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FAA Satellite Navigation Product Teams

SatNav News

WAAS NOTAMS

by Karen Van Dyke, VOLPE

The use of satellite navigation has generated a challenge in predicting availability of service for air navigation. The impact of a satellite outage is not intuitive due to the orbital motion of the Global Positioning System (GPS) satellites relative to the earth. Also, the status of various Wide Area Augmentation System (WAAS) network components needs to be taken into account to determine the availability of service. The WAAS Notice to Airmen (NOTAM) system was developed to provide notification of performance-based WAAS outage information to pilots during preflight planning and to air traffic control. These outages are based on WAAS unavailability for LNAV, LNAV/VNAV, and LPV approaches, as well as for en route operations.

To generate WAAS NOTAMs, a predictive model of WAAS determines service availability and areas expected to experience outages. This model, used to generate WAAS outage information and format this information as NOTAMs, is referred to as the WAAS Service Volume Model (SVM). The SVM relies on GPS satellite status from the GPS Master Control Station; GPS almanac data from a GPS receiver with a backup source from Shriever Air Force Base; WAAS operational data, information of its components, and GEO almanac data through a WAAS interface; and location information for airfields with Area Navigation (RNAV) and GPS procedures from a database.

The SVM generates the WAAS service availability for a 30-hour period at least once every 24 hours. The data is processed at one-minute intervals over the 30-hour prediction window. Any predicted outages are formatted as NOTAMs. The minimum duration for a WAAS NOTAM is 15 minutes even if the outage duration is shorter. Should the SVM detect the loss of a GPS satellite or a WAAS component outage, the SVM automatically will determine if any new NOTAMs have been generated or existing ones need to be cancelled. If so, it produces a new NOTAM output file. Airfield-specific NOTAMs are sent to Flight Service Stations (FSS). Area-wide NOTAMs are sent to the U.S. NOTAM Office (USNOF). Area-wide NOTAMs identify WAAS outages that exist over a large geographic area and eliminate the need to issue individual NOTAMs for every airfield affected. NOTAMs are formatted in the U.S. domestic NOTAM format.

Since WAAS Initial Operating Capability (IOC) in July 2003, the WAAS SVM airfield database has grown to over 250 LNAV/VNAV and LPV airfields. Based on this database of airfields, four to five NOTAMs are issued per day, although when GPS satellites are out

In this issue:

The **SATNAV News** is produced by the Navigation Services (ATO-W) branch of the Federal Aviation Administration (FAA). This newsletter provides information on the Wide Area Augmentation System (WAAS) and the Local Area Augmentation System (LAAS), and initiatives associated with the implementation of satellite navigation into the National Airspace System (NAS).

of service this number can be higher. Airfields that have been determined not to have a high enough availability (98% or an average of one outage per day) are marked on the approach plates with a negative "W" to indicate that WAAS NOTAM information is not provided.

There are several initiatives underway to continually enhance the WAAS NOTAM system. One of the current limitations of the WAAS NOTAM capability is that it can only produce NOTAMs for predictable events. The ability of the SVM to react to unpredictable events, such as WAAS unavailability due to increased ionospheric activity and unscheduled satellite or reference station outages and produce NOTAMs in a timely manner is being investigated.

In the future, when the U.S. NOTAM system can accommodate the ICAO NOTAM format, WAAS NOTAMs will be issued using this format. Additionally, the goal is to develop the ability to display these NOTAMs graphically, in addition to using text information. As improvements are made to increase the WAAS coverage area and improve the availability of the WAAS signal, the WAAS SVM also will evolve to reflect these improvements in the WAAS NOTAMs.

