

Summary of the One Hundred and Second Meeting

Special Committee 159

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

The one hundred and second meeting of SC-159 was held October 5th, 2018 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)	Project Management Enterprises Inc.
Karan Hofmann (Program Director)	RTCA
Barbara Clark (DFO)	Federal Aviation Administration (FAA)
John Savoy (Secretary)	Honeywell International, Inc.
NAME	COMPANY
Ken Alexander	Federal Aviation Administration (FAA)
Laurent Azoulai	Airbus
Denis Bouvet	Thales Group
Mats Brenner	Honeywell International, Inc.
Chip Bulger	Federal Aviation Administration (FAA)
Tim Cashin	The MITRE Corporation
Jed Dennis	NAVTAC (Exempt)
Yi Ding	Esterline CMC Electronics
Pierre Durel	European GNSS Agency
John Foley	Garmin Ltd.
Andrey Galyamov	NNC Consulting LLC
Matt Harris	The Boeing Company
Sai Kalyanaraman	Rockwell Collins, Inc.
Vladimir Latev	Universal Avionics Systems Corp.
Matsuda, Kuniyuki	Japan Radio Air Navigation Systems Association
Takeshi Ono	Japan Radio Air Navigation Systems Association
Jaron Samson	European Space Agency
Khambrel Simpson	The MITRE Corporation
Oleg Skubii	Research Design Lab NAVIS
Dale Swanson	The MITRE Corporation
Hans Trautenberg	European Aviation Safety Agency (EASA)
Monica Vafiades	U.S. Air Force
Hidetsugu WADA	Civil Aviation Bureau of Japan
Joel Wichgers	Rockwell Collins, Inc.

The agenda for the meeting follows:

1. Introductory Remarks: RTCA, GAR and Co-Chairs
 - a. Moment of silence in respect for the passing of former member Professor Per Enge
2. Approval of Summaries of Previous Meeting: One Hundredth Meeting held March 16, 2018 (RTCA Paper No. 075-18/SC159-1071) and One Hundred First Meeting held May 3, 2018 (RTCA Paper No. 230-18/SC159-1073)
3. Final Review and Comment (FRAC) activities
 - a. DO-235() Update
4. Review Working Group (WG) Progress and Identify Issues for Resolution.
 - a. GPS/WAAS (WG-2)
 - b. GPS/GLONASS (WG-2A)
 - c. GPS/Inertial (WG-2C)
 - d. GPS/Precision Landing Guidance (WG- 4)
 - e. GPS/Interference (WG-6)
 - f. GPS/Antennas (WG-7)
5. Review of EUROCAE Activities and Discussion of Joint Activity with EUROCAE on a Dual-Frequency, Multi-Constellation GNSS Receiver MOPS
6. Update on ICAO/Navigation Systems Panel Dual Frequency/Multi Constellation Concept of Operations (CONOPS)
7. Discussion of Terms of Reference Updates
8. Action Item Review
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, Barbara Clark, Federal Aviation Administration (FAA), was the Designated Federal Official for this meeting.

Note that, with the agreement of the chairmen and other participants, the agenda was reordered to accommodate the availability of certain participants. The order in the minutes below reflects the actual sequence of topics.

Agenda Item 1. Chairman’s Introductory Remarks.

- At the suggestion of Co-Chairman Chris Hegarty, attendees introduced themselves.
- Karan Hofmann, Program Director of RTCA, 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.
- All attendees were present in person.

Agenda Item 1a. Moment of silence.

The committee took a moment to remember Per Enge, an important leader in the GPS community since its inception. Todd Walter announced the creation of a graduate student scholarship fund at Stanford University and suggested that interested parties could contribute by visiting the website <https://gps.stanford.edu/resources/giving>.

Agenda Item 2. Approval of Summaries of Previous Meetings.

- a. The summary for the 100th meeting, RTCA Paper No. 012-18/SC159- 1068, and the summary for the 101st meeting, RTCA Paper No. TBD were approved without further comment.

