White Rabbit lab and field trials over GARR optical network

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GARR

WORKSHOP GARR 2020

NET MAKERS

Consortium GARR

Outline

- T&F distribution in Italy
- Time Over WAN – White Rabbit distribution
- Lab and Field Trial
- Conclusion and Discussion

Time & Frequency distribution in Italy

INRiM ISTITUTO NAZIONALE DI RICERCA METROLOGICA

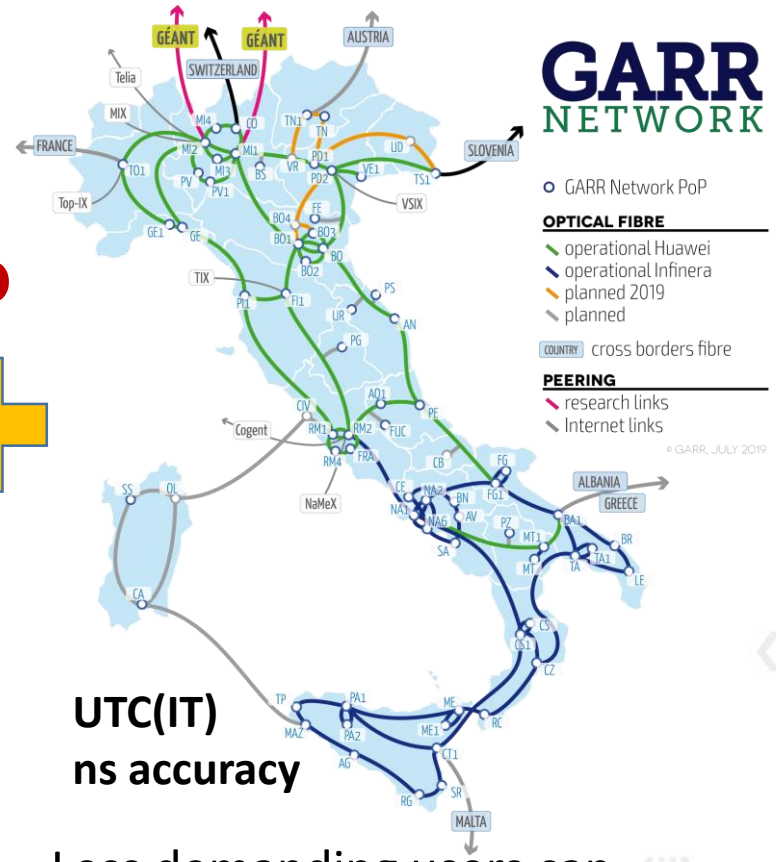
UTC(IT)

INRIM has a **dedicated fiber infrastructure for Frequency dissemination and quantum technologies**

Time & Frequency distribution in Italy

UTC(IT)

?

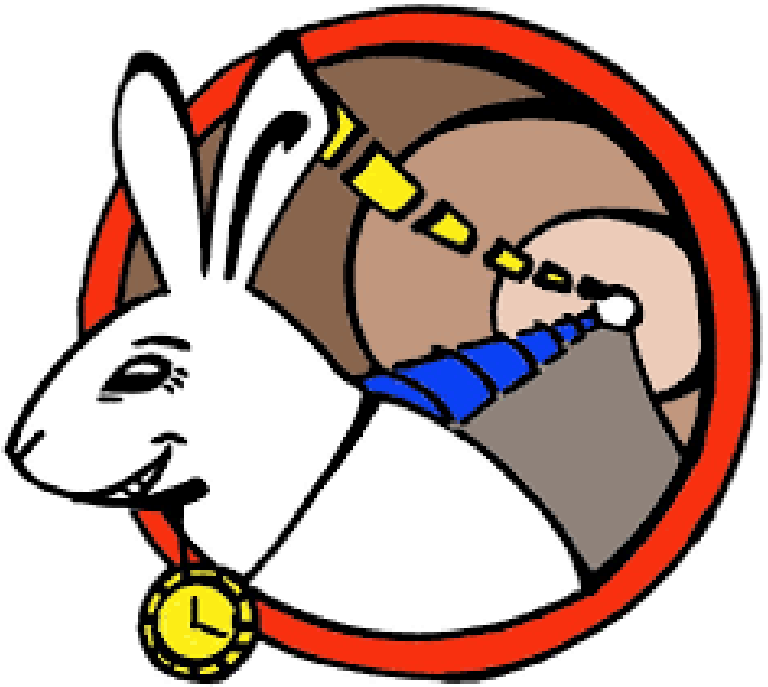


UTC(IT)
ns accuracy

INRIM has a **dedicated fiber infrastructure for Frequency dissemination and quantum technologies**

