



RTCA Paper No. 297-20/SC159-1091  
EUR 318-20/ WG62-114

Saint-Denis, 7 December 2020  
Washington, 7 December 2020

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

The one hundred and seventh meeting of SC-159 was held October 23, 2020, virtually, from 9:00 a.m. to 5:00 p.m., Eastern Daylight Time. The meeting was held jointly with the fifty-second 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
Wes Gooze (Secretary)	American Airlines
Barbara Clark (GAR)	Federal Aviation Administration (FAA)

NAME	COMPANY
Hamza Abduselam	Federal Aviation Administration (FAA)
Ken Alexander	Federal Aviation Administration (FAA)
John Ashley	The MITRE Corporation
Takahiro Aso	Electronic Navigation Research Institute
Laurent Azoulai	Airbus
John Barry	Federal Aviation Administration (FAA)
Kevin Bean	The MITRE Corporation
Nuria Blanco-Delgado	European Satellite Services Provider
Klaus Blatter	Northrop Grumman Corporation

Denis Bouvet  
Mats Brenner  
Jason Burns  
Felix Butsch  
Stefano Caizzone  
Tim Cashin  
Natalia Castrillo  
Song Cheng  
Laura Cheung  
Simona Circiu

Christina Clausnitzer  
Max DeAngelis  
Jed Dennis  
Mark Dickinson  
David Duchet  
Swen Ericson  
Philippe Estival  
Zhe Fan  
James (JP) Fernow  
John Foley  
Seth Frick  
MASASHI Giho  
Joseph Gillespie  
Anna Guegan  
Matt Harris  
Lannie Herlihy  
Ruth Hirt  
Toru Ishita  
Sai Kalyanaraman  
Vignesh Krishnan  
Andreas Lipp  
Fan Liu  
Frank Lorge  
Matthew Lug  
Mikael Mabillean  
Kara MacWilliams  
Tim Murphy  
Lee Nguyen  
Kai Nilsen-Knight  
Takeshi Ono  
Martin Orejas  
John Owen  
Tim Padden  
Jean Michael Perre  
Boris Pervan  
Kristy Pham

Thales Group  
Honeywell International  
Federal Aviation Administration (FAA)  
DFS Deutsche Flugsicherung GmbH  
German Aerospace Center DLR  
The MITRE Corporation  
European GNSS Agency  
CETC Northwest Group Co., Ltd.  
Raytheon  
Deutsches Zentrum fuer Luft-und Raumfahrt e.V  
(DLR)  
Federal Aviation Administration (FAA)  
Federal Aviation Administration (FAA)  
Federal Aviation Administration (FAA)  
Federal Aviation Administration (FAA)  
EUROCONTROL  
ZETA Associates  
Ecole Nationale de l'Aviation Civile  
COMAC BASTRI  
The MITRE Corporation  
Garmin Ltd.  
Honeywell International  
Civil Aviation Bureau of Japan  
Federal Aviation Administration (FAA)  
EUROCAE  
The Boeing Company  
Federal Aviation Administration (FAA)  
Federal Aviation Administration (FAA)  
Japan Radio Air Navigation Systems Association  
Collins Aerospace  
Honeywell International  
EUROCONTROL  
Federal Aviation Administration (FAA)  
Federal Aviation Administration (FAA)  
U.S. Air Force  
European GNSS Agency  
The MITRE Corporation  
The Boeing Company  
Federal Aviation Administration (FAA)  
Garmin Ltd.  
Japan Radio Air Navigation Systems Association  
European GNSS Agency  
Defence Science Technology laboratory  
U.S. Air Force  
Thales Group  
Illinois Institute of Technology  
Federal Aviation Administration (FAA)

Doug Phifer	Federal Aviation Administration (FAA)
Guillermo Fernandez Serrano	GMV
Karl Shallberg	ZETA Associates
Sergey Silin	ZAO “KB NAVIS”
John Studenny	CMC Electronics
Dale Swanson	The MITRE Corporation
Jian Sun	Unknown
Neil Tisdale	Cobham Aerospace Connectivity
Hans Trautenberg	EASA
Andrew Videmsek	General Atomics Aeronautics Systems, Inc.
Hiroshi Watanabe	Electronic Navigation Research Institute
Joel Wichgers	Collins Aerospace
Natalie Wong	Transport Canada

