The European Project HARRISON: applications and services based on Galileo & GNSS Time

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EXODUS e.SOLUTIONS

SEPA

NSL

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CESI RICERCA

Acknowledgements

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European GNSS Supervisory Authority

References

1- The Harrison project: applications and services based on Galileo Time.

L.Bragagnini, Consorzio Torino Time.

Growing Galileo Event, Nov 14-15, 2007, Brussel.

2- Galileo Timing Applications.

M.Blanchi, R.Zanello, C.Cantelmo, Thales Alenia Space, S. Scarda, GSA.

PTTI 2007, Nov 26-29, 2007, Long Beach, CA.

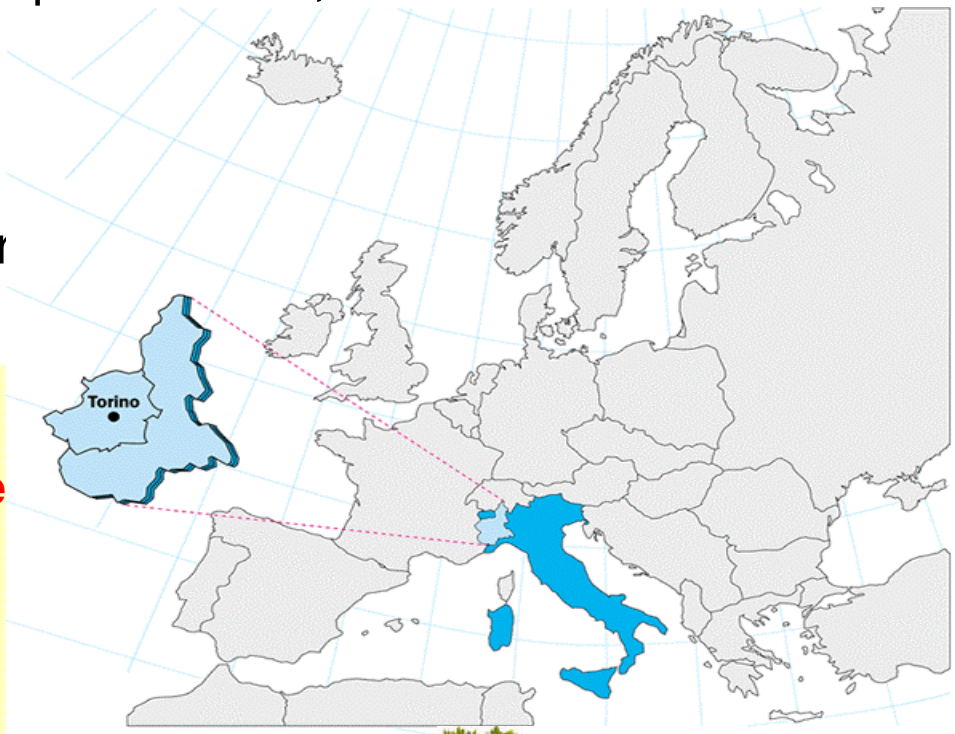
Contents

- Consorzio Torino Time, the Harrison coordinator

- The Harrison project.

Piedmont and Torino key figures

- 4.3 millions inhabitants (7% of Italian population);
- 1.5 millions inhabitants in Torino metropolitan area;
- 74.6 B€ GDP (9% of Italian GPD);
- 17400 € per capita income;
- 10% of national industrial production;
- 25.3 B€ export (13.3% of Italian expor
- 27% export in high-tech sector.



Key Figures in High Tech

- **1st Italian region in terms of employee in the High Tech sector**;
- 53.688 employees in the ICT sector;
- 6.805 companies;
- 20% of national patents;
- 30% of national R&D expenditures

REGIONE PIEMONTE
PROVINCIA DI TORINO
CITTA' DI TORINO

Consorzio Torino Time

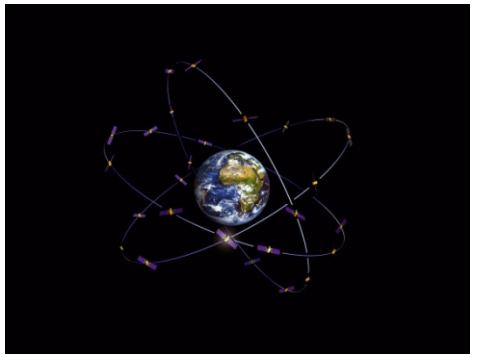
Established in Torino
on the 2nd april 2004

Members:

• Finpiemonte S.p.A	*institution*
• Fondazione Torinowireless	"
• INRiM	*metrological inst.*
• Politecnico di Torino	*university*
• Alenia SIA Sp.A.	*industry*
• Altec S.p.A.	"
• SEPA S.p.A.	"
• Thales Alenia Space Italia S.p.A.	"

Establ.d on initiative of
Comitato Promotore Programma Galileo
and
Fondazione Torino Wireless

The Galileo Precise Timing Facility



The CTT is prime contractor for the implementation and the initial IOV operations of the Galileo Precise Timing Facility (PTF)

