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Navigation System Panel (NSP)
Sixth Meeting
Report of the Status of the GBAS WG (GWG)
Virtual
Nov 2nd – Nov 13th, 2020

1.0 General

The GBAS Working Group (GWG) last met in person Oct 15th – Oct 18th, 2019 at ICAO headquarters in Montreal, Canada. Due to the priority of new core constellation SARPs and DFMC SBAS SARPs, no GWG meeting was held during the Joint Working Group Session 6 held in June of 2020. Between then and the current NSP/6 meeting GWG has met several times virtually including joint meetings with SWG and RTCA SC-159 WG 4. While no dedicated GWG meeting was scheduled during the 2 week period of NSP/6, several papers have been prepared and reviewed by GWG for submission to NSP/6. A joint GWG/SWG session was held on Nov 6th 2020. A list of working papers and information papers considered by the group is given in Attachment A. The GWG reviewed 5 working papers and 3 information papers.

The GWG held the following virtual meetings since the last face to face meeting (JWGs5 meeting October 2019).

Meeting date	Meeting Type and Purpose
Sept 30, 2020	GWG Meeting – NSP/6 planning
Oct 7, 2020	GWG Meeting – Review maintenance change proposal
Oct 14, 2020	GWG Meeting – Progress the work on DFMC GBAS and prepare for joint meeting with RTCA
Oct 22, 2020	Joint GWG/RTCA SC-159 WG 4 Meeting – Progress the work on DFMC GBAS – coordinate schedules
Oct 29, 2020	GWG Meeting – Final preparation for NSP/6

During the virtual meetings the group reviewed the input papers (Attachment A), action items list (Attachment B) and discussed the future work program (Section 6.0).

2.0 Status of GBAS

Given the short amount of time available for teleconferences and no GWG specific meeting time being available during the NSP/6 meeting period, the working group was unable to have the usual general discussion of the status of GBAS in States and organizations. However, one information paper was submitted and is available to the group.

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IP 19 - GBAS Status Update in Japan

This paper presents an update to GBAS development in Japan. The paper informs the GWG that Japan Civil Aviation Bureau (JCAB) has installed the first GBAS at Tokyo international airport (HND), and is conducting CAT-I trial operations. CAT-I GBAS approach procedures for HND runway 34R and 34L have been published. Two Japanese airlines, ANA and JAL have conducted GLS approaches. Pilot feedback indicated GLS provides a more stable approach compared to ILS. The goal is that GBAS at HND will provide CAT-I approach service by the end of FY2020.

In addition the paper informs GWG that Japan is conducting R&D on CAT III GBAS with the GBAS prototype at Ishigaki Airport (ISG). Furthermore, Japan is also conducting R&D on Dual Frequency Multi Constellation (DFMC) GBAS, and will contribute to the ICAO activity to develop and validate DFMC GBAS standards.

3.0 GBAS Maintenance Issues

WP 8 - Allowing GAST D E_{IG} to exceed 2.75m

This working paper proposes revised wording for the SARPs as a maintenance change to allow E_{IG} to exceed 2.75m only when operational requirements permit.

ICAO Annex 10, Appendix B, section 3.6.7.3.4 prohibits the GBAS ground station from transmitting parameters representing the residual ionospheric error that will cause E_{IG} to exceed 2.75m for any threshold supported by GAST D. WP19 of JWGs4 (Apr 19) explained why there would be significant benefit in allowing E_{IG} to exceed 2.75m for some individual runway ends that are located far away from the GBAS reference point.

In October 2019, JWGs5 WP42 was presented in order to justify and propose a change to ICAO Annex 10, to allow the GBAS GAST D residual ionospheric error, E_{IG} to exceed 2.75 m for individual thresholds at an airport. The paper suggested revised wording for Appendix B, section 3.6.7.3.4, and associated guidance material to support GBAS availability simulations. JWGs5 WP50 was also presented to close the action to confirm there is no impact to airworthiness criteria by allowing E_{IG} greater than 2.75 meters.

Action 234 was placed on the IGM ad-hoc group, to do sensitivity analyses looking at the relationship between ionospheric models, distance to runways, E_{IG} and availability. The sensitivity analysis is presented separately in WP 9.

This WP was discussed in the GWG teleconference held on Sept 30, 2020 and the final version of the proposal was reviewed during the Oct 7, 2020 teleconference. The GWG approved the proposed change and agreed that WP 8 should be presented for adoption by NSP during the plenary discussions during NSP/6.

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WP 9 - Validation Material for GAST D E_{IG} to Exceed 2.75m

ICAO Annex 10, Appendix B, section 3.6.7.3.4 prohibits the GBAS ground station from transmitting parameters representing the residual ionospheric error that will cause E_{IG} to exceed 2.75m for any threshold supported by GAST D. WP19 of JWGs4 (Apr 19) explained why there would be significant benefit in allowing E_{IG} to exceed 2.75m for some individual runway ends that are located far away from the GBAS reference point.

In October 2019, JWGs5 WP42 was presented in order to justify and propose a change to ICAO Annex 10, to allow the GBAS GAST D residual ionospheric error, E_{IG} to exceed 2.75 m for individual thresholds at an airport. The paper suggested revised wording for Appendix B, section 3.6.7.3.4, and associated guidance material to support GBAS availability simulations. JWGs5 WP50 was also presented to close the action to confirm there is no impact to airworthiness criteria by allowing E_{IG} greater than 2.75 meters. WP08 for this meeting proposes revised wording for the SARPs as a maintenance change to allow E_{IG} to exceed 2.75m only when operational requirements permit.

