FAA Ground Based Augmentation System (GBAS)

Program Status

Presentation to: RTCA

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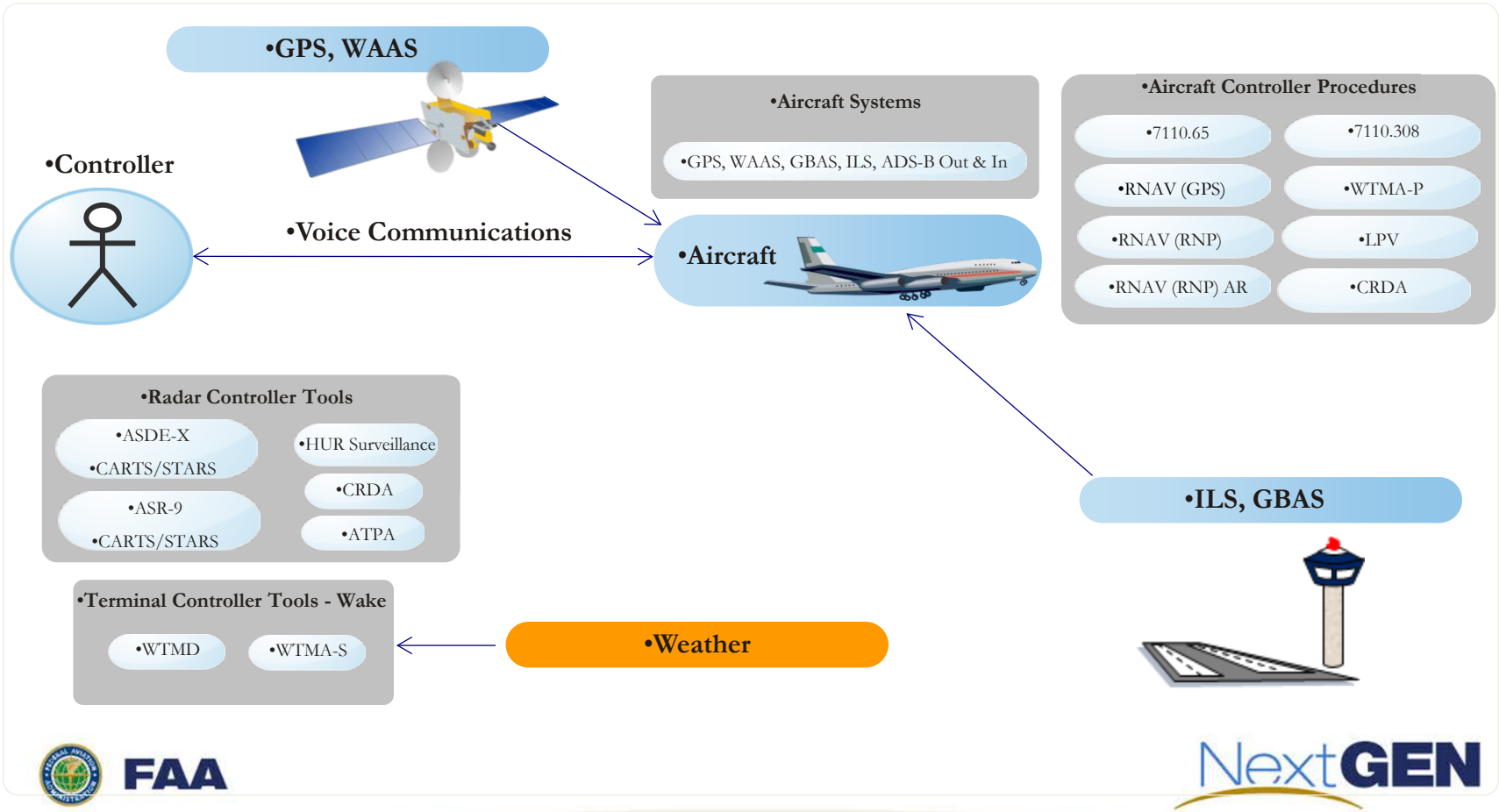
Overview

- **FAA GBAS Program**
- **GBAS CAT I Activities / Operations**
- **FAA non-Fed Process**
- **System Design Approval (SDA) Activities**
  - Block II
  - GAST-D
- **CAT III Validation and Prototype Activities**
- **Issues**

Improved Multiple Runway Operations (IMRO)

•This portfolio supports improving approach and departure operations to closely spaced, parallel, converging, and intersecting runways. Success will be achieved by improving access to those runways, primarily through publication of new policies, standards, and procedures.