*The **PTF**:*

- *is an element of the **Ground Mission Segment** of Galileo,*
- *generates the reference Time Scale of Galileo (**GST Galileo System Time**)*
- *Steers **GST** to **UTC** in cooperation with an external **Time Service Provider***

*The **PTF** is designed for two-fold purposes:*

- ***NAVIGATION TIMEKEEPING**, needed for orbit determination/prediction and clocks synchronization*
- ***METROLOGICAL TIMEKEEPING**, needed to provide accurate dissemination of UTC, Coordinated Universal Time.*

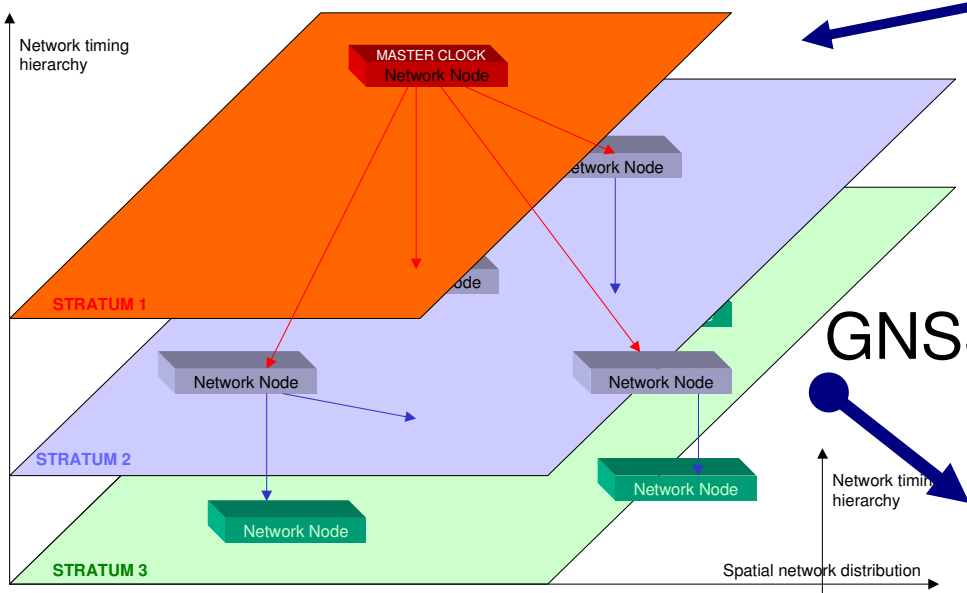
HARRISON project background

- ***GNSS*** provides the User with ***Position*** and ***Time*** information

- ***GNSS,*** as an ***'atomic clock in the sky', provides Time User Communities*** with an accurate reference for ***Timing*** and ***Synchronisation.***

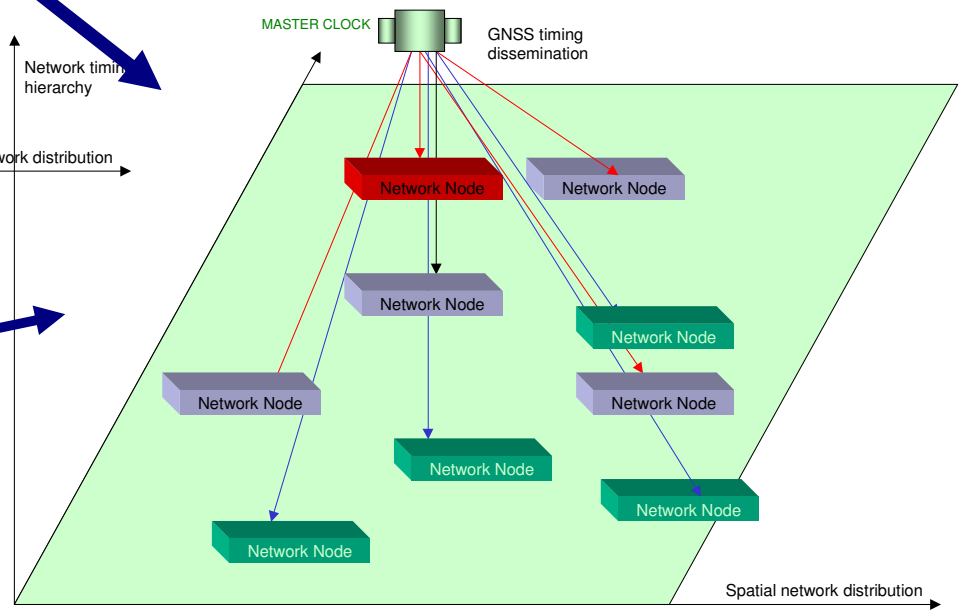
- *Each* ***User community*** *has his* ***own Requirements:***
  Technical, ***Service provision***, ***Regulatory***, ***Certification***