Less demanding users can benefit from the UTC(IT) reference

After several whiteboard sessions … Prototipe Blueprint:



White Rabbit:
Open and Ethernet based network for data transfer and synchronization
https://ohwr.org/projects/white-rabbit

Alien Wave DWDM Transport:
DWDM long haul transport of a 3rd party signal

White Rabbit in a nutshell

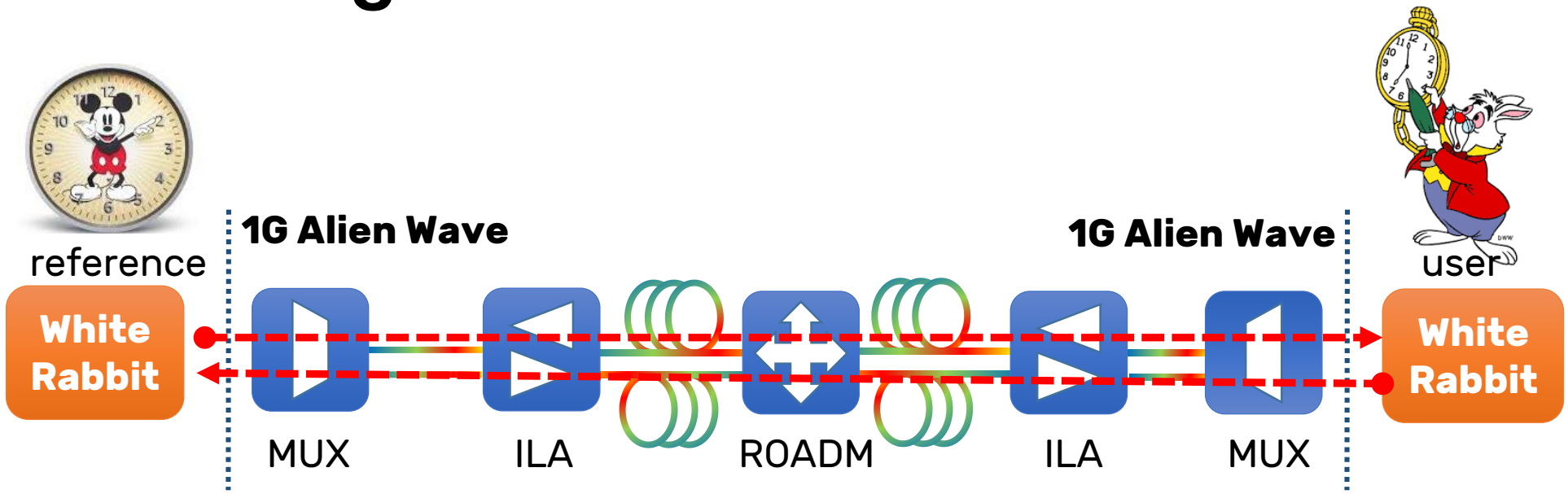
- Open hardware and open software project developed at CERN https://ohwr.org/projects/white-rabbit
- Synchronization:
  - Synchronous Ethernet (SyncE)
  - Precise Time Protocol (PTP)
  - Digital Dual Mixer Time Difference (DDMTD)
- Gigabit Ethernet over fiber
- Sub-ns synchronization
- Very effective with bi-directional transmission over the same fiber
- Requires calibration for compensate:
  - HW delays
  - Fiber asymmetry
- Typical Scale: Campus Network

White Rabbit for Time Over WAN distribution

- **Several research institutions have more relaxed (order of nanosecond) requirements on the T/F signal however, might profit receiving a T/F distribution from a source of "INRIM reference time"**

- In July 2019, in collaboration with INRIM, we started to test the White Rabbit protocol over DWDM in our network
  - The aim is to check which accuracy we can reach using the WR protocol on our optical infrastructure (using a pair of fibers, amplifiers and ROADMs)
  - We want to measure the average accuracy/stability we can get in different parts of our network
  - We want to understand the complexity of operating the WR devices

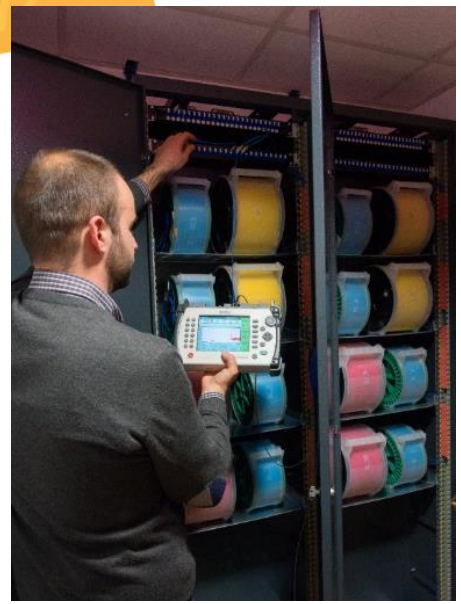
Alien Wave transport of UNIdirectional White Rabbit signal



