NAVISP INDUSTRY DAYS

TOWR: A TIME SERVICE OVER WHITE RABBIT FOR THE FINANCIAL SECTOR IN MADRID

ESTEC, THE NETHERLANDS

JANUARY 18, 2019

BOLSA DE MADRID

SENEN Solutions

gmv INNOVATING SOLUTIONS

PROBLEMS IN GNSS TIMING

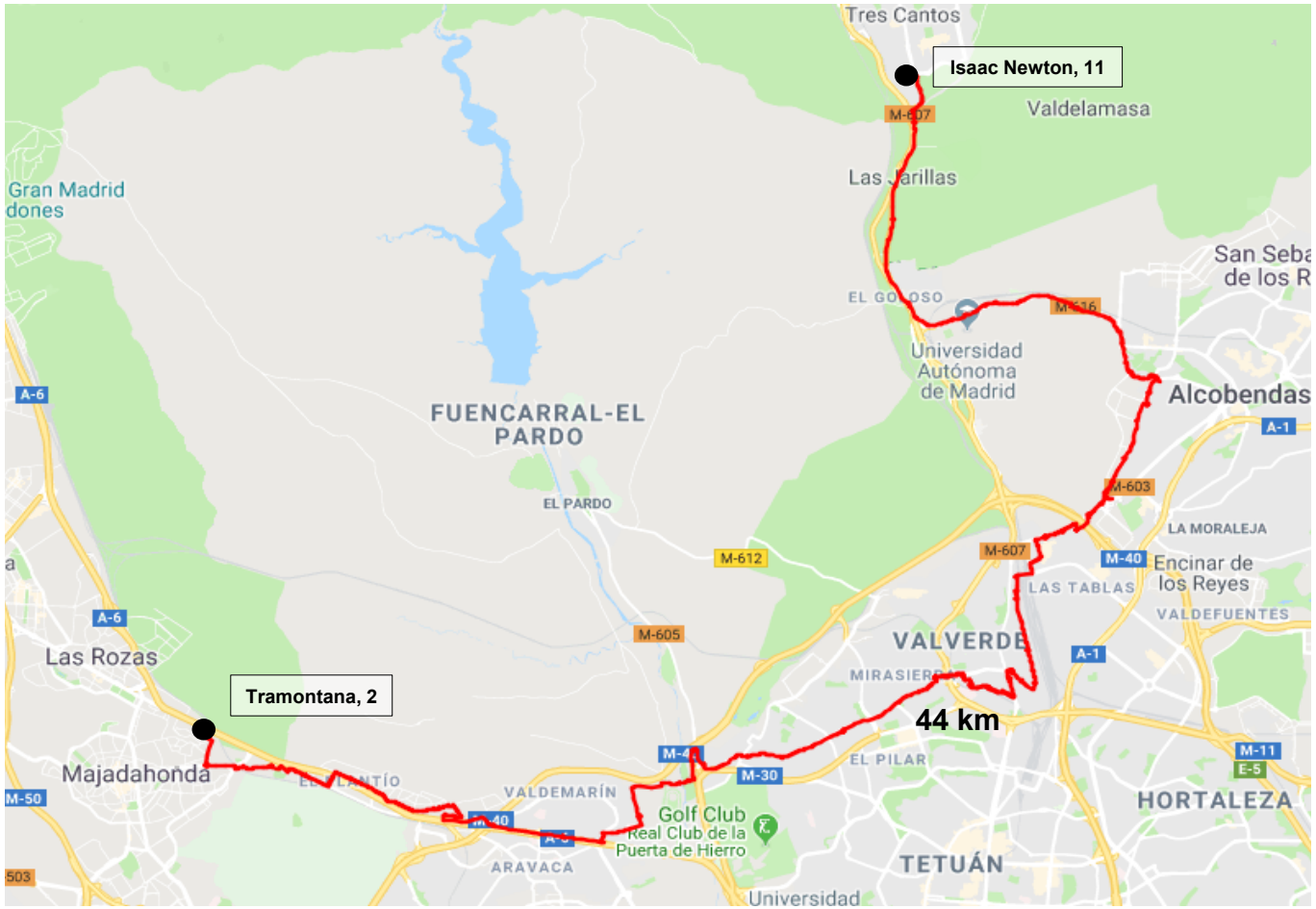
- Lack of roof space or lack of permission for GNSS antenna installation
- Cluttered rooftops, possibly with rogue antennas (interference)
- GNSS signal blocking and reflections by obstacles or adjacent buildings
- GNSS jamming and spoofing
- No GNSS calibration, poor traceability to UTC (required by MiFID II regulation)
- Possible anomalies in GNSS timing (e.g., GPS glitch on Jan 26, 2016)

