Mapping from UAVs

inside unmanned systems

GALILEO: AT THE DAWN OF A NEW AGE OF GNSS SERVICES

Monday, December 19
WELCOME TO
Galileo: At the Dawn of a New Age of GNSS Services

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European Space Agency

Jeremie Godet
Head of Sector
Galileo Implementation
DG GROW
European Commission

Fiammetta Diani
Deputy Head of Market
Development Department
European GNSS Agency

Peter Grognard
CEO
Thales Alenia Space
Leuven, Belgium

Co-Moderator: Lori Dearman, Sr. Webinar Producer
Who’s In the Audience?

A diverse audience of over 700 professionals registered from 57 countries representing the following industries:

- **16%** GNSS Equipment Manufacturer
- **16%** System Integrator
- **15%** Professional User
- **15%** Product/Application Designer
- **14%** Government
- **24%** Other
Welcome from *Inside GNSS*

Glen Gibbons  
Editor and Publisher  
Inside GNSS
Galileo: At the Dawn of a New Age of GNSS Services

Demoz Gebre-Egziabher
Aerospace Engineer and
Mechanics Faculty
University of Minnesota
Poll #1

As of today, how many Galileo satellites are on orbit?  
(Please select one)

A. 4  
B. 8  
C. 18  
D. 22  
E. 26
Galileo: Towards Initial Services
Galileo System Essentials

- Galileo is Europe's initiative for a state-of-the-art global navigation satellite system, providing a highly accurate, guaranteed global positioning service under civilian control;

- While providing autonomous navigation and positioning services, Galileo will at the same time be interoperable with GPS and GLONASS, the two other global satellite navigation systems;

- Two major implementation phases:
  - the In-Orbit Validation phase (IOV);
  - the Full operational Capability phase (FOC);

- The fully deployed Galileo system will consist of 30 satellites (24 plus 6 spare) and the supporting ground infrastructure.
Early services for OS, SAR and PRS will be provided from 2014

<table>
<thead>
<tr>
<th>Service Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Service (OS)</td>
<td>Freely accessible service for positioning, navigation, and timing</td>
</tr>
<tr>
<td>Public Regulated Service (PRS)</td>
<td>Encrypted service designed for greater robustness and higher availability</td>
</tr>
<tr>
<td>Search and Rescue Service (SAR)</td>
<td>Assists locating people in distress and confirms that help is on the way</td>
</tr>
<tr>
<td>Commercial Service (CS)</td>
<td>Delivers authentication and high accuracy services for commercial applications</td>
</tr>
</tbody>
</table>

The former "Safety-of-Life" service is being re-profiled:

<table>
<thead>
<tr>
<th>Service</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrity Monitoring Service</td>
<td>Provides vital integrity information for life-critical applications</td>
</tr>
</tbody>
</table>
Galileo Constellation

Walker 24/3/1
Semi-major Axis: 29,600 km
Circular Orbit
Inclination: 56°
Galileo FOC Satellite

Launch Mass: 733 kg
Total Power: 1900 W
Size: 2.5 x 1.2 x 1.1 m^3
Solar Wing Span: 14.7 m
Design Lifetime: 12 years
Passive Hydrogen Maser
The most stable and accurate
→ Loose no more than 0.5 ns in 12h, i.e. 1s over 3 million years