## AGENDA

1. Introductory Remarks: RTCA, GAR and Co-Chairs
2. Approval of Summaries of Previous Meetings
  - a. One Hundred Sixth Meeting for SC-159 held April 30, 2020 (RTCA Paper No. 088-20/SC159-1085)
  - b. Fifty-Third Meeting for WG-62/SC-159 WG-2 held July 6-10, 2020 (EUROCAE 217-20 / WG62-112 / RTCA Paper No. 266-20/SC159-1090)
3. Final Review and Comment (FRAC) activities
  - a. DO-384 (WG-2C) FRAC Resolution
  - b. DO-235C (WG-6) Release for FRAC Status
  - c. DO-292A (WG-6) Release for FRAC Status
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

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

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### **Agenda Item 1. Introductory Remarks: RTCA, GAR and Co-Chairs**

- SC-159 Co-Chairman Dr. George Ligler welcomed everyone to the Plenary meeting. This Plenary meeting was convened as the regularly scheduled fall biannual meeting. Dr. Ligler commented that a change in the order of the agenda was needed to allow WG-62's items to be discussed first, given the length of the agenda and the time difference between the US and European participants. Agenda items 1 & 2 would be covered first and then the meeting would skip to item 4. This was agreed to by the WG leaders. Dr. Ligler then introduced the SC-159 leadership team.
- Karan Hofmann, SC-159 Program Director at 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 Plenary 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. Karan also discussed meeting "tips" for virtual meetings using WebEx. Ms. Hofmann then proceeded to identify several call in numbers for the meeting attendance list.
- 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 106<sup>th</sup> meeting of SC-159, RTCA Paper No. 088-20/SC159-1085, dated 20 October 2020, was presented to the meeting. Meeting attendees were asked to review the summary and provide any comments to RTCA. **No comments were received and the summary was approved subject to listing any additional attendees.**
- b) The summary for the 51st meeting of WG-62, EUROCAE Paper No. 127-20/WG62-110, was presented. Mikael Mabilieu (WG-62 secretary) provided an update on WG-62 activities. Two additional meetings were added, one in August and one in September, and the summary has been updated to reflect this. He indicated that there may be some error in the attendance list so please advise him accordingly and provide any comments. **None were submitted and the summary was approved.**

**Agenda Item 4a. GPS/WAAS (WG-2 and EUROCAE WG-62) to include update on related ICAO/Navigation systems panel activities. [Note that this agenda item was addressed out of order to accommodate participant availability]**

- a) Laurent Azoulai acknowledged leadership and staff and indicated that the briefing would be somewhat short. he then discussed the progress made by the group during the week.
- b) Joint WG-62/WG-4 EUROCAE WG-62 meetings have been in run mode (3 times in Europe and twice in US) - 2-hour weekly teleconferences on a bi-weekly basis
- c) A summary of papers and discussion items was then presented via slides:

2.a EGNOS status (Mikael Mabilieu)

2.b Galileo Status (Natalia Castrillo)

2.c WAAS status

3.a NSP/6 Input SARPs to ED-259A Draft traceability status (Mikael Mabilieu)

3.b DS2 note on INS and aircraft requirements (Barbara Clark) Feedback to ICAO NSP to remove an ambiguous note on INS integration with SBAS

6.a ADS-B NACv=4 (Barbara Clark) Need to maintain NACv=4 for future applications => need to develop test procedure

ADS-B will limit NACv at installation based on demonstrated NACv

7.a Maintenance of draft ED-259A (Denis Bouvet):

- Coordination between EUROCAE and RTCA is needed on joint document rules
- GPS use criteria updates & Galileo use criteria updates
- REQ 130 update is needed
- Iono blind model updates
- WNRO count update
- Miscellaneous updates (Appendix A and use of SPID)

7.c Gain-roll off & frequency shift requirements (Ikhlas Selmi)

7.d Filter gain roll-off characteristics and center frequency shift (Todd Walter)

