



EUR 127-20 / WG62-110
RTCA Paper No. 117-20/SC159-1086

Saint Denis, 29 April 2020
Washington, 29 April 2020

Summary of the One Hundred and Fifth Meeting
RTCA Special Committee 159 (SC-159)
Navigation Equipment Using the Global Navigation Satellite System (GNSS)
And
Fifty-First Meeting
EUROCAE Working Group 62 (WG-62)
Galileo

The one hundred and fifth meeting of SC-159 was held March 13, 2020 at RTCA Headquarters, 1150 18th Street NW, Suite 910, Washington, D.C. 20036. The meeting was held jointly with the fifty-first meeting of EUROCAE WG-62 (Galileo). The attendees were the following:

NAME	COMPANY
Christopher Hegarty (Co-Chairman)	The MITRE Corporation
George Ligler (Co-Chairman)	GTL Associates
Karan Hofmann (Program Director)	RTCA
Barbara Clark (GAR)	Federal Aviation Administration (FAA)
NAME	COMPANY
Ken Alexander	Federal Aviation Administration (FAA)
Doug Arbuckle	Federal Aviation Administration (FAA)
John Ashley	The MITRE Corporation
Laurent Azoulai	Airbus
John Barry	FAA
Kevin Bean	The MITRE Corporation
Mike Biggs	FAA
Denis Bouvet	Thales Group
Mats Brenner	Honeywell
Jason Burns	FAA
Felix Butsch	DFS Deutsche Flugsicherung GmbH
Laura Cheung	Raytheon
Jed Dennis	NAVTAC
Mark Dickinson	FAA

Yi Ding	CMC Electronics
Daniel Domey	CMC Electronics
James (JP) Fernow	The MITRE Corporation
John Foley	Garmin
Yongchao Geng	CETC Northwest Group Co., LTD
Wes Googe	American Airlines
Anna Guegan	EUROCAE
Alain Guillet	Airbus
Matt Harris	The Boeing Company
Sai Kalyanaraman	Collins Aerospace
Vladimir Latev	Universal Avionics Systems Corp.
Andreas Lipp	EUROCONTROL
Kai Nilsen-Knight	Garmin
Doug Phifer	FAA
Ding Qun	CETC Northwest Group Co., LTD
Madhusudhana Rao	Honeywell
Sergey Silin	ZAO "KB NAVIS"
John Studenny	CMC Electronics
Neil Surti	FAA
Francois Tranchet	Airbus
Hans Trautenberg	EASA
Joel Wichgers	Collins Aerospace

The agenda for the meeting follows:

1. Introductory Remarks: RTCA, GAR and Co-Chairs
2. Approval of Summaries of Previous Meetings
 - a. One Hundredth Fourth Meeting for SC-159 held October 4, 2019 (RTCA Paper No. 014-20/SC159-1081)
 - b. Fiftieth Meeting for WG-62 held December X, 2019 (EUR 38-20/WG62-107)
3. Final Review and Comment (FRAC) activities
 - a. DO-235C (WG-6) Release for FRAC
 - b. DO-292A (WG-6) Release for FRAC
4. Review Working Group (WG) Progress and Identify Issues for Resolution.
 - a. GPS/WAAS (WG-2 and EUROCAE WG-62) to include update on related ICAO/Navigation Systems Panel activities
 - b. GPS/GLONASS (WG-2A)
 - c. GPS/Inertial (WG-2C)
 - d. GPS/Precision Landing Guidance (WG-4), to include update on related ICAO/Navigation Systems Panel activities
 - e. GPS/Interference (WG-6), to include update on related ICAO/Navigation Systems Panel activities
 - f. GPS/Antennas (WG-7)
5. Discussion of Terms of Reference Updates
6. Action Item Review

7. Assignment/Review of Future Work
8. Other Business
9. Date and Place of Next Meeting
10. Adjourn

Barbara Clark, Federal Aviation Administration (FAA), was the Government Authorized Representative for this meeting.

Agenda Item 1. Chairman's Introductory Remarks.