THE TOWR APPROACH

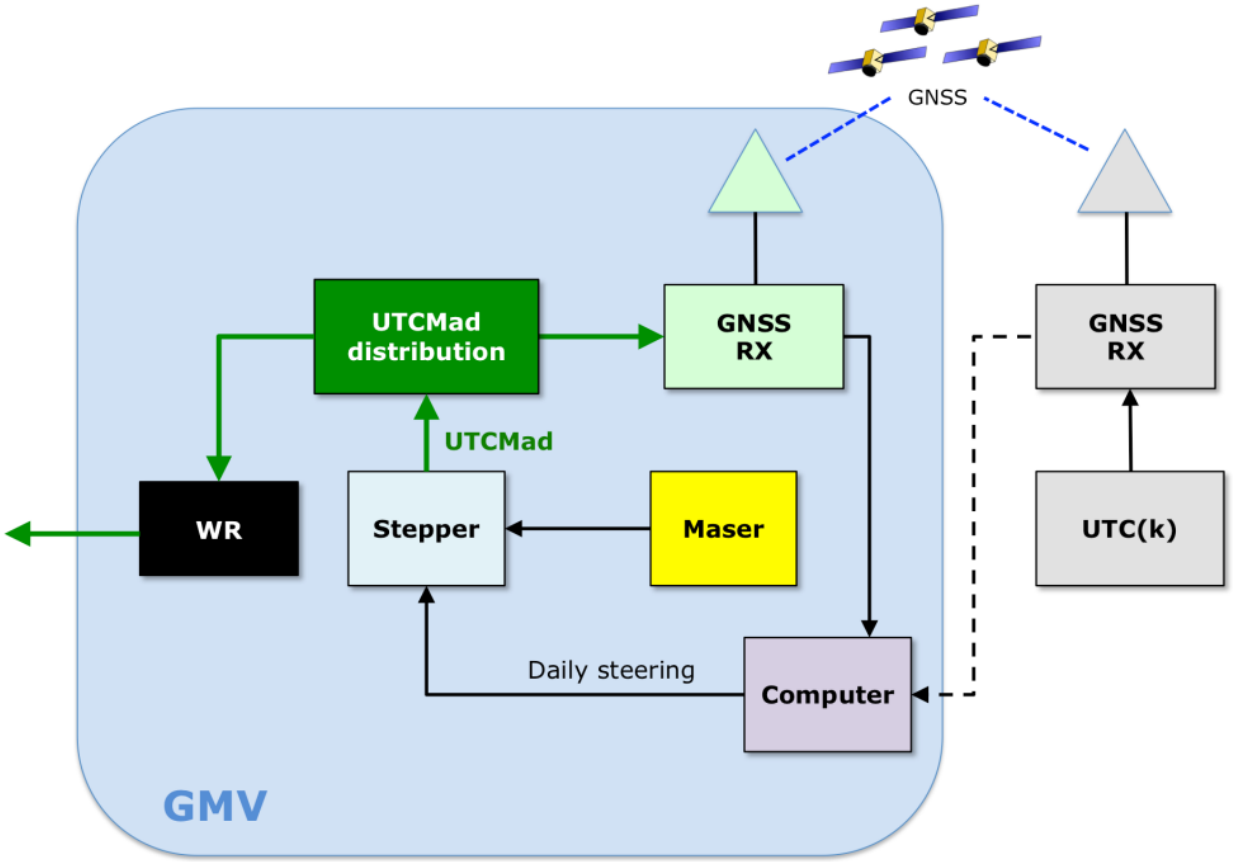
- Generate the time from very stable and autonomous atomic clocks, not directly from GNSS
- Use GNSS "only" for fine adjusting the clocks by means of time-transfer to UTC labs (weekly corrections typically)
- Use Galileo in addition to GPS
- Place the GNSS antenna in a controlled, clean environment away from the city
- Apply GNSS calibration and metrological practices, for traceability to UTC
- Distribute the time by the network (White Rabbit) to the end user downtown