Action 234 was taken on by the IGM ad-hoc group to do sensitivity analyses looking at the relationship between ionospheric models, distance to runways, E_{IG} and availability. This paper summarizes the results of sensitivity analyses supporting Action 234 for validation of the changes proposed in WP08 for this meeting. A high sensitivity of the maximum E_{IG} to threat models and airport size is shown, while a reasonable availability is demonstrated as feasible for many locations in the world for E_{IG} greater than 2.75 meters.

The GWG considered this paper during the Oct 7, 2020 teleconference and agreed to accept the paper as validation material to support the proposed maintenance changes from WP 8 to this meeting. The validation matrix in WP 8 includes a reference to this paper as well as all other material that supports validation of the change proposal.

4.0 Joint GWG/SWG Meeting

A joint meeting of GWG/SWG was held on 11/6/2020. Three Working Papers were discussed: WP 18, WP 30 and WP 33. These papers are described briefly below. For a detailed discussion see the SWG meeting report material.

WP-18 Proposed amendments to the Handbook on Radio Frequency Spectrum Requirements for Civil Aviation (Doc. 9718) Volume II

This paper present proposals to amend the Handbook on Radio Frequency Spectrum Requirements (Doc. 9718), Volume II to incorporate frequency assignment planning criteria for VHF and UHF aeronautical radionavigation aids.

WP-33 Draft ICAO guidance on 'GBAS/VDB siting' and 'same-airport frequency compatibility'

This working paper is an update of JWGs/5-WP/24, rev.1. It presents revised draft ICAO guidance material on 'GBAS/VDB siting' and 'same-airport compatibility'.

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Such guidance material is necessary in order to complement international frequency assignment planning criteria for GBAS/VDB, which may not be sufficient to ensure finding GBAS/VDB frequencies, which are compatible with existing ILS Localizer and or VOR systems at the same airport.

This paper was prepared by GBAS/VDB same-airport compatibility correspondence group of the ICAO NSP. It takes into account comments and change requests provided during the review of the paper by EUROCAE WG28 at its virtual meeting in September 2020.

WP-30 Review of frequency assignment planning criteria for VDB - NSP Secretary

This paper presents a proposal to make use of the actual predicted (desired) GBAS/VDB signal levels in frequency assignment planning. In particular the proposed frequency assignment planning technique to not undertake an assessment of frequency assignments that are separated with more than 50 kHz from the desired GBAS/VDB facility would increase significantly the efficiency in frequency assignment planning. States are invited to assess, on a case-by-case basis (e.g. through flight measurements) the compatibility with VHF navigation facilities.

5.0 DFMC GBAS

DFMC GBAS was a significant, if not the primary subject of the discussion at the GWG meetings held on Sept 30th 2020, Oct 14, 2020, Oct 29, 2020, as well as the Joint GWG/RTCA SC-159 WG 4 Meeting held on Oct 22nd, 2020. The discussions fell into two categories:

1) discussions of the development schedule, and
2) Technical work contributing to the development of the standards

The discussions in Item 1) are summarized below in section 6.0 under the work plan. The rest of this section will outline the technical work discussions (i.e. item 2).

Technical Discussions during the Oct 14, 2020 GWG Meeting

Some technical discussions were conducted during the Oct 14, 2020 GWG Meeting. However, most of those discussions were in the context of determining a reasonable timeline for DFMC GBAS development. The PowerPoint briefing used to guide the discussions for the meeting is provided in Attachment C. Those discussions included a review of the DFMC GBAS developments to date, a review of decisions made by GWG in previous meetings, and a review of a list of all materials submitted to GWG on DFMC GBAS so far. In particular, slide 11 of Attachment C reviews open questions/issues identified in JWGS4 WP35. There was some technical discussion of the items in this list. However, this discussion made it clear that there was no general consensus on the scope of the capabilities to be addressed in the next major update of the SARPs. It was noted during this discussion that no new technical information has been submitted to GWG since NSP/5. In fact, even the most significant body of work submitted to date (NSP/5 WP/41) had received no feedback. The only technical progress since NSP/5 has been the assembly of the list of open questions/issues (originally proposed in JWGS4 WP 35).

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Technical Discussions During the Oct 22, 2020 Joint GWG/RTCA SC-159 WG 4 Meeting

During the Oct 22, 2020 Joint GWG/RTCA SC-159 WG 4 Meeting there were some significant technical discussions. Attachment D to this Flimsy shows the Agenda for the joint meeting. The following technical discussions were held during the joint meeting:

