

Summary of the Ninety-third Meeting

Special Committee 159

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

The ninety-third meeting of SC-159 was held on 20 March 2015 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
Hamza Abduselam	Federal Aviation Administration
Hal Adams	Accord Software & Systems, Inc.
Andrey Anikin	International Aeronavigation Systems
Aberto Arredondo	The Aerospace Corporation
John Ashley	The MITRE Corporation
Laurent Azoulai	Airbus
John Barry	Federal Aviation Administration
Michael Biggs	Federal Aviation Administration
Denis Bouvet	Thales Group
Mats Brenner	Honeywell International, Inc.
Kevin Bridges	Federal Aviation Administration
Jason Burns	Federal Aviation Administration
Mark Cato	Air Line Pilots Association
Michael Cawley	Northrup Grumman
Jacques Coatantiec	Thales Group
Darrell Davis	Northrop Grumman Corporation
Max DeAngelis	NAVTAC
Jed Dennis	NAVTAC
Yi Ding	Esterline CMC Electronics
Dee Ann Divis	Inside GNSS
James Doty	Rockwell Collins, Inc.
Jolana Dvorska	Honeywell International, Inc.
Per Enge	Stanford University
Robert Erlandson	NISC III
John Foley	Garmin Ltd.
Robert Frazier	Federal Aviation Administration

Takeshi Fujiwara	Japan Aerospace Exploration Agency
Andrey Galyamov	Ministry of Transportation – Russian Federation
Dietes Guentes	Pragmatics
Alain Guillet	Airbus
Matt Harris	The Boeing Company
Karan Hofmann	RTCA, Inc.
Bruce Johnson	Honeywell International, Inc.
David Judge	Federal Aviation Administration
Sai Kalyanaraman	Rockwell Collins, Inc.
Dude Kerley	Rockwell Collins, Inc.
Young Lee	The MITRE Corporation
Mikael Mabillean	Egis Avia
Jeff Meyers	Federal Aviation Administration
Eric Miles	Garmin Ltd.
Harold Moses	RTCA, Inc.
Campbell Motley	Pragmatics
Dan O’Laughlin	The MITRE Corporation
Ajay Parikh	LightSquared, Inc.
Kenneth Peterson	NISC III
Sam Pullen	Stanford University
Patrick Reddan	ZETA Associates
Ron Renk	United Airlines
Jaron Samson	European Space Agency
Oleg Skubiy	Navis
Geoff Stearn	LightSquared, Inc.
John Studenny	Esterline CMC Electronics
Dale Swanson	The MITRE Corporation
Toshiaki Tsujii	Japan Aerospace Exploration Agency
Alexey Tyrto	Institute of Aircraft Equipment
Oscar Valle-Colon	Federal Aviation Administration
A. J. Van Dierendonck	AJ Systems
Karen VanDyke	U.S. Department of Transportation
Todd Walter	Stanford University
Joel Wichgers	Rockwell Collins, Inc.
Rui Xue	Aviation Data Communication Corporation
Tin Ying	U.S. Air Force

The agenda for the meeting was as follows:

1. Chairman’s Introductory Remarks
2. Approval of Summary of the Ninety-Second Meeting held October 10, 2014 (RTCA Paper No. 229-14/SC159-1022)
3. Review Working Group (WG) Progress and Identify Issues for Resolution
 - 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. Review/Approve Response to FAA’s GPS Adjacent-Band Compatibility Study Methodology and Assumptions
 6. SC-159 Terms of Reference – Review/Approve Update
 7. GLONASS MOPS – Third Draft – Discussion
 8. GNSS Intentional Interference and Spoofing Study Team (GIISST) – Briefing
 9. Assignment/Review of Future Work
 10. Other Business
 11. Date and Place of Next Meeting
 12. 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 George Ligler, attendees introduced themselves.

Agenda Item 2. Approval of Summary of the Ninety-Second Meeting held October 10, 2014

The summary was approved with no changes.

