



International Civil Aviation Organization

Sixth Meeting of CNS/MET of APANPIRG

Bangkok, Thailand, 15 – 19 July 2002

Agenda Item 6:

Review:

- a) **Strategy for the provision of Precision Approach and Landing Guidance Systems**
- b) **GNSS strategy**
- c) **GNSS implementation**
- d) **GPS measurement campaign**

c) GNSS Implementation

U.S. SATELLITE NAVIGATION PROGRAM STATUS

(Presented by the United States of America)

SUMMARY

This information paper provides an update on the U.S. Federal Aviation Administration's (FAA) Global Positioning System (GPS) augmentation programs, better known as the Wide Area Augmentation System (WAAS) and Local Area Augmentation System (LAAS).

1. The Future of Navigation

1.1 Satellite navigation, represented by GPS and its various augmentation systems under development today, provides significant flight safety and system capacity benefits by making precision approaches possible at thousands of airports worldwide where no such capability exists today. As this technology is based on positioning information provided from space, implementation is not dependent on or restricted to the availability of ground-based navigation infrastructures. As such, the benefits of satellite navigation will be especially significant in many developing countries where the ground-based navigation aids needed to support safe civil aviation operations are limited or even non-existent.

1.2 Satellite navigation will bring about crucial capacity enhancements that will help meet the growing worldwide demand for air transport services well into the century. Service providers benefit from lower costs of procuring new navigation equipment, as well as from lower life cycle costs. Commercial air carriers gain by their ability to fly more efficient routes, saving time and money on each and every flight.

1.3 GPS provides a very reliable and accurate navigation system that dramatically improves safety over a Non-directional Beacon (NDB) approach or a VHF Omni-directional Range (VOR) approach when the VOR is not collocated with the runway. GPS has also improved safety for en route navigation, providing a navigation service at low altitudes where no navigation service

previously existed due to line-of-sight limitations associated with ground-based navigation aids. Oceanic operations have also been made safer by replacing outdated navigation systems with GPS.

2. GPS Modernization

2.1 One of the main GPS modernization efforts is the addition of two new civil navigation signals in addition to the existing civilian service broadcast at 1575.42 MHz (L1). The first of these new signals will be a Coarse/Acquisition (C/A) code located at 1227.60 MHz (L2) that will be added to the remaining 12 Block IIR satellites and be available for general use in non safety-critical applications. This capability will also be added to all future Block IIF satellites. Current timelines have the first scheduled launch of a Block IIR satellite with L2 occurring in 2003.

2.2 Block IIF satellites will also broadcast an additional civil signal located at 1176.45 MHz called L5 to support civil safety of life operations. The first scheduled launch of the enhanced Block IIF satellites with L5 onboard is currently scheduled for 2007, with an initial operating capability date in the 2012-2013 timeframe. This new L5 signal falls in a band that is protected worldwide for aeronautical radionavigation, and therefore will be protected for safety-of-life aviation applications. L5 will provide significant benefits above and beyond the capabilities of the current GPS constellation, even after the planned second civil frequency (L2) becomes available. Benefits include more precise navigation worldwide, increased availability of precision navigation operations in certain areas of the world, and interference mitigation.

2.3 Another aspect of the U.S. GPS modernization effort included the decision by the President of the United States to discontinue selective availability (SA) in May 1, 2000. Discontinuance of SA has improved the accuracy of GPS for civilian users from hundreds of feet to tens of feet.

2.4 It is important to note that the discontinuation of SA does not eliminate the need for differential GPS systems such as the U.S. Federal Aviation Administration's (FAA) Wide Area Augmentation System (WAAS) and Local Area Augmentation System (LAAS). Augmentations to GPS are still necessary to meet the strict requirements for precision approach and safety of life operations.

3. Wide Area Augmentation System (WAAS)

3.1 In its initial phase of implementation, WAAS will use a network of 25 ground reference stations (WRSs), 2 master stations (WMSs), 2 INMARSAT III geostationary communication satellites (GEOs), and 4 GEO uplink stations (GUSs) to establish certifiable service in the oceanic, en route, non-precision, and even precision approach domains.