- A presentation by Andreas Lipp was given titled "Considerations for future GBAS evolutions". This briefing attempts sort and prioritize some of the open questions/issues (Attachment C slide 11) and draw some conclusions about the scope of GBAS evolution that could be pursued for a SARPs update in a reasonable timeline.
- A presentation was given by Tim Murphy regarding comments on DFMC GBAS Conceptual framework (NSP/5 WP 41). The presentation accompanies a matrix of comments that were provided to Eurocontrol (as requested at NSP/5). The presentation noted that a significant body of work is reflected in NSP/5 WP 41. The concept described does a good job of leveraging all the work done to develop GAST D. However, there are still many open issues listed in the document as TBD. Furthermore the document as it currently stands is very SESAR program centric and some significant re-organization and formatting would be needed in order for the document to serve as a concept document for DFMC GBAS. There was some general discussion of the assertion that the concept document will need to address all core constellations, while WP 41 is focused solely on GPS/Galileo. There are a number of other technical issues raised in the presentation and associated comment matrix. These materials are available through the RTCA workspace.
- A presentation was given by Tim Murphy titled "Alternative Architecture for DFMC GBAS". This presentation introduced a proposed architecture for DFMC based on up-linking measurements rather than differential corrections. Up-linking measurements rather than differential corrections has many advantages in that it allows the greatest flexibility in airborne processing, supports full high accuracy/sensitivity iono-anomaly monitoring in the airborne receiver and enables a higher accuracy service while still retaining robustness against anomalous ionospheric threats. The proposal has the disadvantage that it uses twice the datalink bandwidth of the GAST F proposal. The group discussed the pros and cons of the proposal and agreed that it should be included in the architecture trade study (subject of Action 232). This presentation acknowledged that there are many open questions/issues associated with the proposal. However, given that the proposal allows for a GAST F equivalent service to be computed/implemented in the air, many of the open issues are common to GAST F open issues. This presentation has been expanded into IP 17 discussed below.
- A presentation was given by Pere Durba Calvet titled "Pj14/Sol79/WP9 – DFMC GBAS Threat Analysis and Fall-back Modes". Also a companion document was provided. The document provides details and complements the "DFMC GBAS Concept Framework" (NSP/5-WP41). The presentation and document are available on the RTCA workspace. The main goal of this work is to analyse the GAST F proposed processing modes to compare anticipated behaviour against different threat scenarios that the system could encounter. These threat scenarios have been studied previously in the GAST F concept paper and previous documentation of this solution. The list of threats to analyse are been extracted from these documents and each case is studied in detail. Furthermore, this technical note is also focused on the detection process in order to know if this could have implications in the switching mode too. As in the GAST F service the responsibility of the operations is split between the ground and the airborne subsystem, the detection process could be done in three ways: by the ground subsystem, by the airborne or by both. This differentiation is also analysed in this technical note.

Technical Discussions during the Oct 29, 2020 GWG Meeting

During the GWG teleconference on Oct 29th there were 2 technical presentations. The PowerPoint briefing used to guide the discussions during the meeting is given in Attachment E. The two technical presentations were:

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- Andreas Lipp gave a presentation titled "Comments on NSP6 IP17 – First Analysis of feasibility of an alternative GAST F concept". This presentation raised a few points relative to the proposal in IP 17. The presentation also includes some analysis that tries to answer questions that came up during the initial presentation of the idea during the joint GWG/RTCA SC-159 WG 4 meeting.
- Tim Murphy presented a first draft of IP 17 "Alternative Architecture for Dual Frequency Multi-Constellation GBAS" – This was a first draft of IP 17 as described below. The paper introduces an alternative architecture and associated service type dubbed "GAST X".

IP 17 - Alternative Architecture for Dual Frequency Multi-Constellation GBAS

This paper describes a proposed alternative architecture for Dual Frequency Multi-Constellation (DFMC) GBAS. The proposal builds off of the good work done over the last 10 years by the SESAR program. However, the proposal is designed to enable more optimal airborne processing that should enable better performance and higher availability for DFMC GBAS globally.

IP 17 was developed after the initial presentation of the GAST X concept at the joint GWG/SC-159 WG 4 meeting. It is intended to explain the concept in more detail and to begin to explore the pros and cons of the concept. The architecture is a departure from GAST C and GAST D in that a significant amount of the processing is moved to the airborne equipment. Doing that allows for great flexibility in that the airborne can use different carrier smoothing intervals as long as the smoothing used on the air and ground measurements is matched. It also opens up the possibility to do Divergence Free (DFree) smoothing which in turn enables more precise iono anomaly monitoring. In addition, the proposal may enable single frequency fall back modes that will still support CAT III operations, thereby improving the robustness of the system against loss of either frequency. Finally, the proposed service type opens up the possibility for pure carrier based positioning techniques such as RTK to be used.

This proposal is being put on the table for consideration as GWG converges on standards for DFMC GBAS. There is still much work to do to flesh out this proposal. However, much of the work is common to validating any DFMC GBAS architecture.

6.0 GWG Work Plan

The following major items were identified at the last few meetings and these still represent the focus of the GWG:

- GBAS SARPS Maintenance (including VHF compatibility requirements and guidance)
- Impact to Other Annexes
- ICAO Doc 8071 update for GBAS
- Updates to the GNSS Manual (Doc 9849)
- Dual Frequency - Multi-Constellation GBAS
    - Including support for maintenance of the DFMC ConOps
    - Develop (or expand the current) concept paper for DFMC GBAS as an initial step towards development of SARPs.

DFMC Work Plan

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The timeline for DFMC development was a significant subject of discussion during the GWG meetings on Sept 30, 2020, Oct 14, 2020 and Oct 29, 2020 as well as the joint GWG/SC-159 WG 4 meeting on Oct 22, 2020. Two papers, WP 17 and IP 16 were used to facilitate the discussion. These papers and the associated discussions are described in the following sections.