WAAS Outreach Activities

by Mary Ann Davis, GPS TAC

Since the commissioning of the WAAS in July 2003, the WAAS team has been working hard to provide an avenue for users to get information on the system and get answers to questions they may have about WAAS and its capabilities. We have been working to accomplish this in a number of ways – through our website, via the SATNAV News, and with direct involvement with the user community. To effectively reach the various categories of users - pilots, airports, regional and major airlines, and other government organizations - the WAAS team has participated in key aviation community events. For 2004, these events included:

- Helicopter Association International (HAI) Heli-Expo 2004
- Regional Airlines Association (RAA) Annual Convention
- Airline Owners and Pilots Association (AOPA) Fly-In
- American Association of Airport Executives (AAAE) Annual Conference
- Experimental Aircraft Association (EAA) AirVenture Oshkosh
- Air Line Pilots Association (ALPA) Safety Forum
- FAA/Industry New Technologies Workshop
- National Association of State Aviation Officials (NASAO) Annual Convention
- Institute of Navigation (ION) GPS/GNSS 2004
- National Business Aviation Association (NBAA) Annual Convention
- AOPA Expo 2004
- Air Traffic Controllers Association (ATCA) Annual Conference and Exposition

Administrator Blakey stops by the WAAS exhibit at Oshkosh.

These forums have been very advantageous in providing a means for WAAS users to get answers to their questions and better understand the safety, cost saving, and efficiency benefits that WAAS can provide to them. We have received and addressed questions related to system capabilities and benefits, user equipage, procedures, other operational issues, and future plans. Additionally, these forums have provided us with excellent feedback that will help us better tailor our informational materials in the future to address the evolving questions and growing interest in WAAS.

For the upcoming year, we hope to continue to provide opportunities to respond to questions and requests for information as user acceptance continues to grow. We also plan to evolve our website, newsletter, informational materials, and participation in future events to meet the growing de-

mand for WAAS information. We hope to see you at a future event, but in the meantime, please be sure to visit our website at http://gps.faa.gov for the latest program information. If you have questions or suggestions regarding WAAS outreach, please email Shelby.CTR.Wheeler@faa.gov.

Get an Instrument Approach for Your Airport

by Larry Oliver, GPS TAC

Few things are as easy as they seem on the surface, but anyone can request–and receive–an instrument approach for their airport. The Federal Aviation Administration (FAA) has made the process much easier during the past few months in recognition of the new approach capabilities provided by the Global Positioning System (GPS) and its satellite-based augmentation system, better known as the Wide Area Augmentation System (WAAS). A step-by-step procedure for requesting an instrument approach is available on the FAA website at http://avn.faa.gov/index.asp?xml=ifp/index.

This FAA website includes an Instrument Flight Procedure Request Form, which is the first step in the process. This form can easily be completed in 2-3 minutes. The site also has a simple flowchart that takes you through the complete process, addressing such issues as public use versus cost reimbursement and whether a flight check is required. The process itself is relatively simple, but that's not to say that the whole task is easy. By far, the most demanding piece of the task is obtaining an acceptable airport/area survey.

Previously, instrument approaches may not have been feasible for many smaller airports due to lack of navaids or real estate in which to place navaids, but GPS and WAAS have changed all of that. You can develop a GPS or WAAS approach without requiring any additional radio transmitters or equipment at the airport. The purchase, installation and maintenance of Very-High Frequency (VHF) Omnidirectional Range (VOR) or Automatic Direction Finding (ADF) equipment is no longer required for an instrument approach. This means that there are more than 5,000 runway ends that could have their first instrument approach–and the approach could have minimums as low as 250'!

Frequently Asked Questions:

Q. Do you mean anyone can request an instrument procedure?

A. *Yes, whether an airport manager, air carrier or general aviation pilot, anyone can request an instrument procedure.*

Q. Who pays for the procedure?

A. *It depends upon the use. It may be paid for by the local airport through cost sharing agreements, or from funds provided by the FAA.*

Q. What happens to the procedure request after I fill it out?

A. *It goes to the FAA Regional Office for evaluation by the Regional Airspace Procedures Team, and then on to the appropriate airport division.*