- Stanford University results are consistent with ENAC => Recommend: limit offset to 10% max
- General conclusion WG-2/WG-4/WG-62 view:
- Frequency shift should be limited to 10% to enable margin for smaller UDREi
- Center frequency offset effect was unknown requires margin
- Manufacturers: three in favor, two will investigate

- Consensus to baseline the requirement as suggested by ENAC

7.e OBAD equation (A-10) associated with MT 37 and MT-32 (Juan Blanch)

- Several options are being discussed at ICAO NSP DS2 using 4 codes with 2 bits
- WG will wait SARPs to be approved before changing the ED-259A

7.g Galileo BGD model (Ilaria Martini) – answer to AI-53/1

- WG view: Value is very conservative and valid with Psat at 10-5.
- It could evolve with a lower value but if hard coded, it will not change in the MOPS
- Definition of URA for Galileo is not yet available, thus it will be incorporated at a later stage

7.j DUFMAN Multipath error model (Matteo Sgammini)

7.k Boeing / Collins DFMC multipath results (Matt Harris)

- Two consortia have performed a flight test program using Air Transport aircraft from two manufacturers (Airbus & Boeing) coupled with modeling by simulations to develop multipath error models for L1/E1, L5/E5a and IFree
- Models combining multipath and antenna AGDV errors by RSSing have been proposed, separating multipath and antenna errors in two different terms
- The proposed models are valid for 100 seconds smoothing time constant
- The Iono-free model was endorsed at NSP meeting in June 2020 and will be included in the standards
- Discussions around improving antenna error term and specifying a better model for autoland has been challenged

7.n GNSS RFI detection requirement by the receiver and its potential operational use by ATC (Gerhard Berz)

- Several European initiatives and ICAO 40th assembly recommendations
- State letter asks for actions
- cooperate for design, development and realization of ground and on-board mitigation techniques of GNSS loss of service
- Need to know where you are affected when and where. Detect jammer if possible

- Initial request raised concerns over tactical decisions made by ATC, potentially penalizing resilient aircraft. End-use of the interference reporting resolved these concerns
  - The WG agreed to support and to develop detection means and report to ADS-B

7.p EUROCONTROL GNSS spoofing study: Recommendations for DFMC SBAS MOPS (François Tranchet, Timo Warns)

- WG views:
- ANSP is a relay other governmental agencies should play a role: DSN, FAA, ECTL agree.
- Time to recover defined by the test case? Not yet evaluated
- Take into account operational environment and scintillation
- Power detection might be a lot of dBs to be adjusted
- Calibration of repeaters needed

7.q WG-6 Interference mask (Dr. Sai Kalyanaraman)

See WG-6 Report: Actions on Manufacturers

8.a Work Plan & updated DFMC SBAS MOPS schedule (Laurent Azoulai)

- Frac did not happen
- Group needs D)235C and DO292A input
- Continued work on Antenna MOPS needed to finish work in WG-2/WG-62 EUROCAE
- COVID has complicated progression of work

8.a Work Plan & Remain to do for DFMC SBAS MOPS 2020 & 2022 versions (Laurent Azoulai)

"2020" DFMC SBAS MOPS content	"2022" MOPS content	Completion date	Champion
ICAO SARPs 2020 baseline (formerly only 2018 baseline was considered) + DO-235C & DO-292A	ICAO SARPs 2022 baseline fully synchronized		
		March 2021/October 2021	Sai Kalyanaraman
DO-235C/DO-292A		TBC	Sai Kalyanaraman
DO-373A GNSS antenna MOPS		End 2021	John Foley
Gamma class section (Consistency with DO-283)		Mid-2021	François Tranchet
Time to output deviations		H1-2021	Barbara Clark
Time to alert		April 2021	Mikael Mabilieu
SPID & APD requirements		April 2021	Mikael Mabilieu
Multipath error model		Oct-20	Mikael Mabilieu
Gain roll-off & frequency offset		End 2021	François Tranchet
Anti-Spoofing requirements step 1		End 2021	François Tranchet
Jamming Detection		Mid 2021	Editor's group
Integration of DO-229F requirements (Beta only)		Mid 2021	Editor's group
Integration of DO-229F requirements (Delta only)		Mid 2021	Editor's group
Update of Appendix A with ICAO SARPs protocol		Mid 2021	Editor's group
Validation of consistency check between ICAO & MOPS		Fall 2021	Mikael Mabilieu
ADS-B reporting of jamming		End 2021	Receiver OEM
NACv=3		Mid 2021 TBC	Matt Harris TBC
GPS L1 RAIM/FDE and/or GPS L5 RAIM FDE		End 2021	Denis Bouvet

