Summary of the Ninety-Second Meeting

Special Committee 159

Minimum Operational Performance Standards for Airborne Navigation Equipment Using the Global Positioning System (GPS)

The ninety-second meeting of SC-159 was held the week of 6 October 2014 at RTCA Headquarters, 1150 18th Street, NW, Suite 910, Washington, D.C. 20036. The attendees were the following:

Christopher Hegarty (Co-Chairman)  The MITRE Corporation
George Ligler (Co-Chairman)   PMEI
Kyle Wesson (Secretary)   ZETA Associates
Ken Alexander (DFO)   Federal Aviation Administration

Alessandro Adinolfi    Brazilian National Civil Aviation Agency
Laurent Azoulai    Airbus SAS
Frederic Bauer    Thales Alenia Space
Boubeker Belabbes    DLR German Aerospace Center
Denis Bouvet    Thales Avionics
Kevin Bridges    Federal Aviation Administration
Rick Cassell    Engility Corporation
Michael Cawley    Northrup Grumman
Max DeAngelis    NAVTAC
Yi Ding    Esterline CMC Electronics
Dee Ann Divis    Inside GNSS
Per Enge    Stanford University
Robert Erlandson    NISC III
John Foley    Garmin Ltd.
Takeshi Fujiwara    Japan Aerospace Exploration Agency
Matt Harris    The Boeing Company
Victor Iatsouk    Federal Space Agency “ROSCOSMOS”
Robert Jackson    Lockheed martin Corporation
Bruce Jacobs    LightSquared
Sai Kalyanaraman    Rockwell Collins, Inc.
Vignesh Krishnan    Honeywell International, Inc.
Vladimir Latev    Universal Avionics Systems Corp.
Young Lee    The MITRE Corporation
Harold Moses    RTCA, Inc.
The agenda for the meeting was as follows:

1. Chairman’s Introductory Remarks.


   a. GPS/3rd Civil Frequency (WG-1)
   b. GPS/WAAS (WG-2)
   c. GPS/GLONASS (WG-2A)
   d. GPS/Inertial (WG-2C)
   e. GPS/Precision Landing Guidance (WG-4)
   f. GPS/Airport Surface Surveillance (WG-5)
   g. GPS/Interference (WG-6)
   h. GPS/Antennas (WG-7)

4. Review of EUROCAE Activities.

5. Briefing – DOT’s GPS Adjacent Band Compatibility Plan

6. Advance Receiver Autonomous Integrity Monitoring (ARAIM) - Discussion


8. Other Business.

9. Date and Place of Next Meeting.

10. Adjourn.
In accordance with the Federal Aviation Advisory Committee Act, Ken Alexander, Federal Aviation Administration (FAA), was the designated Federal Employee for this meeting.

**Agenda Item 1. Chairman’s Introductory Remarks**

At the suggestion of Co-Chairman Chris Hegarty, the attendees introduced themselves. A new Secretary, Kyle Wesson of Zeta Associates, was introduced and thanked for volunteering to serve the committee in this role.

**Agenda Item 2. Approval of Summary of the Ninetieth Meeting held March 14, 2014**

The summary was approved with one editorial correction provided by Victor Iatsouk.

**Agenda Item 3. Review Working Group (WG) Progress and Identify Issues for Resolution**

a. **GPS/3rd Civil Frequency (WG-1)**

WG-1 was disbanded in October 2012, and thus there has been no activity.

b. **GPS/WAAS (WG-2)** (Co-chairs: John Studenny and Laurent Azoulai)

John and Laurent reported on the WG-2 activities as follows.