•HOME KEY

Current FAA GBAS Program

- **The FAA GBAS program focuses on the following task areas:**
  - **Validation of ICAO SARPS for the baseline set of GBAS Approach Service Type D (GAST-D) Requirements**
    - GAST-D to support approach and landing operations using CAT III minima by augmentation of single frequency GPS (L1)
    - Validation includes work producing commercial prototypes (Avionics/Ground system)
  - **System Design Approvals (SDA) for GAST-C Block II and GAST-D systems**
    - Technical reviews
    - Discussions with Tech Ops on non-Fed implementation
  - **Limited CAT I implementation support**
    - Newark NJ, Houston TX, Moses Lake WA performance monitoring
    - Coordination of user/airlines GBAS activities
  - **International Continuation**
    - International GBAS Working Group – data collection (approaches)
    - Brazil – IONO Threat model (lower latitudes)

GBAS CAT I Operations in the US

- **Airport Operations (Status: August 2014)**
  - Newark, NJ – 366 Operations (737/787)
  - Houston, TX – 499 Operations (737/787)
  - Total 865 approaches (41 – B787, 824 - B737)
- **United Airlines Equipage**
  - B 737 – 95 aircraft / B 787 – 12 aircraft
  - All new B 737 aircraft will be GBAS capable
- **Delta Airlines**
  - B 737 – 34 Aircraft
  - Total order of 112 GBAS capable aircraft

- **International Airline Operations in the US**
  - British Airways use GLS at EWR
    - BA has four B787 with regular service to EWR that request GBAS
    - OpSpec C052 completed / GBAS approaches resumed July 11, 2014
  - Emirates and Lufthansa plan on GLS at IAH (A380)
    - Coordination in progress

GBAS Operational Activities

- **US Airline cooperation**
  - United and Delta GBAS simulator session (July) – operational (cockpit/crew training) discussions and brainstorming potential benefits at airports of interest
    - User concepts discussed
      - Extended Service Volume
      - GBAS CAT II operations against CAT I system
      - GBAS capabilities for variable glide path and displaced threshold for Wake Avoidance/Noise reduction
  - United and American planning similar session
  - Delta Airlines announced GBAS implementation/operations at the CNS Task Force meeting in August 2014.

- **Realizing GBAS benefits for Wake Avoidance and Noise reduction**
  - Presentations during IGWG included Frankfurt and Zurich efforts to benefit form GBAS variable glidepath – displaced threshold capability
  - Presented these efforts to NextGen Wake/CSPO portfolio manager for consideration at GBAS airports

International GBAS Working Group

- **International GBAS Working Group (IGWG) – Eurocontrol Experimental Center in Bretigny, France (June 3-6)**
  - Over 100 participants from 12 nations
    - International Service providers (ANSPs), Industry, OEMs, Airlines, Airports, EUROCONTROL, FAA
    - Cooperation and coordination of implementation and development activities
    - RFI, Siting, World Wide IONO, Ops concepts
  - IGWG Website - flyGLS.net
  - Increased activities by service providers and user community
    - Eurocontrol: “GBAS is here to stay”

- **GBAS and SESAR**
  - Single European Sky ATM Research (SESAR) work packages for GBAS CAT I implementation, Single frequency CAT III, Dual frequency CAT III and multi constellation GBAS

GBAS CAT I Operations Worldwide Airports

- **Operational:**
  - USA
    - Newark, Houston,
    - Private Boeing system: Moses Lake, Charleston
  - Australia
    - Sydney
    - Plan for others (Brisbane etc)
  - Germany
    - Bremen, Frankfurt
    - Munich tbd
  - Spain
    - Malaga
  - Russia
    - 40 airports with LCCS-A-2000 GBAS were successfully flight-inspected with Aerodata “AeroFIS” mission suite.