WP 17 - DFMC GBAS Proposed Workplan for ICAO NSP

This paper proposes the GAST-F standardization roadmap for ICAO. The paper reflects the willingness of European Commission to support and fund development of GAST-F solutions.

WP 17 was first discussed during the meeting of Oct 14, 2020. The general feedback after presentation of the paper was that the proposed timeline was unrealistic given the current state of industry as well as the experience the industry had with the development of GAST D. It was noted that coordination with RTCA SC-159 would be key to developing a timeline for DFMC so the group would discuss the subject during the upcoming joint GWG/SC-159 WG4 meeting.

WP 17 was presented again during the joint GWG/SC-159 WG4 meeting. Members of WG 4 considered that the GBAS standards development timeline presented in WP 17 was too optimistic to develop a first version of the MOPS by 2023 but the effort and resources offered were appreciated. There was agreement within WG4 that the dates in the current TOR for the WG are not realisti However, the prevailing view was that the schedule couldn't really be determined until the initial phase of architecture trade studies is complete and a high level concept is developed. Consequently WG 4 decided not to propose modified TOR at this time.

Members of WG4 wanted to continue considering other GBAS DFMC evolution options (e.g., the GAST-X option as presented in a PowerPoint during the meeting) in addition to the GAST F concept as presented in NSP 5 WP 41. While the approach of having the DFMC GBAS standards be an evolution of GAST-D may result in a faster standards timeline, significant care is needed as the next service to be added will likely consume virtually all of the remaining GBAS VDB bandwidth. Consequently the ability to support other potential GBAS uses could be limited. Thus, WG4 sentiment was that further evaluation of the pros and cons of GBAS alternatives is warranted.

In addition the joint meeting discussed the proposal in WP 17 for RTCA SC-159 WG 4 and EUROCAE WG 28 to work together on a MOPS. After some discussion it was recommended to keep the current working arrangement with SC-159 WG 4 working on airborne MOPS and EUROCAE WG 28 focusing on the ground system MOPS as the most efficient way to work. Members of EUROCAE WG 28 in attendance noted that currently the attendance and contribution from airborne manufacturers is insufficient to progress this work. Any European airborne equipment manufacturers that wish to participate are welcome to participate in SC-159 WG 4. There are also several members common to both SC-159 WG 4 and EUROCAE WG 28 so that coordination of the work can be facilitated. However, it was also recognized that there should be a single MOPS development. So if EUROCAE decides to change the TOR for any group to include development of airborne MOPS for GBAS, the group recommended that the activity should be joint with SC-159 WG 4.

WP 17 was discussed a final time during the meeting on Oct 29th 2020. A revised version of WP 17 was considered. A relaxation of the proposed GAST-F standardization roadmap was considered – a 2-year shift from the original proposal. As discussed below, this new proposed timeline was close enough to a revised timeline given in an update to IP 16 below that a compromise could be reached.

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IP 16 - A view on a potential timeline for DFMC GBAS

A review of the Job Card NSP.005.02 on DFMC GBAS is due, and this paper discusses some background and proposes possible timelines. The paper captures the views of industry with respect to a feasible timeline for development of the next GBAS update to address DFMC capabilities.

IP 16 was first discussed during the meeting of Oct 14, 2020. The general feedback after presentation of the paper was that both timelines presented in the paper were probably somewhat pessimistic as they largely assume that every step in the development of DFMC will take a long as the analogous steps that were taken in development of GAST D. Potentially, some of the lessons learned and developments during the GAST D experience in addition to the ground work done by SESAR on GAST F should perhaps shorten the timeline. It was noted that the current state of industry and the need to support GAST C and D developments in the near term will limit the resources available. Again, it was agreed that coordination with RTCA SC-159 would be key to developing a timeline for DFMC and therefore the subject would be discussed again during the joint GWG/SC-159 WG4 meeting.

A modified version of IP 16 was presented during the joint GWG/SC-159 WG4 meeting. The modified version included a timeline that was accelerated considerably relative to the first version of IP 16 based on the feedback and discussion of Oct 14th. As noted above, SC-159 WG 4 supported the need for a robust review of the concept, consideration of the scope with respect to other operational contexts to be supported and an architectural trade study. One year was discussed as an optimistic scenario for this phase of the work. Considerable coordination will be needed between SC-159 WG 4, EUROCAE WG 28 and GWG in order to drive a decision on the concept by the end of 2021. One of the most interesting aspects of the discussions with WG 4 was the need for standards to support "new entrants" (e.g. Unmanned Aerial Vehicle (UAV) or passenger air taxi operations.) RTCA SC-228 is standing up a WG that is tasked to develop requirements for navigation to support UAVs.

Between the joint GWG/SC-159 WG 4 meeting, industry had a meeting to discuss IP 16 to ensure that the final version of the paper accurately reflects a broadly supported industry view. Some modifications to the paper were in view of all the discussions made in the previous meetings and a revised version was submitted.

The revised IP 16 was discussed during the meeting on Oct 29th 2020. The revised version still includes two timelines, one that is considered very realistic and another that is accelerated as much as industry believes is feasible. This new proposed timeline was close enough to a revised timeline given in an update to WP 17 presented at the same meeting that a compromise consensus could be reached on a timeline (see below).