3.2 The manner in which WAAS operates is relatively simple. Signals from GPS satellites are received by the WRSs, which are located at precisely surveyed locations. Since each reference station is precisely surveyed, and knows exactly where it is located (longitude/latitude/altitude), it is able to determine any errors in the GPS navigation signals being observed throughout the geographic region. Each WRS then relays through either terrestrial ground links or satellite communications links this region-specific data to the WMS, where the GPS signal correction information for the entire WAAS coverage area is computed. A corresponding WAAS correction message is then prepared by the WMS and uplinked to one of the two initial INMARSAT III GEO satellites via the GUS. The message is then broadcast on the same frequency as GPS (L1, 1575.42 MHz) to GPS/WAAS receivers on board aircraft that are within the GEO broadcast footprint.

3.3 Preliminary test results show the WAAS system accuracy to be approximately 2-3 meters (horizontal and vertical). The accuracy requirement for WAAS is 7.6 meters (horizontal and vertical).

3.4 In August 2000, the FAA announced that the WAAS Signal in Space was available for non-“safety of life” aviation use to increase situational awareness during VFR flight, as well as for non-aviation users for recreational, maritime, agricultural, surveying, and other applications requiring precise positioning and time. WAAS has been broadcasting continuously, 24 hours a day, 7 days a week since then. Current schedules have the initial operating capability (Lateral Navigation/Vertical Navigation – LNAV/VNAV) for WAAS in December 2003 though efforts are underway for an IOC three to six months earlier. A recently developed approach procedure, known as Lateral Precision with Vertical Guidance (LPV), takes advantage of a unique mathematical model that considers local terrain, obstacles, existing airport infrastructure, and other factors that influence approach and landing minima. LPV provides more lateral precision over LNAV/VNAV. The number of instrument approaches that can be achieved through implementation of LPV is tremendously increased. LPV will have a direct effect upon flying safety, especially for general aviation. LPV procedures do not require any equipment beyond standard WAAS equipment because it takes advantage of intrinsic features and exploits them to a higher degree. LPV approaches will be available by December 2003.

3.5 Planning is underway to put a third GEO satellite in orbit. Since there are currently only two GEO satellites in orbit, the third GEO satellite will mitigate the loss of geostationary augmentation signals in the event one of the existing INMARSAT-3 GEO satellites is not operational. The third GEO satellite will also improve availability and coverage through more optimized GEO satellite orbital locations. The third satellite is anticipated to be in orbit by September 2005.

4. Local Area Augmentation System (LAAS)

4.1 LAAS is the second augmentation to the GPS signal that will complement the WAAS in U.S. airspace to provide a full satellite-based precision approach and landing capability for all phases of flight.

4.2 The LAAS ground station, as it is being developed, will be able to support Category I, II, IIIa, and IIIb operations depending on the airport-specific service requirements. This will be accomplished through a modular deployment of supporting equipment that is designed to increase levels of availability to ensure continuity of operations critical for Category II and III operations. These different configurations resulted from the requirements for increased frequency of satellite range measurements and redundancy necessary for airports with higher availability requirements.

4.3 The LAAS architecture may also consist of Airport Pseudolites (APL) that act and function just like GPS satellites, but are located on the ground to enhance availability by providing an additional ranging source that originates from the local airport.

4.4 The FAA is pursuing an innovative approach to LAAS production, fielding, testing, and evaluation. The FAA has established cost-sharing partnerships with two industry “Teams” led by the Raytheon Systems Company and Honeywell to develop Category I LAAS ground equipment and associated avionics.

4.5 Current LAAS development schedules show the availability of an initial Category I public use LAAS system by the end of 2004 and a Category III public use LAAS system in the 2006 to 2007 timeframe. If these operational development activities prove successful, it is the intent of the FAA to purchase up to 160 LAAS installations (Category I and III) for operational use in the U.S. National Airspace System (NAS). Full LAAS deployment is scheduled to be complete by 2010.

5. **Conclusion**

5.1 If you look at the history of the development of air traffic management systems and their relationship to aviation safety, you will see a compelling argument for moving forward with satellite navigation. Today's navigation equipment and procedures are so sophisticated that each technological advance only brings modest increases in overall system safety. While conventional ground-based systems will continue to play an important role in our transition to a future satellite-based operating environment, *we need satellite navigation to take aviation safety to the next level.*

5.2 The meeting is requested to note the material presented in this information paper, and consider its contribution to an increase in safety and system efficiency within the region. Meeting attendees are also invited to visit the FAA GPS Product Team's website at <http://gps.faa.gov> for the latest program information on both the WAAS and LAAS systems.