Reliability in White Rabbit Network

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Outline

What is White Rabbit?

- Accelerator's control and timing
- International collaboration
- Based on well-known technologies
- Open Hardware and Open Software
- Main features:
  - transparent, **high-accuracy** synchronization
  - low-latency, **deterministic** data delivery
  - designed for **high reliability**
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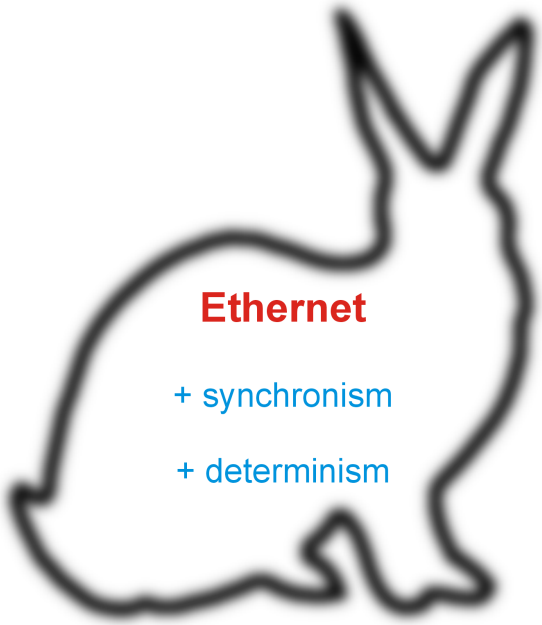
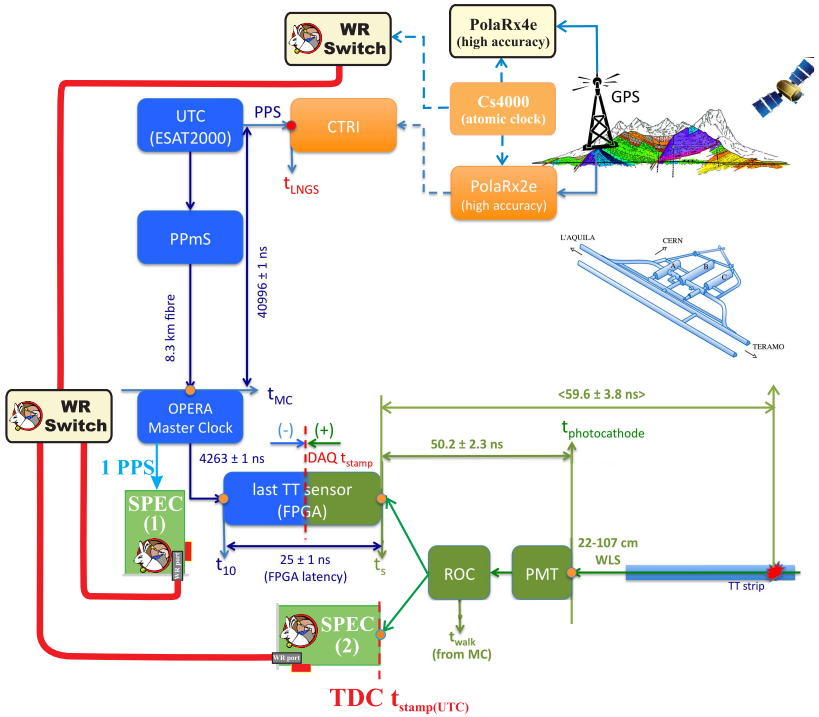


White Rabbit applications

- Existing applications:
  - **CERN Neutrino to Gran Sasso**



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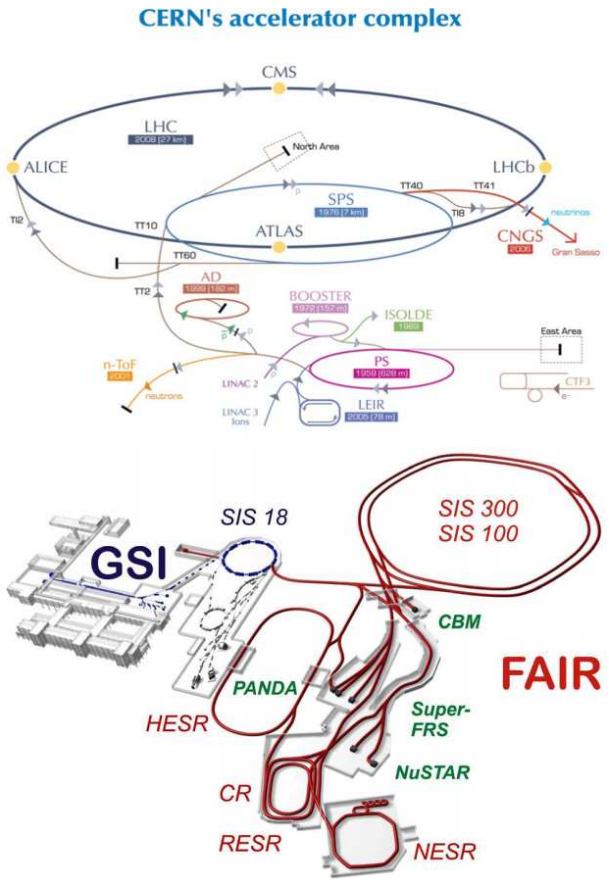