Standard AW transport across UNIDIRECTIONAL DWDM network

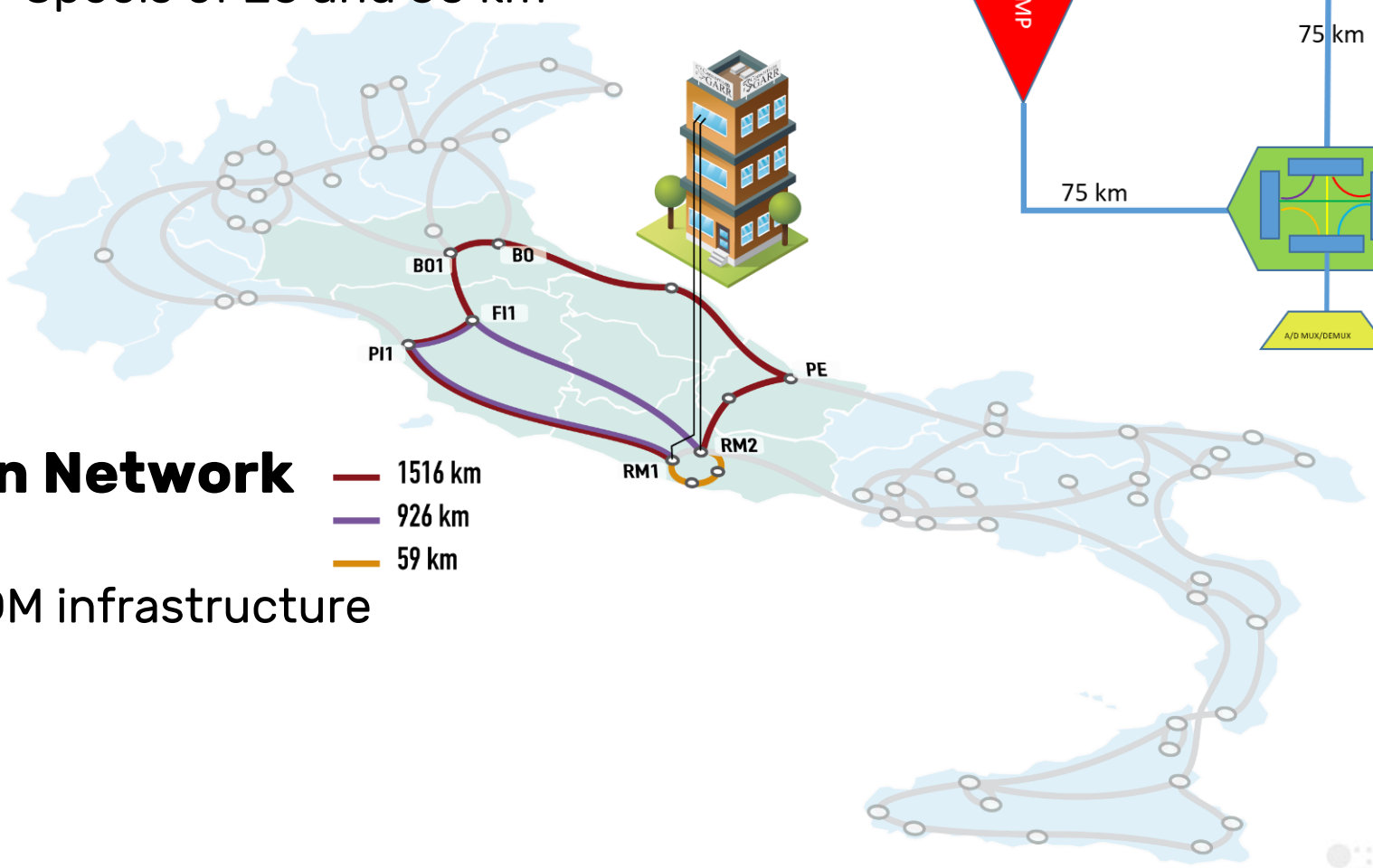
- 1G lambda in C-band
- System based on fiber pair
- CD Compensated Fibers
- Unidirectional Signal
- Required Asymmetry Compensation