NETWORK LINK

- 44 km optical fibre path between GMV and the Stock Exchange building

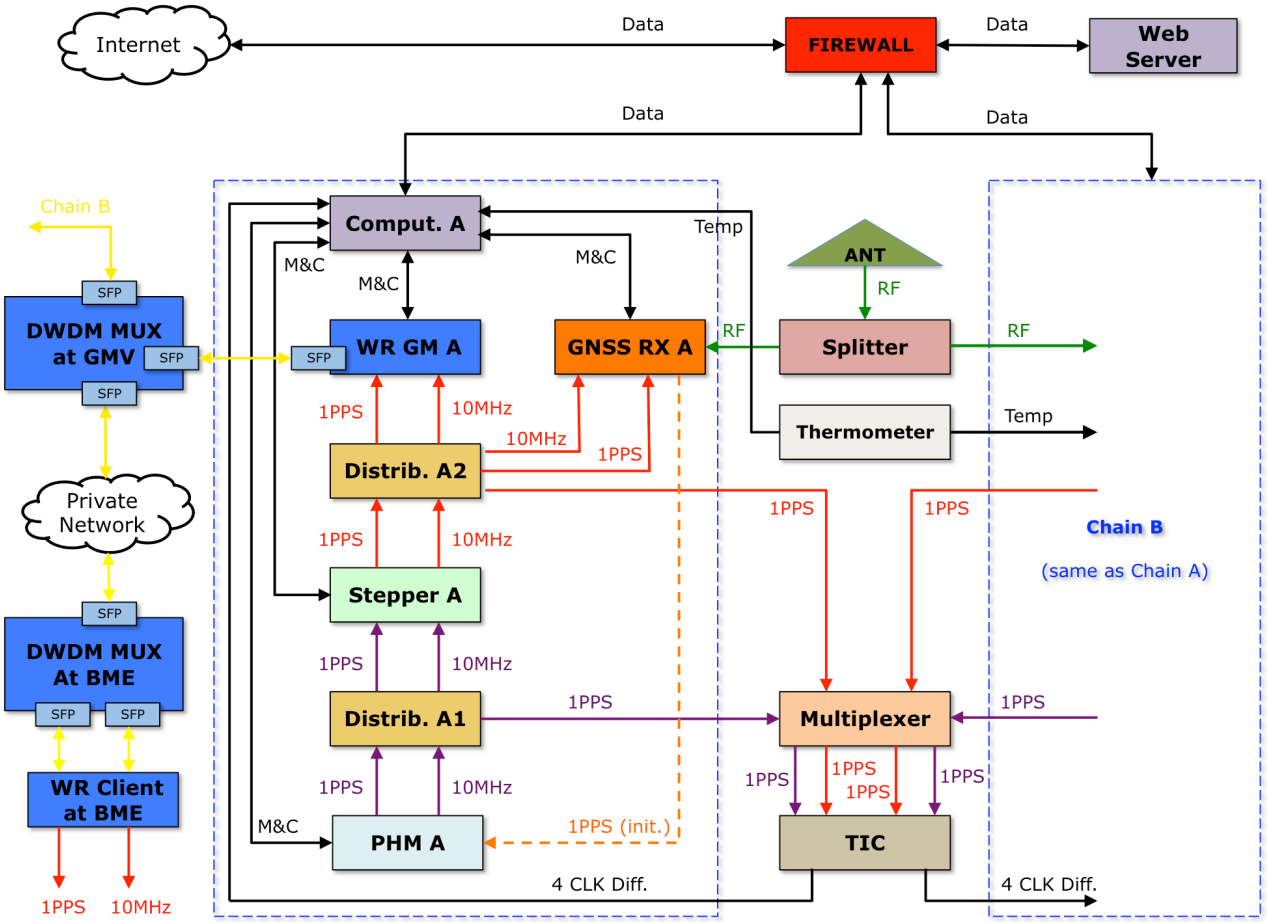


OVERALL ARCHITECTURE



SERVER-CLIENT ARCHITECTURE

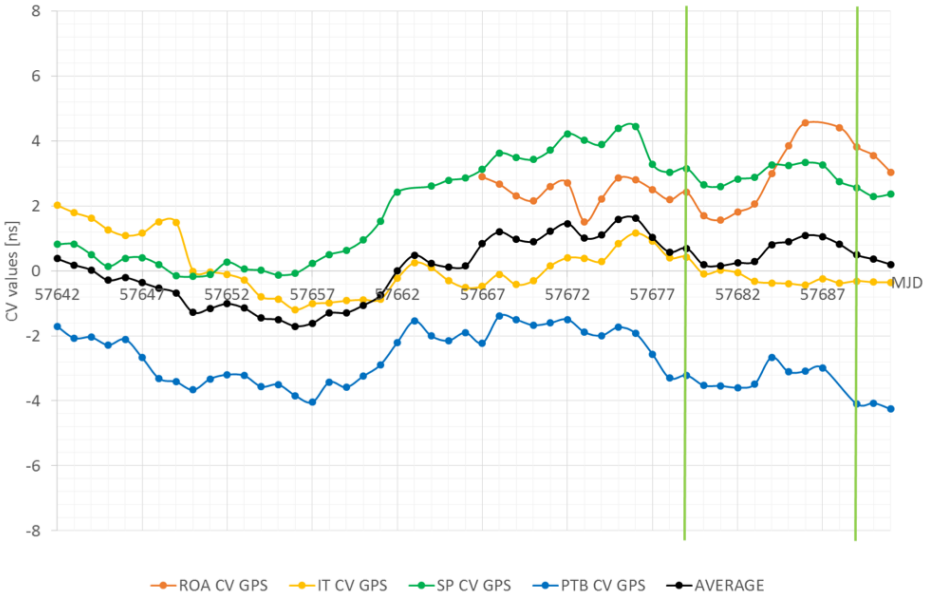