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

- a. DO-235() Update

Sai Kalyanaraman announced that the working group had intended to complete the FRAC process for DO-235 for this plenary session and then commence work on DO-292. For various reasons, the working group had not been able to complete the process and instead proposed to complete the FRAC for the March 2019 plenary session and move on to DO-292 following that effort. Chris Hegarty accepted that proposal and urged the committee members present to volunteer their time to support Mr. Kalyanaraman’s efforts to ensure that the FRAC process could complete in March.

Agenda Item 4a. Review GPS/WAAS Working Group (WG 2) Progress and Identify Issues for Resolution.

Laurent Azoulai, co-chairman for working group 2, discussed the progress made during the week.

- Working groups 2 and 4 met throughout the week to make common progress on the new dual frequency, multi-constellation MOPS. There were three themes for the joint meetings.

- SBAS and core constellation program status and maintenance of DO-229
- DF/MC SBAS MOPS work plan
- Discussion of EUROCAE WG-62 DF/MC SBAS MOPS requirements
- Jason Burns informed the joint working group on the current status of the WAAS program.
 - WAAS coverage for LPV and LPV-200 service remains excellent.
 - Mr. Burns indicated that the WAAS program is planning for dual-frequency WAAS operations. There is a push to put the framework for implementation of Horizontal, Advanced Receiver Autonomous Integrity Monitoring, H-ARAIM.
 - The WAAS ground network will be upgraded with a new, modernized interlink.
 - There is some discussion regarding the implementation of new operations utilizing WAAS with more stringent requirements than the current LPV-200 operations.
 - The Phase IV Segment A activities will complete in September of 2019 with 5 releases.
 - The WAAS team will continue to operate a three-satellite GEO constellation with two satellites under development.
 - There are currently over 4,639 LP/LPV procedures published with over 117,000 WAAS equipped aircraft operating within the NAS.
- Pierre Durel briefed the working groups on the status of the EGNOS program.
 - Mr. Durel showed that there were currently four EGNOS satellites in operation with two serving as active backups. The Ground segment had been operating using system release 2.4.1 since August of 2018.
 - Mr. Durel informed on the extents of EGNOS coverage but indicated that with the release of the new Safety-of-Life System Description Document v3.2, coverage would improve significantly.
 - As of August 31st, 2018, there were 434 runways served with EGNOS LPV procedures.
 - Mr. Durel described to the working group the EGNOS services roadmap, which showed the evolution of EGNOS to support dual-frequency, multi-constellation functionality. Mr. Azoulai showed the assembled committee members a graphic depicting the EGNOS V3 DFMC transition plan. This plan indicated that DFMC operation could commence as early as 2024.
- Hidetsugu Wada described for the working groups the current status of the MSAS program.
 - Mr. Wada showed the joint group an implementation plan which would provide for LPV operations in Japan in approximately 2023 as well as a dual-frequency, multi-constellation implementation phase, which began in 2017.
 - Mr. Azoulai showed the committee members a graphic with the 10-year plan for MSAS enhancement. Interested parties were referred to the presentation that would be posted on the working group workspace.
 - Mr. Wada informed the joint working group that the MSAS user base has been steadily increasing and noted that operators were very interested in having MSAS support LPV operations.
 - A chart was shown describing the various signals which are or will be supported by QZSS satellite.
 - Mr. Azoulai also showed the committee a graphic indicating that utilization of the QZSS L1 C/A signal allows for a significant reduction in the errors observed when utilizing only GPS signals.