- At the suggestion of SC-159 Co-Chairman George Ligler, attendees introduced themselves.
- Karan Hofmann, Program Director of RTCA, noted that RTCA is NOT a federal advisory committee but that meetings are conducted in strict accordance with U.S. anti-trust laws. She discussed RTCA's proprietary references policy and committee participation membership policy. Ms. Hofmann noted that this Advisory Committee meeting is open to the public, that notice of the meeting was published online but not in the Federal Register as had been done previously, and that members of the public may present written or oral statements with the permission of the committee chairmen and program director.
- Anna Guégan, Technical Programme Manager of EUROCAE, discussed EUROCAE's IPR and membership policies.

Agenda Item 2. Approval of Summaries of Previous Meetings.

- a. The summary for the 104th meeting of SC-159, RTCA Paper No. 014-20/SC159-1081, was approved with one minor edit (an update to the affiliation of one participant).
- b. The summary for the 50th meeting of WG-62, EUROCAE Paper No. 38-20/WG62-107, was approved. Laurent Azoulai provided an update on WG-62 activities. The next WG-62 meetings are planned for May (may be virtual due to the COVID-19 situation), July (Paris), October (jointly with SC-159), and January 2021 (EASA, to be confirmed).

Agenda Item 3. Final Review and Comment (FRAC) activities.

- a. DO-235C (WG-6) Release for FRAC

Sai Kalyanaraman, chairman of working group 6, indicated that DO-235C was still not ready to enter FRAC. He requested an extension with an intent to complete the FRAC period prior to the upcoming October meeting. The Plenary meeting approved this extension.

- b. DO-292A (WG-6) Release for FRAC

DO-292A is also delayed and will not be ready to enter FRAC until after the next (October) SC-159 plenary. Dr. Kalyanaraman asked the committee to consider extending the deadline for this document to the March 2021 plenary. The Plenary approved this extension. Plenary approval to enter FRAC can be taken up at the October SC-159 plenary.

Agenda Item 4b. Review GPS/GLONASS Working Group (WG 2A) Progress and Identify Issues for Resolution. [Note that this agenda item was addressed out of order to accommodate participant availability].

The meeting participants discussed a proposal that was made by Ms. Lada Semina of NNC Consulting LLC in Russia at the October 2019 plenary for SC-159 to initiate a new “MOPS for GLONASS / GPS multi-frequency satellite navigation equipment.” John Studenny completed his action item from that meeting to collect questions to the Russian Federation from SC-159 on the planned GLONASS mandate. Informal responses were received by the SC-159/WG-62 DFMC MOPS authors group from the Russian Federation ICAO NSP Panel Member Vladimir Korchagin. Barbara Clark also completed an action from the October SC-159 plenary to post recent NSP papers on GLONASS to Workspace.

Additional discussion took place on complications with antenna and front-end designs to process GLONASS FDMA signals along with GPS and SBAS CDMA signals.

The participants agreed that SC-159 should continue for now with the current work products identified in the ToR. Based upon the information received by and discussed within the meeting, receiver manufacturers were asked to provide input to SC-159 by the next plenary as to whether their companies would support the addition of a GLONASS capability into DFMC equipment. If SC-159 participants have additional questions on GLONASS, these should be provided to the WG-2 co-chairs within 60 days to be sent to representatives of the Russian Federation.

Several participants noted that China is proceeding rapidly with BeiDou operational approvals and SC-159 might revisit the potential inclusion of BeiDou in the DFMC MOPs. A BeiDou roadmap document was reported to have been recently made available in Chinese. SC-159 participants will look for an English version.

Agenda Item 4a. Review GPS/WAAS (WG 2 and EUROCAE WG-62) Progress and Identify Issues for Resolution.

Laurent Azoulai and John Studenny, co-chairmen of Working Group 2, discussed the progress made by that group during the week.

