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GBAS global developments

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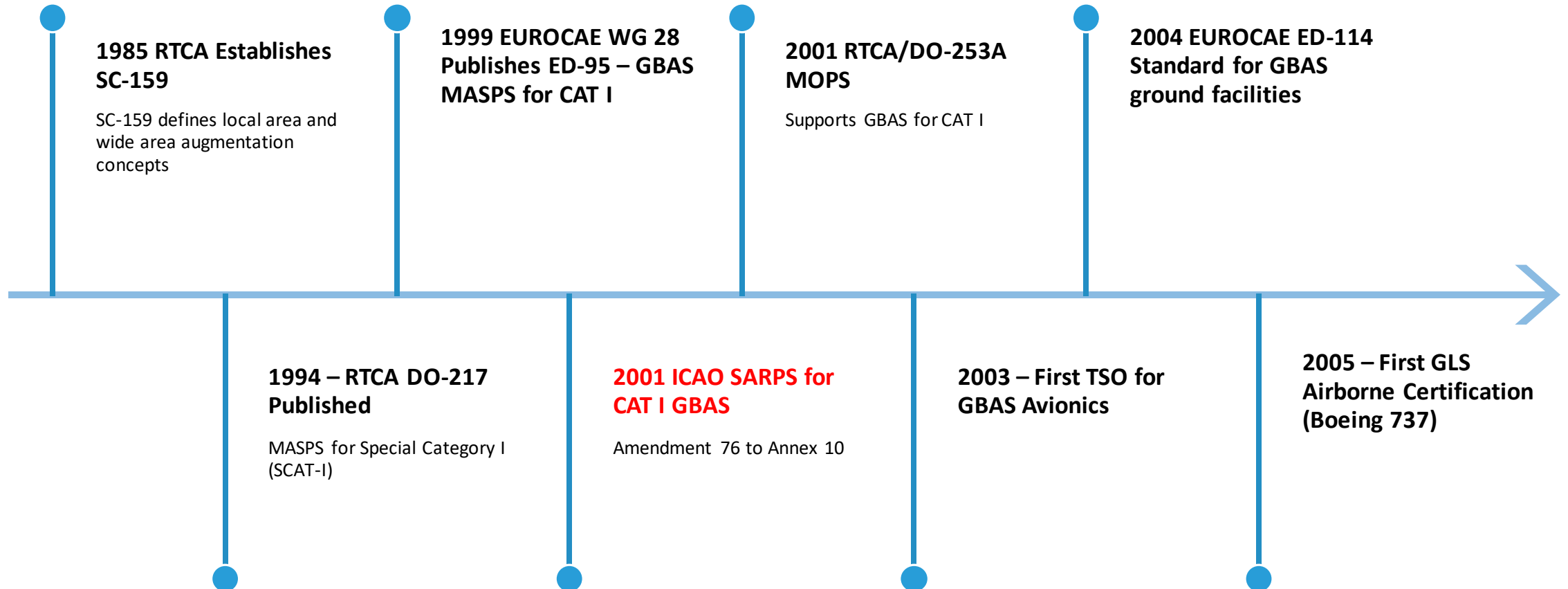
Overview

- Standards Development History
- Relevant ICAO provisions
- Current GBAS Deployment Status
 - GBAS Installations
- Risks and challenges