Q. How much will a procedure cost?

A. *The single most expensive piece may be the new airport/area survey. Other costs may include charting and flight inspection. Further information regarding cost is provided at http://avn.faa.gov/index.asp?xml=ifp/reqmnts#funding.*

Q. This just sounds too easy...what's the catch?

A. *The catch–and it isn't really a catch–is that the airport still must address all environmental concerns, and it still must comply with the requirements for the particular type of operation requested, but you can get an instrument procedure if you follow the process shown on the website.*

LAAS Benefits Analysis

by Kristi Foster, GPS TAC

As reported in the June edition of SatNav News, the Federal Aviation Administration (FAA) contracted with IBM Business Consulting Services to provide an independent analysis that estimates the benefits attributable to the Local Area Augmentation System (LAAS) beyond those provided by existing and planned navigation services. The results of this analysis will be used to support FAA, airlines

and other industry stakeholders in their procurement and implementation decisions related to LAAS. A separate cost study is being conducted internally within the FAA.

IBM completed the first deliverable of the benefits analysis, the "Navigation Capabilities Baseline", in November 2003. This baseline defines all known and expected capabilities of existing and planned systems in the terminal area, approach, and surface operational domains. All LAAS benefits are measured against this baseline.

IBM completed the second deliverable, "LAAS Incremental Capabilities", in December 2003. This task entailed identifying all incremental capabilities that LAAS provides above and beyond the existing baseline.

In February 2004, IBM presented an "Analysis of Preliminary Findings" of the potential incremental benefits from LAAS. This report summarized IBM's preliminary findings, focusing on the efficiency, safety, and societal benefits of LAAS beyond those provided by existing and planned navigation services. Following the delivery of this report, IBM, with the assistance of the FAA Ground-Based Augmentation System (GBAS) Program Office, solicited comments from numerous stakeholders, including airlines, airports, and manufacturers. This included visits to 5 airports (Memphis, Seattle, Bradley, Newark, and Chicago O'Hare) and 5 airlines (FedEx, Alaska, United, Continental, and Southwest). The purpose of the visits was to share the preliminary findings report and to use data gathered during the visits to verify and validate the methodology and mathematical formula that IBM is using to quantify the benefits of LAAS. The objective of the visits was to make the airports and airlines aware of the potential LAAS benefits to their specific operation.

IBM incorporated the data gathered during the airport and airline visits into their third deliverable, "Update to the Preliminary Findings of LAAS Efficiency Benefits", which they completed in June 2004. This report is an update of the efficiency portion of the preliminary analysis. It includes a more detailed analysis based on additional input data, and IBM's responses to comments received on the February report and during the airport and airline visits.

IBM submitted the most recent deliverables, the "LAAS Safety and Social Benefits" in August 2004. This report is an update to the preliminary findings for safety and societal benefits. The update is based on feedback from written comments as well as interviews and site visits with stakeholders and the aviation industry. The full safety analysis report was produced by the Flight Safety Foundation.

IBM incorporated all of the above information into the draft "Benefits Analysis Report", which they submitted in September. The draft report is an update of the LAAS Efficiency, Safety, and Societal benefits. IBM will submit the final "Benefits Analysis Report" in October 2004.

Pioneering LAAS Flight Tests in Brazil Ready for Wheels–Up!

by Jennifer Campbell, GPS TAC

The Brazil Department of Airspace Control (DECEA) is working with the Federal Aviation Administration (FAA), through a cost-sharing agreement, to evaluate preliminary Local Area Augmentation System (LAAS) siting criteria and installation guidelines, and to validate the LAAS operational concept including complex procedure and adjacent airport operations. The FAA and DECEA, in support of creating a harmonized Wide Area Augmentation System (WAAS)/LAAS operating environment across the region, are also studying the advanced applications of LAAS technology and its ability to provide Category I & II precision approach services within an operationally challenging environment (geography, obstacles, ionosphere and scintillation) in Rio de Janeiro, Brazil. The planned outcome of this testing is to provide Terminal Instrument Procedures (TERPS) complex procedure validation feedback to FAA's certification organization as well as input to RTCA for ionospheric algorithms.

