Galileo Terrestrial Reference Frame and beyond: the GGSP project

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Outline

- GGSP Prototype
- Galileo Terrestrial Reference Frame
- Processing of GIOVE data
- Outreach
- Summary and Outlook
Galileo Geodetic Service Provider (GGSP)
Prototype started in July 2005 as project of the 6th FP of the EU
Prolongation until May 2009
Main tasks:
- Realization of a GTRF aligned to the ITRF
- Implementation of a prototype for a permanent service
- Inclusion of GSS when installed
- Recommendations for the permanent service
- Software extension for Galileo: Bernese, NAPEOS and EPOS “Galileo ready”

The GGSP project is managed by the European GNSS Supervisory Authority (GSA) through EU 6FP funds
GTRF realization

- Initial realization in November 2007
- About 100 IGS sites and 13 GESS
- Campaign-like analysis (4 weeks each three months)
- Since September 2008 continuous operation
- RINEX 3.0 as standard data format within GGSP for GPS+Galileo (GIOVE) data
- Software tests and validation
- Combined solution aligned to ITRF2005
- Semi-annual releases
Initial realization including 13 GESS

- IGS station
- GESS site
GTRF realization – GESS residuals
GTRF realization – horizontal velocities

GTRF08v01 Velocity Field

Major plate boundaries are shown in green
GEFS are shown in blue
1 cm/y

Zuheir Altamimi
GTRF realization – orbit and clock combination

Orbits (PF solutions compared to GRF Final)

- AL
- ES
- GF
- IGF

Weighted RMS [mm]

Time [GPS weeks]

Clocks (PF solutions compared to GRF Final)

0.03 ns ≈ 10 mm

Clock RMS [ns]

Time [GPS weeks]
GIOVE-A & -B

Galileo In-Orbit Validation Experiment (formerly GSTB-V2A/B)

GIOVE-A
- Launch Dec, 28, 2005 (aka E01)
- Two Rubidium Atomic Frequency Standards (RAFS)

GIOVE-B
- Launch Apr, 27, 2008 (aka E16)
- Two RAFS and Passive Hydrogen Maser (PHM)

Galileo: Two RAFS and 2 PHM
- More: www.giove.esa.int
GGSP consortium members activities on GIOVE data

- Orbit & clock processing & combination
- Long term and short term frequency stability
- Combination/comparison with SLR → Thaller et al., Tue, 21, A49
GIOVE – orbit processing

- GPS weeks 1500, 1505, 1509, and 1515
- Orbits and clocks from Processing Facilities (PF)
  AIUB, ESOC, and GFZ
- Orbit differences
  PFs to combination: 10 – 30 cm
GIOVE – Allan deviation for selected satellites & stations
GIOVE – Allan deviation for satellite clocks

![Graph showing Allan deviation for satellite clocks]
GIOVE – Allan deviation, short time stability

Allan deviation $\sigma(\tau)$ in s/s

Time interval $\tau$ in s

Ref: BRUS

G17
G28
G29
E01
E16

EGU, Vienna 21/04/09
GIOVE – Code Bias

Receiver Intersystem Code Biases for GESS (244/08 - 013/09)

GESS equipped with experimental receiver / antenna combination!
GPS: IGS+GESS -> no difference visible

GIOVE experimental satellites vs. GPS operational sats.
GGSP - outreach

- Survey about GGSP, GTRF, and Galileo
- Geodesy-related questions about knowledge, acceptance, and user needs
- Questionnaire available as webpage
- Several hundred recipients invited by Email
- > 100 submission from > 50 countries from all continents between Sep ’08 and Jan ’09
- Majority of submissions by governmental organisations and research institutes but also industry, SME, service provider, etc.
What are your current and future latency requirements?

Current latency requirements:
- Predicted
- Real-time
- 1-3 hours
- 1 day
- 1 week
- > 1 week
- Don't know
- Not used

Future latency requirements:
- Predicted
- Real-time
- 1-3 hours
- 1 day
- 1 week
- > 1 week
- Don't know
- Not used
When do you intend to start with Galileo?

- Before FOC: 36
- At FOC: 10
- After FOC: 9
- Don't know: 9
- Not used: 1
- As soon as possible: 40
Summary

- FP6 project covering Galileo Reference Service Provider to be finalized next month
- Necessity of a high-precise Galileo Terrestrial Reference Frame for routine Galileo operation identified
- 3G (GPS + GLONASS + Galileo (GIOVE)) processing on an advanced level at all PFs
- Expected behaviour of GIOVE-B onboard PHM confirmed
- Waiting for Galileo IOV ...
Thank you for your attention!

http://www.ggsp.eu