GALILEO Needs wrt. TWSTFT
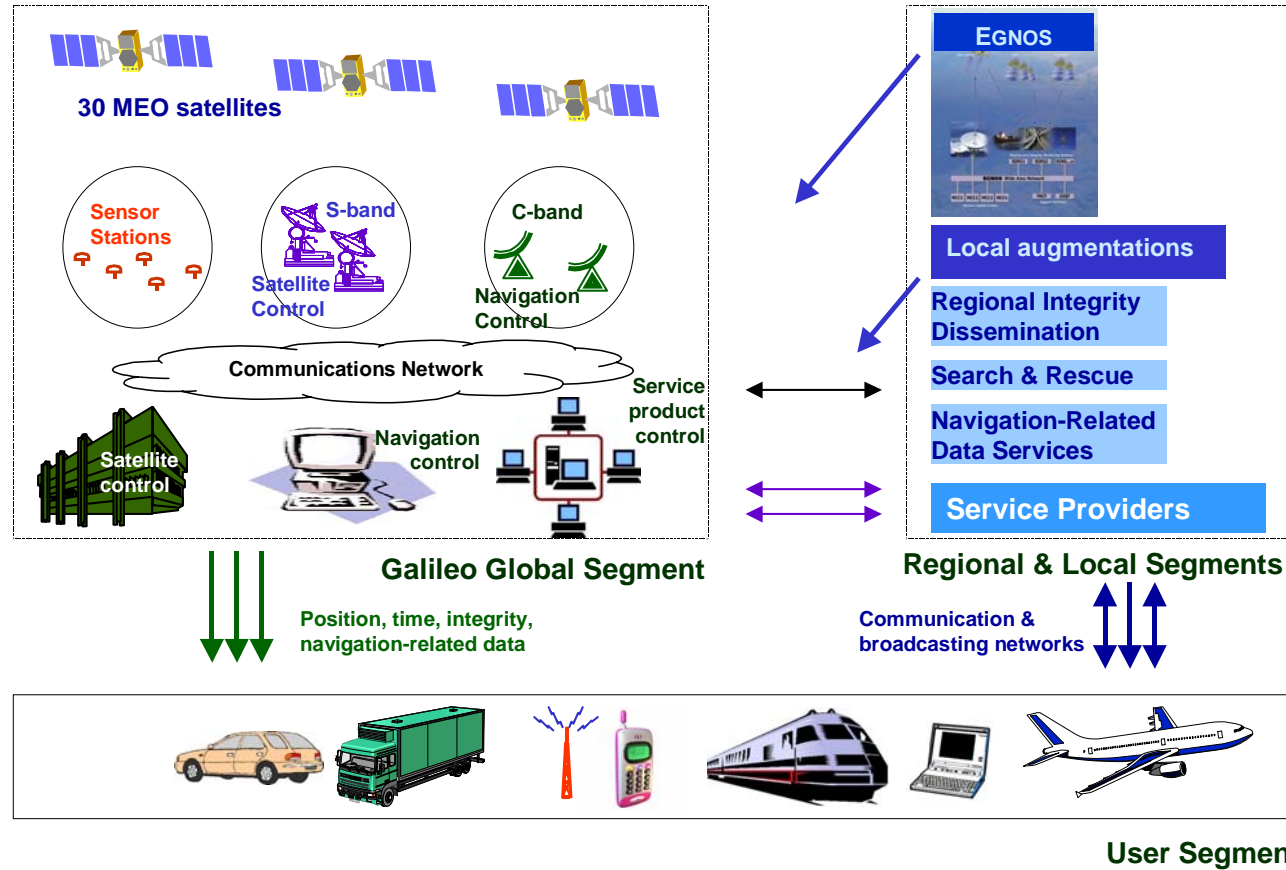
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Galileo Outline Architecture

30 MEO satellites

Sensor Stations

S-band

Satellite Control

C-band

Navigation Control

Communications Network

Satellite control

Navigation control

Service product control

Galileo Global Segment

Position, time, integrity, navigation-related data

EGNOS

Local augmentations

Regional Integrity Dissemination

Search & Rescue

Navigation-Related Data Services

Service Providers

Regional & Local Segments

Communication & broadcasting networks

User Segment

Galileo System Time and Timing User Specs

Parameter	Specification
GST – TAI time offset uncertainty *(relative to TAI, 2σ)*	**<28 ns**
GST Limits *(expressed as a time offset relative to TAI, 95% of the time over any yearly time interval)*	**< 50 ns**

related to accuracy

<u>Drivers</u> for:
→Performance
→Interoperability

related to steering

User Performance	Specification
Frequency Accuracy (expressed as a normalised frequency offset relative to UTC, 2σ, over any 24 h interval)	$< 3 \times 10^{-13}$
User UTC determination uncertainty (2σ)	< 30 ns

accuracy + other user contributions

Timekeeping Function

Twofold:

→ Navigation Timekeeping:
critical for navigation mission, needed for orbit determination/
prediction and clock synchronisation