This cooperation includes a joint project whereby the FAA has loaned and helped to install a LAAS Test Prototype (LTP) system to DECEA at Rio de Janeiro's Galeão International

Airport. Additionally, DECEA purchased 2 multi-mode receivers (MMR) via the FAA for installation on the DECEA Hawker 800 flight inspection aircraft and a commercial regional aircraft. In early 2004, DECEA team members visited the FAA William J. Hughes Technical Center (Atlantic City, New Jersey) and the FAA Mike Monroney Aeronautical Center (Oklahoma City, Oklahoma) where they received technical information and assistance in integrating the LAAS equipment into their aircraft. The installation, integration, and test of the LTP equipment and MMR are complete. Now the FAA/DECEA team is making final preparations to begin data collection flights in October 2004.

This joint LAAS research and development project will permit the FAA and DECEA to gain many mutual benefits. In general, the FAA will be able to test the siting criteria and advanced concepts of a Category I LAAS in an ideal environment that does not exist in the US. DECEA will be able to conduct site survey, validation, and preparation work in advance of an operational LAAS installation at Galeão International Airport. Jointly, both parties will be able to validate the potential applications of LAAS at adjacent airports, the use of the LAAS position, velocity and time (PVT) signal for long-range aircraft use and guidance, and the integration of WAAS and LAAS operations in the terminal environment using MMRs.

Brazil is one of the FAA's early implementation sites for several reasons; the primary being that the FAA can collect data on the ionosphere and scintillation which are the biggest detractors to using satellite navigation from an integrity and availability perspective. Data will be collected, analyzed and flight tests flown throughout the region. All of this research will present a clear picture of the ionospheric effects on LAAS that can be expected for countries near the geomagnetic equator. These countries, and ultimately the region as a harmonious body, will then be able to make educated decisions on what levels of satellite navigation technologies are needed to meet all desired requirements.

The planned DECEA flight operational trials will try to mimic flying through an ionospheric storm or a local disturbance (this is called a plasma depletion or an iono bubble) to prove what the impacts would be on LAAS. The flight tests and ionospheric data collection are planned to include over 200 approaches under specific conditions over the next year.

Also, Brazil is expected to conduct various siting evaluations to determine the factors that degrade performance as one moves away from the primary broadcast site. The test will also evaluate the potential of serving multiple airports with one system, the limiting factors in doing this, and the performance drop-off curve.

Through this joint project, the FAA goals are to:

- ✔ Achieve international acceptance of U.S. technologies and applications
- ✔ Help FAA system performance achieve better availability, integrity and coverage
- ✔ Gain technical knowledge regarding system operational applications
- ✔ Reduce program risk by identifying technical and operational issues during the implementation of the trial
- ✔ Provide inputs to the operational concept
- ✔ Validate potential system performance
- ✔ Develop a foundation for international standardization
- ✔ Increase navigation aid availability in third world country applications
- ✔ Provide TERPS complex procedure validation feedback to FAA's certification organization
- ✔ Provide input to RTCA for ionospheric algorithms.

The flight data collected by DECEA in the project will also provide operational insights into the use of LAAS for complex procedures that will provide significant operational, safety, capacity, and efficiency benefits to the airlines flying in both the U.S. and Brazilian airspaces. DECEA will use this testing to help define their satellite navigation architecture and operational concept before beginning their acquisition phase of implementation. These ground-breaking flight tests are ready to begin, and we look forward to publishing the outcomes of these tests in future editions of SatNav News.

Simultaneous Non-Interfering Operations

by Mike Hilbert, GPS TAC (Vertical Flight Air Traffic Control Manager supporting FAA AAR-460 and AFS-410)

Would you be skeptical if I told you there is a way to further improve the finest aviation system in the world by taking advantage of various satellite navigation technologies? Probably not, since satellite navigation offers so much promise, but what if I told you we can also increase the National Airspace System (NAS) capacity while safely enabling all weather operations capability for rotorcraft and future tilt rotor aircraft? Are you getting a little more skeptical now? What if I also told you that we could provide small fixed wing general aviation aircraft potential access through busy terminal areas throughout the NAS not afforded now? Well, Simultaneous Non-Interfering operations (SNI), is a concept which attempts to achieve all of the above.