- **Planned**
  - Brazil
    - Galeao – SLS 4000 installed
  - Switzerland
    - Zurich – SLS4000 installed
  - India
    - Chennai, SLS 4000 installed
  - UAE
    - Dubai RFP 2014
  - UK
    - Heathrow RFP 2014
  - Norway
    - Oslo – plan for 2015
    - Upgrade SCAT I
  - Prototypes / R&D
    - Japan, Korea

GBAS CAT I Operations Worldwide

OEMs / Airlines

- **Boeing /Airbus**
  - Continued commitment to GLS
  - All new a/c GBAS capable either as option or standard equipment (B787, B747 -8)
- **Airlines**
  - Operational
    - United Airlines, Delta Airlines, Qantas, Emirates, TUIfly, Air Berlin, Lufthansa, British Airways,
    - 2015: Swiss Air, Cathay Pacific
- **Flight Test / R&D**
  - JAL/ANA
- **Airline Interest increasing with new B787 and B747-8 coming off the line with GLS standard equipage**
  - American Airlines, LAN Chile, COPA, Saudia

Non-Federal Facility Overview

- **14 CFR Part 171**
  - Allows the establishment of non-Federal navigation facilities
    - 171.75 addresses the establishment of 'other' types of non-Federal facilities not mentioned elsewhere in Part 171 (e.g., not an ILS, MLS, etc.).
- **FAA Order 6700.20A (dated Dec. 11, 1992)**
  - Provides policy associated with non-Federal facility establishment
  - Provides guidance/direction/procedures associated with FAA management and administration of non-Federal facilities
  - Relies on the 'Program Director for Navigation and Landing' to ensure new equipment types are acceptable for use in the NAS
- **GBAS has a unique role because no federal GBAS exist**
  - NextGen and Tech Ops in discussions on requirements, policies and budget for GBAS implementation as a non-fed system
    - Identify the required FAA activities and associated costs of GBAS nonFed deployments
  - System Design Approval (SDA) activities are intended to review and evaluate new GBAS equipment types for acceptability in the NAS.

GBAS System Design Approval (SDA)

- **Assess the safety and performance requirements associated with non-Federal GBAS designs.**
- **Assess the overall viability of the design with respect to it's use in the NAS**
  - Siting, installation, maintenance, etc..
- **Support NextGen goals associated with establishing a means for GAST-D service in the future.**
  - Potential non-Federal design approval feasible in mid 2018
- **FAA supporting two SDA requests**
  - Honeywell SLS-4000 Block II
  - Honeywell SLS-5000 GAST-D GBAS

Honeywell SLS-4000 Block II

- **Honeywell SDA Request dated Nov. 16, 2012**
- **Modification of the previously approved SLS-4000 Block I configuration**
  - Several updates intended to enhance system availability
    - More efficient masking
      - Benefit at Newark where RFI siting changes introduced additional masks
    - Enable the use of PRN 23, eliminates other signal distortion exclusions
      - FAA-funded university work (Ohio University) identified the cause for SDM triggers and the LIP determined that there was not a hazard

Honeywell SLS-4000 Block II Schedule

- **Initially intended to be a 12 month development effort completing at the end of CY 2013.**
  - NextGen management approved FAA work on the project on December 4, 2013
- **Honeywell's goal is to have all of their SDA submittals provided by the end of CY 2014**
  - Current schedule is heavily loaded in the last quarter of CY 2014
  - Block II SDA will be completed after review of all submittals
    - Incremental and ongoing coordinated activity
  - Block II Operational approval will occur after FAA Safety Management System review are completed

Honeywell SLS-5000 GAST-D GBAS

- **SDA request dated Aug. 12, 2013**
- **ICAO GAST-D compliant configuration (CAT-III)**
- **System architecture updates similar to what has been prototyped at the FAATC**
  - Additional sub-system redundancy
  - Additional siting flexibility
  - Fiber-optic reference receiver interconnectivity option
    - Siting flexibility and additional robustness against lightening
- **Critical Project Dependencies**
  - SLS-4000 Block II design approval (Block II will serve as the initial design baseline)
  - ICAO GAST-D SARPS validation effort
- **Schedule**
  - Current Design Approval target date: May 2018
  - Target date slipped due to the delay for the SLS-4000 Block II (i.e., ~14 months to establish an SDA project after SDA request was received)