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 Studenny and Laurent Azoulai reported on the WG-2 activities as follows:

- A FAA Wide Area Augmentation System (WAAS) presentation was provided by Deane Bunce
 - Phase III: Full LPV-200 Performance (2009 – 2014) Completed.
 - Phase IV: Dual Frequency (L1,L5) Operations (2014 – 2044)
 - Requirement for a 3 Geo SBAS constellation: Continuity of Service and support of “WAAS continuity is a key service parameter driving the ability to divest ground-based NAVAIDs identified in the FAA Navigation Evolution Plan”
 - Dual Frequency &ARAIM under planning & development
- A ESSP presentation on EGNOS Performance and LPV Status was provided by Miguel Aguilera
 - New update called “ESR 2.4.1M” will enable LPV200 service level.
 - LPV200 Service Declaration expected in Q4 2015
 - New version of EGNOS SoL Service Implementation Roadmap foreseen by Q2 2015.
 - A new SoL SDD will be published, leading to service declaration.
 - LPV200 is a major milestone for EGNOS program

- An EGNOS Status was provided by Nathalie Riccard
- A Thales presentation that asked a question about SBAS reacquisition was provided by Denis Bouvet
- Laurent Azoulai reviewed the GNSS Table
 - GNSS table designed to identify:
 - Required data to launch MOPS development
 - Availability of data for core GNSS constellations
 - GPS L1, L5; Glonass L1 FDMA, Galileo E1, E5a reviewed
 - General Summary: Readiness for MOPS development
 - GPS L1 ready: Only Pconst estimate needed
 - GPS L5 not ready: ICAO SARPS, SPS missing and key info.
 - Galileo E1, E5a not mature: Partial or absence of information, ICAO SARPS in draft version with TBDs, performance not yet consolidated, partial info on data processing, constellation plans and environmental models, no info on failures
 - GLONASS, L1 FDMA: No SPS available; partial info on Clock corrections requires validation by Rx manufacturers, faults modes causing hazards still unclear, Pconst and justification of 2014 major constellation failures not available, environmental models GPS dependent
 - Beidou: No info.
 - DF/MC End-user benefits still unclear: Trade-off analysis and ConOps is a Work In Progress (see the discussion of the Airbus presentation on DFMC Tradeoff Analysis below). Visibility of expected benefits from Airspace users' point of view needed.
 - GNSS Table on hold until significant update from GNSS Service Providers
 - DFMC MOPS development on hold until the above situation improves. Volunteers are welcome to provide technical inputs for when the MOPS development should start
 - George Ligler reviewed “ADS-B CTA 11/18/2014: Transition Period for NIC and NAC Requirements” (RTCA Paper No. 073-15/SC159-1034). George stated that a large majority of the air transport fleet will upgrade its GNSS receivers within the next decade, and urged SC-159 participants to help complete the GNSS table.
- An Airbus presentation on DFMC Tradeoff Analysis was provided by Laurent Azoulai
 - Need to identify operational benefits and combinations of GNSS constellations
 - Trade-off analysis in coordination with ICAO NSP WG2
 - Will feed the ConOps to be established by ICAO NSP WG2
 - Work ahead to complete the analysis by early 2016
- A Stanford presentation on ARAIM status update was provided by Todd Walter
 - Stanford seeks input on seven questions by April 30, 2015.
 - These questions are available in the WG-2 Summary.
- A Stanford presentation on SBAS DFMC ICD updates was provided by Todd Walter
 - One single standard, used by all SBAS Service Providers, to allow the augmentation of (any combination of) up to 4 constellations
 - WG-2 Remark: All constellation MOPS will need to be well-advanced or relatively stable so that such an SBAS MOPS can be developed with minimal technical risk.
- A NAVTAC presentation SBAS DFMC Selection was provided by Jed Dennis
 - Please refer to paper for work plan

