GALILEO

GIOVE-A Mission

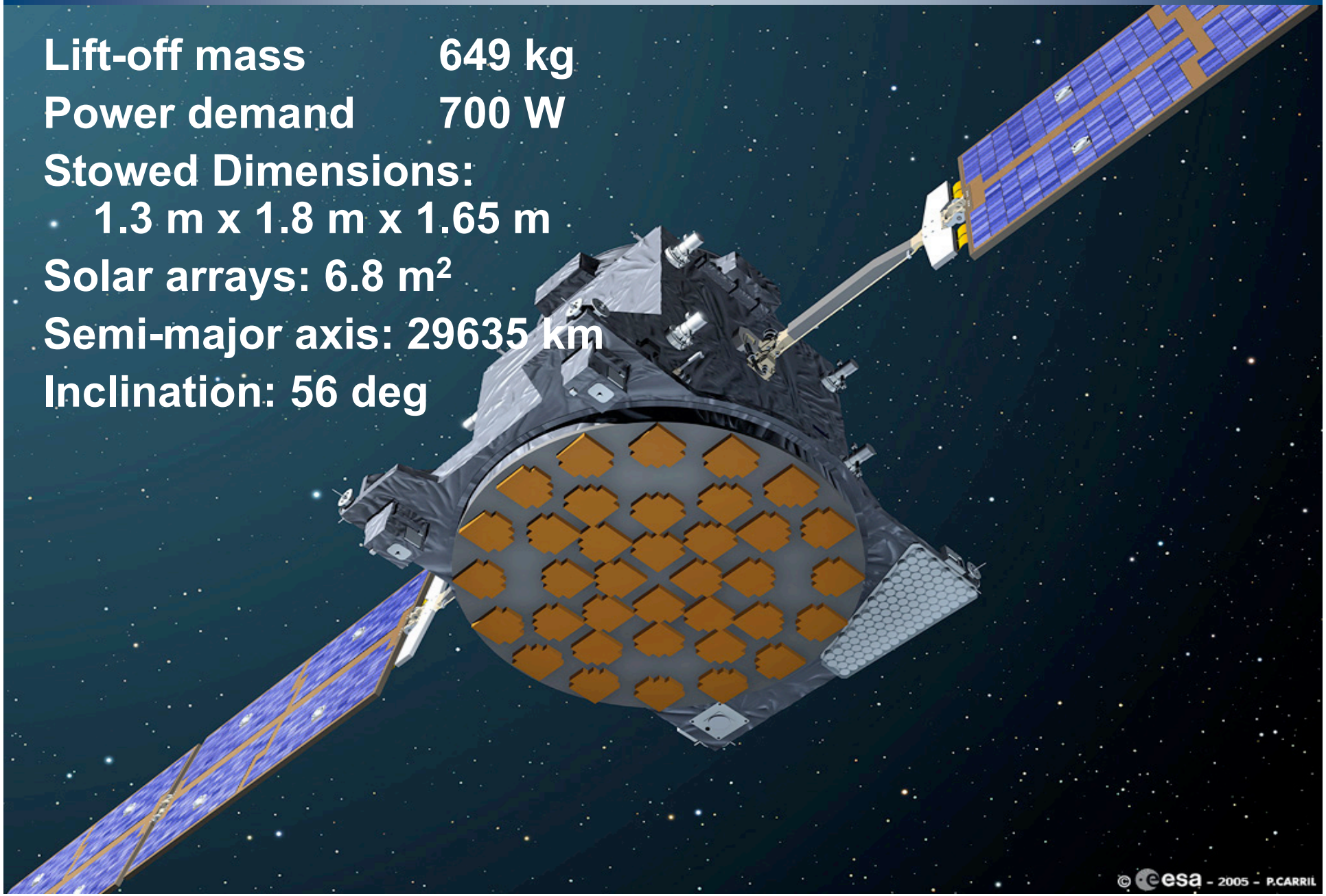
ESA/ESTEC

D. Navarro, M. Tossaint, J. Hahn, M. Falcone

GIOVE Objectives

- **Galileo In Orbit Validation Element**
- **Support Galileo Frequencies Filing Notification.**
- **Test Payload technology in-orbit:**
  - Clocks and Monitoring Control Unit
  - Navigation Signal Generator Unit
- **Provide the first GALILEO Signal-in-Space.**
- **Characterize MEO radiation environment.**