- A European Satellite Services Provider (ESSP) presentation on EGNOS was provided by Miguel Aguilera
  - EGNOS has been broadcasting release ESR 2.3.2 since 7 November 2013.
  - The new ESR 2.4.1M is qualified and ready for deployment. It aligns with existing standards (MOPS, GPS SPS 2008), introduces LPV200 capability, includes two new NLES G2 sites in Redu and Betzdorf, modernizes GEOs, and features improved ionosphere monitoring.
  - Service Notice 11 was released.
  - ARTEMIS GEO satellite (PRN 124) decommissioned since January 2014. INMARSAT 3F2 (PRN 120) and 4F2 (PRN 126) broadcasting EGNOS SIS.
  - Two new operational GEOs will be deployed in 2015 and 2016: ASTRA-4B (PRN 136, aka SES-5) and ASTRA-5B (PRN 123). Both will have L1/L5 capability. ASTRA-4B is already in the EGNOS TEST platform. ASTRA-5B will have GEO ranging capability.
  - New Service Definition Documents (SDD) to be released, including a new EDAS SDD version (in the final stage before publication) and a new EGNOS OS and SoL SDDs versions (to be published in Q4 2014).
  - New Implementation roadmaps for the three EGNOS services (OS, SoL and EDAS) covering a three years period will be made available to all the EGNOS users in October 2014. LPV200 Service Declaration expected by 2016.
- A response from WG-2 to the ICAO Liaison Statement on GNSS Receiver Protection was reviewed. Group consensus reached on an appropriate response, captured in proposed/draft letter/response to ICAO. Draft letter/response prepared, circulated to WG-2 for review, comments received, 2nd draft prepared and circulated again. The letter will be passed to the SC-159 Plenary.
A presentation on the GNSS Table Update was provided by Laurent Azoulai
  o The GNSS Table is a work in progress that attempts to qualify GNSS readiness for safety-of-life MOPS development.
  o A European teleconference held in July 2014 to review comments received during Spring 2014 ICAO NSP GSSG, RTCA SC-159 and EUROCAE WG62 meetings.
  o The current focus is on accurate definition of necessary items for the MOPS development and rationale, determining required versus nice-to-have capabilities, and adding GPS L5 specifics.

A presentation on RAIM Prediction Letter was provided by Kevin Bridges
  o ADS-B availability requirements and SAPT tool comments from RTCA status unknown
  o WG-2 requested response to feedback on SAPT.
  o Letter provided by Kevin on the discontinuation of raimprediction.net tool and replacement by SAPT tool
  o Teleconference planned with FAA/Don Walker on 28 October 2014 to coordinate

A presentation on recent GNSS anomalies was provided by Roland Lejeune
  o An unexpected SBAS SIS anomaly occurred, lasting several weeks, which had a serious operational impact for some users in one State and caused a loss of SBAS & GPS navigation for some users but did not result in any violation of integrity.
  o The anomaly raised several questions including (1) the need for a manual selection/deselection capability in future receivers, (2) compliance with monitoring and incident reporting requirements, and (3) need for user equipment to provide service any time it is possible to do so in future MOPS (already in DO-229D).

A presentation on candidate ARAIM architectures was provided by Todd Walter
  o Proposed two ARAIM architectures online and offline. Assumption that Horizontal service could be implemented at an early stage of Dual Frequency/Multi Constellation while having all the provisions for future Vertical Guidance service Solution seems to be a competitor to SBAS.
  o A variety of questions were raised requesting feedback prior to November 2014.

A presentation on Code Carrier Coherency was provided by Frédéric Bauer
  o Code carrier coherency requirement in the SARPS Annex 10, Vol. I §3.5.2.4 and recalled as an assumption in DO229D Appendix A §A.2.6.4.
  o Request for clarification on: (1) rationale for the short term quantitative requirement with respect to SBAS receivers, and (2) Ways to verify it from the Signal-in-Space provider point of view due to difficulty met and absence of noiseless receivers.

Plenary Discussion: A presentation on the GLONASS/GPS MOPS Draft 2 was given to the Plenary by Victor Iatsouk
  o The draft includes feedback from MITRE and Thales, and Draft 3 will include even more feedback.
  o Several items still require discussion among “mandates,” interference protection for combined receiver, manual selection/deselection of constellation, and dual constellation RAIM prediction
  o Completion of Draft 3 and submission to RTCA for posting at SC-159 Workspace – one month prior to SC159-93
  o Suggested draft 3 review at SC159-93 and decision to enter RTCA final review process with the goal of getting PMC approval by end 2015
An informal poll of manufacturers indicated interest in a L1 GPS/GLONASS MOPS. Laurent agreed to coordinate a readiness assessment for single frequency GPS/GLONASS MOPS. It was agreed that this readiness assessment would be a major factor in SC-159 deciding whether or not to commit to a L1 GPS/GLONASS MOPS and schedule at SC-159-93. Manufacturers who expressed interest were asked to work with Laurent on the GNSS Table (“scorecard”).

Ken Alexander took an action to determine the envisaged use of such a MOPS prior to the 20 March 2015 Plenary.