- Remark: Author recommends δ DFRE; however, more study should be performed as it appears HPL yields acceptable results. Maybe both are good choices.
- A presentation on GPS/GLONASS MOPS Draft was provided by Victor Iatsouk
 - Continued assessment of SC-159 members' comments and resulting updates
 - Continued development and internal coordination of TBD parts
 - Draft 3 review at SC-159-93 and decision to enter RTCA final review process with the goal of getting PMC approval by end 2015
 - Subject to SC-159-93 decision, completion of Draft 4 and submission to RTCA for posting at SC-159 Workspace – one month prior to SC-159-94
- WG-2 will meet for 1.5 days during the week of the next SC-159 meeting.

c. **GPS/GLONASS (WG-2A)**

There has been no activity since the last meeting.

d. **GPS/Inertial (WG-2C)** (Co-chairs: Kevin Bridges and Mats Brenner)

Mats Brenner reported:

- WG-2C met for 2.5 days for the first time since November 2011
- The working group met based on a request from the FAA to create a MOPS for integrated inertial/GNSS positioning systems using AHRS grade sensors
- The first half day was spent assessing the feasibility of the FAA request
 - The WG2C participants at this meeting (with exception of the former chairman) were all new to the working group
 - The former WG2C chairman (Mats Brenner) gave a presentation on the present status and history of WG2C. This material also included the major issues that were addressed by WG2C in the past
- The second day first focused on establishing the terms of reference
 - The group also came to a consensus regarding the MOPS title: “MOPS for GNSS aided inertial systems”
 - Kevin Bridges was elected co-chairman of WG2C
- Day 3 started with a review of the integration methods in Appendix R that provide maintained integrity during coasting (independent of fault dynamics)
- Telecons are planned for June 3, 2015 and August 26, 2015
- WG-2C plans a 2.5 day meeting at the next SC-159 meeting

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

Due to time constraints, the presentation was not presented at the Plenary, but it is posted on the RTCA workspace for review.

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

There has been no activity since the last meeting.

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

Bob Erlandson reported:

- WG-6 group has been re-activated as of 9 October 2014 (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-Frequency MOPS
 - Address other GPS RFI issues as need (e.g. ICAO NSP questions)
- FAA Adjacent-Band Compatibility Study Document Review and Comment:
 - WG-6 conducted 2 preliminary review rounds (13 Oct. - 8 Dec 2014, 15 Dec. 2014 - 2 Feb. 2015) and 1 final FRAC-like review round (9 Feb-13 Mar. 2015) on the GPS Adjacent Band Compatibility Study document
 - Two Webex/telecon meetings were held 8 Dec. '14, 2 Feb. '15) and 2 half-day sessions at the regular meeting (18-19 Mar.) to resolve comments from the preceding review period.
 - First round prelim. review: 36 “standard” comments received (incl. 2 duplicates), 3 comments continued to 2nd round, remainder resolved and entered in marked-up ABC Study doc; 28 “non-standard” comments received + 1 for TOC (Questions 4-6) review, nearly all moved to 2nd round review period.
 - Second round review: 10 “standard” comments received, 2 actions assigned for further input, 3 issues moved forward, remainder resolved and entered in marked-up ABC Study doc (9 Feb).
 - Final (FRAC-like) review: 25 comments received + 2 additional action item inputs from round 2. All resolved were entered into final mark-up version of ABC Study for inclusion in SC-159 response to Questions 1-3. Two additional technical white papers were included on concerns of one member related to Question 3. More information on the topic of Questions 1-3 of the ABC Study may be found in the discussion of Agenda Item 5.
- No further WG-6 activity since the Oct. 2014 meeting on:
 - ICAO Jammer, Repeater, Pseudo-lite letter
 - Update of $I_{0,GNSS}$ for L1 Band
 - Support to Dual-freq. GPS Antenna & Multi-Con. Receiver MOPS with RFI-related parameters
- WG-6 plans a half-day meeting at the next SC-159 meeting.