- Critical hardware at the server is duplicated

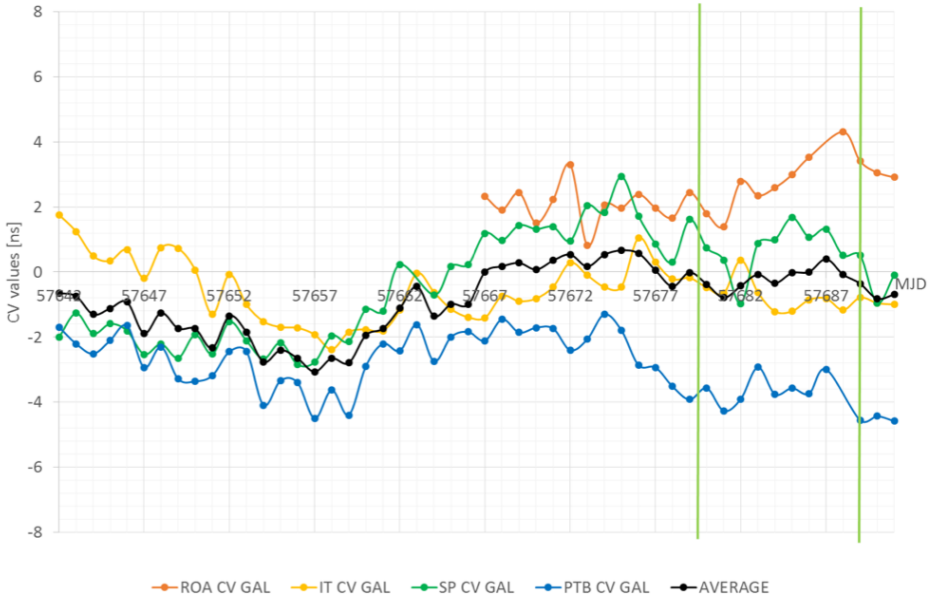


NOTE: Black lines denote data interfaces via Ethernet, Serial, or USB port, depending on the type of equipment.