Timing in telecommunicaton networks based on hierachical structure



GNSS development

Time distribution and synchronization via GNSS



The Harrison project objectives

What: foster the use of ***'Galileo Time'*** for Timing and Synchronisation applications

Why: Timing and Synchronisation applications is a ***growing market***

How: -***Time User communities*** and ***Time application domains*** are analysed

-***Technical and non-technical*** requirements and ***Galileo benefits*** are identified

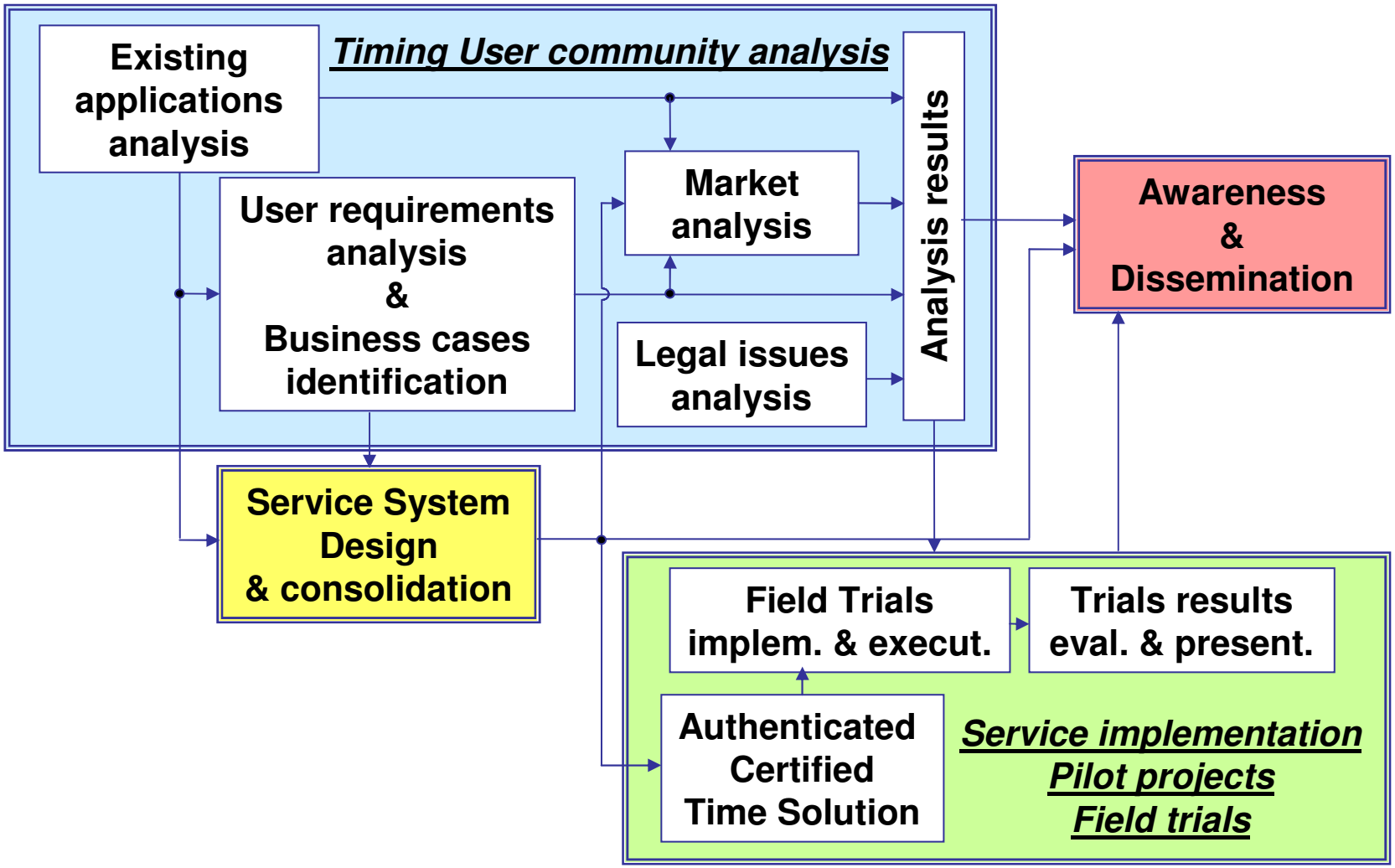
-Service provision models are ***consolidated***

-Pilot projects, awareness, dissemination

Who: the Harrison project consortium

	ITALY	FRANCE	POLAND	GREECE	U.K.	LITUANIA	GERMANY	SLOVENIA
Consorzio Torino Time								
ThalesAleniaSpace-I								
BAIN								
CESI Ricerca								
Ist. Sup. Mario Boella ISMB								
SEPA								
TELESPAZIO								
UNIVERSITY OF PADOVA								
UNIVERSITY OF ROMA								
ThalesAleniaSpace-F								
A O S								
EXODUS								
N S L								
P F I								
TUEV Rail								
UNIVERSITY OF LJUBLIANA								