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

Sai Kalyanaraman and A.J. Van Dierendonck reported:

- RTCA SC159 Working Group 7 to jointly develop Airborne Antenna MOPS with EUROCAE
- NLR (with Space Engineering) developed prototype dual frequency antenna
- Draft version of MOPS document available.
- Continue to obtain input from Antenna, Receiver and Aircraft manufacturers
- Continue to co-ordinate with EUROCAE on dual frequency antenna MOPS development.
- 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.
- The presentations are available on the RTCA workspace for review.

Agenda Item 5. Review/Approve Response to Questions 1-3 from FAA's GPS Adjacent-Band Compatibility Study Methodology and Assumptions

- The WG-6 co-chairs presented the draft response from the working group and the Plenary reviewed the document section-by-section for approval.
- LightSquared raised concerns about the review process, in particular (1) the duration and pace of the review process, (2) the applicability of the 6 dB safety margin during operations, (3) and the lack of ability to review the response in the time allotted. LightSquared subsequently requested that WG-6 reconvene in two weeks to provide WG-6 participants more time to review the study and response.
- At the suggestion of the FAA and RTCA Co-Chairs, LightSquared agreed that instead of a two week delay they would provide a minority opinion/response to RTCA by April 3, 2015 that will be attached to the WG-6 response approved at the Plenary. The minority response will not be reviewed by WG-6 or the Plenary.
- The Plenary approved the WG-6 response with a few minor changes.

Agenda Item 6. SC-159 Terms of Reference – Review/Approve Update

- Chris Hegarty presented the draft updated terms of reference (TOR) for section-by-section review.
- Some changes were suggested and the TOR draft approved at the Plenary will be recommended to the PMC for approval.

Agenda Item 7. GLONASS MOPS – Third Draft – Discussion

- George Ligler posed a question: “How many manufacturers will participate in GPS/GLONASS L1-only MOPS development?” Only one manufacturer from outside of Russia in attendance (Accord Software) responded positively in a show of hands. It was suggested that other RTCA participants not in attendance would also be interested.

Agenda Item 8. GNSS Intentional Interference and Spoofing Study Team (GIISST) – Briefing

- The GIISST briefing has been postponed until further notice.

Agenda Item 9. Assignment/Review of Future Work

- Chris and George took an action to host a telecon to reactivate WG-2A and determine its organization prior to the next SC-159 meeting.
- ICAO jammer/pseudolite letter dated July 16, 2014: The Co-Chairs indicated that they will provide a response letter to the ICAO NSP Secretary.

Agenda Item 10. Other Business

- A European GNSS programs overview and standardization effort presentation was provided by M. Mabileau.

Agenda Item 11. Date and Place of Next Meeting

The next meeting of RTCA SC-159 will be during the week of 19 October 2015 at RTCA Headquarters. The proposed meeting schedule is as follows:

	October 19 (Monday)	October 20 (Tuesday)	October 21 (Wednesday)	October 22 (Thursday)	October 23 (Friday)
WG-1 (3 rd civil frequency)					
WG-2 (GPS/WAAS)	1 st day @ 9:00 a.m.				
WG-2A (GPS/GLONASS)		Half day @ 9:00 a.m.			
WG-2C (GPS/Inertial)		1 st day @ 9:00 a.m.	2 nd day @ 9:00 a.m.	3 rd day (half) @ 9:00 am	
WG-4 (GPS/Precision Landing)		1 st day @ 9:00 a.m.	2 nd day @ 9:00 a.m.	3 rd day @ 9:00 a.m.	
WG-5 (Airport Surface Operations)					
WG-6 (Interference)				Half day @ 1:00 p.m.	
WG-7 (Antenna)				Half day @ 9:00 a.m.	
Plenary Session					One day @ 9:00 a.m.

The subsequent meeting will be during the week of 14 March 2016.

-S-
Kyle Wesson
Secretary

CERTIFIED as a true and accurate summary of the meeting

-S-
Christopher Hegarty
Co-Chair

-S-
George Ligler
Co-Chair