History of GBAS Development

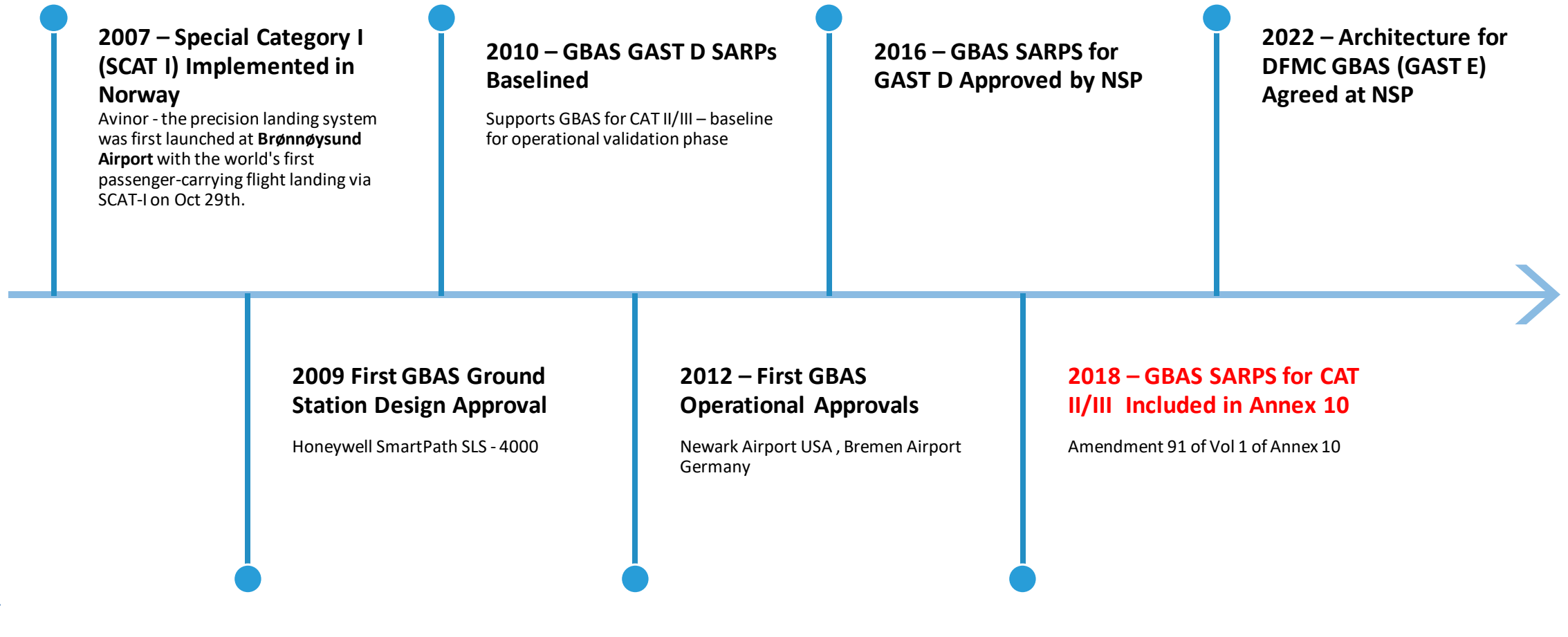
- GBAS Development Spans 4 decades (so far)
 - SARPS Developed for CAT I and CAT II/III
 - Several versions of MOPS for airborne equipment
- Partial Global Deployment
 - CAT I capable ground stations deployed in several countries
 - Several thousand aircraft with GLS CAT I capability
- Standards are Mature ***and*** still Evolving
 - Standards to support CAT I operations mature and tested – significant operational experience
 - Standards to support CAT II/III – Single Frequency GPS only – Operationally validated and published, but no operational experience yet
 - Standards for Dual Frequency Multi-Constellation (DFMC) under development

GBAS Standards Development Timeline



GBAS Standards Development Timeline Continued

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Current ICAO Provisions

- ICAO Annex 10
 - Chapter 3 – Section 3.7.3.5 (and sub sections) – include GBAS SARPS
 - Appendix B – Section 3.6 (and sub sections) – includes detailed GBAS SARPS
 - Attachment D - Section 7 (and sub sections) – Includes Guidance Material for GBAS
- As of Amendment 95, GBAS SARPs include
 - Definitions of GBAS Approach Service Types (GAST):
 - GAST C – intended to support CAT I Operations
 - GAST D – intended to support CAT II/III Operations. Initially single frequency GPS only
- ICAO Doc 9849 – GNSS Manual
 - Has been updated to include GAST D
- ICAO Doc 8071 – Manual on Testing of Radio Navigation Aids – Volume II (5th edition)
 - New edition in work to include expanded guidance on testing GBAS
- ICAO Doc 9718 – Handbook on Radio Frequency Spectrum Requirement for Civil Aviation – Volume II: Frequency Assignment Planning Criteria for Aeronautical Radio Communication and Navigation Systems. (2nd edition 2022 + Amendment 1 (6/18, 2025))
 - Includes guidance for GBAS VHF Data Broadcast Frequency Assignments