MOPS now scheduled to be completed as a draft ready for FRAC/OC Dec. 2021 with risks high, red in table  
DFMC SBAS MOPS would be approved in Spring 2022 at SC-159 Plenary

- d) Laurent Azoulai then reviewed possible future milestones. The DFMC SBAS MOPS is now planned to be ready in draft form for FRAC in December 2021. Then the MOPS would be presented for approval in spring of 2022. In the discussion of the MOPS the WG agreed to use a frozen version of the SARPS (2018) which was met with some resistance from several of the WG members. During the WG deliberations Mikail Mabilleanu presented a bridge of SARPS from 2018 to 2020 so the WG could agree to move forward with a draft MOPS document with the previously mentioned new timelines.
- e) Dr. Ligler asked for any comment or questions on the WG-2/WG-62 report. There were none and the report was accepted.

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

#### **A. DO-384 (WG-2C) FRAC Resolution**

Mats Brenner, WG-2C leader, reviewed the status of meetings and those participants/organizations that worked to prepare the MOPS. He then reviewed the progress made by that group during the week. The MOPS was sent out for FRAC in August. The results were as follows:

- 4 non-concur (Thales 3, Collins 1)
- 41 labeled High
- 57 labeled Medium
- 174 labeled Low
- The rest were editorial
- All non-concur comments addressed and resolution approved
- All comments except 1 high, 4 medium and 3 low related to the assumed fault rate of 10-5/h/satellite were addressed and approved
- There remain some (2) verbally but not formally approved comments

The High comment was then presented to the plenary attendees for discussion and agreement on resolution. The comment is presented as follows:

The FAA, in conjunction with the United States Space Force (USSF) Space and Missile Systems Center (SMC) conducted a review of GPS service history with respect to GPS Step errors exceeding 300 m, Velocity (Ramp) error greater than 0.01 m/s, and Acceleration errors exceeding 0.007 m/s<sup>2</sup> (S/V/A errors) in the GPS L1 C/A code signals. Failure rate estimates of the rates of S/V/A errors with 95% confidence were calculated for the current configuration of the GPS Control Segment as well as the GPS IIR/IIR-M and IIF satellites.

The WG-2C leadership presented their proposal.

- The dynamics of the fault is of importance in an integrated system and we need to know what steps, ramps and acceleration to use in the tests
- Appendix G provides a table with ranges of steps, ramps and accelerations based on historic (observed) faults (IIA,IIR)
- The study did not provide any information about the ranges (e.g. 0.1 m/s – 5 m/s) of the steps, ramps and accelerations fault modes

- at we have is the best information that is available regarding ranges (including current IIR)
- The new data do not support a change of the ranges in Appendix G
- The same study also evaluates the fault rate based on S/V/A thresholds 300 m, 0.01 m/s , 0.007 m/s<sup>2</sup>
- The study added 95% confidence factors to the result
- The achieved rate was  $6.25 \times 10^{-6}$  per hour per satellite
- There is no conflict relative to the assumed rate of 10<sup>-5</sup>/h/satellite in our MOPS
- We offered to add a paragraph about the study and its result ( $6.25 \times 10^{-6}$  ) in Appendix G

Dr. Ligler then asked the plenary members if there was consensus on this proposed disposition of the comment. Barbara Clark commented that the proposal was sound and felt that the commenter, Hamza Abdusalam (FAA), could work with Mats Brenner on final resolution. Hamza Abdusalam agreed that the adding of correct language in Appendix G was an agreeable resolution. Dr. Ligler then indicated that this is an agreed disposition and the resolution is completed.