Rubidium
→ Loose 3s over 1 million years

<table>
<thead>
<tr>
<th>Error in time</th>
<th>Error in distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 s</td>
<td>300 000 000 m</td>
</tr>
<tr>
<td>1 ms (0.001 s)</td>
<td>300 m</td>
</tr>
<tr>
<td>1 ns (0.000000001 s)</td>
<td>0.3 m</td>
</tr>
<tr>
<td>Constellation Status (1/3)</td>
<td></td>
</tr>
<tr>
<td>---------------------------</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Launch Date</th>
<th>SV ID</th>
<th>Orbital Slot</th>
<th>Clock</th>
<th>Technical Status</th>
<th>EIRP (wrt Public OS SIS ICD)</th>
<th>SAR Transponder</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSAT0101</td>
<td>21 Oct. 2011</td>
<td>11</td>
<td>B05</td>
<td>RAHS</td>
<td>Nominal</td>
<td>All bands aligned</td>
<td>N/A</td>
</tr>
<tr>
<td>GSAT0102</td>
<td>21 Oct. 2011</td>
<td>12</td>
<td>B06</td>
<td>RAHS</td>
<td>Nominal</td>
<td>All bands aligned</td>
<td>N/A</td>
</tr>
<tr>
<td>GSAT0103</td>
<td>12 Oct. 2012</td>
<td>19</td>
<td>C04</td>
<td>PHM</td>
<td>Nominal</td>
<td>All bands in temporary back-off</td>
<td>N/A</td>
</tr>
<tr>
<td>GSAT0104</td>
<td>12 Oct. 2012</td>
<td>20</td>
<td>C05</td>
<td>RAHS</td>
<td>Testing</td>
<td>E1 only E5 + E6 permanently unavailable</td>
<td>N/A</td>
</tr>
<tr>
<td>GSAT0201</td>
<td>22 Aug. 2014</td>
<td>18</td>
<td>Ext01</td>
<td>PHM</td>
<td>Testing</td>
<td>All bands aligned</td>
<td>Nominal</td>
</tr>
<tr>
<td>GSAT0202</td>
<td>22 Aug. 2014</td>
<td>14</td>
<td>Ext02</td>
<td>PHM</td>
<td>Testing</td>
<td>All bands aligned</td>
<td>Nominal</td>
</tr>
</tbody>
</table>

Note: Unavailable (NAGU 2014014)
**Commissioning completed**
Operational since December 8\(^{th}\), 2016

<table>
<thead>
<tr>
<th>Satellite ID</th>
<th>Launch Date</th>
<th>SV ID</th>
<th>Orbital Slot</th>
<th>Clock</th>
<th>Technical Status</th>
<th>EIRP (wrt Public OS SIS ICD)</th>
<th>SAR Transponder</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSAT0203</td>
<td>27 Mar. 2015</td>
<td>26</td>
<td>B08</td>
<td>PHM</td>
<td>Nominal</td>
<td>Nominal</td>
<td>Nominal</td>
</tr>
<tr>
<td>GSAT0204</td>
<td>27 Mar. 2015</td>
<td>22</td>
<td>B03</td>
<td>RAFS</td>
<td>Nominal</td>
<td>Nominal</td>
<td>Nominal</td>
</tr>
<tr>
<td>GSAT0205</td>
<td>11 Sep. 2015</td>
<td>24</td>
<td>A08</td>
<td>PHM</td>
<td>Nominal</td>
<td>All bands aligned</td>
<td>Nominal</td>
</tr>
<tr>
<td>GSAT0206</td>
<td>11 Sep. 2015</td>
<td>30</td>
<td>A05</td>
<td>PHM</td>
<td>Nominal</td>
<td>All bands aligned</td>
<td>Nominal</td>
</tr>
<tr>
<td>GSAT0208</td>
<td>17 Dec. 2015</td>
<td>08</td>
<td>C07</td>
<td>PHM</td>
<td>Nominal</td>
<td>All bands aligned</td>
<td>Nominal</td>
</tr>
<tr>
<td>GSAT0209</td>
<td>17 Dec. 2015</td>
<td>09</td>
<td>C02</td>
<td>PHM</td>
<td>Nominal</td>
<td>All bands aligned</td>
<td>Nominal</td>
</tr>
<tr>
<td>GSAT0210</td>
<td>24 May 2016</td>
<td>01</td>
<td>A02</td>
<td>PHM</td>
<td>Nominal</td>
<td>All bands aligned</td>
<td>Nominal</td>
</tr>
<tr>
<td>GSAT0211</td>
<td>24 May 2016</td>
<td>02</td>
<td>A06</td>
<td>PHM</td>
<td>Nominal</td>
<td>All bands aligned</td>
<td>Nominal</td>
</tr>
<tr>
<td>Satellite ID</td>
<td>Launch Date</td>
<td>SV ID</td>
<td>Orbital Slot</td>
<td>Technical Status</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSAT0207</td>
<td>17 Nov. 2016</td>
<td>07</td>
<td>C06</td>
<td>Under Commissioning (NAGU 2016050)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSAT0212</td>
<td>17 Nov. 2016</td>
<td>03</td>
<td>C08</td>
<td>In Orbit Test Review planned June 2017</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSAT0213</td>
<td>17 Nov. 2016</td>
<td>04</td>
<td>C03</td>
<td>In Orbit Test Review planned June 2017</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSAT0214</td>
<td>17 Nov. 2016</td>
<td>05</td>
<td>C01</td>
<td>In Orbit Test Review planned April 2017</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- EIRP (wrt. Public OS SIS ICD)
- SAR Transponder
<table>
<thead>
<tr>
<th>Year</th>
<th>IOV</th>
<th>FOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>2015</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>2016</td>
<td>18</td>
<td>22</td>
</tr>
<tr>
<td>2017</td>
<td>26</td>
<td>24 May 17 Nov</td>
</tr>
</tbody>
</table>
Major Galileo centres and facilities are located throughout Europe