The Harrison project work plan



Galileo benefits for Timing User Community

- ***greater availability/accuracy/QoS than existing GNSS*** because of***:***
  - ***Increased number of GNSS satellites***
  - ***More RF Power*** *(useful in difficult environment)*
  - ***Pilot tones*** *(improved tracking in difficult environment)*
  - ***Greater BW and Signals*** *(more robust against interference and multipath)*
- ***Authentication of SIS (SoL, CS, PRS services)*** *(trusted, potentially certifiable & legal Time information*)
- ***Integrity information*** and ***Warranty of Service:***
  - ***Reliable, dependable***, ***no gaps Time*** and ***Synch source*** *(availability, robustness, guarantee)*

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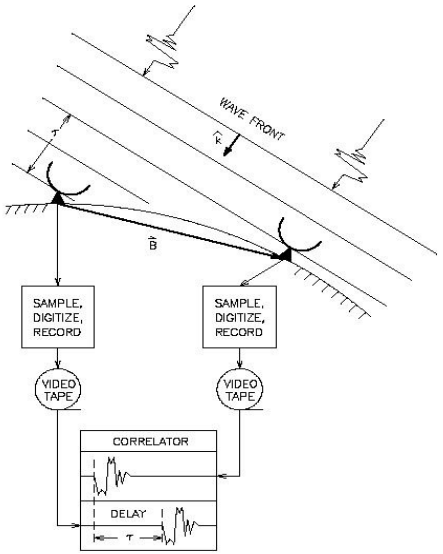
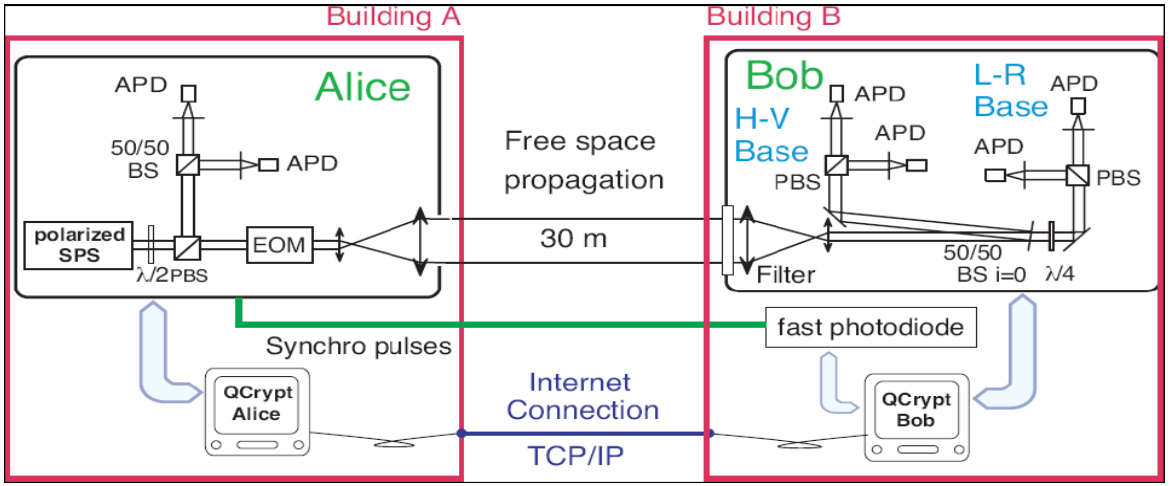
Astronomy and Quantum Cryptography (QKD)





Key parameters

- UTC/TAI reference, 50-100 ns, no time interruptions allowed
- 10-100 ps resolution for photon datation in observation with duration of several hours (performances not compatible with GNSS use). Internal clock used. No post-processing allowed.
- Quantum Astronomy Interferometry stability not compatible with GNSS (often AHM are used). Post-processing allowed.
- QKD: TX-RX sync 1ns, key time stamp 1μs, stability 10^{-12} @ 1 s