The medium comment was presented to the plenary attendees for discussion and comment:

- There is current new ideas being discussed in GNSS related forums regarding how to use the standard fault rate of 10<sup>-5</sup>/h/satellite
- So far the industry focus for RAIM has been the ramp fault since it eventually always will push the position error above the alert limit or in our case the HPL
- There is one special case when the step induced error is at HPL (or very close) when the missed detection(10<sup>-3</sup>) probability directly applies
- This means the error may remain present for a longer time (at HPL)
- This particular situation has been analyzed by IIT and Mitre and there is a push to change the rules for the calculation of probability of a prior fault as assumed in DO-316, DO-229 and in our MOPS
- In our discussions there was no agreement on how to factor this in
- IIT did not agree with Mitre (increase by factor 2 or 360)
- It is our understanding Industry discussions are ongoing regarding this new calculation of prior fault rate for ARAIM applications
- Industry participants (Airbus, Thales and Honeywell on the call at the time) consider this special case too unlikely to impact the prior probability (see illustration next slide)
- We propose we stay aligned with DO-316 and DO-229 i.e. no change in this version of our (L1 based) MOPS

With the completion of the presentation Dr. Ligler proposed that the work in WG-2C stay aligned with DO-316 & DO-229 with the current information available. As information is updated then changes could be made.

Mikael Mabillean then asked if the plan was to create a TSO based on MOPS if approved. There was some discussion on this point and John Fernow joined in supporting Mikael Mabillean in that DO-384 should include the concept of presented current faults and follow on

faults.

Barbara Clark suggested that this was a good conversation but should be broader given that the US/EUROCAE are developing operational information that would be useful to all the WGs, not just 2C. She recommended that there should be a joint activity beyond what is being discussed here.

Dr. Ligler accepted Barbara's suggestion to set up a task group within SC-159 to further study this topic. He then asked if the current comment can be resolved with changes mentioned by John Fernow. The plenary members agreed to the disposition of the comment.

Dr. Ligler then asked for approval to create the mentioned task force to work with the issue as presented by Mats Brenner of WG-2C. There was consensus on approval of the committee and several volunteered to join this group (FAA, Mats Brenner, Boris Pervan, Laurent Azoulai and John Fernow). Mats Brenner was designated as the team lead.

Mats Brenner then presented the two low comments for discussion and possible resolution.

- These two were left out of our discussions (Oct 21) due to its lower priority
- For Navigation systems down to RNP 0.1 nmi (HAL 360 m) the SDM fault rate is assumed to be included in the standard fault rate assumption (10-5/h/sat)
- 1 observed event in GPS history
- For LPV, CAT I-III (VAL 10 m) the assumptions are different (10-4/h/sat in SBAS,GBAS)
- We will update the Sat-Zap paragraph as proposed

There was further discussion on SBAS integration by several members of the plenary as introduced in the remaining slides of the WG-2C presentation. This led to WG-2Cs realization that there could be a need for an Aircraft Equipment Information Vulnerabilities subsection in section 1 of the MOPS. Mats Brenner explained that they were not aware of need for this type of information and wondered if it was needed. It was also discussed if language could be taken from another RTCA document (eg. DO-235) if needed. Ms. Hofmann explained that if this were done then there would be specific format to follow in order to gain PMC approval.

Dr. Ligler then asked the plenary if the document could be approved as it is today given the outstanding issues can be completed prior to the document's final submission to the PMC. **The members of the Plenary voted to accept the FRAC without dissent.**

Ms. Hofmann outlined the timeline to meet the PMC's scheduled meeting on December 17, 2020. Dr. Chris Hegarty remarked that if this can be done then let's proceed but if not then we can push this to the next PMC meeting.

## **B. DO-235C & DO-292A (WG-6) Release for FRAC Status**

Dr. Kalyanaraman reviewed the progress made by that group during the week. He remarked that DO-235 and DO-292 were not ready for FRAC as the group is still working on the

interference mask for DFMC. The group does have an updated L1/L5 mask but they needed a base line for inclusion into the ICAO SARPS. Currently the group is working the out of band issues and believe that their work can be complete by March of 2021 with submission to FRAC in October 2021.