Proposed Compromise Timeline for DFMC Development

During the GWG telecon on October 29th, the group came to an agreement on some basic principles:

- A careful review of the concept is needed, with respect to other operational contexts and use cases than the approach, landing, rollout and take-off phases that the current GBAS concepts are standardized for (AI 232)
- Input from EUROCAE/RTCA is needed in order to consider the dependencies with the DFMC SBAS MOPS and the future DFMC GBAS MOPS (Jwgs4/WP35)

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The following figure (from Jwgs4/WP35) illustrates the dependency of the development between RTCA/EUROCAE and ICAO activities.

The compromise timeline presented in Table 1 takes the both the considerations above into account. Further coordination with SC-159 WG 4 and EUROCAE WG 28 will be required to align their schedules. It should be noted that this timeline is expected to require considerable effort from the relevant stakeholders, and there is uncertainty with respect to the availability of resources, especially in the short term taking the industry's current situation into account. There is therefore some risk associated with this timeline.

Table 1 Proposed Compromise Timeline for DFMC GBAS Development

2021	**Collect requirements from additional operational use cases, evaluate possible concepts against them**
Q4 2021	A high level concept (similar to the level of detail currently proposed by SESAR, with all options selected) agreed in ICAO and RTCA
Q4 2022	A detailed concept paper agreed in ICAO and RTCA, similar level of detail as the 2009 GAST D concept paper GWG drafting group to start an update package to ICAO SARPs RTCA/EUROCAE to start drafting airborne and ground MOPS
Q4 2024	A baseline airborne MOPS - Supporting prototype airborne implementations for validation A baseline development SARPs for GAST F - Supporting prototype ground implementations for validation
2028	Validated SARPs Proposal Ready for proposal to NSP

When ANC reviewed the previously proposed job cards for NSP (JWGs5 IP 12) the Commission suggested that the development date for DFMC GBAS be changed to "TBD" to reflect the uncertainty in the schedule. Some states feel strongly that some date should be included in the job card. Although there is still considerable risk and uncertainty in the schedule, GWG believes the job card could be modified to reflect the dates as given in Table 1.

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Going forward, GWG will meet more frequently virtually to progress the development to the extent possible given the constraints on industry. In particular, the ad-hoc group tasked with architecture trade studies (action 232) is expected to work intensively over the next year.

Future Work Plan – Other Tasks

The GWG discussed the future work. The work of the group will continue to focus on maintenance of the SARPS, changes required in other documents to enable implementations (e.g. Doc 8071 updates) and development of Dual Frequency/Multi-Constellation GBAS standards.

The GWG will

- Review work brought by states doing work to implement GBAS (GAST C and GAST D)
- Assist in the coordination of work between States during implementations.
- Continue maintaining a list of (validated) maintenance changes to the SARPs
- Maintain an Ad Hoc group to work on Ionospheric Monitoring issues

GBAS SARPS Maintenance: GWG will continue to maintain a compilation of maintenance changes and associated validation material in anticipation of the next opportunity for submitting a SARPS change proposal. Such maintenance changes are anticipated to arise as operational experience from fielding GBAS applications grow.

For example:

- Some additional changes to support an extended service volume for GBAS may be introduced.
- Guidance or requirements regarding reference receiver interference masks
- Requirements and Guidance to support VHF frequency compatibility
- Considerations for protection of areas around GNSS reference receivers, VDB antennas and aircraft.
- Low latitude iono mitigation – IGM AdHoc will remain active (see below)

IGM AdHoc Group: The IGM Ad-hoc plans to continue support of the SARPs relative to GBAS operations in iono active low latitude regions as follows:

1. Develop guidance material associated with application of GBAS in low latitude regions to minimize the impact on continuity and availability.
2. Consider maintenance changes to the SARPs that could improve low latitude operations of GBAS.

If you are interested in participating in this Ad-hoc please contact Matt Harris at Matt.Harris@boeing.com.

Doc 8071 update for GBAS: Some progress has been made by EUROCAE WG 28 to develop changes to Doc 8071 to support GBAS. A joint meeting with CNTWG to review this material is planned for Dec 9th 2020.

7.0 Summary and Conclusions

The work of GWG over the last year has been slow due to the priority of DFMC core constellation and DFMC SBAS developments. In addition, COVID-19 has had an impact on the availability of resources. The focus of GWG continues to turn to development of future dual-frequency/multi-constellation GBAS. However, there is significant work still to be done to support GBAS deployment (GAST C and D) around the world such as updates to Doc 8071 Vol II, and of course, maintenance of our existing standards and guidance in Annex 10.

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Attachment A - LIST OF WORKING PAPERS for GWG Meeting – NSP/6

Working papers

WP No.	Agenda Item	Subject	Presented by
8	3	Allowing GAST D E_{IG} to exceed 2.75m	Tim Murphy
9	3	Validation Material for GAST D E_{IG} to Exceed 2.75m	Tim Murphy
17	3	DFMC GBAS proposed workplan for ICAO NSP	Eric Chatre
18	3	Proposed amendments to the Handbook on Radio Frequency Spectrum Requirements for Civil Aviation (Doc. 9718) Volume II	Presented by the Secretariat
33	3	Draft ICAO guidance on 'GBAS/VDB siting' and 'same-airport frequency compatibility'	SWG rapporteur

Information Papers

IP No.	Agenda Item	Subject	Presented by
16	3	A view on a potential timeline for DFMC GBAS	Tim Murphy
17	3	Alternative Architecture for Dual Frequency Multi-Constellation GBAS	Tim Murphy
19	3	GBAS Status Update in Japan	Kuniyuki Matsuda