GIOVE-A Satellite



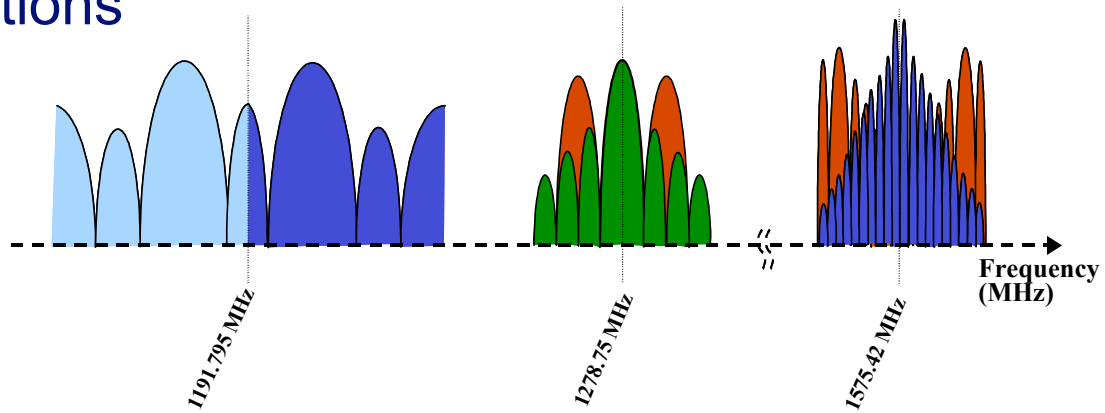
GIOVE-A Status

- Successful orbit injection by Soyuz-Fregat from Baikonur on 28th December 2005
- Payload switch-on 10th January 2006
- From 12th January the first Galileo Navigation signals have been broadcast from Space
- First Objective achieved: GALILEO Frequencies Filing Notified to ITU

- **Navigation Signal Generation**
  - Timekeeping system
    - ✓ 2 RAFS
  - Signal Generator Chain
    - ✓ 2 x CFI Signal Generator Chain (ESA managed)
    - ✓ SSTL Signal Generator Chain
  - Transmit chain: TWTA, Coupler, Diplexers
  - Antenna (Alenia)

GIOVE-A SIGNAL

- GIOVE-A SIS is fully representative of GALILEO SIS:
  - RF and Modulations
  - Chip Rates
  - Data Rate

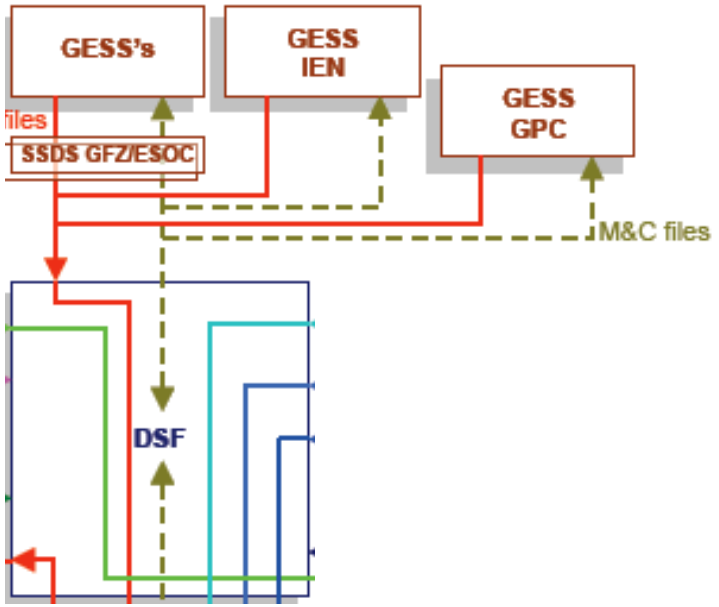


- GIOVE-A can only transmit two signals at a time (L1+E5 or L1+E6)
- GIOVE-A codes are different from GALILEO codes
- GIOVE-A Navigation Message not representative from structure and contents viewpoint (demonstration only purpose)