Other Important Standards/Resources

- RTCA Documents
 - DO-253 (Series) – Airborne GBAS MOPS
 - DO-253D – Includes GAST C and GAST D Receiver requirements
 - DO-296 – MOPS for VHF Data Broadcast
 - DO-246 - Interface Control Document
 - DO-245A – MASPS for Local Area Augmentation System (LAAS) – Note: Obsolete Do Not Use!
- EUROCAE Documents
 - ED-144 (Series) – Airborne GBAS MOPS
 - **ED-144A** (harmonized directly with DO-253)
 - **ED-114B** – *MOPS for GNSS GBAS Ground Subsystem*
- FAA Documents
 - FAA Order 6884.1 – Siting Criteria for GBAS
 - FAA-E-AJW44-2973A – Ground Station Specification for non-Fed GBAS systems
 - AC 20-138D - Airworthiness Approval of Positioning and Navigation Systems
 - AC 20-191 – Airworthiness Criteria for Low-Visibility Takeoff, Approach, Landing, and Rollout Systems

GLS for CAT I operations has been certified and is offered for forward fit and retrofit

- Boeing: Standard feature on 787 and 747-8, 777-9 Customer selectable option on 737NG. In development on other models
- Airbus: Customer selectable option on A350, A380 & A320.
- Two avionics manufacturers produce receivers (Honeywell and Rockwell Collins)
- Cat II operations have been operationally approved on a GAST-C ground station (Frankfurt)
- GLS for CAT II/III currently being certified for 777-9

Ground Facilities

- Depending on how you count, about 65-140 installations
- ~ 10 approved for full CAT I operations (US, Germany, Spain, Japan, Australia)
- Others are either research prototypes, in development towards approval or Special CAT I (SCAT I, a precursor to GBAS)
- Many (~120) ground stations in Russia (operational status is unknown)
- Four companies make CAT I Stations (Honeywell, Spektr, NEC, CETC (China))
- Many planned sites – **but deployments have stalled in the last few years**
- No current development for GBAS GAST D capable ground stations

GBAS Installations

<https://pbnportal.eu/epbn/main/PBN-Tools/FlyGLS.html>

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GBAS Working Group (GWG)

- Focus of the GWG:
 - GBAS SARPS Maintenance
 - Impact to Other Annexes, and ICAO publications
 - Development of a GBAS Manual
 - Mostly complete draft presented and reviewed at this meeting (NSP/8 WP 19), target for completion – NSP/9
 - Dual Frequency – Multi-Constellation GBAS,
 - Including support for maintenance of the DFMC Concept of Operations,
 - Develop concept paper for DFMC GBAS as an initial step towards development of SARPs
 - Development of SARPs (SARPs drafting ad-hoc).
 - Baseline Development Standard (BDS) – Target (revised) NSP/9
- Issue: Global resources devoted to GBAS development declining
 - Some states/organizations have withdrawn support or deprioritized
 - Consequently, low priority for industry
 - International GBAS Working Group (IGWG) – not currently supported