Note: Only major centres, facilities and stations are shown. Not all of them are (fully) implemented yet.
2 Complementary Control Centres:

- **Ground Mission Segment (GMS)** in Fucino (Italy) has the responsibility for the mission aspects;

- **Ground Control Segment (GCS)** in Oberpfaffenhofen (Germany), to control and monitor the constellation.

Both centres are being completed to become fully redundant.
Galileo Service Center (Madrid)
From a System to Services
Galileo: eager to serve
GALILEO INITIAL SERVICES

Jeremie Godet
Head of Sector, Galileo Implementation, DG GROW
European Commission
European Space Strategy

26 October 2016

- 1- Maximise benefits of space for Society and EU
  - Market uptake
  - EU delivers!

- 2- Foster competitiveness and innovation

- 3- Autonomy and access to space

- 4- Promote International cooperation

- Copernicus

- **Galileo** and EGNOS
Galileo Initial Services

- **Open Service**
  - free and interoperable with other GNSS
  - world-wide access

- **Public Regulated Service**
  - access authorised and controlled by Competent Authorities
  - world-wide coverage

- **Search and Rescue**
  - free
  - world-wide, under the international organisation Cospas- Sarsat
  - locate emergency beacons and communicate the distress to Search & Rescue centers
Today

**Infrastructure tested:** excellent Performances

- Constellation of satellites: 18 in orbit today
- Ground segment: world-wide
- Last launch 17-11-2016: Ariane-5: success!

**For the Initial Services:**
- 11 sat for OS/PRS
- 12 sat for SAR
- ... not yet including the 4 satellites launched on Nov.17
- Stay posted! [www.gsc-europa.eu](http://www.gsc-europa.eu)

... delivering high performance services

- ~ 0.8 meters (avg. ranging, 95%)
- ~ 3/~8 meters (avg. H/V accuracy, 95%, when PDOP<6)
- ~ 9.5 nanosec (UTC dissemination accuracy, 95%)
- ~ 7 nanosec (Galileo-GPS time offset, 95%)
- SAR location probability within 10 minutes above 98%
Service Definition Documents

- Documents ready for OS, PRS and SAR
- Published: 15/12/2016
- Based on predefined Minimum Performance Levels (MPL)
- Include additional technical information and expected evolution of services

The conditions under which the Galileo Initial Services will be delivered, including their expected performance (accuracy, etc) and availability, have been published on the website of the European Service Centre found here: www.gsc-europa.eu
<table>
<thead>
<tr>
<th>Performance parameter</th>
<th>MPL Value</th>
<th>observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ranging Accuracy for any satellite (SF/DF, monthly)</td>
<td>≤ 7 m (95%)</td>
<td>1.4 m</td>
</tr>
<tr>
<td>Ranging Accuracy over all satellites (SF/DF, monthly)</td>
<td>≤ 2 m (95%)</td>
<td>0.81 m</td>
</tr>
<tr>
<td>UTC Time Dissemination Accuracy (SF/DF, annually)</td>
<td>&lt; 30 ns (95%)</td>
<td>9.5 ns</td>
</tr>
<tr>
<td>UTC Frequency Dissemination Accuracy (SF/DF, annually)</td>
<td>&lt; 3E-13 (95%)</td>
<td>2.15E-14 ns</td>
</tr>
<tr>
<td>Per-Slot Availability (SF/DF, annually)</td>
<td>≥ 87%</td>
<td>95.1%</td>
</tr>
<tr>
<td>Availability of the Ranging Service (SF/DF, monthly)</td>
<td>≥ 87%</td>
<td>99.6%</td>
</tr>
<tr>
<td>Availability of the UTC Time Determination Service (SF/DF, monthly)</td>
<td>≥ 87%</td>
<td>99.6%</td>
</tr>
<tr>
<td>Galileo GST-GPS Time Offset Determination Accuracy (annually)</td>
<td>&lt; 20 ns (95%)</td>
<td>6.8 ns</td>
</tr>
<tr>
<td>Galileo GST-GPS Time Offset Determination Availability (annually)</td>
<td>≥ 80%</td>
<td>82%</td>
</tr>
<tr>
<td>Timely publication of NAGUs (planned events)</td>
<td>≥ 24 hours</td>
<td>100%</td>
</tr>
<tr>
<td>Timely publication of NAGUs (unplanned events)</td>
<td>&lt; 72 hours</td>
<td>100%</td>
</tr>
</tbody>
</table>
Galileo Initial Services offer:
  up to 3 frequencies for Open Service (E5a, E5b, E1B/C)
  2 frequencies for Public Regulated Service (E6A, E1A)