GIOVE Mission Segment Tasks

- **Early demonstration of the navigation service (generation, uplink, and broadcast of navigation message)**
- **On Board Clock Characterisation**
- **Sensor Station Characterisation (interference and multi-path characterisation)**
- **Validation of Galileo Ground Segment Models**

Core Infrastructure



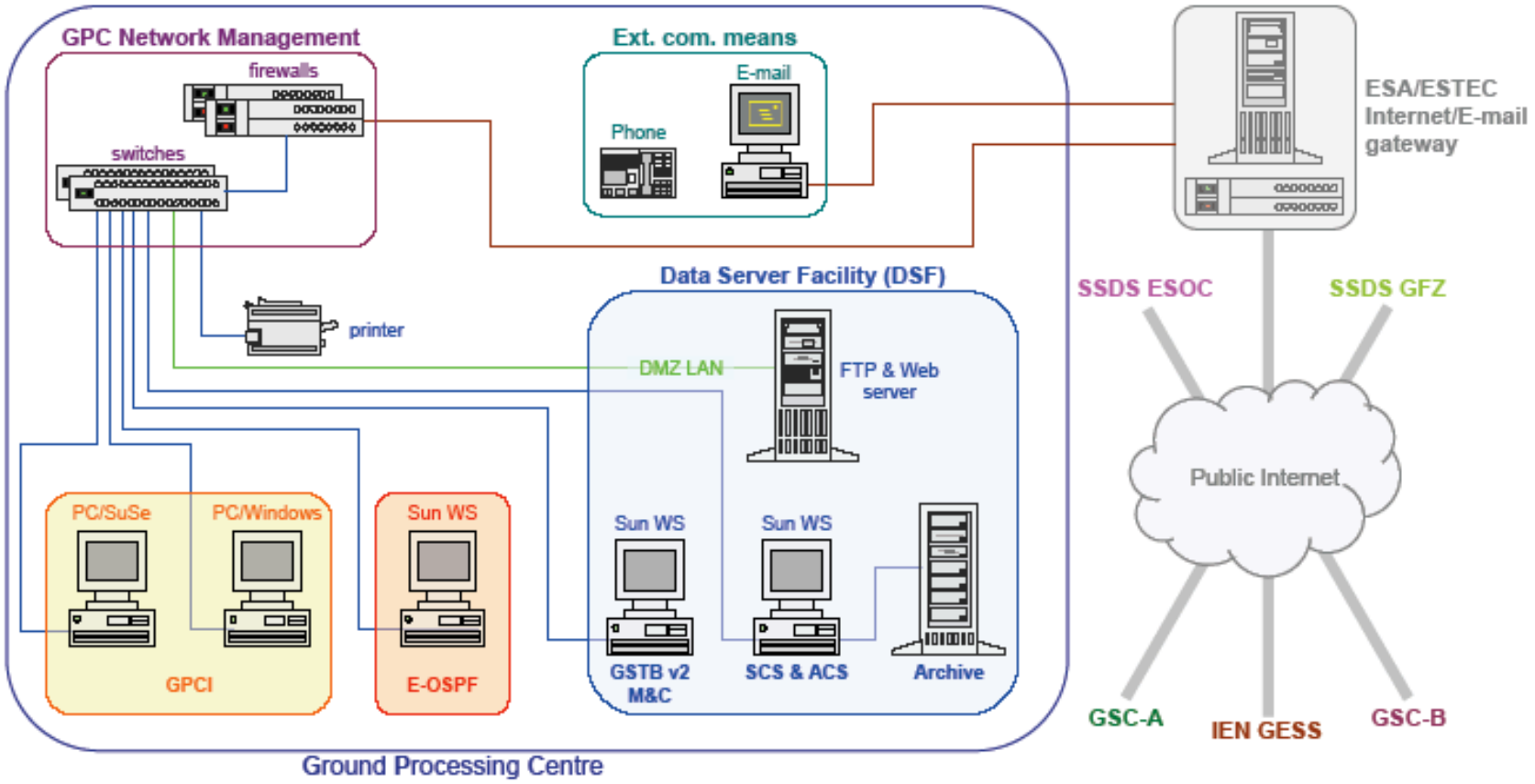
(1) the "Env. Data" are the re-constituted environmental information built

M telemetry.