GARR Optical LAB



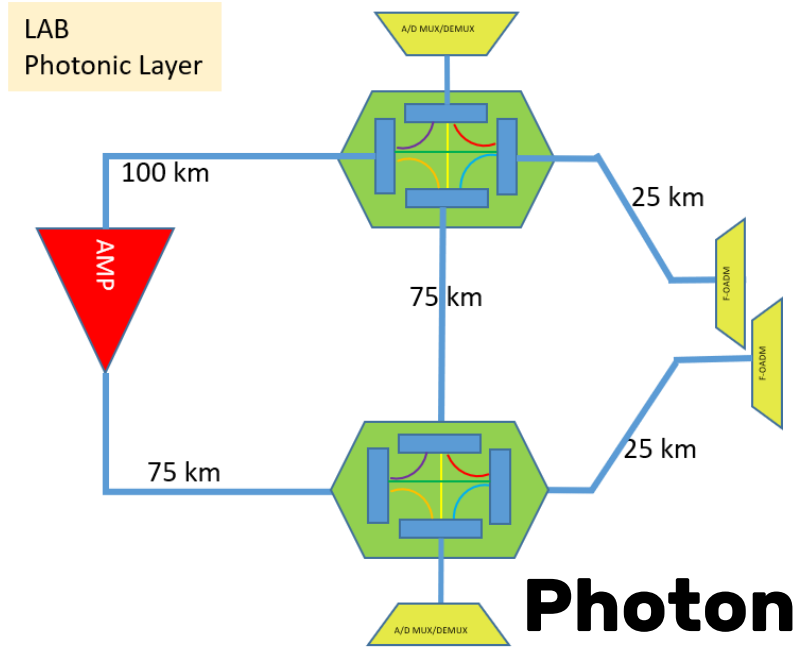
Fiber spools

300km G.652d fiber
Spools of 25 and 50 km



LAB/Production Network Integration

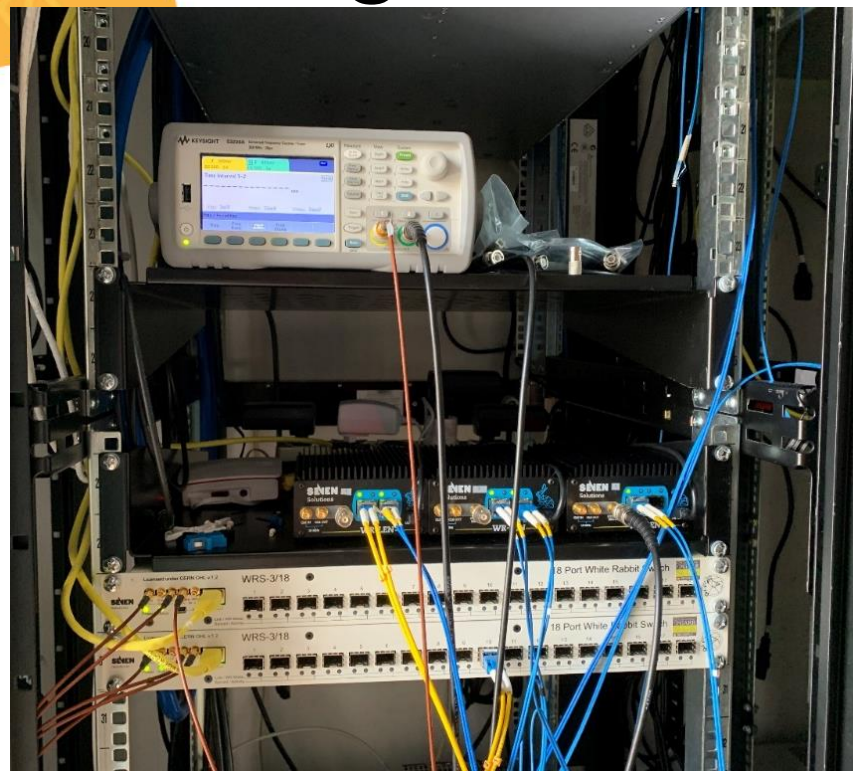
Paths on GARR DWDM infrastructure
60km
900km
1500km