Dr. Ligler asked for comments on this plan. **There were none and the Plenary members approved the plan.** The discussion then moved to the Terms of Reference (TOR) changes needed by this requested change.

Dr. Hegarty began discussion by inquiring if the date changes offered will support the completion of the deliverables. Dr. Kalyanaraman indicated that his dates were correct for DO-235C and DO-292C.

Laurent Azoulai then added that for WG-2/WG-62, the GNSS/SBAS L1/L5 MOPS would change their FRAC to March 2022 (possible update for DFMC changed to October 2023). He further indicated that there is a need to integrate SBAS authentication, but he was not sure an update would be ready by October of 2023. This would depend on when ICAO finishes their work on SBAS authentication.

Dr. Hegarty asked Joel Wichgers, co-chair of WG-4, if these proposed dates would necessitate any changes to WG-4 timelines. Joel Wichgers indicated that, while their dates could beat risk, it was too early to ask for a change until they reviewed the complexity of current work. Dr. Hegarty then indicated that the requested changes to the TOR (dates and editorial edits) would be forwarded to the PMC. He asked for additional comment from the group in regard to the TOR.

- Ms. Hofmann asked if the GNSS-Aided inertial work should be removed from the TOR given the approval of the MOPS for WG-2C
- Dr. Kalyanaraman indicated there may be a change that would revise DO-373
- John Barry asked if DO-384 needed to be updated for DFMC before it would be removed from the TOR.

Dr. Hegarty responded these proposed edits could go forward except that of updating DO-384. He felt that the PMC was not ready to make that decision. Barbara Clark and Dr. Ligler both concurred with this comment. Dr. Ligler asked for approval of proposed changes to the TOR with the noted exception. **The Plenary membership approved the recommendation without dissent.**

#### **Agenda Item 4b. GPS/GLONASS (WG-2A)**

Sergey Silin briefed out the WG-2A work being done in reference to the TOR. Dr. Ligler reminded the group of the discussion that was held at the March 2020 Plenary in regards to a request by NNC Consulting LLC. The request was to support new MOPS for GLONASS / GPS multi-frequency satellite navigation equipment. Receiver manufacturers were to be asked for interest in pursuing this and that information passed back to the chairs of SC-159 and Ms. Hofmann.

Lauraent Azoulai indicated that no interest had been shared among OEMs. The feeling was that WG-2 should deliver on the current MOPS before tackling a third input. Sergey Silin asked the

group if they were ready to include discussion on L1C / L3C for inclusion into the TOR. Dr. Ligler then reminded the group that in March 2020 Plenary we decided to continue work within the current TOR but again asked if the group wanted to add this item to the TOR. Matt Harris offered that the work should be done within the framework of WG-2 but efforts should continue on just GPS/Galileo. Possibly a parallel track of work could be undertaken with inclusion of a new 3<sup>rd</sup> GNSS (GLONASS).

Dr. Kalyanaraman agreed as 3<sup>rd</sup> frequency provided a bigger hurdle for the antenna. He did not feel that the WG had the bandwidth to expand the scope and tackle this near term. Dr. Ligler suggested that WG-2A develop a white paper to determine what work would be necessary to add this to the current DFMC MOPS. Matt Harris added that this paper would need to explore compatibility with all Sat systems before Boeing would be interested. Dr. Ligler then closed out discussion with a need to follow up with Sergey Silin to determine what is needed to start this internal work.

#### **Agenda Item 4c. GPS/Inertial (WG-2C)**

This briefing was covered within the discussion of Agenda item 3a.

#### **Agenda Item 4d. GPS/Precision Landing Guidance (WG-4), to include update on related ICAO/Navigation Systems Panel Activities**

Matt Harris reviewed the progress made by the group this week. First Matt shared some changes for DO-253D and possible changes for the TOR.