This article explains the SNI concept, and focuses on SNI's potential benefits to the NAS. Future articles will look at how specific satellite navigation technologies will be used to implement SNI, both in the short term and long term, the planned execution of the SNI project, and information on the New York Terminal Radar Approach Control (TRACON) SNI test project's progress.

Helicopters and future tilt rotor aircraft are also known as Vertical Flight (VF) aircraft and play a critical role in the nation's homeland security efforts, emergency medical transport, and unique transport missions. VF aircraft are vastly different from the fixed wing aircraft they compete with for airspace in busy terminal areas. They demonstrate flight performance characteristics significantly different from high performance turboprop commuter, corporate aircraft, business jets, or air carrier turbo jets. Currently, an Instrument Flight Rules (IFR) helicopter conducting an Instrument Landing System (ILS) approach to a runway at an airport in poor weather typically uses the same airspace as three or more IFR fixed wing turbojet aircraft. In today's congested airspace, this disparity is significant and limits VF aircraft access to the IFR system. SNI recognizes these significant performance differences and will provide additional landing slots at busy airports, and increase VF aircraft IFR capabilities by enabling separate flight paths via new routes. Additionally, separate instrument approach and departure procedures, as well as separate landing areas for VF aircraft in the terminal area, are major factors that will make SNI a success. Future SNI routes could also potentially provide light general aviation aircraft increased access through busy terminal areas not afforded today.

The SNI concept is based on a system of low-altitude GPS waypoints, and narrow flight route corridors. The corridors or Designated Flight Tracks (DFTs) will be connected to rotorcraft category-specific Departure Procedures for departures and to new Vertical Terminal Approach Procedures for arrivals.

In order for SNI to become reality, many different emerging technologies need to be used in concert to create a new navigation system. These new, state-of-the-art technologies will be used to explore the possibility of developing new criteria for reduced width airways and separation standards, new WAAS and vertical flight terminal instrument approach and departure procedures, as well as new satellite navigation based surveillance methods.

With the SNI concept being dependant on so many different evolving technologies with vastly different delivery schedules, a step-by-step approach to SNI implementation will need to be adopted. SNI can be looked at in the terms of short, medium, and long-term goals. Short-term goals should be achievable in the next 4 years, using mostly available or nearly available technology. Medium term goals should be achievable between 4 and 8 years. Long-term goals are the goals that are achievable beyond 8 years.

SNI is an ongoing project that will involve research, testing and implementation that will span a number of years. Next time, we will discuss specific short-term SNI goals and how the FAA General Aviation and Vertical Flight Program, FAA Flight Stadards Service Flight Operations Branch, along with local ATC facilities, and industry helicopter pilots are testing short-term SNI goals in the New York TRACON test project.

JPALS...Into the Future

by Rick Packard, ARINC/JPALS

On July 21, the Navy's PMA-213 office at Naval Air Station Patuxent River hosted a JPALS Industry Day. The Joint Precision Approach and Landing System, more affectionately known as JPALS, is the Department of Defense effort to define a single, interoperable precision approach capability. JPALS is similar to the Federal Aviation Administration's Local Area Augmentation System (LAAS) and will be used not only for military land-based locations, but sea-based operations as well. Over 100 people representing 31 different companies participated to hear the program offices' vision and expectations for the contract to support System Design and Development. This contract will take JPALS from Milestone B slated for April 2006 to Milestone C at the end of fiscal year 2010. Recently, those interested companies had the opportunity to meet with DoD officials in Arlington, Virginia for one–on-one meetings to ask questions, clarify issues and to gain further information.

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