- Inaki Alcantarilla Medina described the current status of the Galileo program to the joint working group.
 - Performance of the Galileo signals has been excellent and continues to improve. Parameters such as Signal-in-space error, per satellite availability, UTC dissemination error, et al. all continue to show that Galileo performance is on track to achieve the Initial Services targets.
 - Mr. Medina informed the joint working group of a new web site, [HTTP://IPS.GSC-EUROPA.EU](http://ips.gsc-europa.eu) which provides a prototype prediction service for space weather.
- Mikaël Mabilieu described the current status of the H-ARAIM Concept of Operations effort; a follow-on to the DFMC CONOPS discussions held previously.
 - The proposed standard was presented to RTCA with few changes from previous baselines.
 - The most significant changes were in the dissemination of the Integrity Service Message parameters, which should be transmitted by the satellites impacted by the ISM data. This of course necessitates a delay while changes to the signals-in-space are effected and therefor an interim means of providing ISM parameters should be considered. This interim means will, itself, be quite complicated.
 - The working groups were not entirely satisfied with the prescriptive nature of the proposed H-ARAIM algorithm, fearing that there would be no room for innovation.
- Barbara Clark and Gary Berz lead the committee in a discussion regarding the localization of GNSS interference sources using ADS-B.
 - The May 3rd 2018 SC-159 Plenary had tasked committee members with examining the feasibility using ADS-B inputs to help determine the location of potential aviation impacting interference sources.
 - The joint working group made the following recommendations:
 - Do not constrain WG-2/4 efforts to meet the near-term ADS-B MOPS update schedule
 - Allow the ADS-B community at RTCA to decide if/how to forward fit, reserve bits, etc. for this proposal in parallel to SC-159's efforts.
 - Ad hoc to continue and participate with EUROCONTROL to mature the concept, identify aircraft/aircrew requirements, ATM requirements, and engage operational and spectrum protection community within ICAO, prior to developing receiver MOPS requirements.
 - Pending further discussion of operations /concept of use with WG-2/4, support the development of requirements for new outputs for future DFMC equipment. This effort would be accomplished within the framework of the current DFMC MOPS development.
- Barbara Clark and Pierre Durel described for the joint working group the status of the ICAO DS2 regarding the L5 SBAS SARPs.
 - The ICAO SBAS L5 SARPs currently under development is a key input to the dual-frequency, multi-constellation MOPS with completion targeted for the end of 2018.
 - Barbara Clark had been nominated as the liaison between the FAA and ICAO.
 - A review of the SARPs A and B documents was conducted and comments provided to the ICAO DS2 group.

- Several topics were considered by the DS2 but not in scope for the baseline to be made at the end of 2018, including the L5 interference mask, DFMC SBAS authentication principals, and a DFMC service area message.
 - The DS2 is expected to consolidate validation evidence and develop Guidance material.
 - Equipment manufacturers are strongly encouraged to review this material and provide feedback to Ms. Clark.
- Denis Bouvet described EUROCAE WG-62 efforts to draft a DFMC SBAS MOPS.
 - EUROCAE WG-62 is working together with RTCA members to draft an initial version of the DFMC SBAS MOPS.
 - Requirements are largely completed but equipment manufacturers' participation is required to mature the initial baseline.
 - No test procedures have, as of yet, been developed
 - Several requirements need further development, including Satellite acquisition time, minimum number of channels, tracking constraints, impact of loss of SBAS signals, time to alert, et cetera.
 - This draft MOPS should become the baseline for a joint EUROCAE/RTCA activity.
- Jaron Samson led the joint working group in a discussion regarding a proposed requirement change that would increase the smoothing time for signals to be used in a DFMC SBAS solution to 600 seconds.
- Jed Dennis described to the joint working group a proposal to increase the number of bits used to identify an SBAS provider to five. This would provide for a total of up to 32 SBAS service provider identifiers. There are some technical challenges with the proposal,
- Barbara Clark and Todd Walter lead the working groups in a discussion regarding the development a nomenclature developed by an EU / US bilateral working group. The purpose of this nomenclature is to provide a means describe and standardize threats to GNSS signals and the means by which standards compliant equipment would mitigate those threats.
 - The SC-159 terms of reference are quite clear that future GNSS MOPS should address various spoofing threats.
 - There is common belief that the response to these threats may require the participation of more than just the GNSS receiver.
 - A joint meeting of working groups 2, 4 and 2C was proposed to determine a path towards addressing these threats.
- Hamza Abdusalam proposed to the working group that requirements for and L5-only mode be developed. This mode, not currently addressed in the EUROCAE DFMC MOPS, would support operation in an L1-denied environment. The working group expressed some concern about both the need and feasibility of such a mode. However, further study of this concept is to be included in the RTCA work plan.
- John Barry present a proposal to expand the use of the operation type field in the FAS Data Block to describe operations that are limited to dual frequency operation. This proposal

conflicts with the current GBAS FAS data block definitions. The working group was further concerned with the possibility for unintentional discrimination of L1-only equipment.

