- * LPV procedures have nominal minimums of a 250' decision height, ½ mile visibility with proper lighting (¾ mile without proper lighting), 40m HAL, and 50m VAL.

2.8 After IOC, the FAA focused its attention on completing several other WAAS service/system enhancements to achieve a full operating capability (FOC) for WAAS by 2008. These enhancements will be incrementally implemented and include the following:

- More efficient monitor algorithms
- Elimination of GEO coverage single point of failure
- Expansion of the terrestrial communications network
- Improved efficiency of operations and maintenance functions
- Equipment refresh
- Installation of additional WAAS reference stations (WRS) to expand coverage of the existing service availability (4 in Alaska, 4 in *Canada*, and 5 in *Mexico*)

Creation of a North American WAAS

2.9 The FAA must install additional WAAS reference stations in order to meet its FOC requirements for availability and coverage. The FAA looked to its successful satellite navigation trilateral relationships with Canada and Mexico to determine where to install these additional WRSs. Architecture analyses and service volume models were conducted that showed maximum benefits for installing these WRSs, not in the United States along the Canadian and Mexican borders, but throughout Mexico and Canada. In addition to maximizing the availability and coverage in the U.S. National Airspace System, this approach would also provide availability of LPV service in Mexico and Canada.

2.10 The FAA's Air Traffic Organization (ATO), NAV CANADA, Mexico Air Navigation Services Provider (SENEAM) immediately began activities to implement operational WAAS reference stations in Canada and Mexico that would integrate into the operational WAAS. This cooperative effort was endorsed in June 2003 at the 9th North American Aviation Trilateral (NAAT) meeting in Mexico City, Mexico. At this meeting, the trilateral partners agreed to "establish essential interoperable Air Traffic Control functionality" and "*jointly develop regional satellite navigation systems*" that would serve as a model for regions worldwide.

2.11 After the NAAT/9 meeting, advanced technical preparations began in earnest at the candidate WRS locations, including radio frequency interference (RFI) analyses and full site surveys. The initial communication architecture has been finalized with Mexico and Canada for the first communication line of a dual communication line network. Work continues to finalize the second communications line architecture.

2.12 The first WRS was installed in Gander, Canada in June 2005 and in Mexico City, Mexico in August 2005. The installation schedule for the remaining North American sites is as follows:

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|----------------|----------------------------------------------------------------------|
| September 2005 | Goose Bay, Canada |
| October 2005 | Puerto Vallarta, Mexico |
| October 2005 | Merida, Mexico |
| Late 2006 | Tapachula, Mexico; La Paz, Mexico; Winnipeg, Canada; Iqaluit, Canada |

2.13 All WRSs are scheduled to become operational approximately one-year after installation is completed. Based on current schedules and budget/resource projections, the North American WAAS architecture will be completely operational by the end of 2008.

LAAS Research and Development Activities

2.14 Within the GNSS concept, basic GPS and WAAS/SBAS systems will not be able to meet all precision approach requirements for civil aviation. Therefore, Local Area Augmentation Systems (LAAS/GBAS) are required to provide complement WAAS/SBAS and provide a full range of precision approach operations (Category I-III).

2.15 The FAA's LAAS program was baselined in 1999, creating a Government – Industry Partnership (GIP) to develop a Category I LAAS system. A Category III LAAS system was then to be developed leveraging off the experience from the GIP. In 2001, the FAA migrated from the GIP concept to a full-scale development contract for a Category I LAAS system. Honeywell received the contract award in April 2003. An aggressive schedule and integrity issues resulted in program delays, and then in February 2004, the FAA redirected the LAAS program from a full-scale development contract back to research and development to lower the overall program risk, resolve integrity issues, and complete an updated benefits assessment.

2.16 The FAA completed an independent benefits analysis in October 2004 that showed approximately US\$1.49B in benefits for LAAS without a WAAS, and approximately US\$429M in benefits with a WAAS. Thus, the FAA is continuing its LAAS research and development activities through FY2006 to resolve integrity issues.

2.17 The FAA will also establish a new LAAS business case and continue its support of international LAAS/GBAS development activities to leverage the FAA's investment to date in LAAS technology. This international cooperation will also promote the continued global development of a Category I LAAS/GBAS system.

3. Conclusion

3.1 The Meeting is requested to note the material presented in this information paper, and consider its contribution to the implementation of a global satellite-based navigation system.

3.2 Attendees are invited to visit the FAA's GPS Product Team's website at <http://gps.faa.gov> for up-to-date WAAS and LAAS program info.