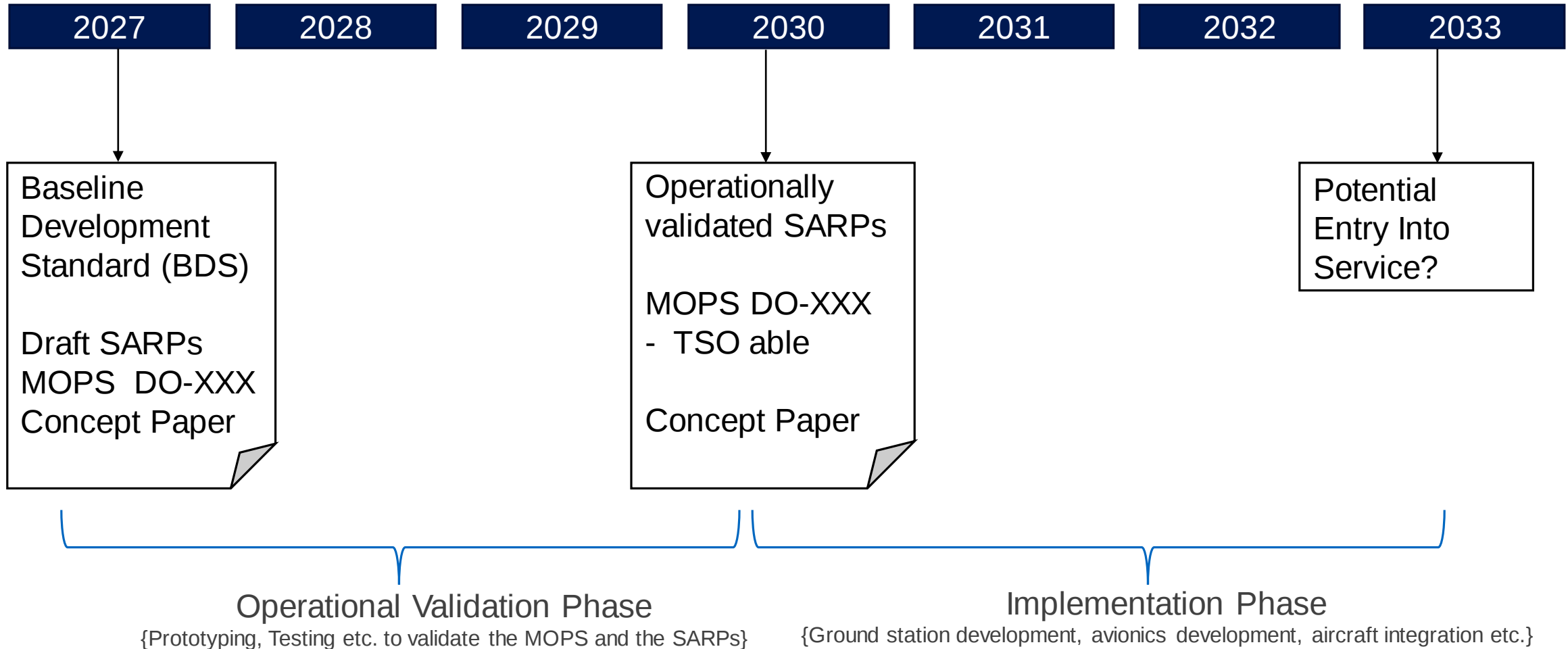


Timeline for DFMC GBAS SARPS Development

Q4 2024	A high-level concept (similar to the level of detail currently proposed by SESAR, with all options selected) agreed in ICAO and RTCA/EUROCAE This deliverable is Complete (JWGs11 WP 16)
Q2 2027	A detailed concept paper agreed in ICAO and RTCA, similar level of detail as the 2009 GAST D concept paper Current target is NSP 9
Q2 2027	A baseline airborne MOPS - Supporting prototype airborne implementations for validation A baseline development SARPs for DFMC GBAS – with technical validation complete - Supporting prototype ground implementations for validation Current target is NSP 9
2030*	Operationally Validated SARPs Proposal Ready for proposal to NSP

* - There is no agreement across all stakeholders on the delivery date for validated DFMC GBAS SARPs

Work Plan on DFMC GBAS SARPS and MOPS



Risks and Challenges for GBAS Development

- Threat of ionospheric gradients
 - Addressed in the development of GAST D
 - GAST D may have limited availability in equatorial regions
 - Being addressed in DFMC GBAS development
- GBAS faces significant political and economic challenges
 - Recent GNSS RFI Experience has eroded confidence in the GBAS solution
 - Business case for GBAS is difficult
 - Rationalization of ILS infrastructure not practical until sufficient airborne equipage
 - Both ILS and GBAS infrastructures may be required indefinitely
 - GBAS capabilities not yet fully exploited to enable new operational capabilities
 - GBAS deployments have slowed and are almost at a standstill
 - World appears to be:
 - waiting for DFMC GBAS, or
 - Considering other alternatives
 - Lack of any recent investment in GBAS could result in industry losing interest