The Definition and Implementation of Galileo System Time (GST)

Jérôme Delporte
CNES – French Space Agency
jerome.delporte@cnes.fr

Outline

- General Architecture
- PTF design
- Link to UTC
- Interoperability

General Architecture

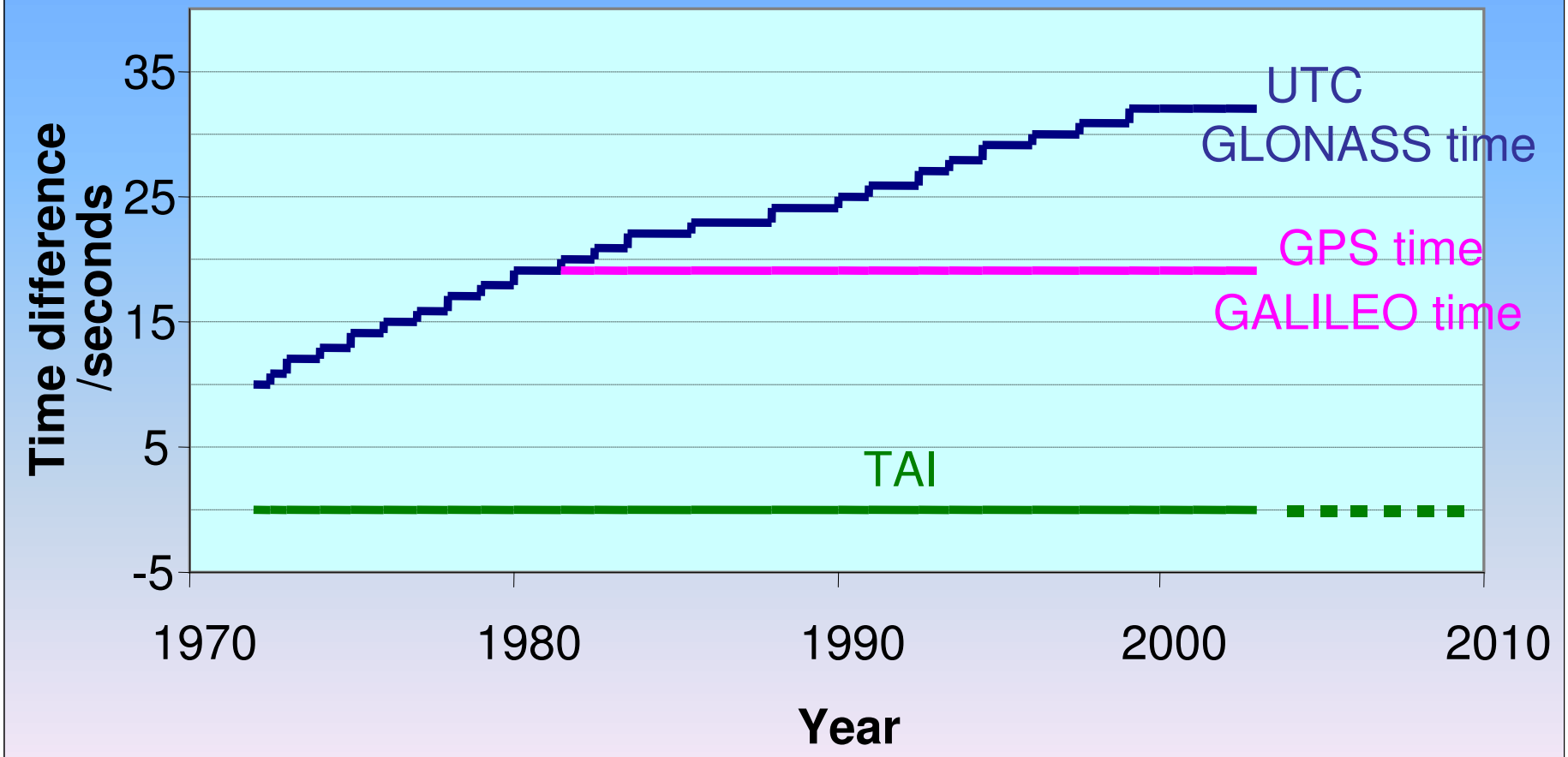
- GST = Galileo System Time
  = reference time for the whole system
  in particular for prediction of Galileo satellite clocks
- GST is under responsibility of the Galileo Mission Segment (GMS)
- GST is generated physically and autonomously by two Precise Timing Facilities (PTF)
- GST is visible to Orbitography and Synchronization Facility (OSPF) through the Galileo receiver at PTF