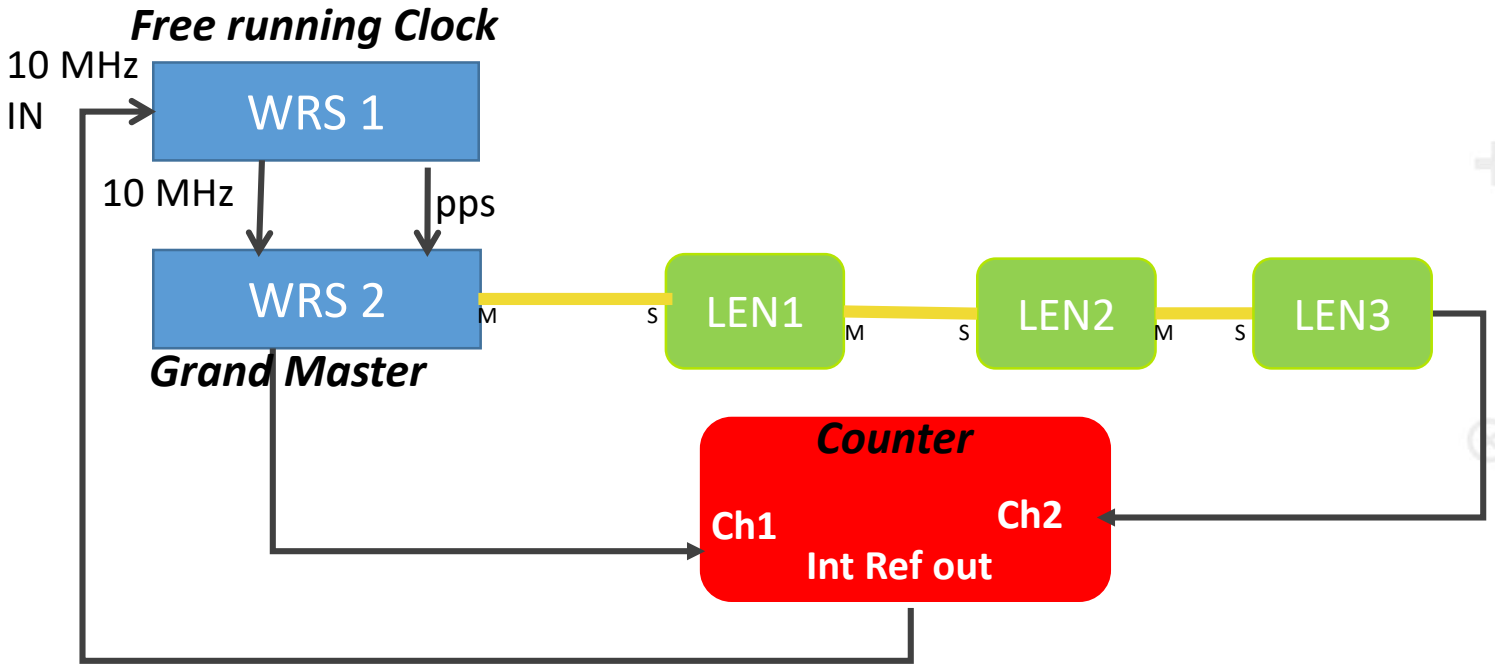


Photonic Layer

2 ROADM
1 FOADM
1 ILA

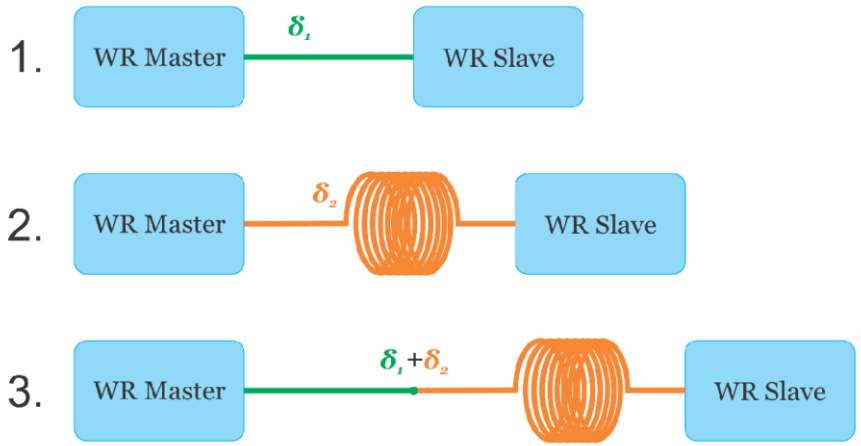
Following the White Rabbit



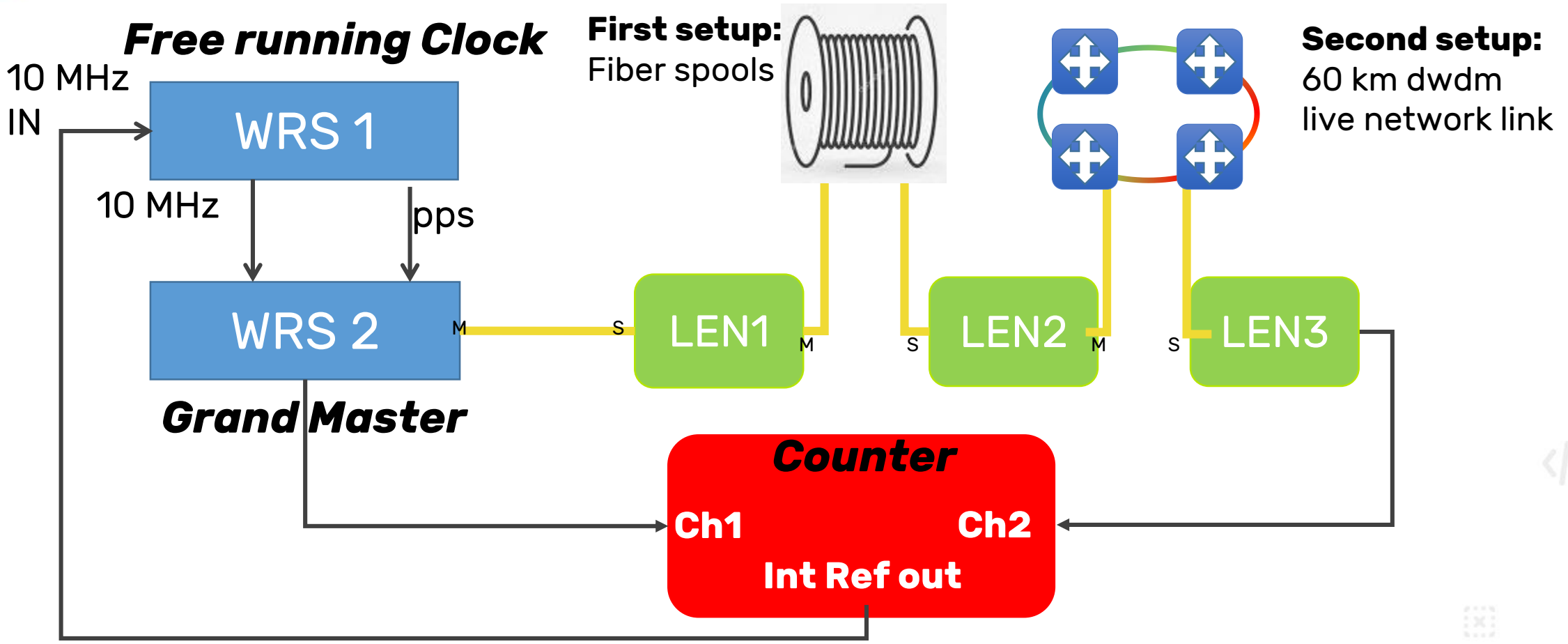


WR Relative Calibration:

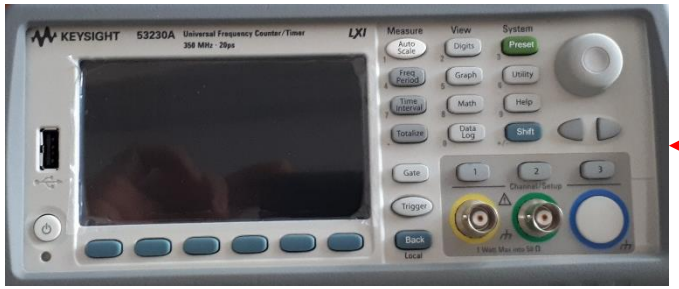
It is mandatory to perform calibration in order to compensate fiber pair asymmetry
(INRIM – TOPIX guided and taught us how to!)



Following the White Rabbit



Measurement acquisition



Counter

python™

Python script for counter setup and data acquisition (owner INRIM-TOPIX)