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> Institute for Nuclear Research of the Russian Academy of Sciences
> Moscow State University
> Irkutsk State University

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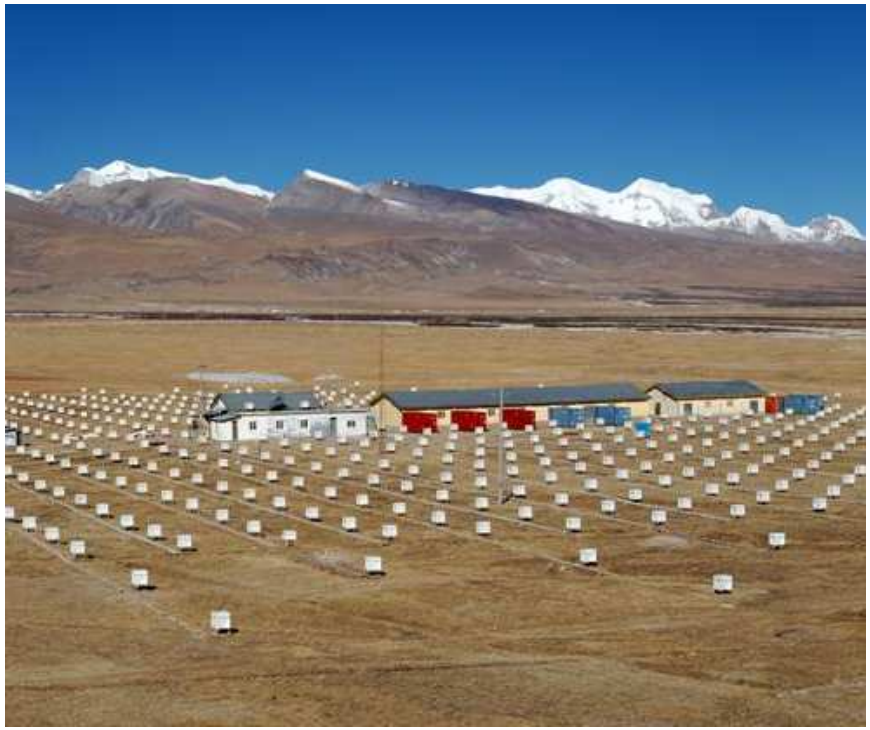

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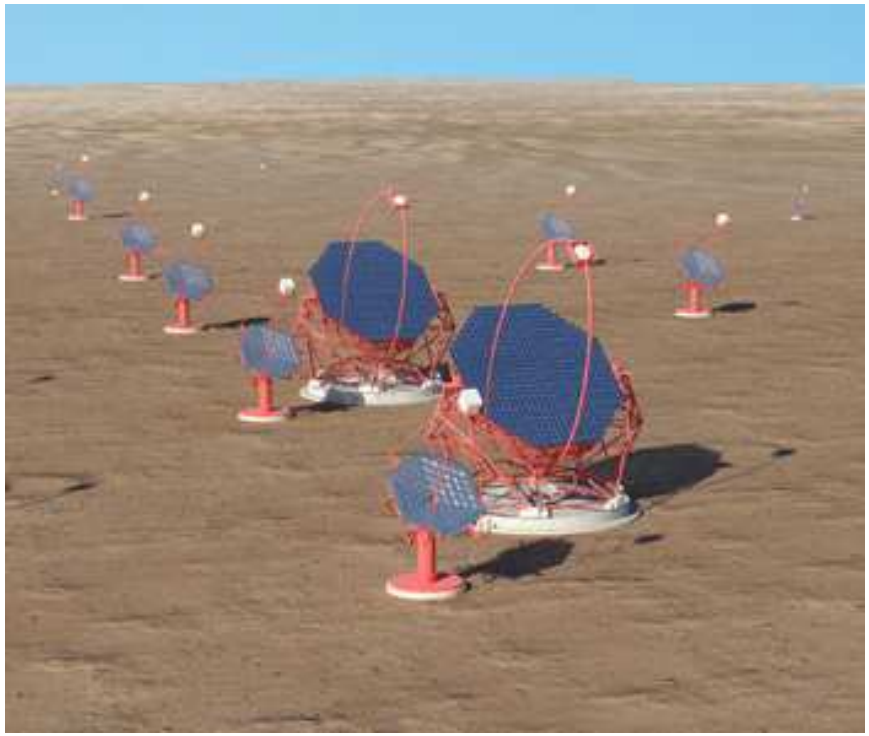

