Galileo Programme status

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Galileo Today

- 26 satellites in-orbit (22 operational)
- Ground Segment deployed in 23 sites Worldwide
- Global PNT and SAR services since Dec 2016
- Over 1 billion Galileo-enabled chips sold every year
- Best ranging performance of all GNSS (GPS, Glonass, Beidou, Galileo)
- Leader in dual-frequency sub-meter accuracy market
- Leader in Search-and-Rescue services within COSPAS SARSAT (Return-Link certified)
- Interoperable with 5G Location-based services standardization
- Galileo (with GPS) is the only FCC-licensed GNSS in the USA
Galileo Constellation Status

Navigation (22 in service)
Search and Rescue (23 in service)

- 26 satellites in orbit
- 2 in testing (NAV P/L only)
- 1 spare
- 1 unavailable (NAV P/L only)
- 2 no SAR (by design)
Batch 3 Satellites

- 12 additional Batch-3 Satellites under production
  - Contract with OHB/SSTL

- Ready for launch end 2020 onwards
Future Launch services

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GALILEO GROUND SEGMENT OVERVIEW

LEGEND
- GCC: Ground Control Centre
- GSS: Ground Sensor Station
- ULS: Uplink Station
- TTC: Telemetry, tracking and Command
- SAR-ML: Search and Rescue Medium Altitude Earth Orbit Local User Terminal
- GSMC: Galileo Security Monitoring Centre
- TGVF: Timing and Geodetic Validation Facility
- IOT: In Orbit Test Centre
- LEOPCC: Launch and Early Operations Control Centre
Signal In Space Ranging Performance

- Decreasing Ranging Error trend due to increasing number of Satellites and G/S improvements
- **Ranging accuracy 0.27m (95%)** all satellites in August 2019 FNAV
- Stable ranging accuracy despite removal of GSS-ASC and GSS-FAL on 14/02/2019
Galileo Timing Performance

Broadcast UTC Offset

GGTO accuracy

- Evaluated with calibrated timing GPS/Galileo receiver operated in UTC(k) laboratory (PTB, INRIM)
- 10-15ns bias since mid June caused by residual calibration offset (being corrected)

16.8ns (95%) < 30ns IS target

14.9ns (95%) < 20ns IS target
Positioning Performance & Availability

- 4 more satellites operational since February 2019
- Satellites in operational constellation: 22
- Availability of H. Accuracy <10 m: 100% (Average User Location)
- Global PDOP <=6 availability: 99.99% (Average User Location)
- Availability for Timing Service: 100%

Measured PVT Accuracy (Source TGVF)

Availability of Horizontal Position Accuracy < 10 m for 22 satellites
Sub meter positioning accuracy with Dual Frequency GNSS chipset

- Dual Frequency outperforms Single Frequency positioning Accuracy (~3 mt difference)
- Positioning Accuracy can still be increased below one meter using PPP approach

Source: Galileo Hits the Spot: Testing GNSS Dual Frequency with Smartphones (Inside GNSS)

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Towards FOC and Beyond

- Completion of the Satellite Constellation and Ground Segment evolution leading to Full Operational Capability

- Introduction of new service capabilities:
  - **Search and Rescue Return Link**
  - **OS Navigation Message Authentication**
  - **I/Nav message improvements**
  - **High Accuracy Service**
  - **Commercial Service Authentication (“trustable signal”)**
  - **OS for Safety of Life Users**
  - **Emergency Warning Service**
Towards G2G Second Generation

"G1G"  First Generation

"G2G"  Second Generation

Transition

- Automated operations
- Increased lifetime
- Increase reliability
- Security threats
- Optimize receivers
- Lower costs
- ...

... backward compatibility

flexibility

forward compatibility ...

Transition: ensuring service continuity while validating new concepts in orbit
Galileo Second Generation main features

- Ensure continuity of Legacy services over 2025-2030
- Incremental introduction of new system features and services towards G2G
  - Open Service capabilities (power consumption, convergence)
  - High Accuracy evolution (integrity, availability)
  - PRS robustness
  - Transmit power
  - System and SIS in-orbit flexibility / reconfiguration / time-to-market
  - Interoperability with non-GNSS, e.g. 5G
  - Inter-Satellite Links (ranging, mission dissemination, command & control)
  - SAR 2nd Gen Beacons
  - Security resilience
  - Reduce operations / maintenance cost
  - Ground technology modernisation
  - Accelerate time-to-market
Galileo Second Generation: Technology Development

- ESA EGEP & EC H2020 HSNAV Programmes are investing up to 2020 around 340M€ (150+ contracts) in GNSS R&D
Long-Term Constellation Deployment

L10 (FOC FM19,20,21,22)

FOC Batch 3 (FOC FM23 - FM36)

G2G Transition Batch

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Batch 3 Satellites Contract

G2G Transition Satellites procurement

G2G Procurement Process

G2G Satellites Development

Launch of G2G Competition
G2G Transition workplan 2020

- G2G Mission Requirements consolidation
- G2G System Requirements Review:
  System and Segment requirements in support of Transition satellites
  BAFO request and Transition GSEG procurement

- Satellites Transition Batch: Procurement on-going
- Transition Ground Segment: Phase B studies on-going
  Phase C/D Procurement actions preparation in 2020 in support of
  Transition satellites command & control and legacy mission

- G2G / Transition pre-developments / Test Beds: SSEG and GSEG
Conclusions

- Excellent Galileo ranging and timing performance
- New SAR Return Link service
- Programme Priority: reinforce Galileo PVT service continuity
- Next satellites Batch 3 well under way
- Galileo E5 boosting GNSS dual-frequency market
- INAV, OS NMA, High Accuracy, Commercial Authentication and Safety of Life coming
- Transition towards Second Generation
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Click on the icons to find Galileo-enabled devices.

http://www.esa.int/Applications/Navigation