- The first joint WG-2/WG-4/WG-62 meeting was held Monday - Wednesday (March 9 - 11) to make progress on the dual frequency, multi-constellation MOPS.
- Jed Dennis provided a WAAS program update.
 - Release 7 will change the WAAS L5 broadcast from a copy of the L1 message to a MT-0 message with correct L5 preamble/formatting.
 - The transition will occur initially only on GEO-7 (Galaxy 30) in the first half of 2021. The GEO-5 and GEO-7 broadcast will follow approximately Q2 2022.
- Mikael Mabilleau briefed on the status of the EGNOS program.
 - The GEO 3 payload entered service on EUTELSAT 5 West B in February 2020.
 - Three GEO swaps will have occurred before the end of Q1 2020.
- Pierre Durel provided status on the work by the ICAO DFMC SBAS SARPs Subgroup (DS2)
 - The DS2 group aims to produce SARPs amendments for SBAS L5 and propose them to NSP for approval by October 2020.
 - Progress has been made on various topics (e.g., validation, interference masks, review of RTCA comments).
 - The following items are not in the current SARPs baseline: authentication, service area message, non-GEO SBAS, augmentation on QZSS.

- Kevin Bean provided an update on adding requirements tags to DO-229E in support of the DFMC MOPS and Hans Trautenberg discussed the improvement of a note wording in Section 2.1.2.3
 - The tagging activity is complete, and WG-2 recommended that SC-159 enter FRAC for DO-229F contingent upon a PMC approval of a SC-159 ToR change at their March 26 meeting to add this product.
 - This path forward was approved by the Plenary. A special SC-159 Plenary, to be held via WebEx is planned for April 30 at 10 am EDT to consider approving the document.
- François Tranchet and Laurent Azoulai led a discussion of the DFMC SBAS MOPS ConOps
 - This topic was discussed during multiple Author's groups telecons.
 - Chapter 1 has been updated and reviewed. The intent is to integrate this chapter in the draft DFMC SBAS MOPS revision A version 0.5.
- Denis Bouvet provided a summary of updates to EUROCAE's DFMC MOPS, ED-259, since the last SC-159 meeting in October.
 - ED-259A v0.4 was circulated in January. Updates include: residual ionospheric error model after ionospheric-free dual-frequency combination, editorial modifications, clarification notes, additional checks on GPS L1 LNAV and L5 CNAV messages, and a clean-up of the appendices.
- Ikhlas Selmi presented on gain roll-off requirements
 - Impact of gain roll-off on differential receiver biases was assessed.
 - Various participants took actions to make further progress on this topic.
- Todd Walter provided two presentations:
 - SBAS timing requirements - additional robustness requirements were proposed to verify proper alignment of the SBAS signal with the received GNSS signals.
 - Scintillation – data from Boston College was shared and suggestions were made on improving receiver robustness to ionospheric scintillation.
- Mikael Mabilleau provided a presentation on Galileo almanac accuracy.
 - 34 months of almanac data were assessed
 - At an age of almanac (or prediction time) of 7 days, almanac errors are below 12 km (99.7% - 3-sigma)
- Mikael Mabilleau presented on a complement to REQ-208
 - An increased exposure time of 5 minutes leads to a negligible impact in the Psat and Pconst evaluations for Galileo.
 - A wording change was suggested and accepted by the group.
- Denis Bouvet provided a presentation comparing the SBAS L1 SARPs to DO-229E Appendix A.
 - A suggestion to remove Appendix A and reference SARPs was discussed. There are pros and cons.
 - The FAA has been supporting ICAO to ensure that GPS signal characteristics are kept updated in the SARPs. Galileo, BeiDou, and GLONASS will need to do so also.
- Presentations were provided on spoofing:
 - Denis Bouvet provided a presentation with suggested spoofing test procedures.
 - Daniel Domey and John Studenny presented a proposal on spoofing detection.

- Simona Circiu provided an update on the EC DUFMAN project
 - Data was presented from flight campaigns on large fixed-wing aircraft (Airbus A321, A330, and A350). Additional campaigns are planned on A320 and A350.
 - Models for multipath error vs elevation angle were proposed based upon the flight data.
- Barbara Clark presented on the NACv3 appendix review
 - The Combined Surveillance Committee prepared some text to address NACv3, as discussed with SC-186 in the past year.
 - The group was asked to review and provide feedback.
- WG-2 requested to meet jointly with WG-4 and WG-62 for 3 days (M/T/W) during the October 2020 SC-159 week.