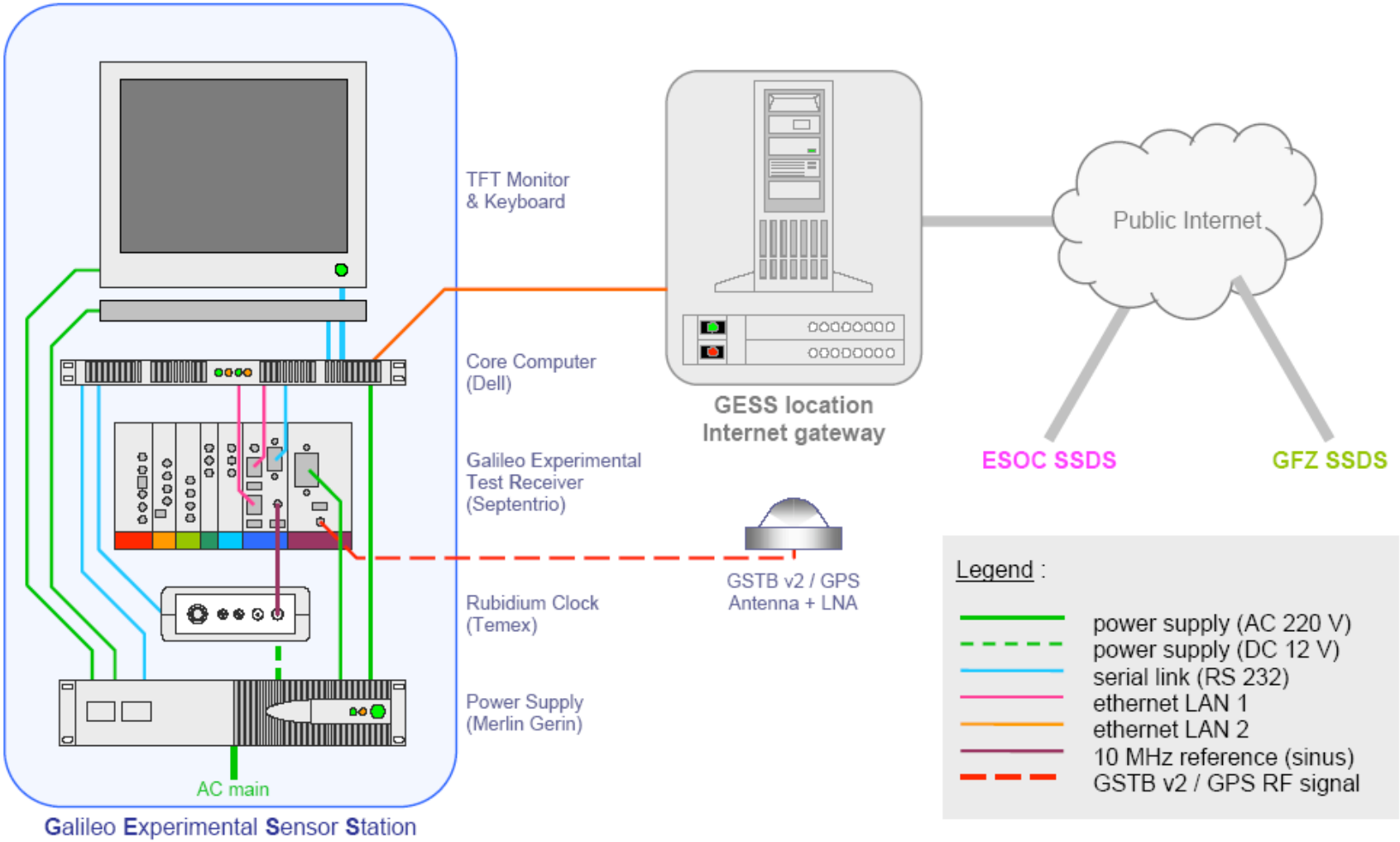
Routine Navigation Message generation

Step	Description	Periodicity	Data ageing (best case)	Total ageing (best case)	
1	Nominal data file building	Every 15 '	-	-	
2	Nominal data file compression	Every 15 '	< 1 '	1 '	GESS
3	Transfer to the space polled by the SSDS	Every 15 '	< 1 '	2 '	
4	SSDS polling on the GESS FTP server	Every 5 ' (TBC)	< 1 '	3 '	
5	SSDS retrieving of the file on a temporary storage space	~ Every 15 '	< 7 '	10 '	SSDS
6	Transfer to the space polled by the DSF	~ Every 15 '	< 1 '	11 '	