GAST-D Validation

- **The primary focus of the current FAA GBAS program is validation of the ICAO SARPS for GBAS Approach Service Type D (GAST-D) requirements**
  - GAST-D is intended to support approach and landing operations using CAT III minima by augmentation of the L1 single frequency service of GPS
  - Validation includes work producing commercial prototypes
    - Vendor could seek NonFed approval
  - Online validation database created by ANG-C32 to house validation references, FAA requirement interpretations, and comments from the GBAS community

GAST-D Validation-Milestones

- **GAST-D Flight Testing at ACY-July/August-September 2014**
  - Testing of final funded ground and avionics GAST-D prototypes
- **SARPS Validation – February 2015**
  - Community progress and FAA budget cuts have delayed many elements
  - Delayed from original September 2014 goal date
- **GAST-D GBAS System Approval – 2018**
  - Schedule driven by vendor investment and priorities as well as a dependency on FAA SDA support
  - Honeywell has already applied for GAST-D SDA support

GAST-D Validation: Flight Testing

- **Airborne**
  - Final HI INR avionics achieved during the avionics prototyping contract (GAST-D prototype)
  - CAT-I approved Rockwell Collins MMR
  - Novatel DL-4 (independent GPS receiver)
- **Ground**
  - ACY SLS-4000 with GAST-D updates and 6 references
- **Flights to include**
  - Basic 3° straight-in ILS look-alike approaches
  - Approaches where reference switching takes place (primary to secondary replacements with 6-reference prototype)
  - Approaches where VDB switching takes place