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Attachment B Action Item List at the output of the Virtual GWG Meeting Sept 30th 2020

Number	Action	Volunteer	Due By	Status
85	Develop a concept paper addressing future multi-constellation, multi-frequency GBAS. Define a hypothetical architecture and assess the viability of that architecture to be supported by a single frequency given the impact of MT 11 and the current GBAS change proposal for GAST D. Also consider the extensibility of the classification scheme and requirements methodology.	~~Andreas Lipp~~ SESAR Team (Tim Murphy and ICCAIA to support).	~~Oct 2008 meeting~~ ~~May 2010~~	Opened Mar 2008 meeting. CSG 07/08 WP 9 and IP 2. CSG 03/09 WP 31 CSG 05/2014 IP 15 CSG 09/2014 IP 8 NSP/2 IP 11 NSP/3 WP 13 and IP 14 JWGs 3 WP 27 and IP 23 NSP5 WP 41
139	Writing a paper directed at IFPP and OPS Panel which would: ask for the rationale for why GBAS is limited to not lower than 3 degree GPA. make IFPP aware of specific GBAS applications that would be affected by such a limitation (e.g. multiple approach angles to a single runway end for wake turbulence mitigation). This description should include some indication of how widely such applications could ultimately be deployed.	Takayuki Yoshihara, Bruce Johnson	Fall 2013 Draft for CSG review at the Dec meeting	Opened: Nov 10 Mtg Recommended for closure by teleconference 10/26 due to lack of operator interest WGW_Dec_11_WP23 – proposes not closing this issue. Coordinate with secretary regarding the best way to communicate with IFPP. Feedback was provided in response to JWGs2_IP 22. To be communicated to IFPP by Andreas Lipp. If the proposed PANS-OPS modification is adopted by IFPP, this action can be closed. Closed: see NSP4 IP21 – IFPP as expanded range.

Number	Action	Volunteer	Due By	Status
146	Review and edit GNSS section of Doc 8071. Work proactively and in parallel with CNTSG activities to revise Doc 8071.	Ad hoc lead: Jules Hermens Volunteers: Winfried Dunkel, Luisa Cavero , Pierre Ladoux, Jason Burns, Dale Courtney, Tim Murphy, ~~Andre Schuettpelz~~, ~~Ed~~ , ~~Andreas Lipp~~, Mike Spanner, Gary Berz	Schedule depends on CNTSG schedule for overall revision of Doc 8071	Opened: May 11 Mtg NSP_may11_wgw_WP_14 May14_wgw_14 SepOct2014_wg1_AND_wg2_WP3 SepOct2014_wg1_AND_wg2_Flimsy_2 SepOct2014_wg1_AND_wg2_WP5 JWGs2_WP_11 NSP4 WP 6 Closed to continue in action 223

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Number	Action	Volunteer	Due By	Status
177	Ad-hoc group to develop SARPS proposal for separation criteria for GBAS VDB versus VHF COM as well as GBAS VDB versus ILS based on SeptOct2014_wg1_AND_wg2_Flimsy10. Review and modify separation criteria in Attachment D, section 7.2.1.3, 7.2.1.4, 7.2.1.5 and 7.2.1.6 as necessary.	Pierre Ladoux – Felix Butsch.	Validated proposal by April 2018 meeting. April 2015 Meeting	Opened Oct. 2014 SeptOct2014_wg1_AND_wg2_WP6 SeptOct2014_wg1_AND_wg2_Flimsy10 Feb15_CSG_WP19 NSP/2 WP 6 NSP/2 WP 10 NSP/2 WP 8 NSP/2 WP 17 NSP/3 WP 16, WP 11, IP 25, IP 22 and IP 21 JWGs2:WP 11, WP 12, WP 13, WP 19, IP 14, and IP 27 NSP4 WP 28, WP 15, WP 16, WP 17, IP 11, WP 2, IP 9 flimsy 5. JWGs3 WP 4, WP 5, WP 6, WP 18 WP 21, WP 22, WP 28 and IP 8 JWGs4 WP 6, WP 25 JWGs5 WP 24 Move to SWG?
178	Felix Butsch to present further results on GBAS VDB versus VHF COM based on more detailed analysis of the impact of GBAS slot utilization and message length	Felix Butsch	Feb 2015	Opened Oct. 2014 SeptOct2014_wg1_AND_wg2_WP6 NSP4 IP 30 JWGs 3 WP 21 Closed April 2018