Grafana

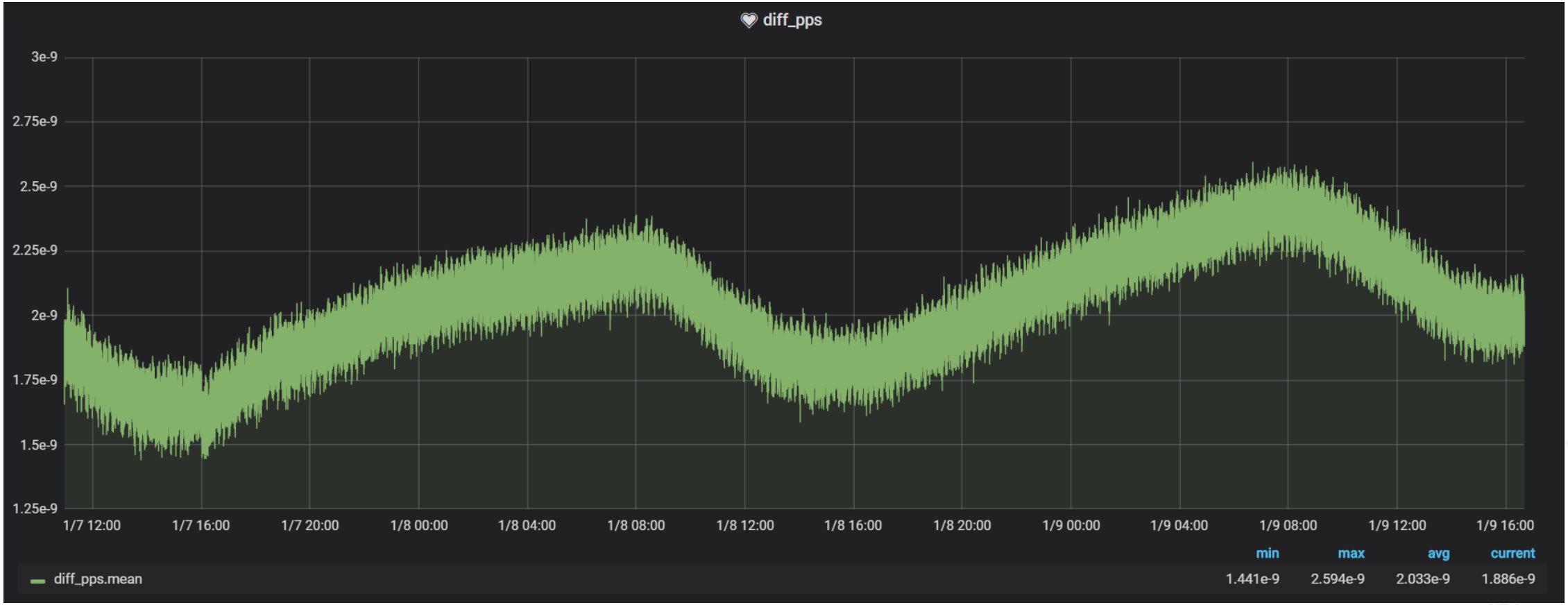
influxdb

Time Series Database

White Rabbit: 50km fiber spool (span len1-len2)

diff_pps = PPS_{ch2}-PPS_{ch1}
diff_pps order of 10^{-10} s

White Rabbit: 60km production DWDM line system (span len2-len3)



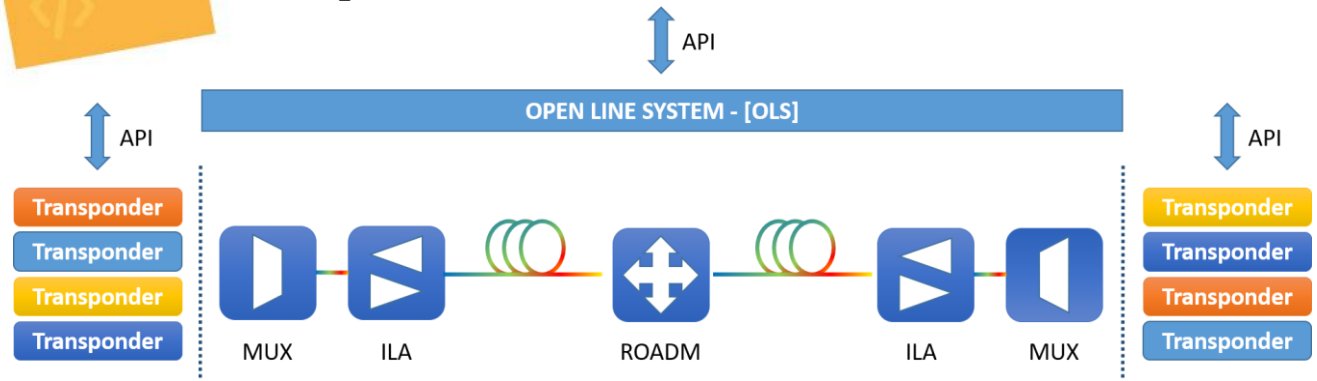
- diff_pps order of 10^{-9} *s*
- Night-day variation in the range of 2ns

WR operational considerations

- Main concerns on possible operational models:

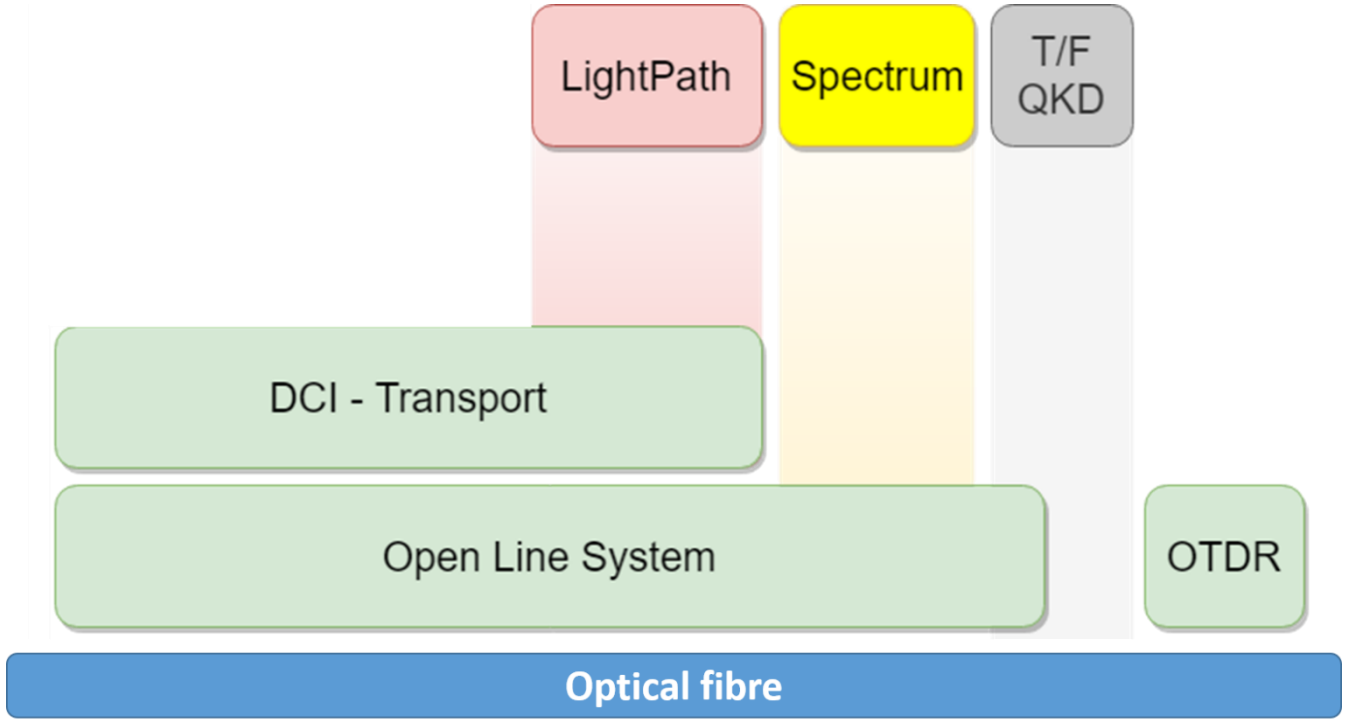
1. Lack of management and control tools for White Rabbit devices.
   - no remote control possible for LEN devices, a console connection is mandatory
   - device reboot required after calibration parameters change
   - experienced several freezing states or crashes both on CLI and on service
2. For unidirectional signals, calibration with external reference (GPS) is required after any path variation and/or fiber cut and splicing.

GARR optical network evolution



Open Line System (partially disaggregated) to replace the oldest infrastructure

GARR-T optical network architecture



Further investigations

- ✓ GARR didn't force a strong requirements on GARR-T design for T&F and WR distribution
- ✓ After choosing the GARR-T design and its transmission platform, it is necessary to update the WR signal transport reference model
- ✓ Our expectation is that some opportunities should be seized

Standard AW transport across UNIDIRECTIONAL ?
DWDM network

- 1G lambda in C-band
- System based on fiber pair
- ~~CD Compensation Fibers~~
- Unidirectional Signal **?**
- Required Asymmetry Compensation

! Any new oppotunity to reduce ops complexity?

Conclusions

- ✓ White Rabbit T/F transfer can be coupled and deployed over a DWDM data network:
  it works with some attention points.
- ✓ Operational concerns on live calibration after fiber cuts or splicing could represent a major issue.
- ✓ A dedicated dark fiber infrastructure for high demanding T/F distribution is the Italian reference model.
- ✓ White rabbit or PTP over DWDM network can be explored for less demanding users in R&E community.
  - T&F distribution has a key role in GARR-T architectural model
  - However, GARR didn't force a strong requirement for these applications on the new optical network design, which can be considered as a plus for future evolutions and services.
  - WR distribution model probably must be updated to fit in GARR-T optical network.
  - Again GARR will support INRIM for the network aspects, relying on NMI for the metrological topics.
- ✓ **Looking for Beta Users**

Q&A

Q&A

menti.com

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Virtual Coffee Break

https://bbb.meet.garr.it/b/fed-umr-9ve-ptb