- Barbara Clark and Laurent Azoulai led the joint working group in a discussion regarding the work plan for the DFMC SBAS and GBAS MOPS. The plan would be to reconcile the current EUROCAE draft MOPS, current RTCA guidelines, DO-229E and a proposed outline presented by John Studenny.
 - Open Consultation for the EUROCAE WG-62 DFMC MOPS is planned to begin before the end of 2018.
 - RTCA SC-159 comments will be provided to EUROCAE WG-62
 - There is some concern about the ability to deliver the DFMC MOPS on time in a joint activity.
- Capucine Amielh presented a thesis describing a new surface multipath model. This effort was sponsored by E-knot, ENAC and Airbus.
 - The work described a deterministic, statistical multipath error model which incorporates biases due to phase center and group delay center variations.
 - Members of the plenary session took issue with portions of the methodology, specifically treating the aircraft body as a reflector. It was suggested that modeling the aircraft as a diffractor would provide more correct results
 - Barbara Clark noted that SC-186 would like for SC-159 to more thoroughly address ground-based operations. Members of the plenary session decided that SC-186 would need to initiate the ISRA process.

Agenda Item 4b. Review GPS/GLONASS Working Group (WG 2A) Progress and Identify Issues for Resolution.

Working Group 2A is inactive and no discussion took place.

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 was continuing to develop performance standards for GNSS-aided inertial systems. This included systems utilizing less accurate Attitude Heading Reference Systems (AHRS) or Micro-Electro-Mechanical systems (MEMS) sensors. Drafts of much of this work was completed prior to this plenary.
- The group has been meeting for some time and the current draft contains sections 1, 2, 3 and 4 including introductory text, requirements and testing guidance, installed equipment performance, and operational performance as well as drafts of appendices A through P.
- Since the previous plenary session, the working group held a series of teleconferences to address the following topics:
 - The applicability of the MOPS to RNP and RNP AR.
 - Environmental testing

- The introduction of ADS-B requirements
 - Proper modeling of multipath down to 2 degrees relative to the horizon
 - Observations of ionospheric “bubbles” made in Brazil
 - Behavioral online testing
 - An example of a stochastic ionospheric delay model to be used for detection and exclusion testing. This was developed from the IRI model
 - An alternative methodology for studying availability based on evaluation over a regular grid of locations as opposed to a random long-haul trajectory
 - Testing for rare normal conditions while coasting
 - The lack of need of an RFI S/N0 monitor and its subsequent removal from the draft MOPS
 - The inclusion of text from Rockwell Collins regarding a dual GPS antenna based heading
 - Updates of appendix J regarding magnetic sensing
 - Removal of references to solution separation from the body of the MOPS
- Karan Hofmann provided the group with guidance from the RTCA PMC regarding intellectual property.
 - The Japanese Aerospace Exploration Agency (JAXA) discussed findings regarding the impact of a severe ionospheric gradient of 850 mm/km observed in Brazil. JAXA noted that this gradient only resulted in rate of change of 0.03 m/s rather than the expected 1 m/s predicted by previous modeling. JAXA’s observations support the updated testing methodology discussed later in the week. JAXA further noted that the solar peak in 2014 was comparatively weak.
 - The working group considered temperature compensation of pressure altitude to be discussed in Appendix K. This included the integrity of single vs. dual inputs of temperature data as well as the possibility of redundant compensation by the an FMS
 - Northrup Grumman discussed various testing issues to be addressed in Appendix M. The current descriptions for false detection and rare-normal faults are fairly mature. Exposure to ionospheric bubbles was added. Issues remain for detection and exclusion testing when coasting and further effort will be required.
 - The group updated the MOPS based on feedback from Garmin regarding the use of SBAS measurements. When the GNSS is in SBAS mode, autonomous integrity monitoring may not be available.
 - The MOPS was modified to refer to DO-334 requirements and tests rather than older TSO such as TSO-C3, C4, C5 and C6 which are no longer in use.
 - Testing involving ionospheric bubbles was modified to take into account the fact that even severe gradients would have only small impacts on the rate of the change in pseudorange error. Current testing is very conservative, requiring a ramp taken from a uniform distribution [0, 1] m/s. This is very large compared with the rate of only 0.03 m/s seen in the data recorded in Brazil. The new test will take select a gradient from a normal distribution with a standard deviation of 150 mm/km and apply it to a randomly selected satellite, accounting for the motion of the ionospheric pierce point with respect to the aircraft motion.
 - The working group discussed a pressure altitude bias test to be added to Appendix K. Modeling of the bias in this altitude is critical when coasting.

