ESA Proposal for
Multi GNSS Ensemble Time – MGET

Werner Enderle
Erik Schoenemann
Overview

• Introduction - Multi GNSS Ensemble Time (MGET)
• Impact on User - PVT and POD
• Impact on System Level
• Who could provide Multi GNSS Ensemble Time
• Summary
Introduction – Current Situation

• Each GNSS has it’s own System Time
• Each individual GNSS System Time is linked to UTC
• To generate a multi-constellation PVT it is mandatory to know the relative time offsets between the GNSS
• GNSS time offsets are provided as relative offsets between GNSS (e.g. GGTO)
• To calculate PVT, the receiver time is referred to a time realisation of a single GNSS time
Introduction – ICG Initiatives

One of the key Requirements for computation of interoperable PVT solutions is **Intersystem Timing**

At the 2nd interim WG-S meeting (Paris, July 2017) the EC presented an ESA idea "UTCg", now renamed: **Multi GNSS Ensemble Time (MGET)**.

Other possible name option: **GNSS Time Coordinated (GTC)**

---

**DRAFT RECOMMENDATION**

2nd System Time Workshop

- The workshop participants concluded that all System Providers should continue to improve the alignment of their individual system times with UTCK to benefit users
- It was also recognized that currently, the only GNSS to GNSS system time offsets (G2GTOs) that are being broadcast are relative to GPS system time
- The participants identified a number of possible approaches for system time interoperability:
  1. System time offsets are calculated at the user receiver level – No Action from System Providers
  2. System Providers broadcast additional GNSS to GNSS system time offsets (G2GTOs)
  3. The development of a GNSS Ensemble time, such as the UTCg proposal, with the broadcast of individual system time offsets relative to the ensemble time

- **Recommendation**: *Conduct a second System Time Workshop in 2018 focused on assessing these approaches*
Introduction - Basic Concept

• All GNSS providers have committed to steer their system time towards UTC
• MGET is proposed to be common, but system independent time reference
• MGET is proposed to be an ensemble paper time, generated based on contributions from the different GNSS, predicted and valid for a specified time period, e.g. 24 hours
• GNSS Systems Time offsets against MGET is considered to be known in advance with a certain accuracy
• Each GNSS Service Provider would provide the respective time off-set between MGET and their GNSS System Time in the navigation message
• Each GNSS Service Provider would be solely responsible for computing their offset to the common time scale - MGET
Introduction - Basic Concept

Calculation and Prediction of Ensemble Time MGET

MGET t0 Publication

Next MGET Publication

Validity of MGET 24 hours

t0 ______________________ t1

Time offset GNSS I
Time offset GNSS II
Time offset GNSS III

GNSS 1 Clocks

GNSS 2 Clocks

GNSS 3 Clocks

GNSS 4 Clocks

...
Impact on User - PVT and POD

• **PVT Calculation**
  - Receiver can directly use MGET to process all GNSS data
  - Offset between GMET and individual GNSS System Time is provided in the navigation message of the respective GNSS
  - Potential benefits in challenging environments (urban canyons)

• **Precise Orbit Determination - POD**
  - Reduce complexity of GNSS data processing
  - Possibility to process each constellation individually, no need to include all constellations in a single solution -> Reduce impact on overall solution in case one constellation has a problem
Impact on System Level

Example

- Galileo-GPS Timing Offset (GGTO)
- Galileo transmits this timing offset in its signal to achieve tighter interoperability
- It took considerable resources to implement at EU and US level
- Individual timing offsets, non-trivial and costly
- No other intersystem timing offsets planned for Galileo
- These changes impact the system, depending on the method selected
Who could provide Multi GNSS Ensemble Time

**Different potential options are possible**
- A single institution could provide the MGET
  - IGS, BIPM
- MGET computation by each individual GNSS provider with an agreed algorithm and weighting
- Closer steering of all GNSS timescales to UTC mod 1 sec
- ...

**Potential way forward (subject to ICG and IGS approval)**
- ICG initiates together with IGS a Trial Project (similar to the IGMA)
- ICG/IGS Task Force defines the ToR and Work Plan for MGET
- IGS generates MGET based on existing infrastructure and new partners which would like to be involved
- Based on progress of Trial Project, ICG/IGS decide on evolution
Summary

- The Multi GNSS Ensemble Time (MGET) would be a paper time, linked to UTC and readily available
- The MGET would be a common time scale, but system independent
- MGET would enable true GNSS interoperability at receiver level while keeping independence between systems
- MGET reduces the need to make significant GNSS System changes
- MGET would provide ensemble clock accuracy and stability
- MGET would support PVT, POD and PPP calculations at end user level
- A Trial Project is proposed to develop and provision MGET
- Detailed assessment required to assess benefits on PVT and POD