Agenda Item 4c. Review GPS/Inertial Working Group (WG 2C) Progress and Identify Issues for Resolution.

Mats Brenner, chairman of WG 2C, presented the current status of that group.

- The working group is continuing to make good progress on the GNSS-aided Inertial System MOPS. WG-2C met for 2.5 days this week and held 7 telecons since October. The draft MOPS is now about 200 pages in length.
- This week's meeting and recent telecons focused on reviewing the latest MOPS draft contributions, making final corrections, and promoting a better understanding of its implications.
- Specific topics discussed included:
 - Monica Vafiades (USAF) reviewed all of the requirement ("shall") statements and provided comments that were addressed by the group.
 - Appendix Q on alternate trajectories.
 - Status reports and feedback to Ohio University on Appendix O (gravity modeling).
 - Attitude bias test model update.
 - Scintillation.
 - ADS-B/RNP-AR requirement updates.
 - Ionospheric storm test change.
- Proprietary material previously discussed at the PMC level has been removed. Export issues may exist for Appendix Q. Manufacturers may want to coordinate with their export officers.
- WG-2C anticipates completing the MOPS by July. Telecons will continue towards this end.
- WG-2C recommended that SC-159 approve initiation of FRAC for the MOPS. The Plenary approved this request.
- WG-2C requested 2.5 days for the October 2020 SC-159 meeting (T/W and half Th)

Agenda Item 4d. Review GPS/Precision Landing Guidance (WG 4) Progress and Identify Issues for Resolution.

Joel Wichgers and Matt Harris, chairmen of WG-4, provided a summary of the WG-4 activities throughout the week.

- WG-4 spent much of the week in joint meetings with WG-2 and EUROCAE WG-62. See summary above for Agenda Item 4a.
- WG-4 has the following work products:
 - GBAS MOPS and ICD maintenance – two very minor issues have been identified in non-normative explanatory appendices. These will be addressed at an appropriate time.
 - DFMC GNSS(GBAS) MOPS – initial and validated. WG-4 recommended delaying the completion dates for these products in the SC-159 ToR from 2021 and 2023, respectively, to 2023 and 2025, respectively.
- The following items were discussed at the Thursday (March 12) WG-4 only meeting:
 - Tim Murphy presented an update on the ICAO NSP GBAS Working Group (GWG) and Matt Harris presented on details of the IGM Ad Hoc Group. The GWG is currently focused on:
 - Maintaining GBAS SARPs (including VHF compatibility requirements)
 - ICAO Doc 8071 update for GBAS
 - Updates to the GNSS Manual (Doc 9849)
 - Ionospheric Gradient Monitor (IGM) Ad Hoc Group
 - DFMC GBAS activities (including ConOps)
 - Jointly working with the Spectrum Working Group (SWG) on GBAS spectrum guidance
 - Shelly Beauchamp provided updates on two topics:
 - International GBAS Working Group (IGWG) – this four-day annual event co-chaired by FAA and EUROCONTROL was planned for May 26 – 29, 2020 in Dublin. It is in the process of being rescheduled because of the coronavirus.
 - FAA GBAS program changes – the FAA GBAS project had been managed by the FAA’s NextGen Portfolio Management and Technology Development Office. Effective January 2020, management of the FAA GBAS project was moved to the newly established ATO Technical Operations, Operations Support, NAS Technical Services, Advanced System Design Services (ASDS) Team.
 - Barbara Clark provided an update on Appendix O of the EUROCAE WG-28 ground GBAS MOPS (ED-114). This appendix has been updated (updated table mapping the DO-253D Change 1 requirements with relevant references to Annex 10) and is intended to be included in ED-114B amendment 1.
 - Jed Dennis provided comments to be considered for DO-253 MOPS maintenance. These have been noted in WG-4’s Maintenance Matrix.
- WG-4 plans to hold telecons as needed prior to the next (October 2020) SC-159 week. WG-4 requested to meet jointly with WG-2 and WG-62 for 3 days plus 1 day just for WG-4 at the October 2020 meeting.