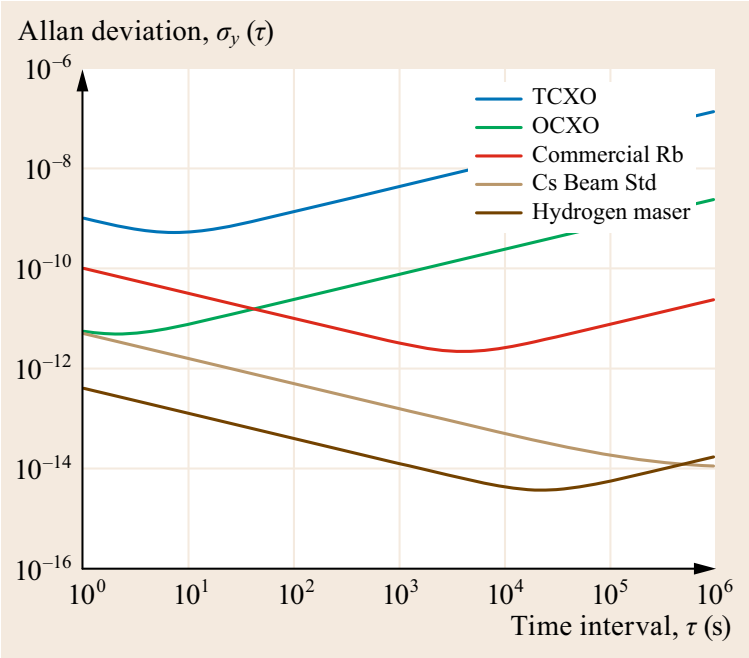
GPS AND GALILEO TIME-TRANSFER

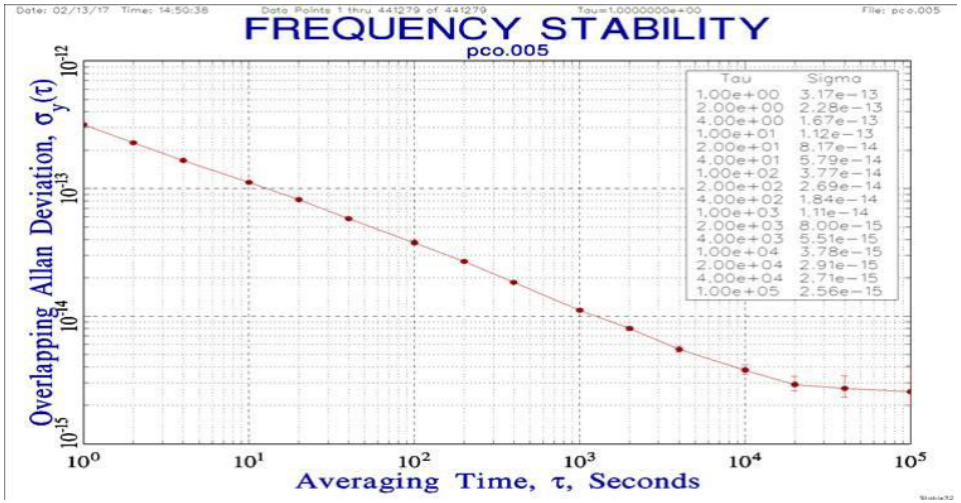
- GNSS Common-View (CV) between the TOWR and UTC(k) labs
- Similar results (within 1 ns) for GPS and Galileo when averaging several UTC(k) labs
- Left: GPS CV; right: Galileo CV