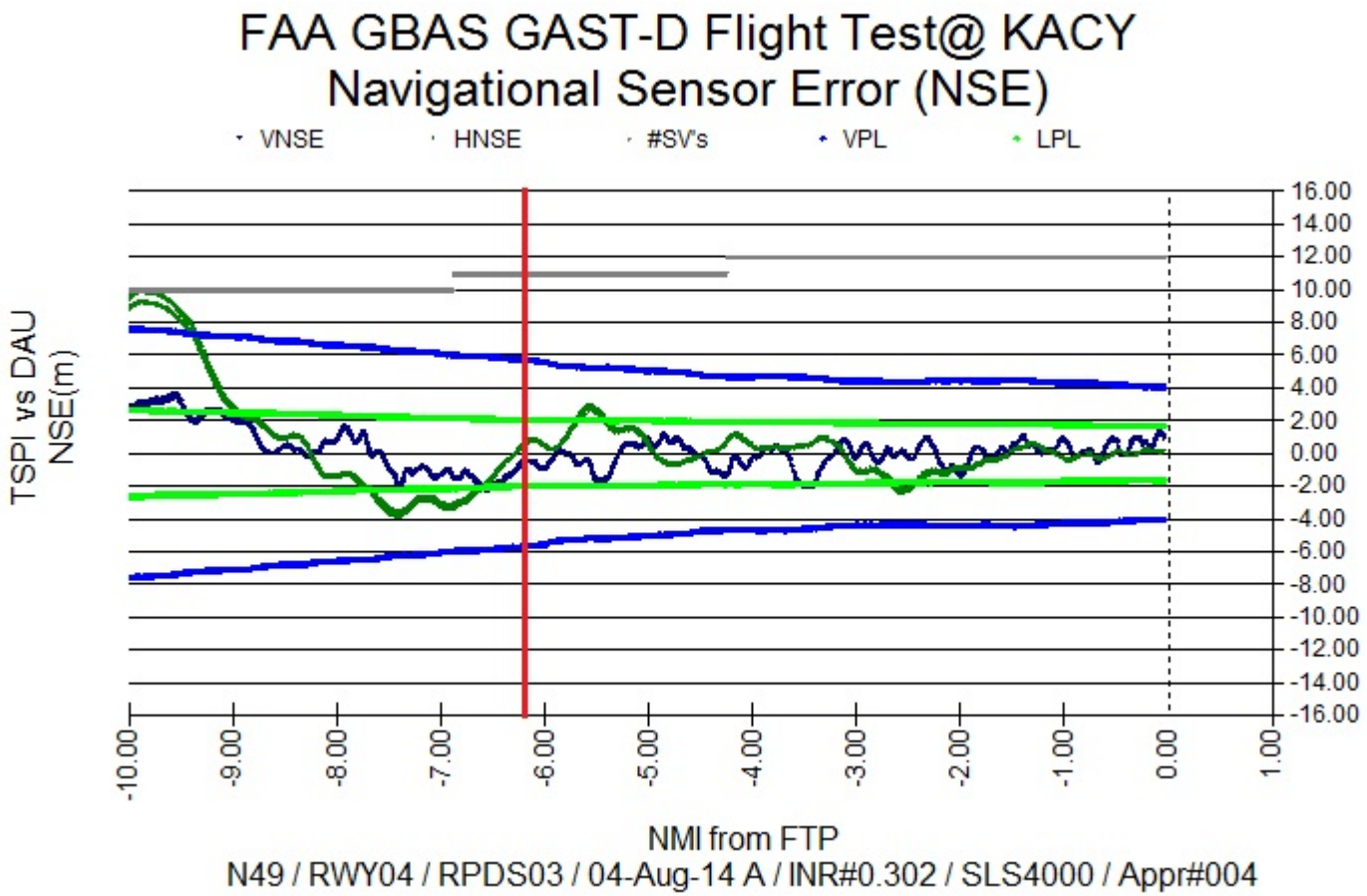
GAST-D Validation: Flight Testing

- **Flight testing completed late May, July, & August 2014 at ACY**
  - Nominal approach data collected
    - 10 and 20nmi approaches to all runways
    - 20 nmi orbit
    - 10 nmi radials over each runway
  - Multiple approaches completed during swaps from primary to secondary reference receivers
    - 10 nmi approaches to RWY 04
- **Flight test objectives were to verify that no anomalous behavior results from**
  - reference switching while the aircraft is on approach
  - VDB switches while the aircraft is on approach