- A presentation on GPS/Galileo ConOps Review and ConOps Trade-off discussion was provided by Laurent Azoulai
- Following the need for a North American DFMC ConOps to provide rationale & basis for L1/L5 MOPS
- EU JASMIN ConOps reviewed by RTCA members
- Proposal agreed to develop a trade-off analysis to identify operational benefits and combinations in coordination with ICAO NSP WG2 & EUROCAE WG62 using IWG DFMC Doc: Ad-hoc group created
- Upon trade-off completed (i.e. System defined): Will develop a ConOps (ATM definition) in coordination with ICAO NSP WG2 focusing on cockpit requirements
- WG-2 sent out a presentation from A. J. Van Dierendonck on Manchester encoding for review.
- WG-2 will meet for 1.5 days during the week of the next SC-159 meeting.

c. GPS/GLONASS (WG-2A)

No activity.

d. GPS/Inertial (WG-2C) (Co-chairs: Mats Brenner and Young Lee)

There has been no activity since the last meeting.

e. GPS/Precision Landing Guidance (WG-4) [Joel Wichgers (Chair) and Dean Rudy (Vice Chair)]

Joel Wichgers reported on the activities of WG-4 as follows:
- Discuss Status/Plans and Coordinate Items for LAAS Relevant Groups
  - FAA GBAS Activities Update provided by John Warburton
    - FAA GBAS will focus on (1) Validation of ICAO SARPS for the baseline set of GBAS Approach, (2) System Design Approvals (SDA) for GAST-C Block II and GAST-D systems, (3) limited CAT 1 implementation support, and (4) international continuation
    - Examining Honeywell SLS-5000 GAST-D GBAS with a design approval target date of May 2018
  - DoD JPALS Program Updated provided by Tin Ying
    - In 2013, USAF transferred responsibility for Land-based JPALS to US Navy
Based on last year’s study of Navy and Marine Corps Precision Approach and Landing Capability (PALC) requirement, US Navy is restructuring JPALS Program

- ICAO Navigation Systems Panel CSG Activities Updated provided by Bruce Johnson
  - The work plan will focus on GBAS SARPs maintenance, GAST D operational validation, impact to other annexes, and multi-constellation, multi-frequency GBAS.
  - Goal is to close operational validation and NSP approval in Q1 2015 with an applicability date of November 2017

- EUROCAE WG-28 Activities Update provided by Laurent Azoulai
  - Report on review of ED-114A expected by Q4 2015
  - ED-114B development “MOPS for GBAS ground subsystem to support all types of precision approach and landing” in the context of GBAS CATII/III L1. Expected by Q2 2017

- Proposed VDB Format Definition Changes to Support Multi-constellation provided by Andreas Lipp
  - Proposed Minor VDB Format Definition Change to Support GBAS Multi-Constellation. WG-4 agreed with change

- GBAS Cat III VDB Link Budget Update and ICAO Activities provided by Laurent Azoulai
  - Seeking from ICAO VDB SIS requirement of +10 dB over minimum of -72 dBm at 36 to 80 feet height above runway

- VDB Change Proposal and Aircraft Implementation Loss provided by Orville Nyhus
  - Obtained WG-4 consensus on VDB Change Proposal based on modified link budget

- GBAS Cat III Flight Tests on Airbus Aircraft provided by Laurent Azoulai
  - GBAS Cat II/III flight tests performed on Airbus A380 and A320
  - MMR prototype based on a certified LRU, tested to verify that GAST-D function properly operates with real equipment interfaced with a GBAS GAST D station prototype

- SESAR GAST D Validation on GBAS CAT II/III Flight Test Initial Results provided by Jolana Dvorska
  - Verify performance in operational environment in nominal and non-nominal conditions

- Potential MOPS Issue: GCID Changing Selected Service Type provided by Barbara Clark

- Discussed Guided Takeoff using GBAS ConOps (like ILS) and First Identification of LAAS MOPS Requirements

- Needed to Support GBAS-based Guided Take off Action Item review, discussion, and resolution
  - There were over 16 action items

- LAAS Mops Document Review
  - Entire DRAFT LAAS MOPS Set of Changes provided by Barbara Clark
  - Walk through of Proposed Potential Appendix on Inertial Integration provided by Mats Brenner
    - WG-2C Developed an Information Paper on GBAS GAST D Inertial Integration Considerations
• Other Business
  o GBAS Fault Detection Performance provided by Jolana Dvorska
    ➢ Validation of GBAS Fault Monitors
  o Proposed New Uplink Parameter for GAST D for Distance Dependent Iono Bounding
    provided by Bruce Johnson
    ➢ Expect ICAO to soon Propose New Uplink Parameter for Iono Bounding
  o Proposal to Always Link B-value Index to a Physical Reference Receiver in GS
    provided by Bruce Johnson
    ➢ Agreed with linking, proposal was incomplete and rationale needs to be
      documented in Inertial Integration Information Paper
  o Question Regarding Airborne VDB Receiver Recovery Time from Operation at or
    Above Saturation provided by Bruce Johnson
    ➢ Expect future VDB requirement on receiver recovery from saturation
  o GBAS MOPS Comments provided by Y. Ding and J. Studenny
    ➢ Comments on LAAS MOPS Draft Review

• WG-4 will meet for three days during the week of the next SC-159 meeting

f. GPS/Airport Surface Surveillance (WG-5)