General Architecture

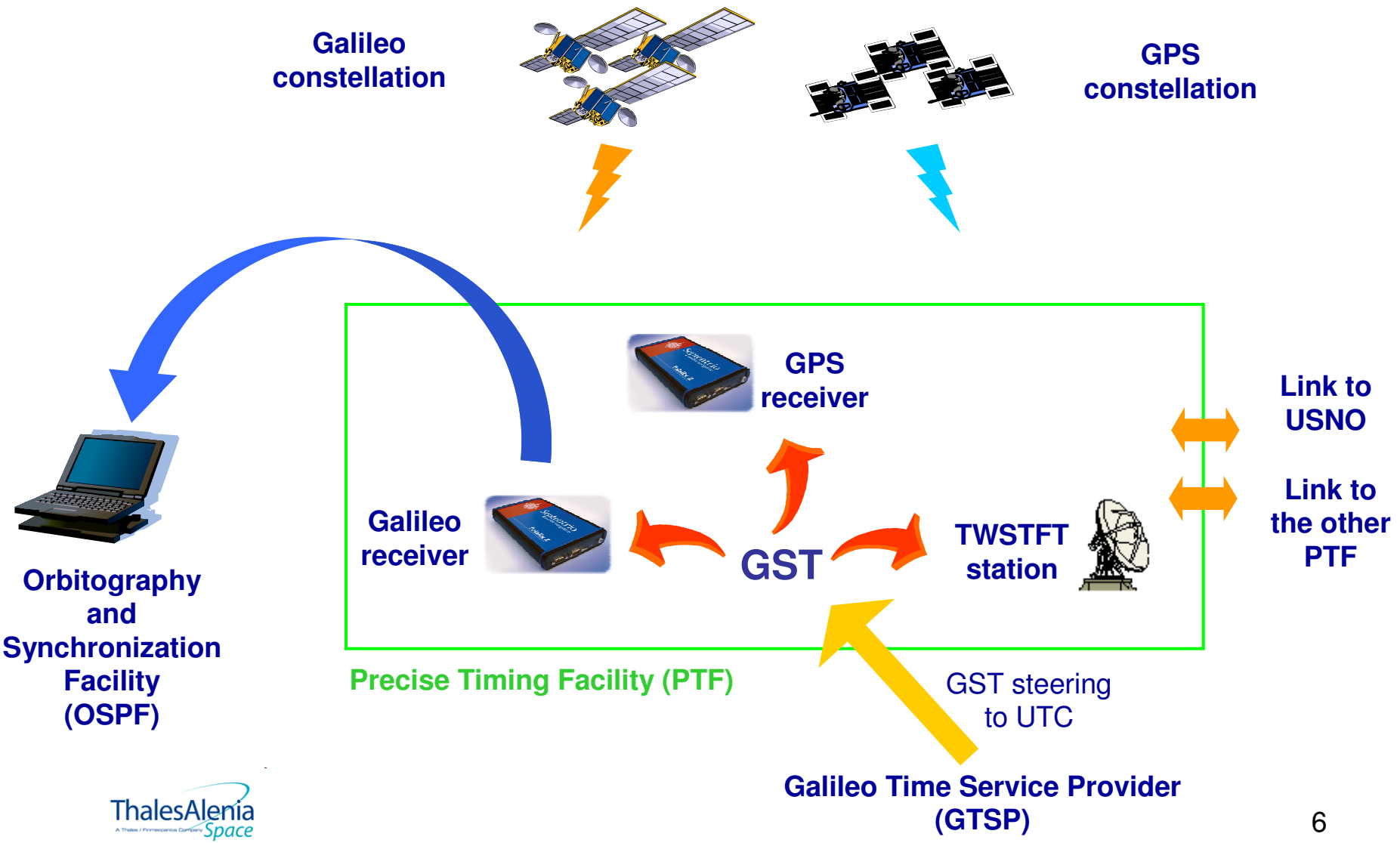
- GMS shall also support :
  - metrological function : GST will be precisely measured vs. UTC and steered to it modulo 1 second
    with inputs from GTSP
  - GPS-Galileo interoperability : GPS-Galileo Time Offset (GGTO) will be precisely measured and broadcast to users
    in coordination with USNO