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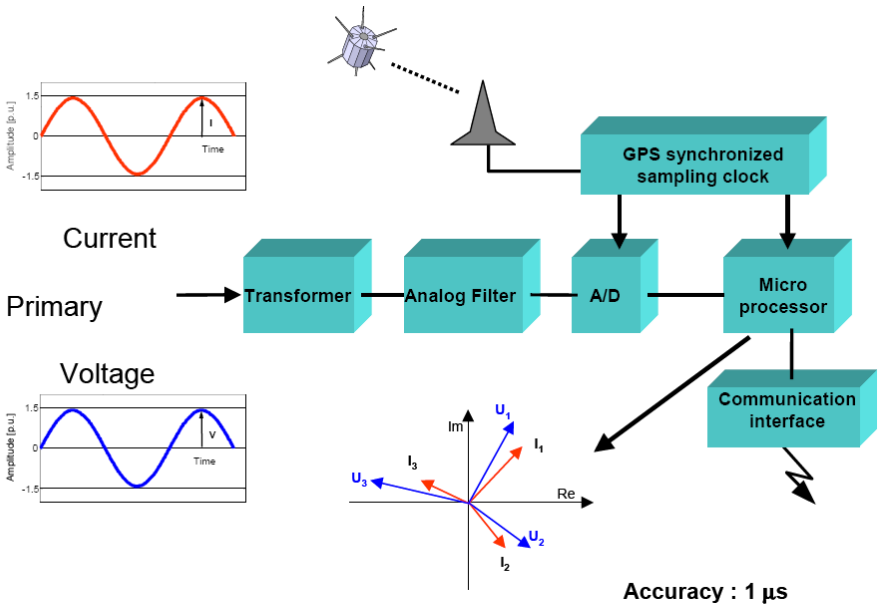
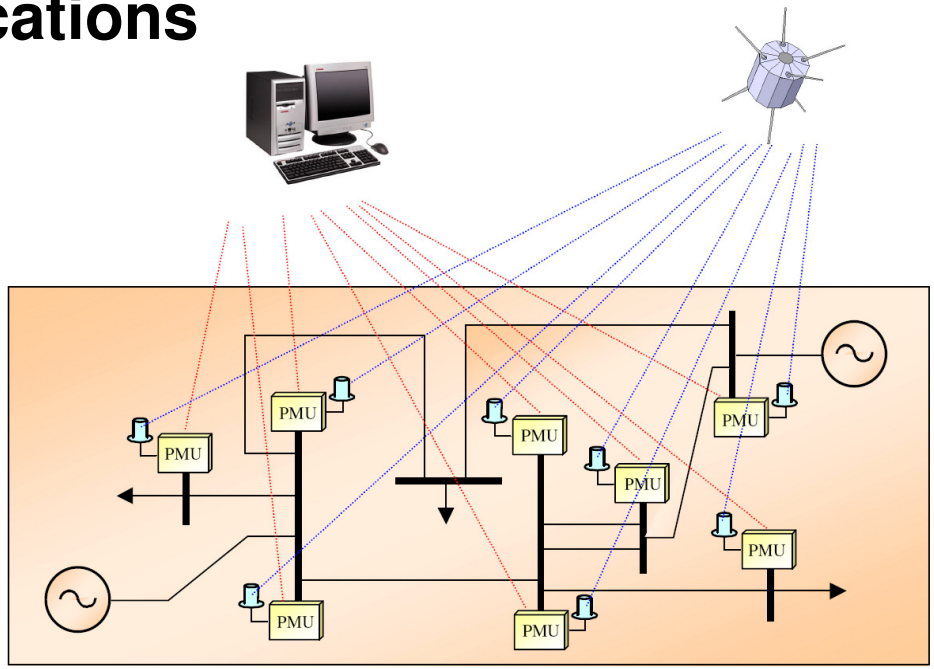
Power and Energy applications

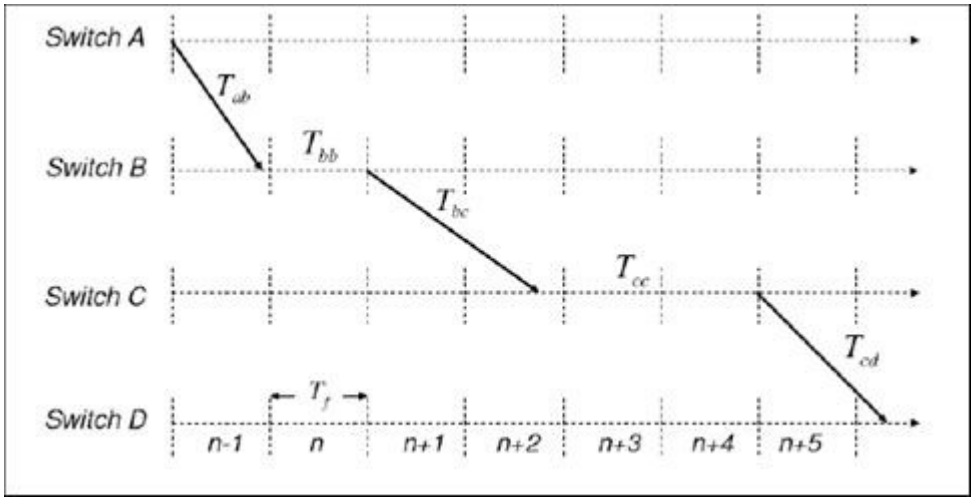


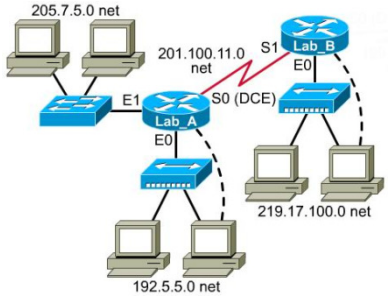


Key parameters *(Eu size 50knodes, 300.000km)*

- Synchronization requirements 1 µs for network control
- 10 – 100 ns transient propagation on short distances
- High dependability, security, reliability requirements
- Legal time as added value in case of incident analysis