- The FAA and SC-159 secretary reminded the working group that the SC-159 terms of reference requires new MOPS to address intentional interference and spoofing. Most of working group 2C believes that this is better addressed by the GNSS receiver rather than the inertial navigator. Two working group participants believe that there is likely an opportunity to address the spoofing threat. The working group feedback to the FAA was that detailed threat models would need to be developed. The goal of this effort is to ensure that errors are properly bounded in support of ADS-B.
- Michael Braasch presented on gravity modeling. Errors in the EGM2008 model were compared to other higher resolution models. Discrepancies of up to 20 arcseconds were identified. Real world measurements also showed discrepancies in the EGM2008 model of up to 1 arcsecond. The spherical harmonic models provided in the EGM2008 are too computationally complex to evaluate in real time. It is significantly less expensive to simply store a grid of data. Ohio University is investigating the possibility of using a spherical harmonic model of significantly lower order to achieve adequate performance.
- The working group included new methods for testing false detection and rare normal bounding in the MOPS.
- The working group discussed the opportunity to incorporate dual frequency and multi-constellation observations in the first version of the MOPS. The group stands by its decision to forgo inclusion of DFMC features for the first revision of the MOPS.
- The group discussed use of ARAIM-type algorithms. While the group believes there may be no technical issues, the FAA and EASA representatives indicated that there may be policy issues that remain to be examined.
- The working group currently believes that the MOPS will not be completed in mid-2019 as originally planned. Mr. Brenner indicated July 2020 would be a more realistic projection.
- Appendix F of the MOPS includes several examples of integration methods which are proprietary to contributors. This is allowed but requires permission from the RTCA PMC. The working group has determined that this proprietary material should be included and is the process of seeking permission.

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

Joel Wichgers, co-chairman for working group 4, discussed the activities of that group.

- Working group 4 is working towards the release of an updated revision of DO-253 and a change to DO-246, both due in March of 2019.
- The working group further plans to create an initial version of a L1/L5 MOPS and ICD to be used for validation during the 2020-2021 time frame, intentionally lagging the DFMC SBAS MOPS by one year.
- The working group spent the majority of its effort this week on the resolution of VDB/VOR adjacent channel interference issues.
 - The previous plan to use an elevated message failure rate when dealing with proximate strong signals proved to be incompatible with existing fielded equipment.
 - An alternative method is currently under development in which message can be lost for a brief period of time, but the receiver must recover within a very short time. This levies additional requirements on a GBAS ground station to ensure that data

is transmitted sufficiently frequently to ensure adequate continuity even given these dropped messages.

- These requirements can allow an ILS localizer to remain on during
- The working considered several examples of VDB/VHF compatibility scenarios including both GLS approach and guide takeoff with both ILS and VOR as the undesired signal.
- The working group also considered the impacts of short outages on continuity”
 - DO-245A allocates a probability of message of loss to 1×10^{-7} / 15 seconds to the VDB function.
 - For outages of less than 2.5 seconds, as long as there are at least three opportunities for the airborne equipment to receive a message, the continuity requirement can be met. For example, for a GAST C approach, at least 3 Message type 1 opportunities must be provided to the VDB receiver in each and every 3.5 second sliding window.
- The working spent some time working on maintenance issues in the GBAS MOPS and ICD.
 - Test procedure table 2.26 for VDB Unique Word
 - Appendix D Interference Mask
 - Update with VDB Changes to section 2 Adjacent Channel Interference Requirements and Test Procedures, Appendix K (Rationale for VDB Requirements)
 - A note in the ICD Appendix B that is incorrect.
- Mr. Wichgers formally asked the SC-159 plenary for permission to begin the FRAC process for the LAAS MOPS and ICD changes, assuming that the ICAO NSP adopts the SARPs changes in Fall of 2018. After some discussion, the SC-159 plenary members concluded that both the MOPS and ICD would be sent through the FRAC process as changes to the baseline documents. The FRAC period is to begin no later than 30 days prior to the March 2019 meeting of SC-159.
- Barbara Clark noted that an updated TSO referencing the newly updated MOPS is waiting for review.