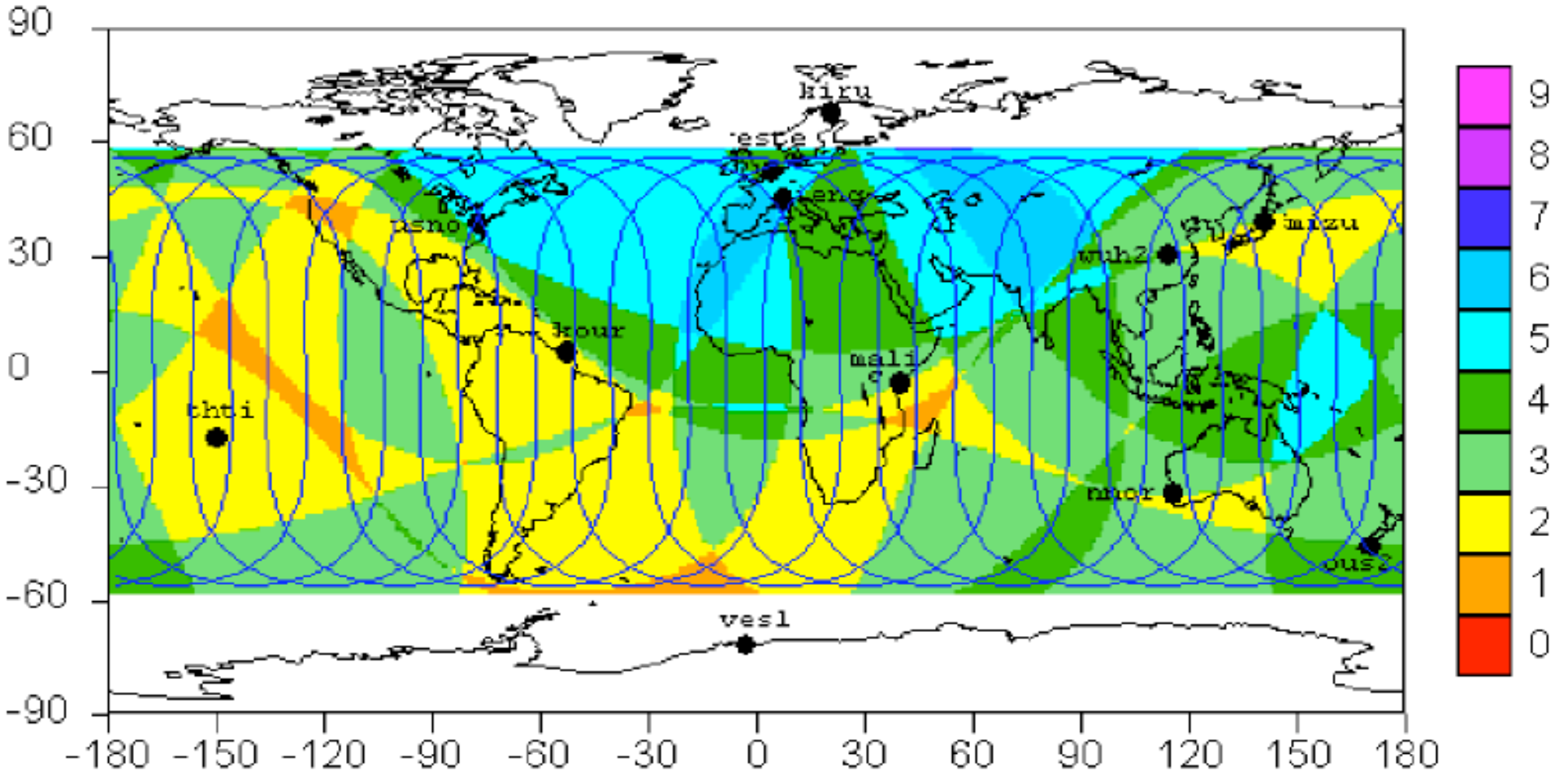
GPC Hardware

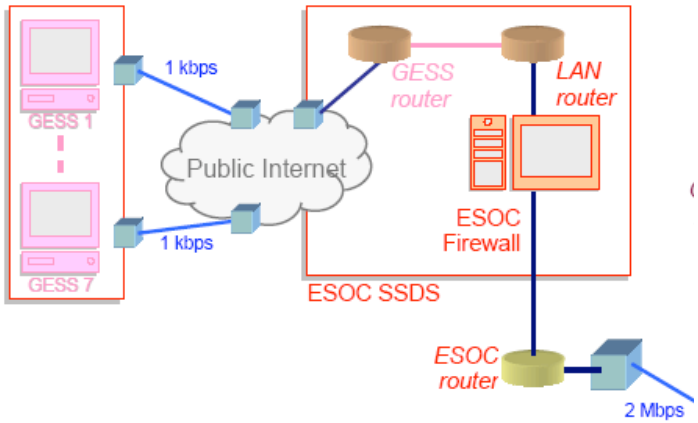


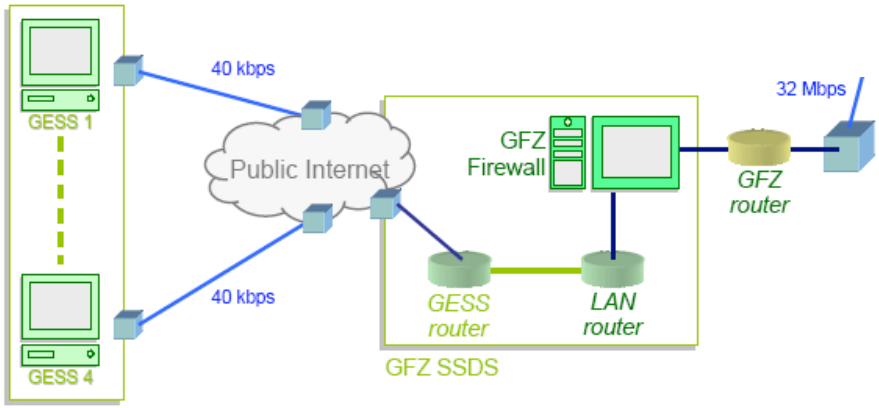
GESS Hardware

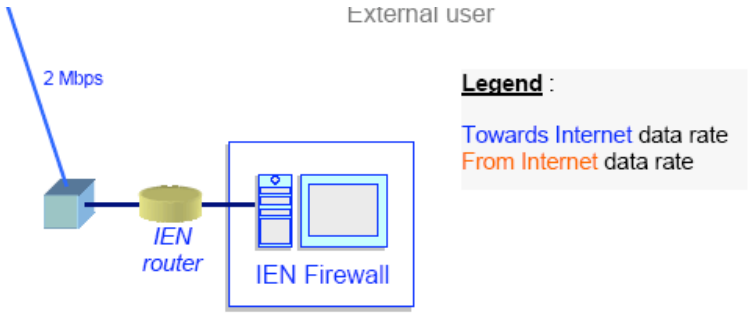


