



Directorate-General
for Energy
and Transport



EUROPEAN
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Galileo View on Interoperability

ICG Workshop on Interoperability

Vienna, Austria
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European Commission



● Background

- ICG WG-A decided at ICG#3 meeting in Dec. 08 to conduct at least two interim meetings with system providers and industry before ICG-4 to consolidate further the definition of Interoperability
 - 1st Workshop in Munich in March 09
 - 2nd Workshop here in Vienna
- Galileo supports actively ICG efforts to reach consensus definition of Interoperability
- This presentation provides:
 - brief status on EGNOS and Galileo
 - Galileo's view on interoperability requirements in a multi-GNSS environment

● EGNOS Programme Status

- EGNOS is already broadcasting signals of excellent quality
- Year 2009:
 - Assets have been transferred from ESA to the European Community in April 2009
 - **First EGNOS operator** contract as of 1st April 2009
 - **OS declaration** of "entry into service" planned for late 2009
 - EC has finalized the procurement and lease of an EGNOS transponder to replace ARTEMIS as of 2011
 - Geographical service extension is under study
- Year 2010:
 - SoL declaration of "entry into service" planned for mid-2010 (after certification milestone)



● Galileo Programme Status (1/2)

- Galileo is progressing, at the crossing between the development (IOV) and deployment (FOC) phases
 - GIOVE-A, GIOVE-B missions on-going
 - FOC procurement started in July 2008
 - 4 IOV satellites in 2010
 - Full Operational Capability in 2013

● Galileo Programme Status (2/2)

- GPS proposed at ICG Workshop in Munich (March 09) that GNSS providers document civil performance commitments and that WG-A develops a such a document template
- Galileo is currently working on such a future civil performance standard document
- Actual implementation of this goal will take time:
 - Convergence on the list of parameters for commitments
 - Impact on system verification (and therefore on procurement)
 - Commitment on some of these parameters will not be possible until experienced is gained through in-service operation
- List of parameters to be recommended should not be binding for service providers that may want to commit differently

● ICG and Providers' Forum Definitions (1/3)

- The principles of compatibility and interoperability and their definition were **adopted** at the first meeting of the Providers' Forum, held in Bangalore, India, in September 2007
- At the third meeting of the Providers' Forum, held in Pasadena, California, USA, in December 2008, these principles and their definition were **updated**
- EU actively promotes and uses those definitions when coordinating with other GNSS service providers
 - bi-lateral and multi-lateral (ITU, ICG) fora



● ICG and Providers' Forum Definitions (2/3)

- Regular bi-lateral coordination meetings are taking place between system providers to ensure firstly Compatibility
- Some system providers are currently consolidating their system characteristics (e.g. modulation, frequencies and power levels)
 - Consolidated characteristics depend on coordination outcomes

● ICG and Providers' Forum Definitions (3/3)

- Consequently, we need stable principles and definitions of Compatibility and Interoperability
 - In particular for compatibility which is essential
- Galileo proposes that the updated definition of Compatibility as of ICG #3 be frozen and applied between providers
 - Definition of interoperability may require update (reason for the 2 Workshops)

● Galileo Objectives with other GNSS (1/2)

- **Ensure compatibility at a minimum:** means the assurance that one system will not cause interference that unacceptably degrades the stand-alone service that the other system provides, and without adversely affecting national security
 - Radio frequency compatibility (ITU provides a framework)
 - Spectral separation between PRS and other signals
- Compatibility is a **MUST**
 - Once Compatibility has been achieved, interoperability can be addressed

● Galileo Objectives with other GNSS (2/2)

- Galileo encourages **interoperability** between Galileo open signals (OS, SoL and CS) and other space-based PNT signals when desirable for users benefits
 - Focus on E1 CBOC (MBOC), AltBOC E5 (which includes E5a & E5b) and E6 CS signals
 - Interoperability can be achieved only when certain requirements are satisfied (see next 3 slides)

● Interoperability Requirements (1/3)

- In order to reduce receiver cost and complexity:
 - Common (or very close) center frequency and frequency band
 - Similar kind/family of modulations and signal characteristics
- To facilitate navigation solution computation
 - Alignment of Geodetic References
 - Common basis of orbital description (ITRF)
 - Time References synchronised to international standards (UTC)

● Interoperability Requirements (2/3)

- In order to avoid harmful interference jeopardizing interoperability benefit for multi-GNSS receivers (mainly improved geometry) : need for common maximum power level
 - Adherence to ITU Recommendations which requires no harmful interference
 - Adherence to limitation of maximum noise level
 - Initial proposal for not more than +3dB cumulative noise on thermal level from all RNSS
 - Otherwise damages performance of all GNSS receivers
 - Example: if 4 global systems transmit MBOC in E1 the noise floor increase for MBOC receivers can be significant. We must put a limit on this increase
 - Additional contribution from number of SVs – G_{agg}
 - Lowers maximum power from each satellite for larger constellations
 - Max. power levels must be defined on common link budget assumptions (eg atmospheric losses, antenna gain etc)

● Interoperability Requirements (3/3)

- Availability of open information
 - On system architecture
 - signals information (e.g. Interface Standard) allowing design of receivers
- Guarantee of performance standards
 - Commitment to deliver levels of service
 - Actual performance to provide proof of standards
- Reliability
 - Open process for evolution
 - Trust in constancy of signal availability
 - Constellation sustainment

● Conclusions

- EU is actively involved in bi-lateral and multi-lateral coordination processes with other space-based PNT in order to ensure **Compatibility** at a minimum
 - EU supports ICG Providers Forum definition but asks to freeze definition on Compatibility from ICG #3
- Currently, there are opportunities and challenges for Galileo and other GNSS in some frequency bands
 - Galileo welcomes **Interoperability** with other space-based PNT when desirable and as long as the necessary requirements are satisfied
- Frequency diversity is a positive aspect for user benefits
 - Provide improved robustness to interference
 - Examples: L1 & G1 bands and E5a/L5 & E5b bands