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

Sai Kalyanaraman discussed the Working Group efforts during the week.

- Working group 6 considered the impact of interference between two L1 CA code satellites as these satellites align in Doppler when one of these satellite is critical to maintaining performance. Several locations were considered including Honolulu, Los Angeles and Minneapolis. Chris Hegarty provided a receiver model which would give ideal I & Q output streams allowing the examination of effective noise and tracking loop stress. This methodology was used to examine how the link budget is impacted by the alignment of signals in frequency. Several conclusions have been drawn:
 - Use of “Critical Satellite” constraints significantly reduces the scenario $I_{0,CA}$.
 - Applying actual receiver antenna gain dynamics can help in reducing scenario $I_{0,CA}$.
 - Strong “multipath-like” C/A self-RFI events were identified that will likely. require separate receiver testing with high stress scenario conditions.
 - More location-specific parameters for other GNSS satellite components is needed.

- Additional aviation receiver testing is needed.
- The working group also considered the definition of the L5/E5a interference masks which will be used to quantify the maximum tolerable aggregate equivalent noise density created by non-aeronautical and non-allocated systems. The L5 interference environment is dominated by pulsed interference (DME/TACAN//JTIDS/MIDS) which is strongly dependent on altitude.
 - The methodology involved assessing the aggregate interference level at the receiver at various locations throughout the CONUS and Europe.
 - Given the link budget margin a proposed interference mask is proposed that is a function of altitude.
 - The SC-159 plenary discussed the application of the worst case threat to the generic situation. While this is conservative, it ensures that the receiver will be able to function anywhere.
- Working group 6 investigated the impact of Distance Measuring Equipment on GPS signals in the L5/E5A bands. This effort considered several new elements to improve the fidelity of the assessment.
 - The data for this analysis was collected using an RF recorder connected to a top-mounted, multi-frequency GNSS antenna.
 - Data was collected from on-orbit satellites transmitting L5/E5A signals.
 - Data was collected using “production” receiver hardware with recommended RF filtering and pulse blanking implementations.
 - Data was collected on a cross-country flight at FL400
 - Actual receiver performance was compared with the GNSS RFI Environment Evaluation Tool (GREET)
 - Capability was demonstrated to collect aircraft RF data and replay in a laboratory for assessment of aircraft flight environment
 - GREET and collected data agree reasonably well
 - Future work would be focused on providing a more complete description of the differences between GREET and observed aggregate pulsed duty cycle.
- Working group 6 considered the impact of code/carrier divergence on carrier to noise ratio. A test signal was generated from INMARSAT and observed by a ground station in an effort to assess the SARPS CCD requirements for SBAS satellites. The current SARPS CCD requirement of 0.5 m/s is not achievable with the current test-bed hardware. This study was intended to determine if a significantly larger CCD value would adversely impact the ability of airborne equipment to track the SBAS signal.
- The working group also considered the impact of selectivity of the L1 and L5 frequencies. The data collected to date are not conclusive and there is insufficient information available to provide a recommendation to ICAO at this time.
- The intent as of this meeting is to complete DO-235 updates in March 2019.

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

Sai Kalyanaraman discussed the Working Group efforts during the week.

- Working group 7 released the DFMC antenna MOPS, DO-373 and a deviation request was received from one manufacturing almost immediately. Working group 7 is working with EASA and will feed any results back to SC-159.
- The working group has been considering the practice of modeling antenna elements independently from the aircraft. For example, there is significant difference between the group delay seen when considering just the patch element as opposed to that seen when examining the patch element in conjunction with the aircraft. This is important as we consider the impacts of the multipath on the dual frequency antenna. This investigation is ongoing.

Agenda Item 10. Other Business

- There was a discussion about how status updates from various service providers can be repetitive and consumes significant time. It was suggested that we restrict status updates to just changes from the previous briefing.

Agenda Item 5. Review of EUROCAE Activities and Discussion of Joint Activity with EUROCAE on a Dual-Frequency, Multi-Constellation GNSS Receiver MOPS

The SC-159 plenary discussed the current activities of EUROCAE Working Group 62.