GAST-D Validation: Flight Testing

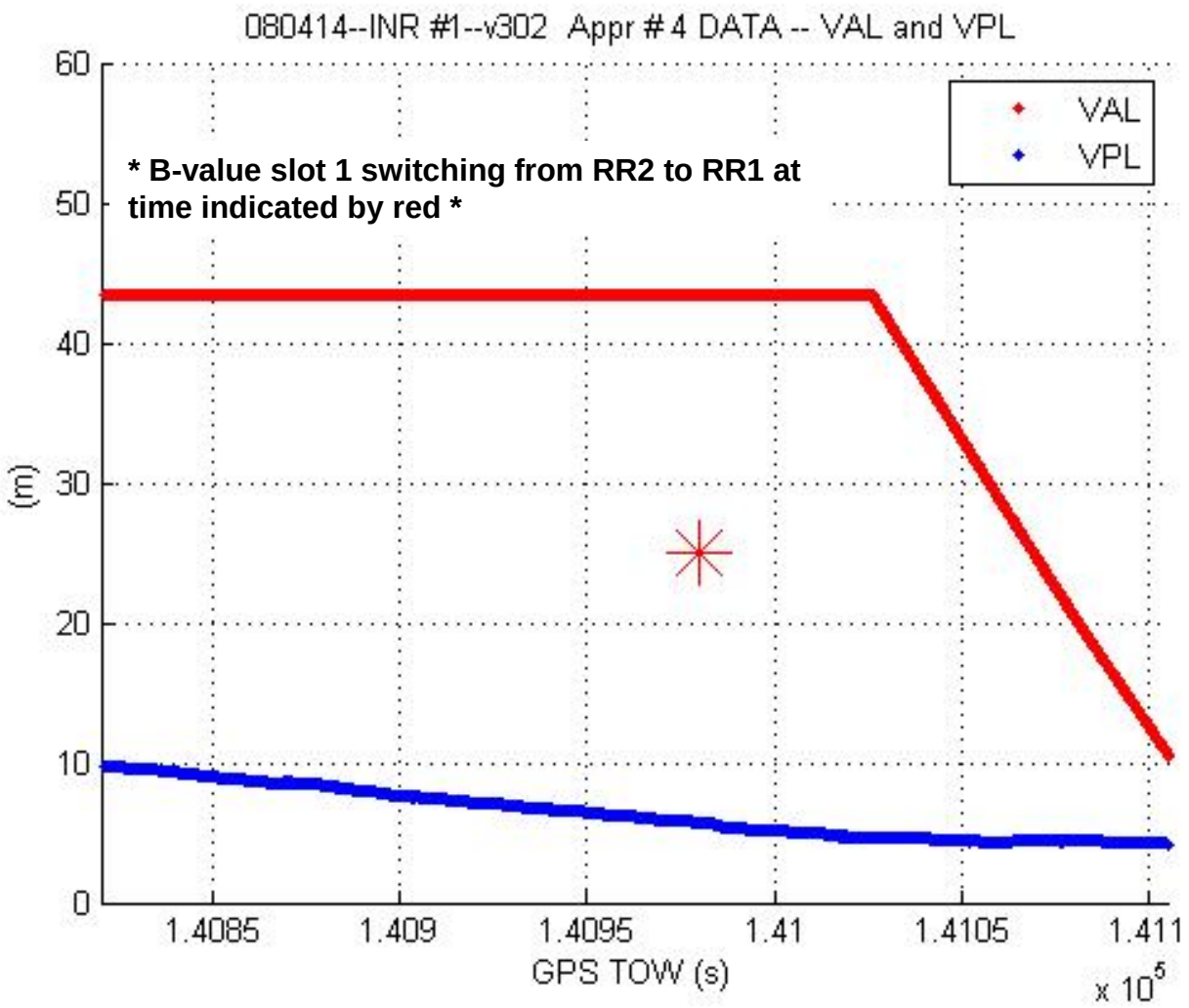
- **Data processing in final stages**
- **Worse than expected performance required more time to investigate that originally planned**
  - GAST-D INR data affected by a combination of SV loss of lock during periods of higher aircraft roll angle and a bug in the prototype CCD filter implementation
- **No issues observed due to switches between RSMUs in data analyzed thus far**
  - NSE, VPL, and RRFM example data for one approach follows
- **Complete results and flight test report will be posted on the Documents links at laas.tc.faa.gov by the end of October**