- DO-253D Change 1 GPS/LAAS Airborne MOPS
  - Three very minor issues identified in non-normative explanatory appendices – (WG-4 will address at the appropriate time, e.g., errata or defer until next update)
    - 1) Appendix K: Identified a small correction/clarification for the Rationale for VDB Requirements Appendix (reported in the last WG-4 plenary meeting status)
    - 2) Appendix I: Identified a minor update to GBAS classifications Appendix
    - 3) Appendix J: Identified minor clarification if ICAO SARPs change is approved to allow EIG > 2.75 m (new)
- Future Documents (from Terms of Reference)
  - Initial GNSS/GBAS L1/L5 MOPS & ICD for V&V to include GPS and if possible
  - Galileo [2023 (optimistic) -- Dependencies: Lag initial DFMC SBAS/ABAS GPS + Galileo MOPS, and in parallel with ICAO NSP DFMC GBAS baseline SARPs development]
  - ICD: Incorporate in an update to DO-246
  - MOPS: Plan is a new document, separate from DO-253 and DFMC SBAS/ABAS MOPS
  - MASPS: Do not plan to develop MASPS
  - Validated GNSS/GBAS L1/L5 MOPS & ICD to include GPS and if

possible, Galileo [2025 (optimistic) – Dependencies: Lag validated DFMC SBAS/ABAS GPS + Galileo MOPS, and in parallel with validated ICAO NSP validation and approval of DFMC GBAS SARPs]

Matt Harris then discussed the rest of the weeks work in regards t the following items from their agenda:

- Considerations for future GBAS evolutions
  - Recall of GBAS services definition
  - Positioning, Regional, Approach (8 types)
  - NSP JWG/4-WP/35 proposals (2019)
  - VDB physical layer, Surface Ops, Psat/Pconst, Positioning Service, Carrier Phase, Cyber, Robustness, etc.
  - Details regarding the WP35 services
  - Cybersecurity –not an urgent concern for augmentations
  - Robustness, Psat/Pconst covered in SESAR PJ14
  - Positioning service for credit requires operational changes
  - Work lists for NEW carrier phase, physical layer, surface ops.
  - Ideas for “GAST G” use cases and requirements
  - Start of a Carrier Phase Positioning work list
  - Start of an alternate data link definition work list
  - A lot of discussion – requires continued stakeholder collaboration
- Comments on SESAR DFMC Framework
  - SESAR DFMC Framework distributed March 2020 SC-159 WG-4
  - Tim Comments Discussed 10/22:
  - Great work which can be a basis for a DFMC GBAS concept paper with some reorganization – currently a trade space
  - Section 2.3 – List of threats
  - Progress was made and reviewed in another paper
  - Support for multiple or single DF core constellations
  - Political issue, should support DF single
  - Vertical Alert Limit, IFree sigma computation
  - GAST D as optional but recommended mode
  - We need a lot of discussion around this
  - Has big ramifications operationally
- Alternative Architecture for DFMC GBAS
  - Proposed Alternative Architecture:
  - Uplink raw Pseudorange and Carrier phase measurements for 2 frequencies
  - New MT XX – based on RTCM 10403.2 standard – MT 1003
  - Discussed Pros/Cons:
    - Pros: Eliminate evil waveform, multipath issues, and more
    - Cons: Sorting out integrity and time to validate due to complexity
  - Reviewed RTCM 10403.2 and compared with SESAR Framework
  - Many Open Questions
  - Can this be done using current physical layer to reduce development

- o time?
  - o Ultimate goal is transition to RTK with integrity
  - o For aviation and potentially add service for additional users
- Review of DFMC GBAS Development Timelines

2021-2024	Collect requirements from additional operational contexts, evaluate possible concepts against them, revisiting fundamental GAST D design choices such as smoothed pseudoranges and choice of data link
2024	A high level concept (similar to the level of detail currently proposed by SESAR, with all options selected) agreed in ICAO and RTCA
2026	A detailed concept paper agreed in ICAO and RTCA, similar level of detail as the 2009 GAST D concept paper
2028	A baseline development SARPs for GAST F
2034	A validated GAST F concept ready for proposal to NSP

Barbara Clark asked if there was any clarity from Europeans as to GAST D was a backup mode or something else. Matt Harris indicated that it could be an option but unsure. Andreas Lipp indicated that GAST D would be degraded for GAST F while GAST C and GAST F are primary modes. Dr. Ligler asked for any questions and there were none.