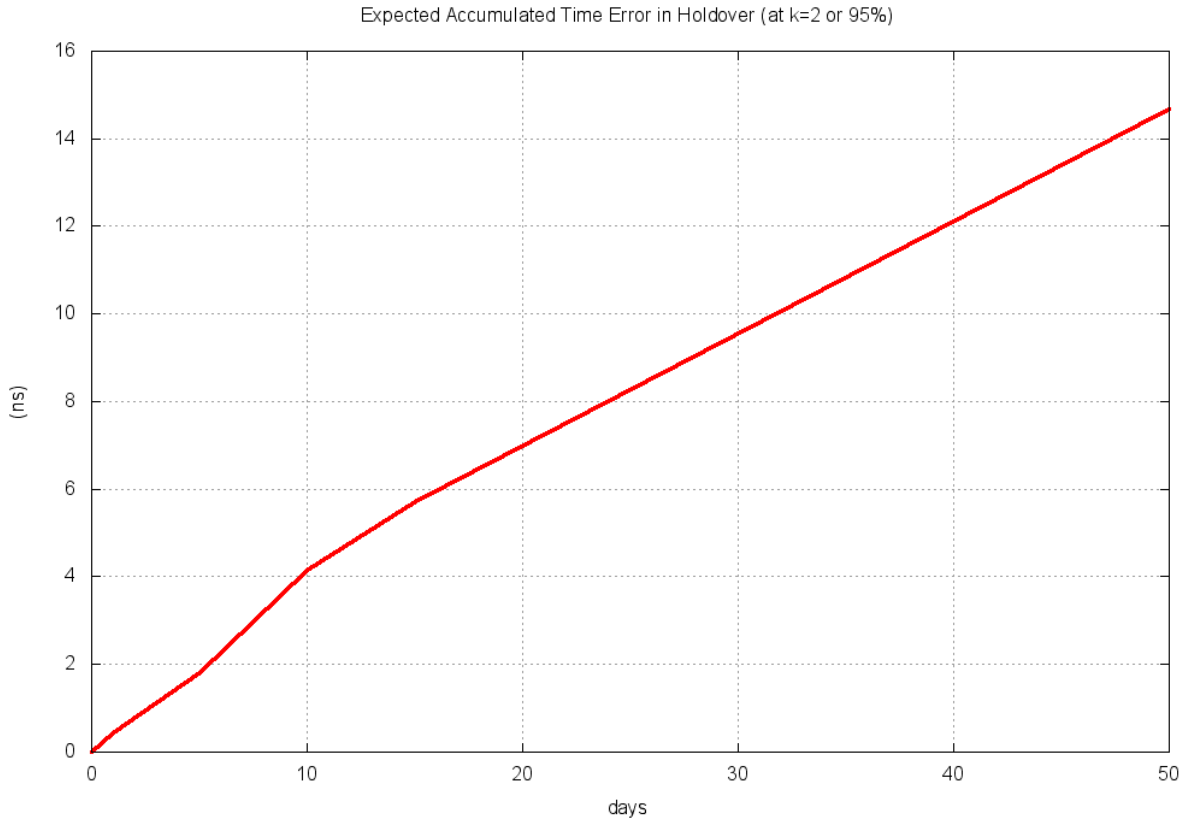
PASSIVE HYDROGEN MASER (PHM)





PHM AUTONOMY ("HOLDOVER")

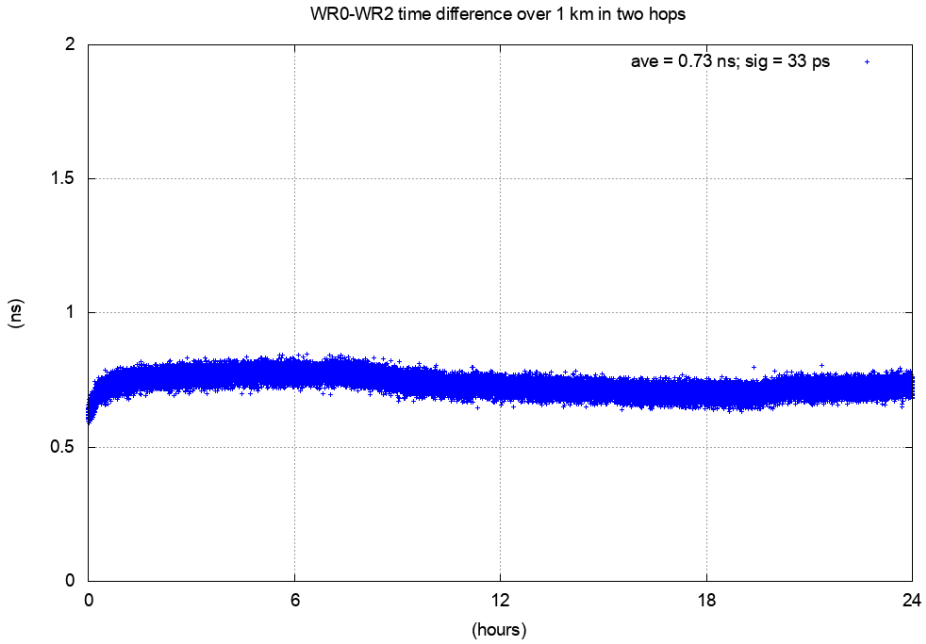
- Assumes zero time offset at T=0, and daily PHM steering for the deterministic part (frequency offset and drift)
- Simulates total loss of GNSS after T=0
- Accumulated time error: **3 ns every 10 days** (at 95% confidence level)