Synchronization in Communication Data Networks



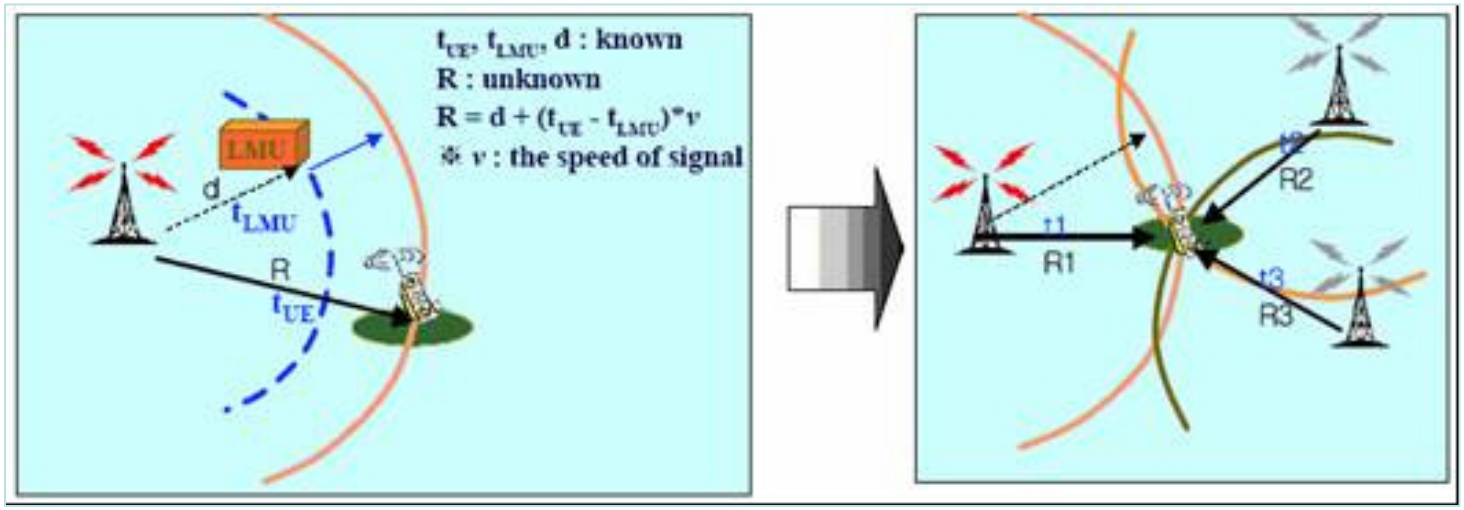


Routers Pipeline Forwarding techniques to guarantee Quality of Service in case of **network congestion**

Key parameters

- Synchronization requirements 1 µs for network control
- Medium dependability requirements (in case of loss of Synch the network continue to work asynchronously)

Mobile Cellular Network Synchronization of Base



Used for BTS Synch in LBS service for evaluation of the ToA (Time of Arrival)

Key parameters

- Synchronization requirements 1 µs
- Needs for Assisted GNSS (e.g. Indoors), Galileo has more power than GPS, the need for AGNSS to be evaluated
- High dependability requirements

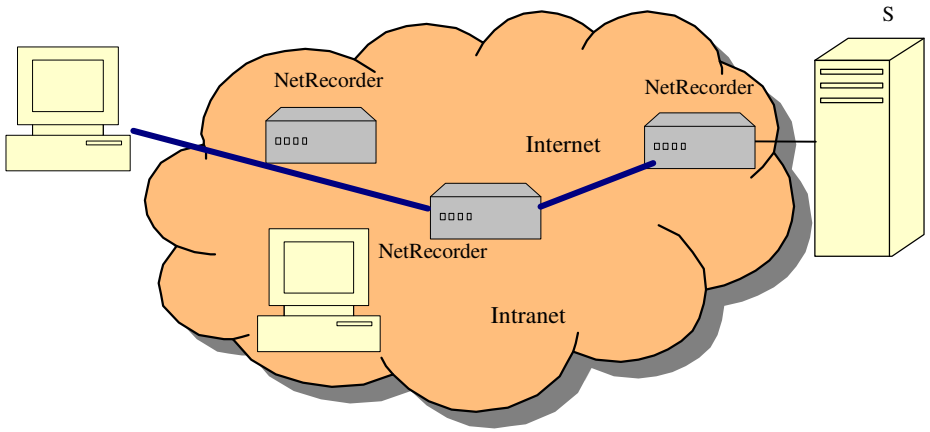
Financial and Banking Applications

- Financial and banking community is **very conservative** wrt innovation if the advantages are not clearly proved.
- Time used for **event logging**
- Presently NTP time reference from official BIPM server list is often used

Key parameters

- Server Synchronization, accuracy requirements 10 - 300 ms
- High dependability requirements
- Needs for time reference with legal validity