GESS Locations

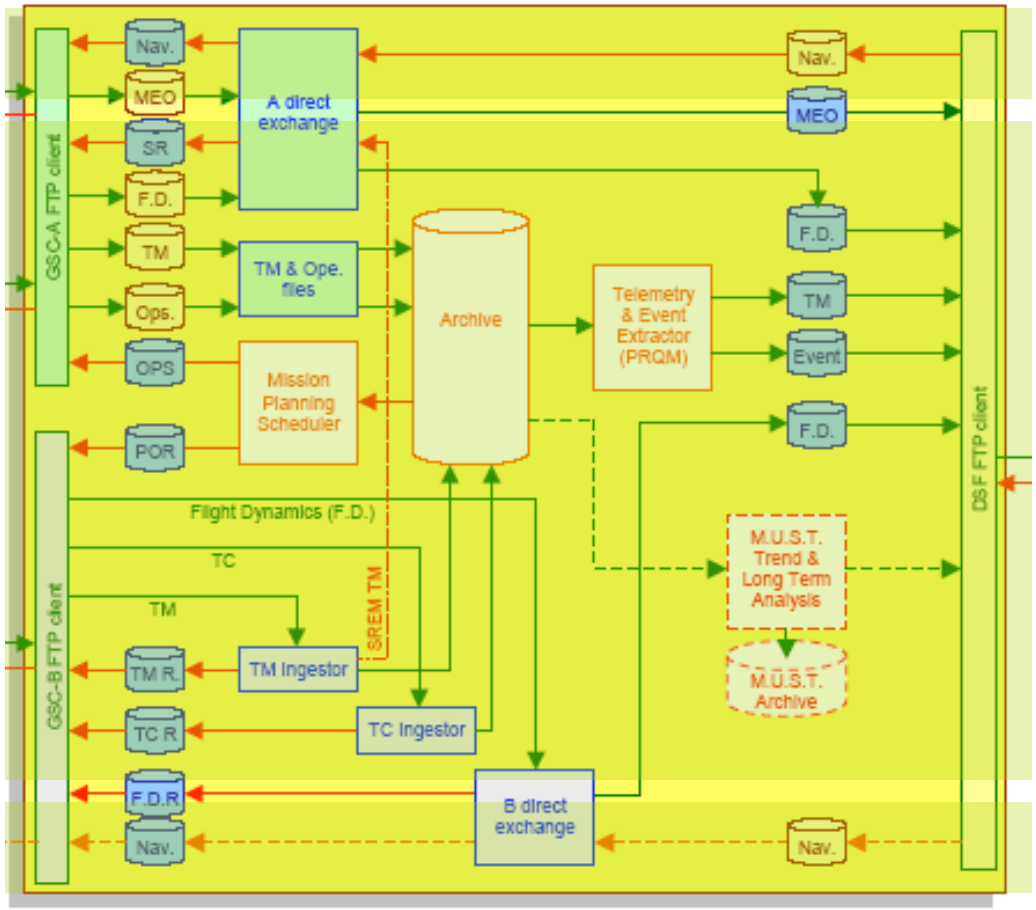



1 kbps
GESS 1
GESS 7
Public Internet
1 kbps
GESS router
LAN router
ESOC Firewall
ESOC SSDS
ESOC router
2 Mbps


40 kbps
GESS 1
GESS 4
Public Internet
40 kbps
32 Mbps
GFZ Firewall
GFZ router
GESS router
LAN router
GFZ SSDS


External user
2 Mbps
IEN router
IEN Firewall
Legend :
Towards Internet data rate
From Internet data rate