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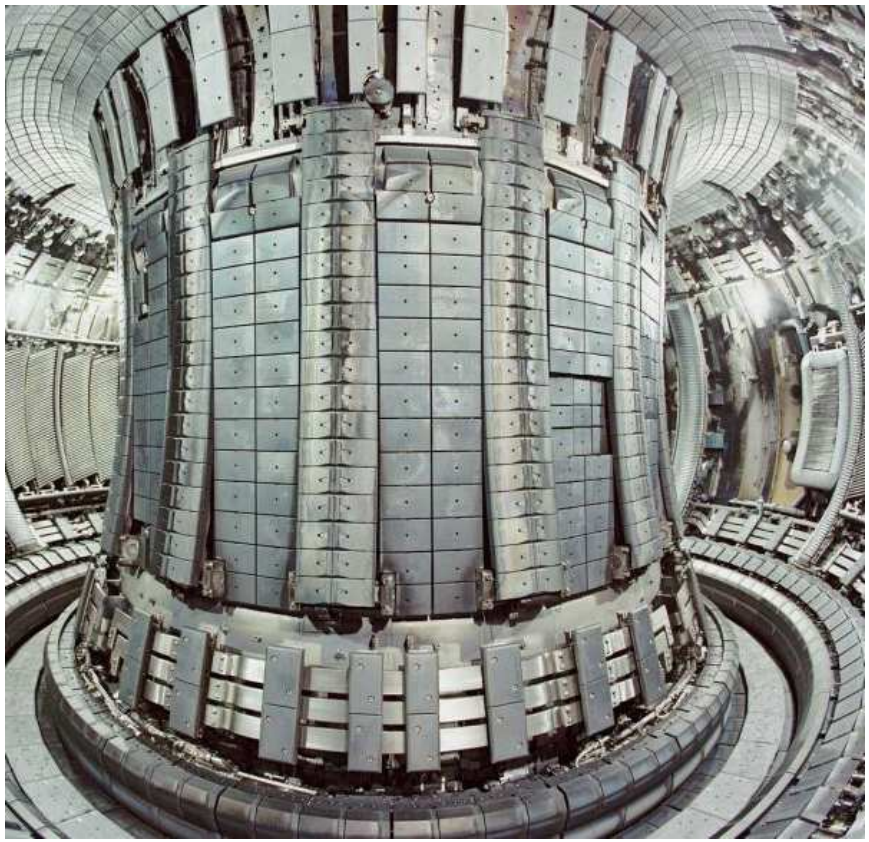

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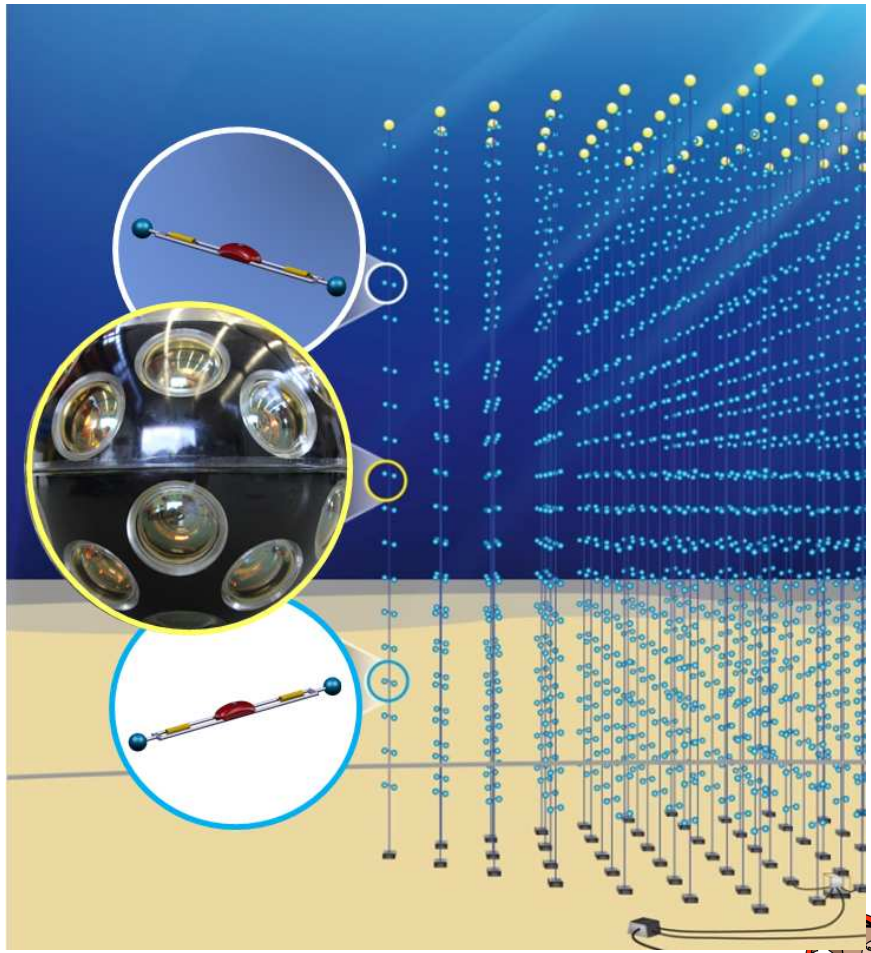
  - **European deep-sea research infrastructure (KM3NET)**