Number	Action	Volunteer	Due By	Status
179	Consider possible actions on standardization of FAS data parameters. (SeptOct2014_wg1_AND_wg2_WP12) Include action 167 issue (May14_wgw_WP20)	Ad-hoc led by ~~Andreas Lipp~~, **Laurent Azoulai**, Jolana Dvorska, Barbara Clark, ~~Boubeker Belabbas~~ , John Dyson, Takayuki Yoshihara.	As time and resources allow	Opened Oct. 2014 SeptOct2014_wg1_AND_wg2_WP12 JWGs2 IP 22 JWGs2 – Laurent takes on interim task of figuring out if this is still a relevant task. Closed NSP 5 (Nov 2018) – based on group discussion and consensus.
193	Prepare a WP to introduce a requirement for GBAS ground reference receivers to meet the same airborne interference masks. ICCAIA to support validation by assessing impact of new requirement on current ground stations. Jun 2016: Provide revised SARPs text to make interference mask also applicable for GBAS reference receivers	Mike Spanner/Tim Murphy	~~May 2016~~ ~~End July 2016~~ In time to support Mature input by end of 2018 for 2020 SARPS cycle	Opened 12/4/2015 Flimsy 12 3 Jun 2016, JWG WP 30 and Flimsy 26 GWG_Aug16_IP9 NSP/3 IP 6 JWGs2: WP 21 (not discussed. Deferred to next meeting). Closed; NSP4 WP 34
205	Propose text for SARPs (or GM) which explains that sensitive areas are not required for GBAS operation provided that the siting of the ground station was done properly. NSP/3 action revised to: Develop considerations for protection of areas around GNSS reference receivers, VDB antennas and aircraft.	~~Mike Spanner~~ {Need a new leader}; with Matt Harris, Jason Burns, Winfried Dunkel, Stefan Naerlich, Pierre Ladoux, Laurent Azoulai, Bruce Johnson, Gary Berz	~~End July 2016~~ In time to support ~~Mature input by end of 2018 for 2020 SARPS cycle~~ Fall of 2019	Opened: 3 Jun 2016 JWG 1 IP 10 GWG_Aug16 IP 7 NSP/3 IP 5 JWGs2 – WP20 (Not discussed, deferred to the next meeting). NSP4 WP 33

Number	Action	Volunteer	Due By	Status
214	Further consideration of the possible impacts of elimination of CAT IIIa, IIIb and IIIc definitions on GBAS service types etc.	John Dyson	GWG to discuss at the April 2018 meeting	Opened: 6/16/2017 JWGs2: WP 9 Closed NSP 5 – OBE as FltOpsP adopted change
215	Provide a revision of WP 18 re doc 9157 Part 6 frangibility requirements for GBAS. For the secretary to present to ADOP (Aerodrome Design and Operation Panel).	Pierre Ladoux	Within 2 weeks	Opened 10/13/2017: NSP4 WP 18 See JWGs 3 – Flimsy 9 (WP 3 from ADOP 3 mtg.)
216	GWG members to contribute to the development of a specification to be included into ICAO Doc 8071, Vol. II, how to evaluate field strength measurement results.	Winfried Dunkel & Matt Harris – VDB Ad-hoc group	~~April 2019 GWG meeting -~~ Next meeting – final target is Doc 8071 completion	Opened NSP4 WP 6 NSP 5 IP 34 JWGs IP 4 and IP 26
217	Provide a derivation of the impact of VDB fieldstrength fluctuation on the Message Failure Rate in the context of GWG developing a specification to be included into ICAO Doc 8071, Vol. II , how to evaluate fieldstrength measurement results	Matt Harris	Prior to next meeting	Opened NSP4 WP 6 Closed: JWGs IP 4 and IP 26
218	GWG members to analyse the possibility of allowing a message failure rate of 1 in 10 messages for GBAS VDB in order to support Category I approach scenarios and develop consequential proposals covering this in Annex 10.	Matt Harris	Prior to next meeting	Opened NSP4 WP 28 Closed Apr 2018 JWGs3 WP 5
219	Identify additional frequency coordination scenarios if needed.	Matt Harris	Prior to the next meeting	Opened NSP4 WP 16 Closed April 2018 JWGs3 WP 18
220	Create a new validation matrix for the next package of maintenance changes	Rick Cassell		
221	Review the figure and associated proposal for Attachment D in JWGs 3 Flimsy 4 and provide feedback to Linda Lavik by June 25th in preparation for further coordination EUROCAE WG 28.	Linda Lavik to receive but action to all to review and provide comments.	June 25th	Opened JWGs 3 WP 7 & Flimsy 4 Closed JWGs 4 WP 7

Number	Action	Volunteer	Due By	Status
222	Look at all uses of the term "transmitter" to find cases where "transmitting antenna" should be used instead. Bring a paper with an appropriate change proposal.	W. Dunkel	NSP 5	Opened JWGs 3 WP 20. NSP 5 WP 11 and Flimsy 3
223	Prepare GBAS related material for the Doc 8071 Vol II update (chapter 4).	Ad-hoc. Led by Mike Spanner {Need a new leader}. Membership:, Bruce Johnson, Winfried Dunkel, Susumu Saito, Matt Harris, Barbara Clark,	Outline and plan/schedule in a paper for NSP 5	Previous action 146 History: NSP_may11_wgw_WP_14 May14_wgw_14 SepOct2014_wg1_AND_wg2_WP3 SepOct2014_wg1_AND_wg2_Flimsy_2 SepOct2014_wg1_AND_wg2_WP5 JWGs2_WP_11 NSP4 WP 6 Opened JWGs 3 WP 2 JWGs4 WP 14, JWGs5 WP 48
224	Develop new guidance material on the conversion from receiver performance requirements to Signal-in-Space requirements regarding maximum undesired Power Flux Density levels for GBAS operations and desired-to-undesired (D/U) as well as the impact of spurious emissions based on JWGs/3, WP18, rev.1 and the new draft Appendix K of RTCA DO-253().	Tim Murphy and the VDB ad-hoc and SWG	2 month prior to NSP 5	Opened JWGs WP 18. Rev 1. Closed - NSP 5 WP 14 Over to SWG
225	Members of NSP to check whether they would have avionics backward- compatibility issue and/or ground station deployment issues related to new VDB requirements and VHF compatibility criteria. – Reference WP 18 Rev 1 and WP 6 and WP 4 Rev 1.	All GWG members	2 months prior to NSP 5	Opened JWGs WP 18. Rev 1. Closed NSP5 WP 4 and WP 15
226	Bring the outcome of the discussion of proposed SARPs Changes for GBAS VDB compatibility with ILS from the Joint GWG/SWG meeting to the attention of the CNTWG	Tim Murphy	JWG3 CNTSG Meeting	Opened JWGs3 WP 4 Closed