USER EQUIPMENT: THE WR SWITCH

- White Rabbit switch: no GNSS antenna required!
- Time distribution error at the level of 1 ns over tens of km

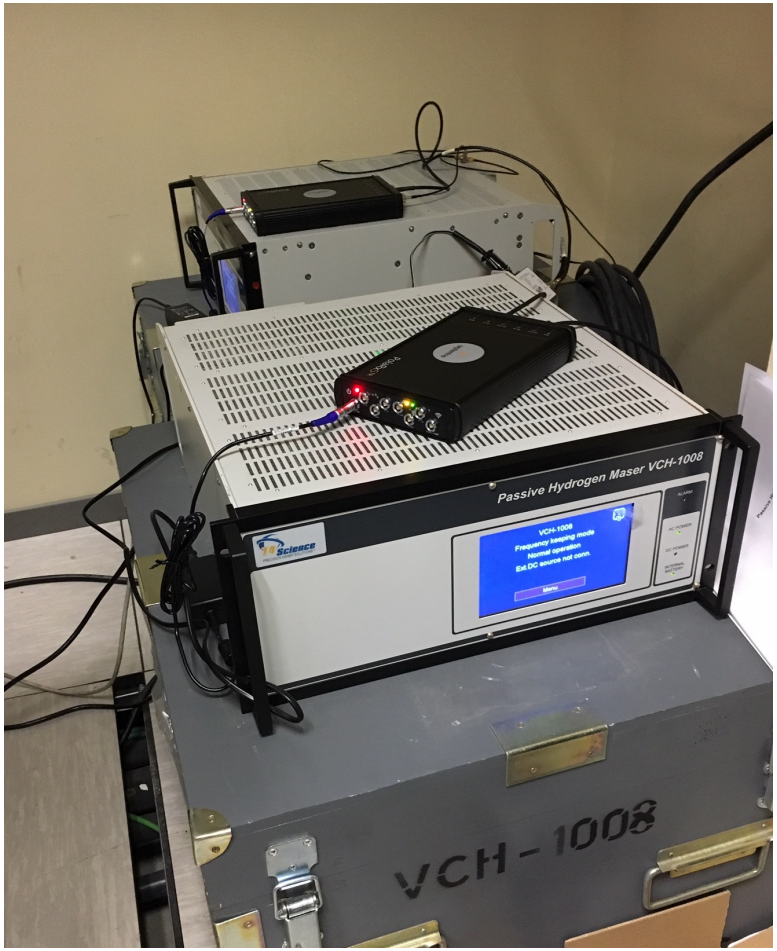
SEVEN Solutions



SLA WITH THE STOCK EXCHANGE

Criticality ID	KPI ID	Requirement	Description of criticality	Evaluation method
1	KPI #1	Maximum continuous downtime per month < 1 hour	Impact for the end customer of having a downtime of the timing service lasting a continuous duration of more than one hour over one month	Log System
2	KPI #2	Average monthly service availability > 99.9%	Impact for the end customer of having an average availability of the timing service of less than 99.9% over one month	Log System
3	KPI #3	Maximum time error (versus UTC) at the customer endpoint <10 ns	Impact for the end customer of having a timing error larger than 10 ns over one month	Comparison between source and endpoint 1PPS signals

WORK IN PROGRESS



PROJECT SCHEDULE AND STATUS

SUMMARY

- The objective of TOWR ("tower") is the development of a robust and accurate time distribution service via optical fibre (White-Rabbit) over the Madrid region, and traceable to UTC(ROA), the Spanish legal time
- Key technologies:
  - Time generation from very stable clocks (Passive Hydrogen Masers)
  - GNSS time-transfer to UTC(k) laboratories (using GPS and Galileo)
  - IEEE-1588 PTP / White Rabbit (WR)
- Exploits the concept of Time as a Service (TaaS)
- Mainly (but not only) oriented to banking and finance applications, in particular to fulfil the "business clocks" synchronization requirements derived from the new European MiFID II regulation
- Pilot project for a first customer: the Madrid Stock Exchange (Bolsa de Madrid)
- Builds on the combination of GMV's experience developing and operating the Galileo Time Validation Facility (TVF), and Seven Solutions' experience in precise time distribution via optical fibre (WR-PTP)

Thank you

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