Time Reference for Secure Applications



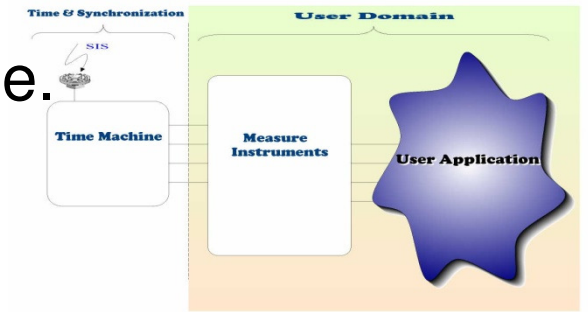
- Event logging
- Trusted Third Party for network monitoring
- Time Stamping Authority
- One Time Password

- High security cryptrography products (GeoCodex™)
- Application field of time information in cryptography:
  - Business to Government (e.g military, juridical report)
  - Business to Business (e.g business data security)
  - Business to Consumer (e.g Digital TV, banking retails, Service disabler, on line gambling, LBS)

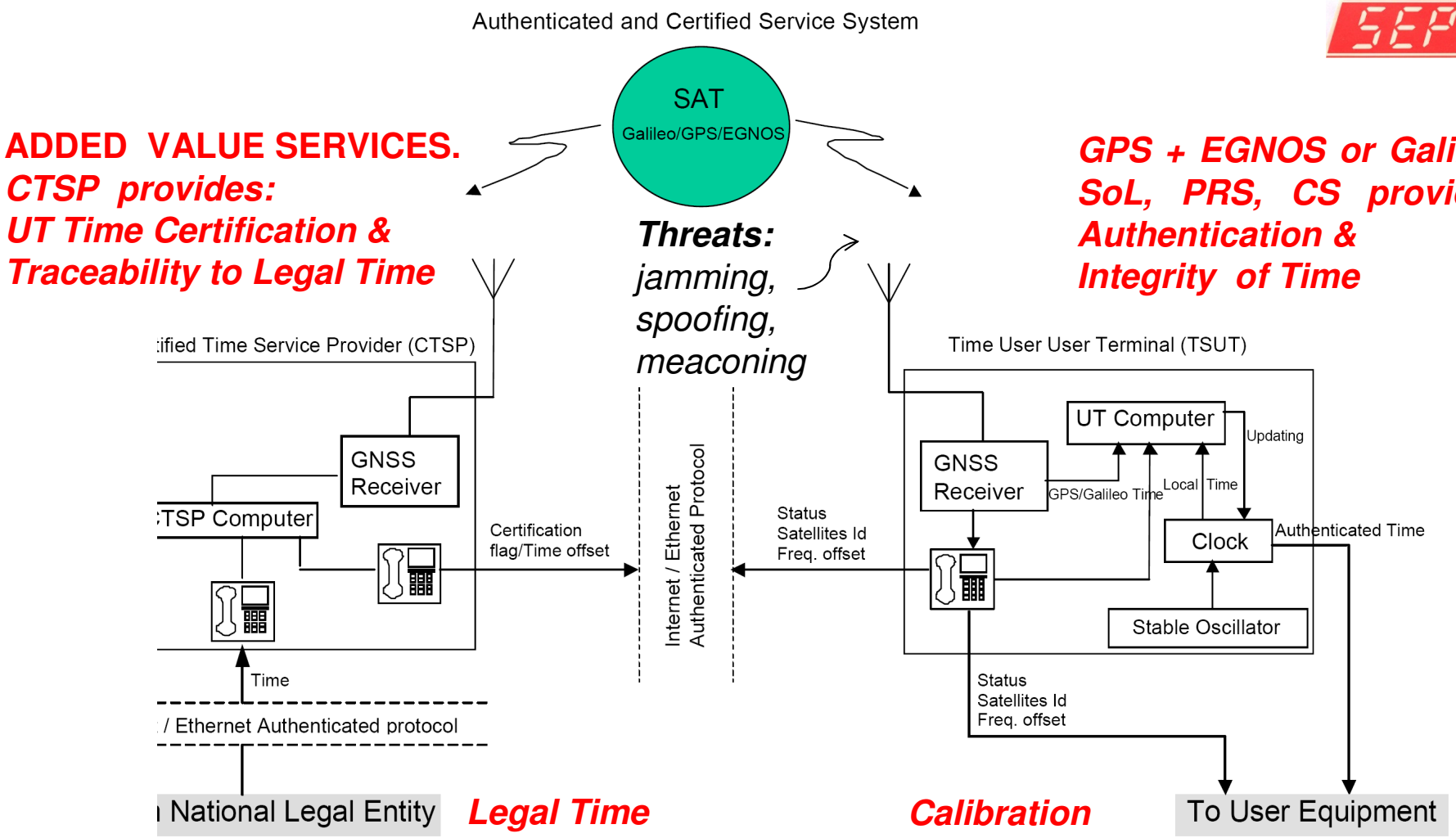
Authenticated and Certified Time System ACTS

GNSS offer timing performance **sufficient for almost all** the application studied.
GPS nor Galileo are/will legal time reference
To provide users with Authenticated and Certified Time Reference **added value services** have to be implemented to prove at **user level** that the **time received signal is the correct** Galileo, free from jamming, spoofing, meaconing

The ACTS under development is a prototype.