- GST start epoch is 00:00 UT on August 22nd 1999
- At this epoch, GST shall be ahead of UTC by 13 s and will not apply leap seconds
- GST is therefore “aligned” to GPST
- As of today, GST is ahead of UTC by 15 s

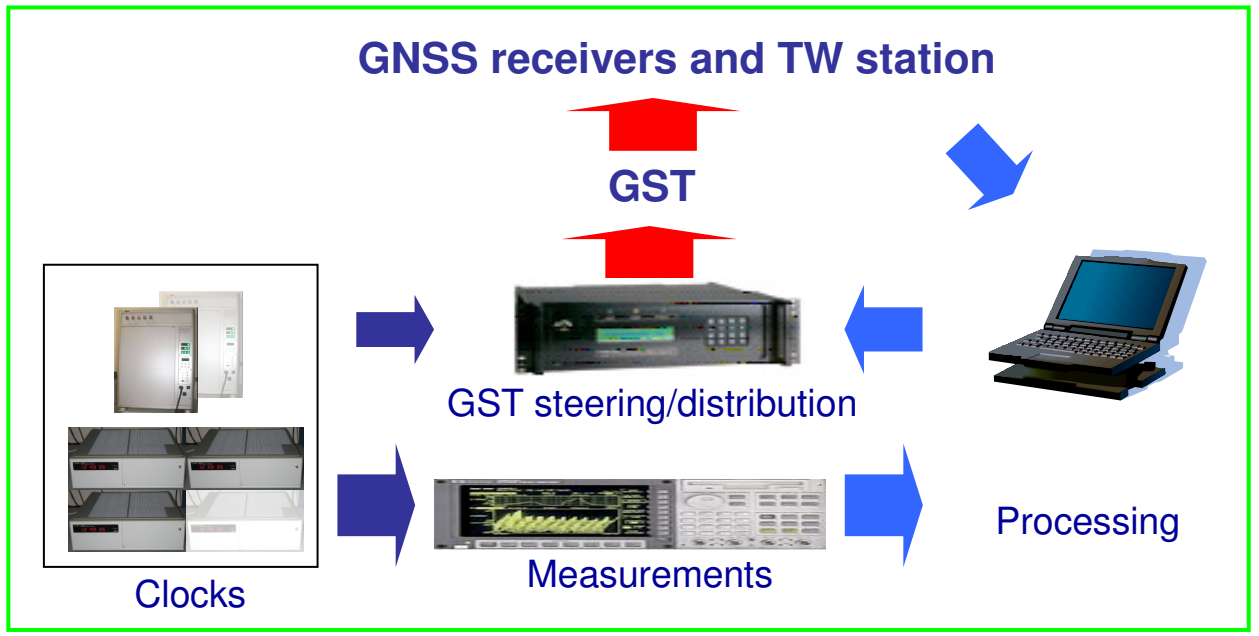
[TAI - Time scale (i)]