→ Metrological Timekeeping, not critical, but needed to steer GST
towards TAI and to provide the UTC timing (dissemination)
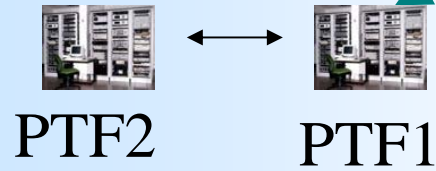service

Core System

Precision Timing Facility (PTF)

External

Time Service

Galileo Time Keeping System Setup

TS

UTC(k)

UTC(k)

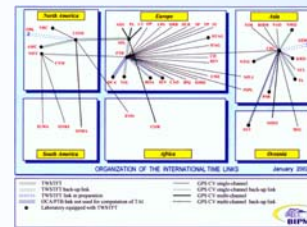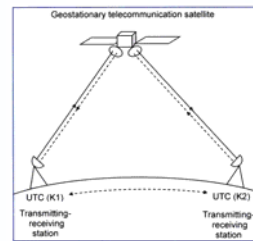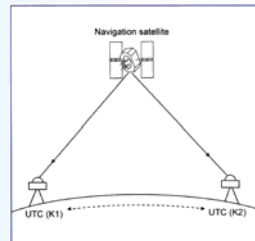UTC(k)

GST-TAI, UTC-TAI, etc.

CV , TWSTFT

PTF2

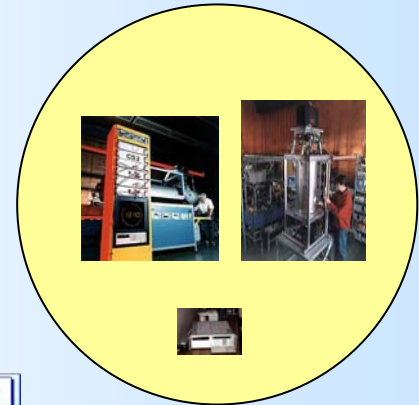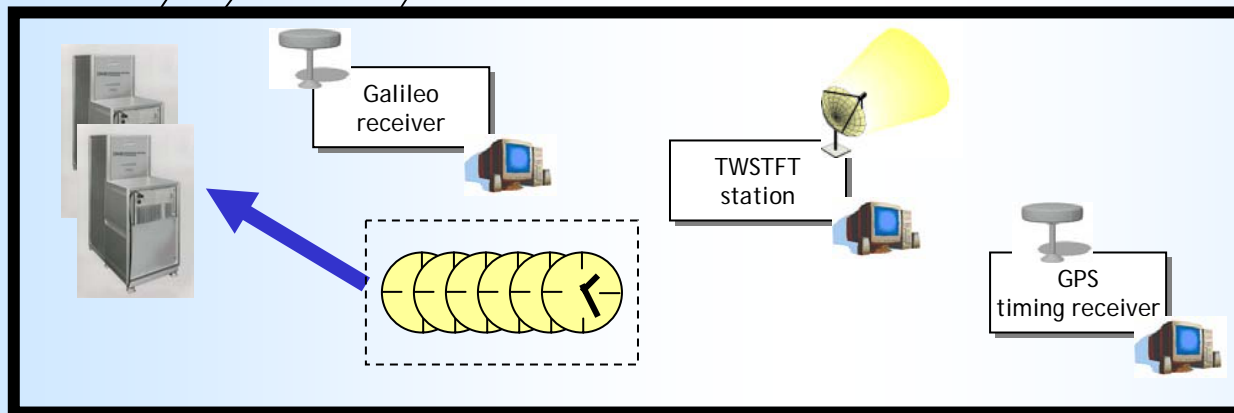PTF1

UTC

Access to Galileo System Time

Internal use:

1 pps <u>PHYSICAL OUTPUT</u>
5 or 10 MHz
Pseudo-Range referenced to GST
TWSTFT data
Time codes

Galileo
receiver

TWSTFT
station

GPS
timing receiver

User access:

via SIS

Timing Service

GNSS CV data
TWSTFT data

GPS/Galileo Interface to UTC Time Services

GST-TAI, UTC-TAI
CV, TWSTFT

Time Service Provider

UTC(k)

UTC(k)

UTC(k)

UTC

UTC(USNO)