ACTS Architecture



Market Analysis

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The most appealing domains

•**Power and energy** leveraging on availability and integrity Galileo value drivers

•**Mobile communication** to implement Location Based Services

•**Astronomy** leveraging on accuracy Galileo value driver and from the great benefits for the research activities

• **Rail**

The definition all over Europe of a common acts and rules to define **common time reference** to be used for **forensic dispute and for juridical event recording or logging will create big opportunities** for:

•Data network monitoring for security reason, Trusted Third Party

•Quality of service

•Power and Energy, Railways.

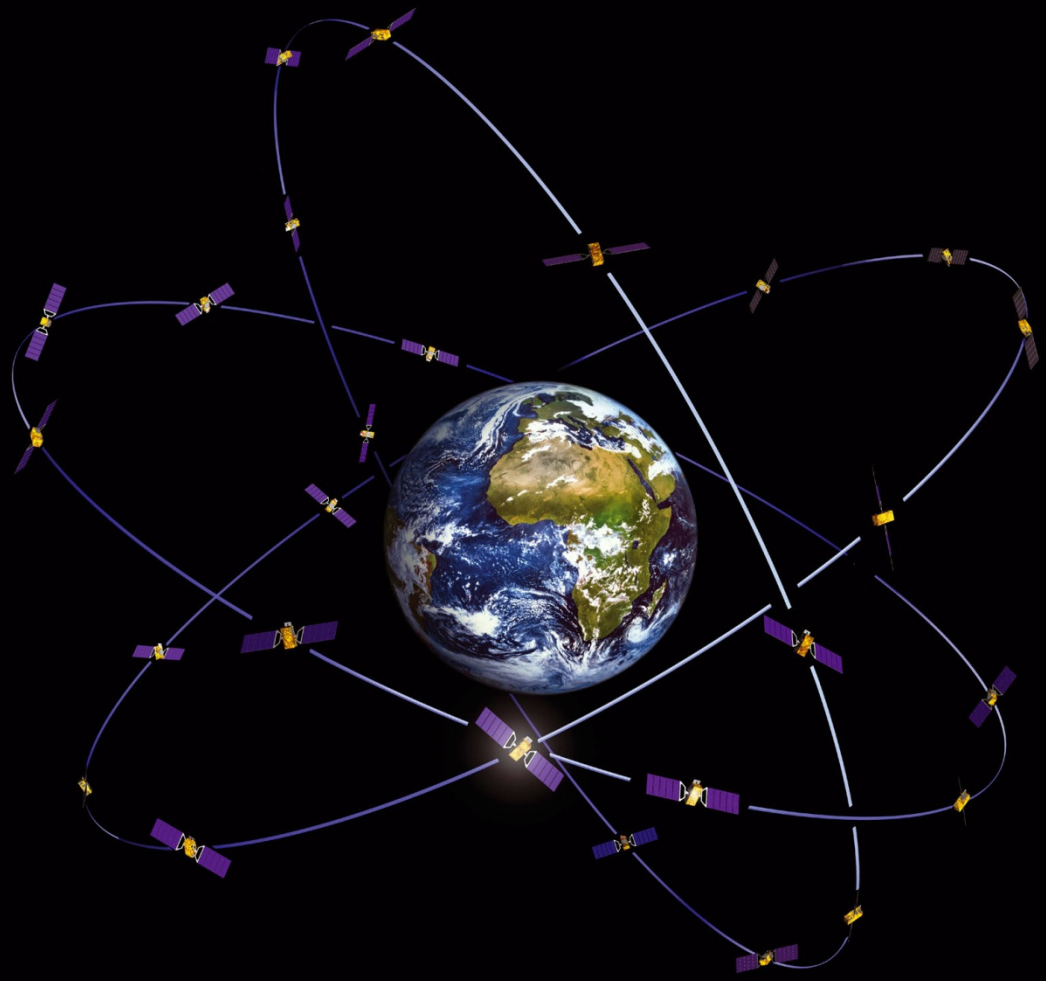
Legal Time Aspects

Harrison highlights the need of a definition valid in all Europe of the 'legal time'

- There is no explicit definition of a Legal Pan European (or EU wide) time or time reference
- UTC is implied as a reference time (with timezone and summer time offsets) in the summer time directive of the EU. However the same document in different languages uses contradicting terms like "UTC", "GMT" and world time to refer exactly the same thing
- Individual countries have national legislation on the matter, and it is different the concept of legal time reference from country to country

Conclusion

- Timing and synchronisation is a ***developing market***
- ***Galileo*** can obtain a ***leading position*** because of its ***added values*** such as:
  - time ***authentication*** and ***certification***
  - improved ***accuracy***, ***reliability***
  - ***commercial focus*** intended to provide ***contractual responsibility*** of the service.



Thank you!