First Open Service Definition Document with global coverage multiple frequencies navigation signals
### Galileo SAR Initial Service offers:

- Cospat Sarsat (C/S) MEOSAR Ground Segment Early Operational Capability (EOC) over SAR Galileo Service (SGS) coverage and Global Space Segment coverage
- Endorsed by C/S Council Decision
- Based on Galileo L-band SAR repeaters and GPS S-band experimental repeaters
- EOC to FOC: Full space segment coverage with operational L-band SAR repeaters
- Observed performance for all MPL above FOC targets in the SGS coverage

<table>
<thead>
<tr>
<th>Performance parameter</th>
<th>MPL Value</th>
<th>observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of transmitted bursts that are detected by at least one MEOLUT</td>
<td>&gt;99%</td>
<td>99.5%</td>
</tr>
<tr>
<td>Location probability after 1 transmitted burst</td>
<td>&gt;75%</td>
<td>97%</td>
</tr>
<tr>
<td>Location probability after 12 transmitted burst</td>
<td>&gt;98%</td>
<td>99%</td>
</tr>
<tr>
<td>Location accuracy (within 5km) after 1 transmitted burst</td>
<td>&gt;70%</td>
<td>96%</td>
</tr>
<tr>
<td>Location accuracy (within 5 km) after 12 transmitted burst</td>
<td>&gt;95%</td>
<td>96.5%</td>
</tr>
<tr>
<td>Location accuracy (within 2 km) after 12 transmitted burst</td>
<td>&gt;80%</td>
<td>88%</td>
</tr>
</tbody>
</table>

The table above summarizes the performance parameters and their observed values for the Galileo SAR service.
Search and Rescue is now much faster (->3h to <10 minutes) more accurate (10 km to 5 km)
Galileo work ahead...

- **Galileo Initial Services** are the first step towards reaching Full Operational Capability by end of 2020

  - **Infrastructure**: Complete the constellation
  - **Operations**: Ensure that performances are maintained
    - New operator ("GSOp")
  - **Services**
    - Differentiators (target 2018)
      - Open Service Navigation Message Authentication
      - Commercial Service High Accuracy
      - Search And Rescue Return Link
  - **Improvements**: OS Navigation Message improvement for TTFF, robustness, synchronisation for LBS
  - **Markets**: Uptake in different sectors of the economy
    - Available for use in EU policies
Ask the Experts – Part 1

Marco Lisi, Dr. eng.
Senior Manager
European Space Agency

Jeremie Godet
Head of Sector
Galileo Implementation
DG GROW
European Commission

Fiammetta Diani
Deputy Head of Market Development Department
European GNSS Agency

Peter Grognard
CEO
Thales Alenia Space Belgium
Poll #2

Approximately, how many major vendors provide Galileo-capable receivers today? (Please select one)

- 3
- 10
- 17
- 30
- None.
GALILEO and initial services: the users perspective

European GNSS Agency - GSA

Fiammetta Diani
Deputy Head of Market
Development Department
European GNSS Agency
Agenda

The Galileo initial services: benefits for the users and readiness of receivers

Galileo ready to use: from smartphones to transport

An outlook on the future and current R&D opportunities
Ready for transition from deployment to operations!