Example: NSE v. Distance

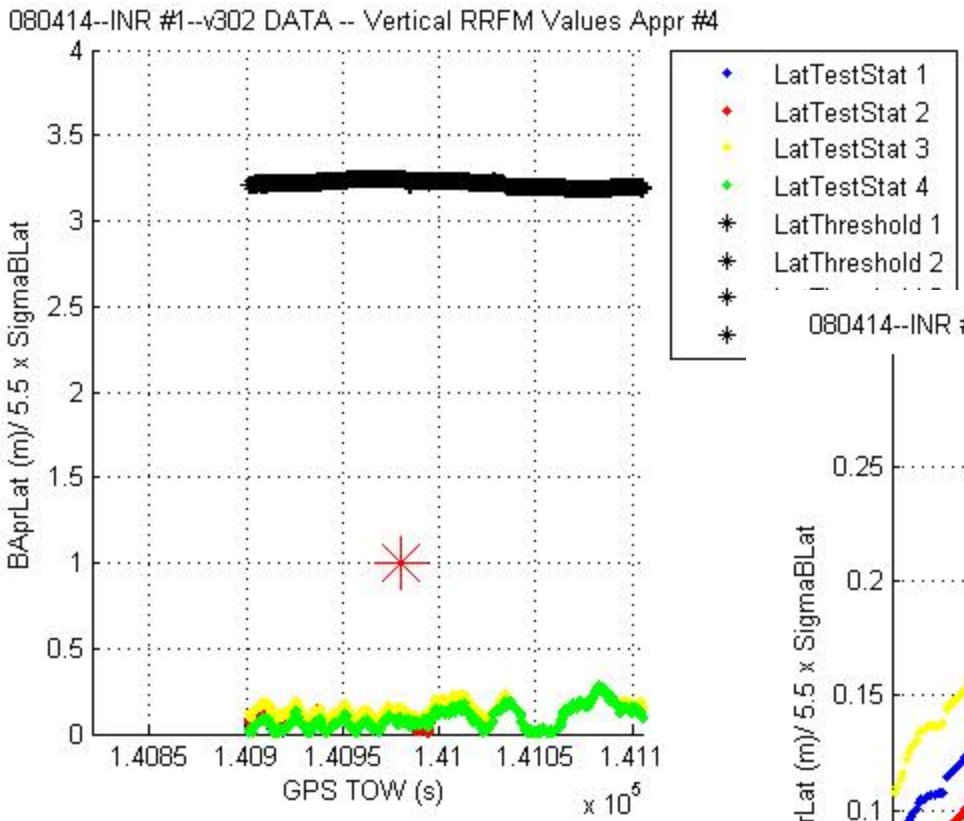


*** B-value slot 1 switching from RR2 to RR1 at time indicated by red line**

Example: VPL v. GPS TOW



Example: Vertical RRFM v. GPS TOW



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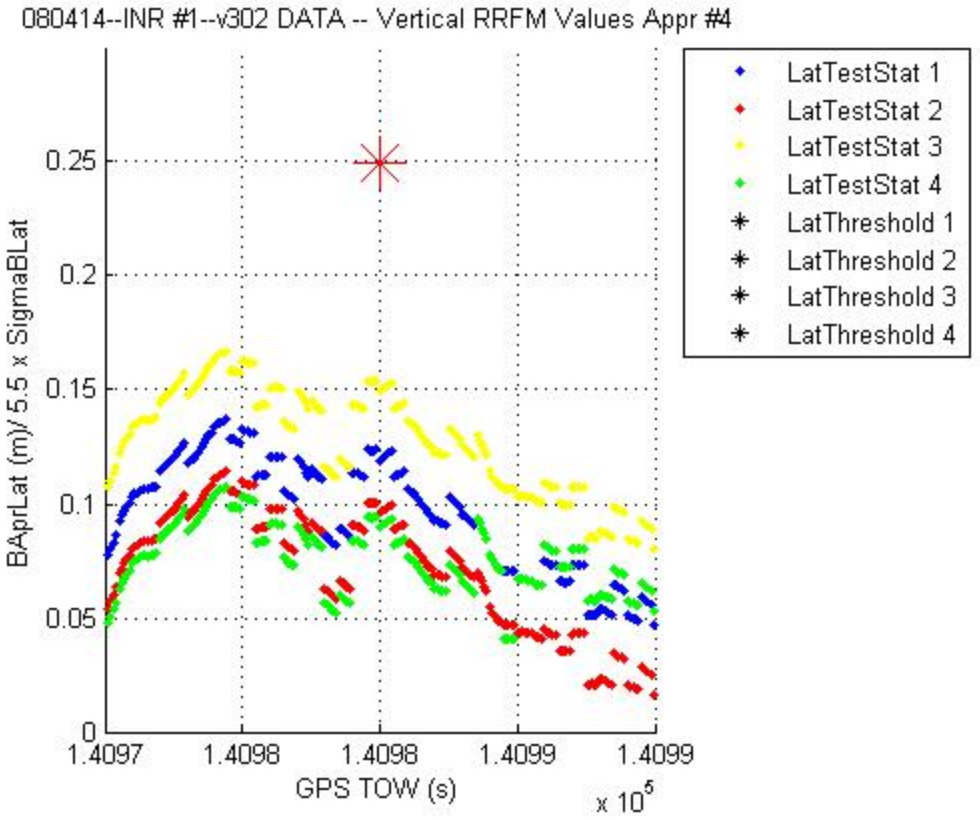

CAT-III Issues

- **Funding cuts have caused associated cuts in planned validation activities**
  - VDB signal-in-space validation testing
  - RFI robustness of the airborne receiver
  - No planned FAA activities for multi-constellation or multi-frequency GBAS prototyping
- **Schedule is vendor-driven**
  - Vendor participation is required to achieve a CAT-III GBAS in 2018
- **GAST-D success also requires FAA funding to carry out SDA work**
  - NextGen continues to fund GBAS SDA, with the focus on CAT III activities
  - FY16 budget allocation will be key to moving forward

Questions?