Number	Action	Volunteer	Due By	Status
227	Analyse the impact on the VDB Message Failure Rate of "sub-second" exceedances of the power limit by the undesired signal and to explore the possibility to introduce a sliding-average mechanism for GBAS VDB flight-inspection results, based on this analysis.	Mat Harris and VDB ad-hoc	Draft paper in time to support VDB GM development months prior to NSP 5	Opened JWGs3 WP 28 Closed NSP 5 WP 17
228	Review NSP/5 WP 41 and provide comments o pdurba@indra.es using the Review Sheet attached to the paper.	All GWG Members	Next GWG Meeting	Opened NSP/5 WP 41 Closed OBE see action 232
229	Develop Dependency Schedule	Matt Harris Lead Supported by: Barbara Clark Tim Murphy Pere Durba	Mid Dec 2018 Teleconference	Opened NSP/5 – Job Card Discussion (WP 36) Closed: JWGs WP 35
230	Feedback to IFPP on PANS-AIM proposal. Harmonization of NSP 5 WP 8 and WP 32. Panel secretary to coordinate.	Barbara Clark, Andreas Lipp, Alessandro Capretti, Tim Murphy	Nov 12 2018 to support discussion at NSP 5	Opened NSP/5 – WP 8 and 32 Closed JWGs 4 – Oral report by panel secretary
231	Develop guidance material on GBAS/VDB siting and same-airport compatibility with other VHF-navigation aids for inclusion into ICAO Annex 10, Vol. I Attachment D => GWG/SWG.	GWG/SWG Joint Effort	JWGs 5 (in time for the Frequency Management Handbook next year).	JWGs4 WP 25 JWGs5 WP 24
232	Ad-hoc activity to explore expanded concepts and potential services for DFMC GBAS.	Led by Matt Harris and Andreas Lipp	NSP/6 (or 4Q 2020)	Opened: JWGs4 WP 35
233	Confirm if exceeding the 2.75m limit on Eig is supported by airworthiness criteria.	Barbara Clark	JWGs5 Oct 2019	Opened: JWGs4 WP 19 Closed: JWGs5 WP 50

Number	Action	Volunteer	Due By	Status
234	Continue development of SARPs requirements to support Eig>2.75 at remote runways or in equatorial regions • Perform sensitivity study to look at continuity and availability as a function of Eig, Ev, El, etc. • Build some hypothetical scenarios and quantify the benefit of allowing Eig>2.75	Linda Lavik & IGM AdHoc	4Q 2020	Opened: JWGs4 WP 19 JWGs5 WP 42 & WP 50.
235	Review GBAS AIS information in WP 2 and provide feedback to Gary Berz.	All GWG members	A reasonable time before the next meeting	Opened: JWG25 WP 2

Green – denotes closed actions (these will eventually be removed from the list).
Yellow – denotes actions opened at this meeting

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Attachment C – PowerPoint Briefing Used to Guide the Discussions During the GWG Meeting on 10/14/2020.

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Attachment D – Agenda for the Joint RTCA SC-159 WG/4 – GWG Meeting Held Oct. 22nd, 2020.

WG-4 only part of March 2020 Agenda

Thursday (October 22, 2020)

1. Review Agenda

2. Joint WG-4 / ICAO NSP GWG Meeting
   - 2a. Considerations for future GBAS evolutions — Andreas Lipp
   - 2b. Comments on DFMC GBAS Conceptual Fr (Ctrl) NSP5/WP-41 — Tim Murphy
   - 2c. Alternative Architecture for DFMC GBAS — Tim Murphy
   - 2d. Review of DFMC GBAS Development Timelines
     - 2d.1. European Commission Proposed DFMC GBAS Work Plan — N. Castrillo / I. Alcantarilla
     - 2d.2. DFMC GBAS Timeline — Linda Lavik
     - 2d.3. Other Views on Timeline — All
   - 2e. Discuss DFMC GBAS Development Timeline — All
   - 2f. Other Business — All
     - 2f.1. DFMC GBAS Threat Analysis & Fallback Modes — Pere Durbá

3. WG-4 Only Portion of Meeting
   - 3a. ~~Discuss Status and Plan for EUROCAE WG-28 Update of Ground MOPS focus on completing review for Appendix O (Characterization of Airborne GBAS MOPS Requirements)~~ — ~~Barbara Clark~~
   - 3b. GBAS GAST D to Broadcast EIG > 2.75 meters — Matt Harris
   - 3c. Other Business — All
   - 3d. Discuss Work Plan & Establish Time/Place for the Next Meeting — J. Wichgers / M. Harris

[Note that the agenda items and order when they are discussed are subject to change.]

- End –

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Attachment E – Agenda for the Oct 29th GWG Teleconference.

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