- European GNSS Agency (GSA) to progressively manage exploitation activities delegated by European Commission acting as programme supervisor

- European Space Agency (ESA) to continue with its role for the system design and development
What Initial Services mean for the users?

**Better availability of satellite signals:**

Being compatible and interoperable with GPS, all Galileo-enabled navigation devices are capable to ‘see’ more satellites → especially important in urban environments where the presence of high buildings can prevent signal reception.

**Improved Search and Rescue service:**

SAR services enhanced with Galileo will improve:
→ Detection time of a person in distress (3 hours vs 10 minutes)
→ Accuracy of position of the distress beacon (10km range vs 5 km range)

**Very precise timing:**

Galileo timing will provide very high accuracy and resilience, e.g. in combination with GPS, needed for infrastructure synchronisation.

→ The timing of Galileo can be used with only one satellite in view
**Advantages of dual frequency**

<table>
<thead>
<tr>
<th>Better accuracy</th>
<th>Why L5/E5 is the best solution for a second frequency?</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ionosphere error correction</td>
<td>• A protected frequency</td>
</tr>
<tr>
<td>• Faster and more reliable carrier phase ambiguity resolution</td>
<td>• There will be soon more L5/E5 satellites than L2C satellites</td>
</tr>
</tbody>
</table>

**Increased robustness**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Reduce vulnerability risks of GNSS signals to jamming and/or spoofing</td>
<td>• Shared by all GNSS and all SBAS</td>
</tr>
<tr>
<td></td>
<td>• More widely separated from L1, thus minimising the iono-free linear combination errors</td>
</tr>
</tbody>
</table>

**Specific key advantages of L5/E5 signal**

<p>| | |</p>
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>• Better multipath mitigation and better accuracy using L5/E5 signals vs using L2C</td>
<td>• Higher received power for L5/E5 vs L2C</td>
</tr>
</tbody>
</table>
The European GNSS Service Centre (GSC) is the single interface between the Galileo system and the users of the Galileo Open Service (OS), and the Galileo Commercial Service (CS).

www.gsc-europa.eu
Is it possible to use Galileo in receivers?

From 3 manufacturers adopting Galileo in 2010 to 17 in 2016, representing more than the 95% of global supply

- **2010**
  - u-blox
  - septentrio
  - STMicroelectronics

- **2016**
  - **TIMING**
    - Spectracom
  - **SMARTPHONES/MASS MARKET**
    - Intel
    - Qualcomm
    - Broadcom
    - Mediatek
  - **AUTOMOTIVE**
    - CSR
    - STMicroelectronics
    - Qualcomm
    - u-blox
  - **UAVs**
    - Thales
    - Furuno
    - Leica Geosystems
  - **HIGH PRECISION**
    - NovAtel
    - TOPCON
    - septentrio
Agenda

The Galileo initial services: benefits for the users and readiness of receivers

Galileo ready to use: from smartphones to transport

An outlook on the future and current R&D opportunities
Use Galileo.eu, a dedicated online database of Galileo ready devices

USEGALILEO.EU

Galileo Initial Services triggered many forward-looking companies to create Galileo-enabled receivers, chipsets and modules and launch them in the market.

Users can keep track of Galileo-enabled devices in the different market segments, and be informed as soon as new ones become available.
The BQ Aquaris X5 Plus is the first European Galileo ready smartphone

- Launched in July 2016 it features a Galileo enabled Qualcomm Snapdragon 652 chip
- Today, thanks to the release of the new firmware, the smartphone is capable to track Galileo satellites
The eCall case: Automatic Emergency Call Systems

Galileo compatibility required in every new car/van model sold in Europe

United Nations Economic Commission for Europe (UNECE) working in a eCall harmonised regulation

From April 2018

13 Millions of light vehicles sold every year in EU

Decision in 2017
Digital Tachograph (DT) is the early driver of Galileo Authentication

- **Digital Tachograph** (DT) improves road safety, supporting the respect of time of drive and rest rules.

- The new amended **EU legislation** is proposing GNSS inside the new generation of Digital Tachograph requiring in particular Galileo compatibility.

