Status of Galileo SSV Characterization

UNOOSA ICG 9 – Working Group B
Prague, 12 November 2014
Outline

★ Relevance of GNSS SSV for Europe and ESA
★ Status of Galileo SSV Characterization
★ GSAT0201/0202 Orbit Anomaly – Unique Opportunity for SSV Characterization
★ Conclusions and Way Forward
GNSS Space Applications

★ Main applications of GNSS in space:
  ★ Orbit determination
  ★ AOCS & Timing
  ★ Formation Flying & Rendezvous
  ★ Scientific instruments (RO, Reflectometry)

★ GPS is used at LEO, MEO and GEO altitudes
★ Several studies done at ESA-level identifying the benefits of adding the new GNSS systems
★ Several GNSS technologies under development, new ASICs and receivers
Relevance and added value of an interoperable GNSS Space Service Volume (SSV) is well noted.

Already today a large number of ESA and EU Member State space missions have GNSS space receivers embarked.

<table>
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<tr>
<th>GNSS spacecraft navigation applications and missions</th>
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<td><strong>Application</strong></td>
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<td>Absolute Navigation (Platform Rx)</td>
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<td>Relative Navigation (Platform Rx)</td>
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<td>EO/Scientific Instruments</td>
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<td>Support to other subsystems</td>
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Status of Galileo SSV Characterization

Galileo SSV characterization is currently ongoing following the conventions identified by ICG WG-B regarding

- Relevant User Orbits
  - LEO (represented by sphere at 3000 km altitude above earth)
  - MEO (represented by sphere at 8000 km altitude above earth)
  - GEO/HEO (represented by sphere at 36000 km altitude above earth)

- Availability Evaluation
  - Availability of 1 satellite and availability of 4 satellites
  - Availability evaluation done per user on a sphere at relevant radius over time
  - Availability to report is the minimum out of the best 95% of all user locations

- SSV Characteristics Reporting
  - User received power (not necessarily constrained by data demodulation threshold) at GEO altitude and corresponding off-boresight angle
  - Availability evaluation at GEO altitude
  - Availability evaluation at MEO altitude (based on off-boresight angle specification for GEO altitude)
Important note: It is assumed that the user has capability to receive signals from

- NADIR direction and
- Zenith direction
Important note: It is assumed that the user has capability to receive signals from NADIR
First two Galileo FOC satellites (GSAT0201/0202) launched in August 2014 face orbital anomaly

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<th>Nominal Galileo Orbit</th>
<th>Current GSAT0201/0202 Orbit</th>
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<tr>
<td>Semi Major Axis (SMA) [km]</td>
<td>29600</td>
<td>26180</td>
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<tr>
<td>Eccentricity</td>
<td>0</td>
<td>0.23</td>
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</tbody>
</table>

Plans are existing to raise orbit, reduce eccentricity and conduct In-Orbit Testing

Eccentricity and lower SMA provide unique opportunity

Characterization of SSV-relevant antenna off-boresight range from ground!
★ Off-boresight angles expected during In-Orbit Testing (IOT) of GSAT0201/0202

SSV-relevant off-boresight angle range that can be characterized on ground for GSAT0201/0202

★ Assuming future Galileo satellites in Nominal Orbit with very similar Antenna pattern: Galileo SSV characterisation up to altitude of 2100 km (LEO) is supported by ground measurements!
Conclusions and Way Forward

★ Importance of an interoperable GNSS SSV is fully recognized

★ Characterization of Galileo’s contribution to an interoperable GNSS SSV is currently ongoing

★ Planned In-Orbit Testing (IOT) of GSAT0201/0202 gives unique opportunity to characterise SSV-relevant antenna off-boresight range from ground

★ Results of GSAT0201/0202 need to be awaited before Galileo SSV characteristics are published

★ Publication of Galileo SSV characterization for FOC satellites can be expected for Spring 2015