Agenda Item 4e. Review GPS/Interference (WG 6) Progress and Identify Issues for Resolution

Sai Kalyanaraman, WG-6 Chair, discussed the Working Group efforts during the week.

- Discussions related to DO-235C (L1 Interference Report):
 - WG-6 continues to make progress on a C/N_0 link budget for the GPS L1 C/A-code.
 - Worst-case space/time points have been identified for different phases of flight
 - Receiver manufacturers are assisting with testing to help validate the interference conditions.
 - WG-6 is hoping to start FRAC for DO-235C this summer and have it approved by SC-159 in October.
- Discussions related to DO-292A (L5 Interference Report):
 - ENAC and GMV continue to provide significant inputs towards DO-292A, on topics including: (a) results on anticipated interference from DME/TACAN and JTIDS/MIDS in the United States, (b) other interference sources (e.g., case emissions), (c) link budget computation methodology and results (d) an L5 interference mask as a function of interference bandwidth and frequency.
 - WG-6 hopes to enter FRAC for DO-292A prior to the March 2021 meeting and seek SC-159 approval of DO-292A at its March 2021 plenary.
- WG-6 is getting closer to finalizing an interference mask vs frequency for DFMC equipment (that spans L1-to-L5 and beyond), which will also be needed for both DO-235C and DO-292A.

Agenda Item 4f. Review GPS/Antennas (WG 7) Progress

Sai Kalyanaraman, WG-7 Chair, discussed the Working Group efforts during the week.

- WG-7 released the DFMC antenna MOPS, DO-373, last year. WG-7 continues to discuss new material on DFMC antennas and will consider whether any changes to DO-373 are necessary.
- Stefan Caizzone of DLR provided an update on DUFMAN-related antenna activities.
- WG-7 discussed the DLR presentation and also whether additional equipment classes or new requirements (e.g., on group delay variation) should be considered for the DFMC Antenna MOPS. No decisions were made, and these discussions will continue.

Agenda Item 5. Discussion of Terms of Reference Updates

Chris Hegarty led the committee in a discussion regarding changes to the SC-159 Terms of Reference. The following changes were approved by SC-159 and will be included in a proposed ToR update to be presented to the PMC on March 26:

- Update to George Ligler's affiliation. Deletion of John Savoy as Secretary since he has stepped down from this position.
- Addition of a new product – “update to DO-229E” – with a April 2020 due date (see discussion under agenda item 4a)
- Revisions of product dates:
 - DO-235C from March 2020 to October 2020 (see discussion under agenda item 3a)
 - DO-292A from October 2020 to March 2021 (see discussion under agenda item 3b)

- GNSS(GBAS) L1/L5 MOPS and ICD. Initial MOPS and ICD from 2021 to 2023. Validated MOPS and ICD from 2023 to 2025 (see discussion under agenda item 4d)

Agenda Items 6 and 7. Action Item Review and Assignment/Review of Future Work

These topics were addressed in the WG outbriefs and there was no further discussion.

Agenda Item 8. Other Business

Barbara Clark brought it to the attention of the group that an Executive Order was issued February 12 in the United States on “Strengthening National Resilience through Responsible Use of Positioning, Navigation, and Timing Services.” She provided a link to the document for the group’s awareness.

Agenda Item 9. Date and Place of Next Meeting

The 106th meeting will take place via WebEx on April 30, 2020 (pending RTCA PMC approval of this new product) with the primary purpose of considering approval of DO-229F. The next full SC-159 meeting (the 107th meeting) will take place the week of October 19th – 23rd, 2020. The subsequent meeting (108th) was scheduled for the week of March 22nd – 26th, 2021.

George Ligler adjourned the meeting.

CERTIFIED as a true and accurate summary of the meeting.

-S-

Christopher Hegarty
Co-chairman

-S-

George Ligler
Co-chairman