Working group 62 met twice since the last SC-159 meeting; June 25th-29, 2018 and September 11th – 13th 2018.

- Working papers are available at <https://www.eurocae.sharepoint.com>.
- The major topics of the 45th meeting of WG 62 included:
 - An update to ARINC 743
 - SESAR Solution PG 14-03-02-6
 - GNSS RFI reporting and localization using ADS-B
 - Longer smoothing time for DFMC SBAS MOPS
 - DGD
 - L5 band interference activities
 - An ad hoc session addressing
 - Satellite selection and minimum satellite tracking capability
 - BOC(1.1) false lock requirements and alternative means of compliance
 - Robustness against cross-correlation and auto-correlation
 - Acquisition time
- The major topics of the 46th meeting of WG 62 included:
 - Continuous navigation message decoding
 - Initial acquisition time / Satellite acquisition time
 - Loss of 4 consecutive SBAS L5 messages
 - Acquisition of the main correlation peak
 - Cross-correlation
 - BOC(1.1) false lock requirements and alternative means of compliance
 - DFMC SBAS and fault detection
 - Step detector
 - Smoothing filter
 - LP/LPV prediction

- WG-62 continues to plan for the initial release of the DFMC SBAS GPS-Galileo MOPS by December 2018 with the following scope
 - Focus on SBAS L5 augmentation
 - Prepare the use of Galileo signals outside SBAS L5 coverage either with GPS or in autonomous mode
 - Include an initial batch of test procedures for the requirements on which consensus is reached.
- The final DFMC SBAS GPS-Galileo MOPS is expected by the end of 2020 with the following scope:
 - Full specification of the SBAS L5 integrity mode augmenting GPS and/or Galileo signals.
 - Galileo requirements consolidated for use in H-ARAIM/FDE mode.
 - Improved response to interference if required by Authorities guidelines.
- The next meetings of WG 62 are shown below
 - 10-14 December 2018 (ENAC, Toulouse, FR)
 - 13-17 May 2019 (Venue – TBC)
 - 10-12 September 2019 (Venue – TBC)
 - 9-13 December 2019 (EUROCAE, Paris, FR) 50th Meeting.

The SC-159 plenary discussed to coordination between WG 62 and SC-159. A plan was made for a call between the leadership of the two committees early in January 2019. This needs to be coordinated with the TAC and the PMC. The logistics of this cooperation is yet to be determined.

Agenda Item 6. Update on ICAO/Navigation Systems Panel Dual Frequency/Multi Constellation Concept of Operations (CONOPS)

Laurent Azoulai spoke briefly about the activities of the ICAO Navigation Systems Panel. The DFMC CONOPS was finalized since the last SC-159 meeting and was attached as an appendix to a secretariat paper. The CONOPS will be presented to the ANC in the next weeks. The ICCIA coordinated with the IATA to write a paper reiterating the desire to have no mandates and no requirements for databases.

Agenda Item 7. Discussion of Terms of Reference Updates

Chris Hegarty led the committee in a discussion regarding changes to the SC-159 Terms of Reference. In an effort to minimize the time required, the committee agreed to forgo editing while in committee.

- The committee agreed to add Change 1 to DO-246 to the terms of reference using language similar that used for the update to DO-253
- The release date for updates to DO-253 is to be updated to March 2019.
- The release date for DO-292 is to be moved from March 2019 to October 2019.
- The release date for the new Inertial MOPS is to be moved to October 2019.

The committee agreed to these changes.

Agenda Items 8 and 9. Action Item Review and Assignment/Review of Future Work

These items were addressed throughout the meeting and were not addressed again.

Agenda Item 11. Date and Place of Next Meeting

The 104th meeting will take place the week of September 30th – October 4th, 2018. Working groups 2, 2C, 4, 6 and 7 plan meet throughout the week beginning on Monday with the plenary session on Friday morning.

Chris Hegarty adjourned the meeting.

-S-

John Savoy
Secretary

CERTIFIED as a true and accurate summary of the meeting.

-S-

Christopher Hegarty
Co-chairman

-S-

George Ligler
Co-chairman