**Agenda Item 4e. GPS/Interference (WG-6), to include update on related ICAO/Navigation Systems Panel Activities**

Dr. Kalyanaraman reviewed the progress made by the group this week. He started with a quick review of the agenda.

- Updated L5 Interference analysis
- Interference mask definition (L1/L5) for SARPS
- DO-235C updates
- DO-292 updates

Dr. Kalyanaraman then reviewed the path forward for WG-6.

- Resolve the details of the final interference mask for L1/L5.
- Need participation and support from manufacturers and other stakeholders
- Complete updating the link margins for the various SF and DF scenarios under consideration
- Reorg sections of the DO-235C and 292A documents in support of the DFMC updates
- Mar 2021 for DO-235C completion
- Oct 2021 for DO-292A completion

**Agenda Item 4f. GPS/antennas (WG-7)**

Dr. Kalyanaraman reviewed the status of the work group for this plenary. He stated that DO-373

(DFMC Antenna MOPS) is in the maintenance mode currently. There has been discussion on what would be needed to improve performance to support CATII/III operations. Stefano Caizzone remarked that was not specific data to support reopening this MOPS. There might be a request to reopen considering the recommendations from Sergey Silin though.

Matt Harris then asked if DO-373 covered single frequency antennas to which Dr. Kalyanaraman responded that it was covered under DO-301. If there was a desire to add this to the scope of work then WG-7 would need to discuss this. He then asked if DO-373 updated to include single frequency antenna, do we have the time before March 2021 to get DO-301 amended. Dr. Ligler asked if there was a formal recommendation to change the TOR for DO-373 to include single frequency antenna. Matt Harris added this could wait and it could be handled on a case by case basis for now. Dr. Ligler restated the WG-7 request to add another row to the table for the TOR for DO-373A update.

There was another request to add this to the TOR for DO-301A but it was decided that this could wait till later given that Boeing and Airbus did not need to pursue this in the near term.

Dr. Ligler then asked the plenary members if they approved of this additional change to the TOR for DO-373A. **The Plenary membership approved the recommendation without dissent.**

**Agenda Item 5. Discussion of Terms of Reference Updates.**

The TOR updates were addressed during each WG out brief. A summary of the proposed changes to the TOR are listed below.

Product	Description	FRAC Completion Due Date*	Change
DO-235C	Updated L1 interference environment report	March 2021	October 2020
DO-292A	Updated L5 interference environment report	October 2021	March 2021
DO-373A	Update to GNSS dual-frequency (1575/1176 MHz) antenna MOPS for airborne equipment	October 2021	
GNSS(SBAS) L1/L5 MOPS **, ***	GPS/Galileo/SBAS MOPS developed jointly with EUROCAE WG-62 that are intended to be usable for ETSO/ TSO production and certification of the receivers for aviation use Update to GPS/Galileo/SBAS MOPS for dual-frequency equipment ***, ****	March 2022  October 2023	December 2020  December 2022
GNSS(GBAS) L1/L5	Initial MOPS and ICD for	2023	

MOPS and ICD**	Verification and Validation Validated GPS/Galileo/GBAS MOPS and ICD for dual-frequency equipment.	2025	
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**Agenda Item 6. Action Item Review**

Dr. Ligler reminded the plenary that a group of 4 individuals would be formed to begin work on the white paper discussed in WG-2A out brief. This would encompass what work is necessary to add GLONASS to the current DFMC MOPS.

**Agenda Item 7. Assignment/Review of Future Work**

As these items had been addressed in the WG out briefs, there was no further discussion.

**Agenda Item 8. Other Business**

No items identified.

**Agenda Item 9. Date and Place of Next Meeting**

- The next full SC-159 gathering (to include the 108<sup>th</sup> Plenary) will take place the week of March 22nd – 26th, 2021.
- The subsequent gathering (to include the 109<sup>th</sup> Plenary) is scheduled for the week of October 18th – 22nd, 2021.

Dr. Ligler thanked all participants and adjourned the meeting.

CERTIFIED as a true and accurate summary of the meeting.

-S-  
Dr. Christopher Hegarty  
Co-chairman

-S-  
Dr. George Ligler  
Co-chairman