



Global Air Navigation Service Provision Implications of ARAIM

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ICAO Basis for Air Navigation Service Provision



- Article 28 of Chicago Convention (1944)

Air navigation facilities and standard systems

Each contracting State undertakes, so far as it may find practicable, to:

a) Provide, in its territory, airports, **radio services**, meteorological services and other air navigation facilities to facilitate international air navigation, in accordance with the standards and practices recommended or established from time to time, pursuant to this Convention;

- ICAO GNSS Manual, Doc 9847

“By approving GNSS-based operations, a State or regional safety oversight organization (RSOO) accepts responsibility to ensure that such operations meet accepted safety Standards. States can either provide GNSS signals or can authorize the use of signals provided by other entities. In the latter case, the State retains the responsibility to oversee the safety of the service.”



ICAO Charter on GNSS

- **ICAO Assembly Resolution 32-19 (1998)**
- *“Charter on the rights and obligations of States relating to GNSS Services”*
 - Core constellation service is **NOT an ANS under Article 28**
 - To respect sovereignty of States
 - Instead *“provide navigation aid signals for use in aircraft positioning”*
- Result of Panel of Legal and Technical Experts on the Establishment of a Legal Framework with Regard to GNSS (LTEP)
- ICAO GNSS Charter is still in effect



ICAO GNSS Charter Obligations

- *“States recognize that in the provision and use of GNSS services, the **safety** of international civil aviation shall be the **paramount principle**”*
- *“**States shall cooperate** to secure the highest practicable degree of uniformity in the provision and operation of GNSS services”*
- *“**Every State providing GNSS services**, including signals, or under whose jurisdiction such services are provided, shall ensure the continuity, availability, integrity, accuracy and reliability of such services, **including effective arrangements to minimize the operational impact of system malfunctions or failure**”*
- *“...State shall ensure that the services are **in accordance with ICAO Standards**. States shall **provide in due time aeronautical information** on any modification of the GNSS services that may affect the provision of the services”*



ANS with GNSS (supporting PBN, ADS-B, etc.)

Core Constellation Service

- GPS
- GLONASS
- Galileo
- Beidou



Augmentation Service

- ABAS
- SBAS
- GBAS



**ICAO Air
Navigation
Service**

CS Provider

- NOT an ANSP
- Standards in Annex 10

Augmentation Service Provider:

- ANSP with limited scope
- Falls under Article 28

“Aeronautically used” RNSS per ITU



Implications for ARAIM / ISM

- Aviation use of GNSS requires Augmentation
 - ISM Provider is Air Navigation Service Provider
 - Provider sets ISM values
 - Message delivery channel is non-critical (similar to SBAS GEO)
- ISM Parameter setting should be independent
 - ...from constellation provider (but cooperation needed)
 - Fully transparent
 - Some States require ANSP certification
 - Mutual agreements likely necessary for global acceptance



Approval

- States are to approve or authorize GNSS elements
- Current provisions exist, but are generally not used
- Creates unclear situation for GNSS use in a given State
- Even when approving, not so clear what it means

- ICAO CONOPS: current view is that States must approve elements and that future receivers will need to implement geo-dependent tuning
 - In ARAIM, approval status could be implemented through ISM
 - But ISM and approved GNSS element selection could also be separated (open issue)



Goal of Single Global ISM

- Consequences of Multiple ISM
 - Non-uniform safety level
 - Receiver Impact:
 - geo database and update mechanism
 - switching between ISM regions
 - additional avionics interfaces and AIM developments
 - Risk of availability loss due to incorrect or missing ISM
- Increased cost may destroy benefit case
 - May prolong GPS L1 “dependence” indefinitely
- Global ISM at least for En-Route and Terminal H-ARAIM
- Selection mechanisms much easier to implement for V-ARAIM Approach Applications



Sovereignty

- States hesitant to accept dependence on foreign State to meet Air Navigation Service Provision responsibility
 - Provision of radio signals does not infringe on sovereign right to allow or deny access to its airspace
- Terrestrial Infrastructure is efficient mitigation
 - Enables to continue operations if GNSS fails
- Multiple GNSS Provider-States is efficient mitigation
 - Approving as many as possible should be the goal
 - For ARAIM, requires State endorsement of ISM process
- **Combination of multiple providers and terrestrial back ups should be sufficient to address sovereignty concerns**



Liability

- Aircraft Operator is primary liable party in case of accident
 - Passengers & relatives will sue airline
 - Airline may seek compensation from ANSP
- Proceeding against illegal act needs legal basis
 - No suitable law exists for ANSP to in turn claim damages from a GNSS core constellation provider
 - Solution would be to pay CSP, but this is also “against” ICAO policy (problem with fair charging of multi-modal system)
- However: Proving negligence will be difficult
 - GNSS operating in accordance with standards (ICAO & SPS)
 - Extensive validation and monitoring
 - **Responsible system design and operation should limit need for liability provisions**
 - **ANSP can insure residual risks (cost of “free” system)**



Summary

- Building ARAIM Service Provision Framework
 - Based on ICAO GNSS Charter
 - Building on significant established history with GPS
- Providing arguments to overcome past concerns on sovereignty and liability
 - Requires transparency and confidence in Standards
- Key ARAIM Challenge is Global ISM Provision
 - Airspace users deserve “seamless GNSS” at reasonable cost



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Thank you

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This briefing summarizes the current assumptions and progress of Working Group-C. The Working Group will continue to investigate ARAIM assumptions, algorithms, and candidate architecture implementations in order to mature the concept.