General Architecture



PTF Design



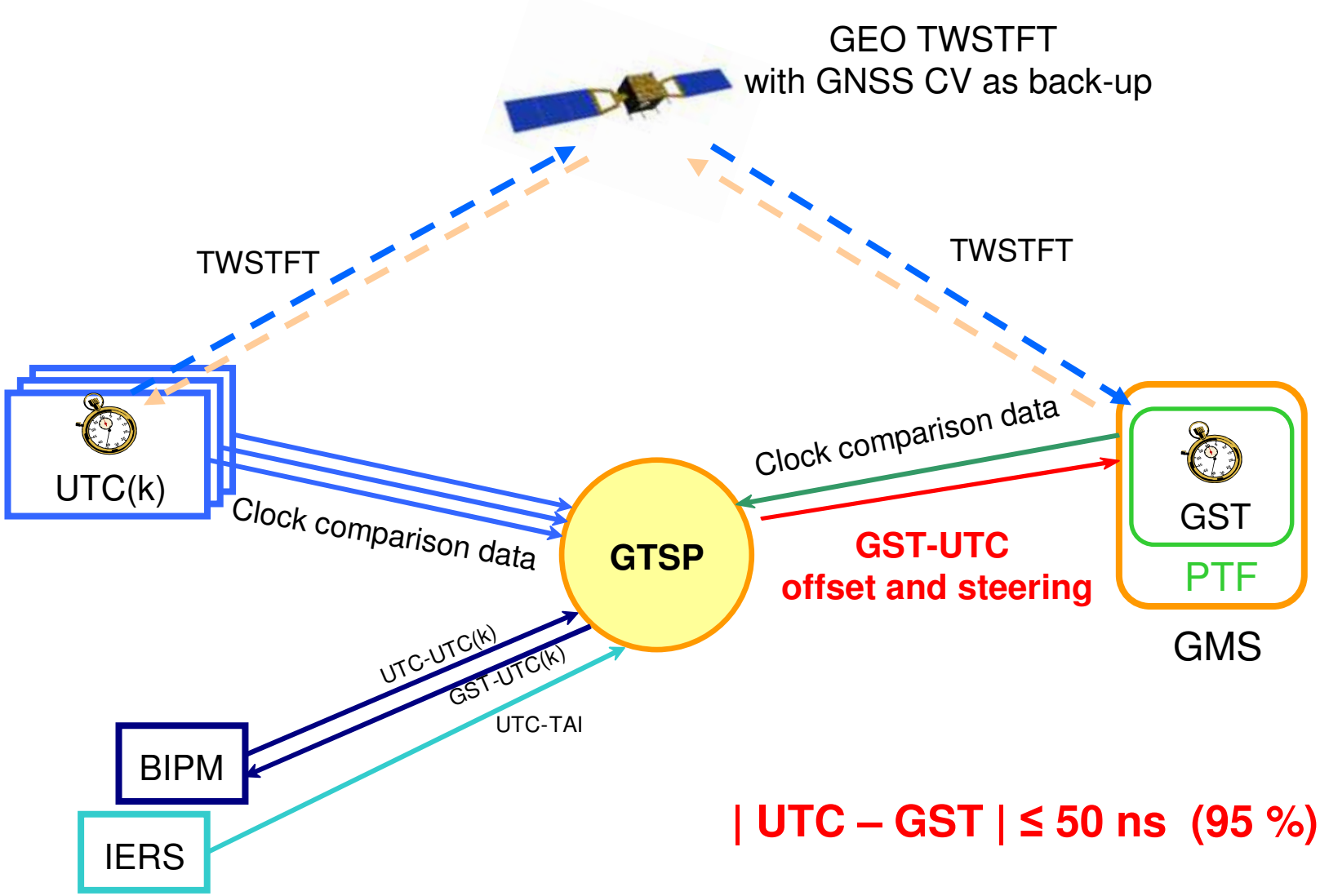
Precise Timing Facility (PTF)

- Both PTF comprise :
  - a master clock (AHM) steered to a local ensemble of Cs clocks + steering to UTC
  - a back-up clock (AHM) steered to the master clock
  - GNSS receivers and TWSTFT stations for PTF/PTF steering, GGTO determination and steering to UTC

PTF Design

- The 2 PTF are in master-slave configuration :
  - each one provides its own realization of GST
  - GST is the output of the master PTF
  - PTF-to-PTF offset is measured through internal OSPF products, TWSTFT and GNSS Common View
  - the difference between the 2 PTF shall be < 4 ns (95 %)
  - a transition law is implemented in case of switch to ensure a smooth transition

Link to UTC



| UTC – GST | ≤ 50 ns (95 %)

Interoperability

- GGTO = GPS-Galileo Time Offset
  - GGTO is computed on both GPS and Galileo sides independently but its broadcast value will be coordinated between the systems
  - GGTO is determined by TWSTFT and/or GNSS Common View between the PTF and the USNO
  - GGTO accuracy shall be < 5 ns (95 %)
- Galileo will also broadcast GST – UTC and the leap second information
- It is also foreseen that Galileo broadcast UTC – UT1