GPCI Design

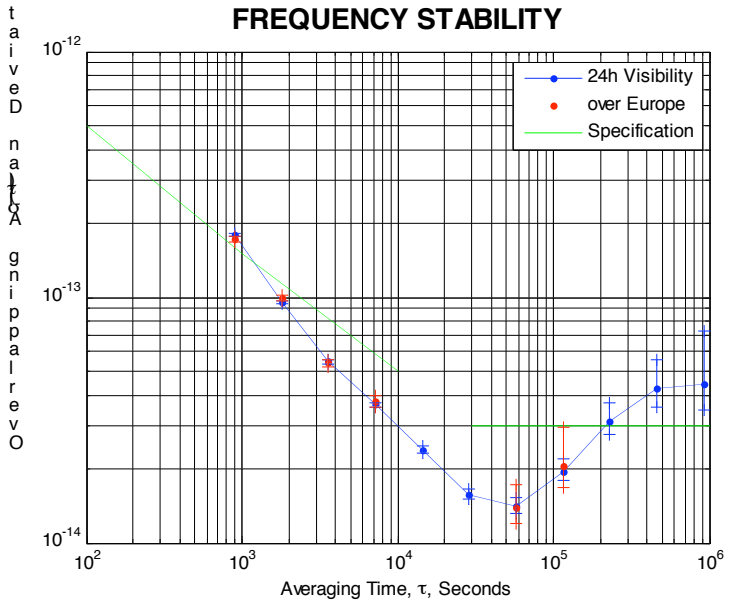

Nav.
MEO
SR
F.D.
TM
Ops.
OPS
POR
GSC-A FTP client
A direct exchange
TM & Ope. files
Mission Planning Scheduler
Archive
Telemetry & Event Extractor (PRQM)
Nav.
MEO
F.D.
TM
Event
F.D.
DSF FTP client
Flight Dynamics (F.D.)
TC
TM
SREM TM
GSC-B FTP client
TM R.
TC R.
F.D.R
Nav.
TM Ingestor
TC Ingestor
B direct exchange
M.U.S.T. Trend & Long Term Analysis
M.U.S.T. Archive
Nav.

First Mission Campaign

- **Objectives**
  - To carry out a preliminary characterisation of the O/B clocks
- **Available Infrastructure**
  - 2 GESS: at ESTEC (Noordwijk) and INRIM (Torino)
  - GIOVE Processing Centre at ESTEC
- **Time Line**
  - Starting from 15th May: GESS Signal quality assessment during first week
  - Starting from 22nd May: Processing of Orbits and Clocks for 6 to 8 weeks

Expected Performance in First Campaign

- **According to analysis based on using a Glonass s/c as a mock-up for GIOVE, the available infrastructure (2 stations in Europe) would allow to determine**
  - Orbits with a precision of 200 cm
  - Clocks with a precision of 4 ns
- **This performance can be drastically improved by using SLR* data which would provide**
  - Orbits with a precision of 20 cm
  - Clocks with a precision of 0.4 ns
- **Due to clock data gaps (2 stations in Europe), Allan deviation will present gaps at some intervals. However the RAFS behaviour can be fully characterized:**
  - Short term results are fully representative
  - Long term stability can be assed from the data.



Contribution from/to GNSS Community

- **GIOVE Mission has adopted IGS Standards:**
  - SINEX, SP3, RINEX clock…
  - RINEX 3.00
    - ✓ Galileo has cooperated in the creation of RINEX 3.0 observable file
    - ✓ GIOVE mission will help validate
    - ✓ Galileo RINEX Navigation to be confirmed after SIS ICD publication
- **TEQC enhancement for RINEX 3.0**

Opportunity for GNSS Community

- **GIOVE-A SIS ICD publicly available in June 2006**

- **Possible participation of IGS members**
  - ➢ Deployment of receivers at IGS sites
    - ✓ Access to Galileo Signal through GIOVE observables
    - ✓ Enhancement GIOVE Mission Segment

Opportunity for ILRS Community

- **GIOVE-A Laser Retroreflector Characterisation**
  - Made by IPIE (supplier for GLONASS and GPS)
  - 76 cubes (27 cm Ø)
  - Return about 10% better than GPS

- **Enhancement of SLR stations**
  - Changchun station refurbishing procured by NRSC of China

Conclusions

- **GIOVE-A signals are fully representative of GALILEO Signals and have been brought into use**
- **Importance of the GIOVE Mission**
  - Onboard Clock Characterisation
  - Sensor Station Characterisation
  - Feedback into Galileo System Development
- **GIOVE represent opportunities for both IGS and ILRS**
- **GPC and 2 GESS installed and tested**
- **First Tracking Campaign**
  - Preliminary Clock Characterisation
  - Use of SLR data contributes significantly to campaign success
- **More info soon available at www.giove.esa.int**