There has been no activity.

g. GPS/Interference (WG-6) (Co-chairs: Bob Erlandson and Sai Kalyanaraman)

Bob Erlandson reported:

• GPS/Interference (WG-6) (Co-chairs: Bob Erlandson and Sai Kalyanaraman)
  o WG-6 group has become active again as of the 9 Oct. 1st meeting:
    ➢ Short term task to review and comment on FAA Adjacent-Band Compatibility
      Study document.
    ➢ Support WG-7 and other WG’s on RFI issues for Dual-freq. GPS Receiver MOPS
    ➢ Address other GPS RFI issues as need (e.g. ICAO NSP questions)
• FAA Adjacent-Band Compatibility Study Document:
  o Bob Erlandson presented a summary briefing on Study methodology (to be posted to
    WG-6 workspace)
  o Webex/telecon set for Dec. 8 help address questions and early comments. Suggested
    discussion questions to be sent to co-chairs by 1 Dec. Second Webex/telecon possible
    for Jan. 2015 (as needed)
  o WG-6 proposed a FRAC-like process for SC-159 to develop responses to FAA
    questions (#1-#3) in the Study Doc. related to the RFI level derivations. Responses to
    be finalized at the SC-159 Mar. 2015 meeting
• Discussion of response to ICAO letter on GPS pseudolites, repeaters, and jammers:
  o Jammers, pseudolites, repeaters
  o Plan is to come up with an appropriate power level for regulated use of repeaters.
    Plan to leverage IRAC recommendation seen in the NTIA Red book.
• Additional activities:
  o Update of Io_{GNSS} for L1 Band
  o Support to Dual-freq. GPS Antenna MOPS
Next WG-6 meeting: 1-day during Mar. 2015 SC-159 week.

h. GPS/Antennas (WG-7) (Co-chairs: A. J. Van Dierendonck, Sai Kalyanaraman)

Sai and A.J. reported:
• WG-7 to jointly develop Airborne Antenna MOPS with EUROCAE to include standards for GPS L5/Galileo E5a with objective for operation with legacy L1 receivers as well as with new L1/L5 receivers
• WG-7 continues to discuss dual-frequency (L1/E1/L5/E5a) antennas with backward compatibility for L1-only receivers.
• NLR provided an update on their prototype dual-frequency antenna. Seeking input from A/C OEM on max antenna height (1.25 inches)
• WG-7 plans a half-day meeting at the next SC-159 meeting.

Agenda Item 4. Review of EUROCAE Activities
• A review of EUROCAE activities was presented by Laurent Azoulai.

Agenda Item 5. Briefing on DOT’s GPS Adjacent Band Compatibility Plan
• Discussion of the DOT’s GPS Adjacent Band Compatibility study occurred during the review of WG-6. Webex/telecon set for Dec. 8 help address questions and early comments. Suggested discussion questions to be sent to WG-6 co-chairs by 1 Dec. Second Webex/telecon possible for Jan. 2015 (as needed).

Agenda Item 6. Advance Receiver Autonomous Integrity Monitoring (ARAIM)
• Per Enge presented on ARAIM.

Agenda Item 7. Assignment/Review of Future Work
• Chris and George took an action to create a plan to respond to the ICAO letter concerning GPS jammers, pseudolites, and repeaters.

Agenda Item 8. Other Business
• Kevin Bridges (FAA) noted that several manufacturers have expressed an interest in a new MOPS addressing performance requirements for a higher quality AHRS-based IRU-like system integrated with GNSS inputs. An informal poll was conducted among SC-159 plenary participants that indicated support to revive WG-2C to address the gap between the DO-334 AHRS MOPS and high performance IRUs. Kevin took an action to draft a letter of support from FAA with a timeline for development.
• Ken Alexander (DFO) noted that future SC-159 MOPS (e.g., DFMC) needed to take into account: (1) spectrum implications, e.g., Phase 2 of the Department of Transportation’s GPS Adjacent Band Compatibility study, and (2) security.
Agenda Item 9. Date and Place of Next Meeting

The next meeting of RTCA SC-159 will be during the week of 16 March 2015 at RTCA Headquarters. The proposed meeting schedule is as follows [Ed. note – the schedule below includes some adjustments that were made after the plenary]:

<table>
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<tr>
<th>WG-1 (3rd civil frequency)</th>
<th>March 16 (Monday)</th>
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The subsequent meeting will be during the week of 19 October 2015.

-S-
Kyle D. Wesson
Secretary

CERTIFIED as a true and accurate summary of the meeting

-S-  -S-
Christopher Hegarty  George Ligler
Co-Chairman  Co-Chairman