- The need for **increased robustness and trustability** is opening new opportunities for Galileo OSNMA Authentication!
Galileo IMO recognition opens Galileo market in commercial shipping

Galileo recognised as part of World Wide Radio-Navigation System during the 96th session of the Maritime Safety Committee in London on 17 May 2016

- A huge **milestone enabling** Galileo adoption in commercial shipping worldwide

- A potential ~110 m€ market **enabled** with relevant positive effect on recreational market segment
Agenda

The Galileo initial services: benefits for the users and readiness of receivers

Galileo ready to use: from smartphones to transport

An outlook on the future and current R&D opportunities
Galileo will provide an **efficient, resilient and low-cost solution** against spoofing attacks.

**Expected availability:**
- OS E1B with OSNMA starting 2018, at very low cost. (*)
- CS E6 signals with Spreading Code Encryption/Authentication by 2020

**OSNMA receiver implementation efforts/HW are low.**

(*) Source: EC. Current OSNMA proposed in "Reserved 1" field (20bps) of E1-B through TESLA protocol. Analyses and simulations incl. degraded environments show no performance degradation wrt. standard PNT.
The 1st edition of the GSA’s GNSS User Technology Report provides an overview of the state-of-the-art of GNSS receiver technology including:

- General overview of the latest GNSS receiver technology common to all application areas
- An in-depth analysis of GNSS user technology as it pertains to three key macrosegments:
  - Mass market solutions
  - Transport safety and liability-critical solutions
  - High precision, timing and asset management solutions
- Supplement on location technologies that looks beyond GNSS in the positioning landscape

Available for download here: HTTP://BIT.LY/2CGARXF
Funding mechanisms promote the development of Galileo compatible solutions

Applications Development:
- Going beyond state-of-the-art
- With effective business plan
- Exploiting the Galileo initial services and differentiators

40 projects already running
Third Call open now: **33 millions euros**
Deadline: **1st March 2017**

Receivers Development:
- Innovative receivers, chipset devices valorising Galileo and its signal
- Addressing main market segments (mass market, automotive, maritime, timing, etc.)

Overall budget (EGNOS and Galileo): **111.5 millions euro**
**7 new calls** by end of 2017.

http://www.gsa.europa.eu/r-d/gnss-r-d-programmes
Galileo Initial Services: Perspective from a User

Peter Grognard
CEO
Thales Alenia Space
Leuven, Belgium
Galileo Initial Services
Congratulations to the Galileo Programme!

- We have come a long way since the first signal reception on January 12, 2006 from GIOVE-A, the first Galileo satellite.

- **Eighteen Galileo satellites are now orbiting the Earth.... Galileo is now ready to be used.** Source GSA

- Almost there: 16 more satellites to go!
  - 4 S/C in 2017, 4 S/C in 2018
  - 8 S/C there after!
Mass market / professional: today’s market is a two-dimensional world
- Accuracy: low/high
- Integrity (or cost): low/high

For **professional** users, accuracy and availability key – integrity for aviation users
- Traditional multi-system/multi-frequency approach works

For **mass market** users, cost, power consumption, size.
Galileo Initial Services Perfectly Addressing Today’s needs for High Accuracy & High Availability Around the World (1/2)

Source: Septentrio
ASECNA Test Campaign

Source ASECNA – TAS-F – Pildo - SSN
- Market segmentation will be along three axes tomorrow:
  - Accuracy: low/high
  - Integrity (or cost): low/high
  - Authentication

- Road becoming the biggest professional segment (?) – safety and security become key requirements, too
  - Accuracy
  - Integrity
  - Authentication – spoof-proof?

You’ll need it all
Galileo proposing solutions for tomorrow’s challenges

“Spoofing will attain virus status”

- Several layers of defense against spoofing
  - Open Service
  - Commercial Service
  - PRS

- Galileo proposes new solutions - on other GNSS systems too?

- Integrity Monitoring Service
  - Providing integrity information for safety-critical applications

Source: The Japan Times
Visit [www.insidegnss.com/webinars](http://www.insidegnss.com/webinars) for:

- PDF of Presentations

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Now that Galileo is here, our (my) company (organization) plan is:

(Please select all that apply)

- Develop, purchase, and/or use Galileo-capable solutions
- Evaluate future use of OS capabilities
- Evaluate future use of PRS capabilities
- Evaluate future use of the SAR capabilities
- None of the above
Ask the Experts – Part 2

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