USNO-AMC

Existing/Planned Interface

Potential Interface

CV, TWSTFT
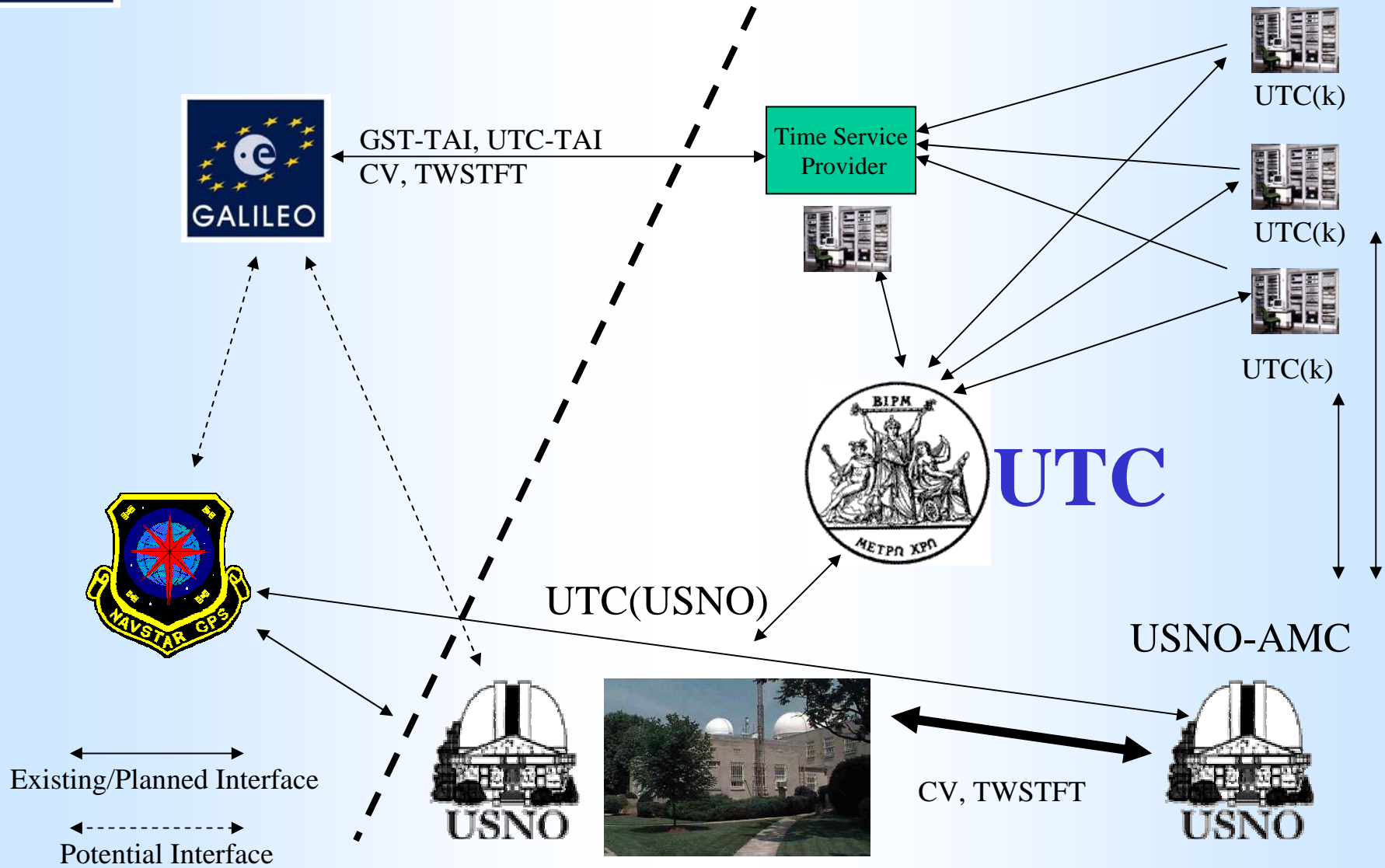
…Timing Interfaces of Interest…

- External:
  - Time Service Provider / collaborating UTC(k)-labs
  - GPS / USNO for GPS to Galileo Time Offset (GGTO)

- Internal:
  - Connection between the two Precision Timing Facilities (PTF) in FOC

Despite Common-View all these interfaces will be implemented through TWSTFT.

…Issues…

- Lease of a GEO-Transponder for Galileo usage!
  - In-Orbit Validation Phase (IOV, max 4 SV + limited ground segment)
  - Deployment Phase
  - Full Operational Capability (FOC, 27 + 3 SV, full ground segment)
- Calibration
  - IOV - initial calibration
  - FOC - routine calibration campaigns

…Galileo Phases…

- IOV – full ESA responsibility
  - Validation / algorithm tuning etc.
  - Final activity is the IOV Test Campaign (min. 6 months)
  - Not commercial
  - Operation subcontracted to industry
- Post-IOV – responsibility with the Galileo Concessionaire
- FOC – full Concessionaire's responsibility
  - Full service and performance available
  - commercial

…Proposed Solution…

- IOV
  - Establish full synergy with the TW-community: Use the same GEO-Transponder for all three interfaces
  - Basis should be an <u>updated TW-group MoU with Intelsat</u> for at least the duration of the IOV Test Campaign [+Deployment Phase]
  - Technical cooperation required with the TW-community in defining slots for
    - PTF-USNO
    - PTF-UTC(k)
    - [PTF-PTF]
  - Calibration should be jointly tackled with USNO and EU-labs
- FOC
  - The Concessionaire will address further arrangements with coms satellite providers

…way fwd for IOV…

- The Project asks the group for support to arrange an updated MoU with Intelsat, i.e.
  - Explanatory Meeting with Intelsat
  - MoU update drafting
  - Signature
  - R/F Interfacing with the satellite in a coordinated way with the TW-group
- Develop a Calibration approach including Galileo in the calibration campaigns