White Rabbit – enhanced Ethernet

Two separate services (enhancements to Ethernet) provided by WR:

- High accuracy/precision synchronization
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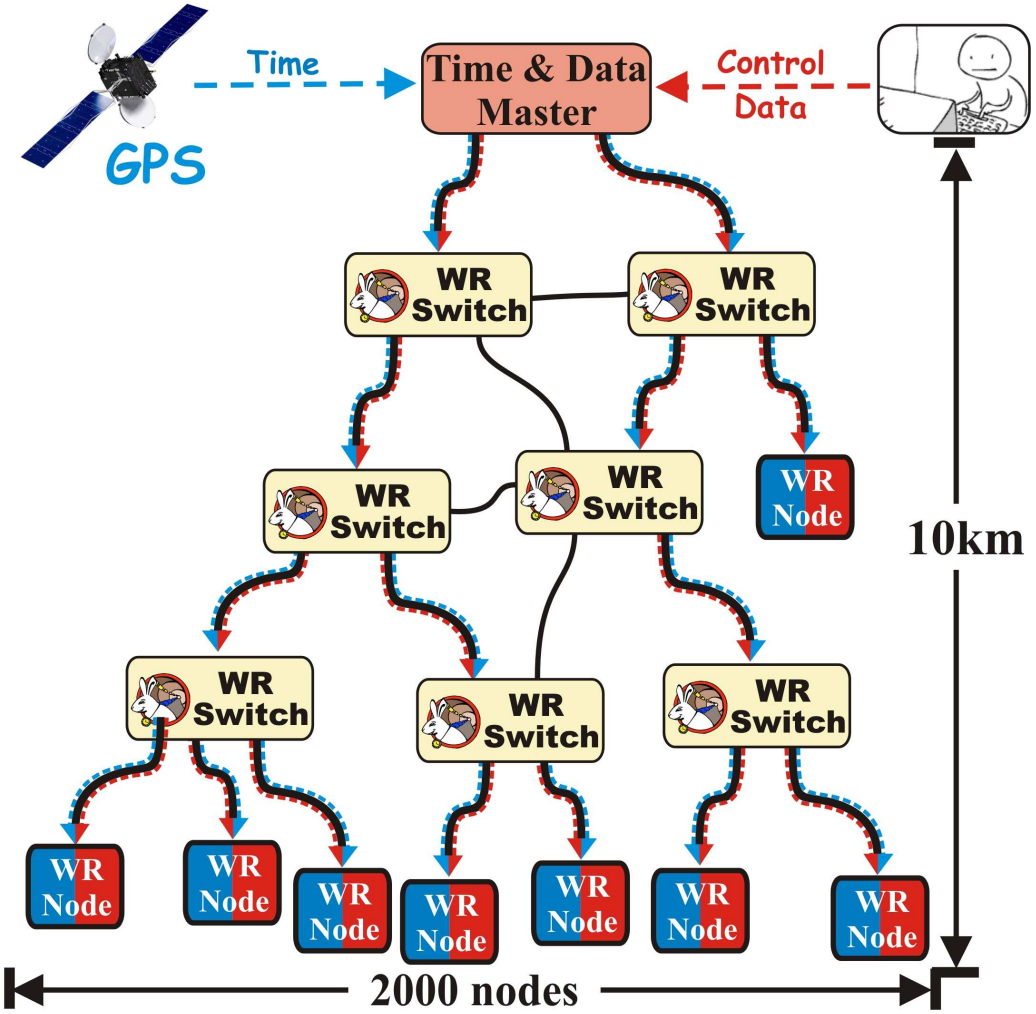
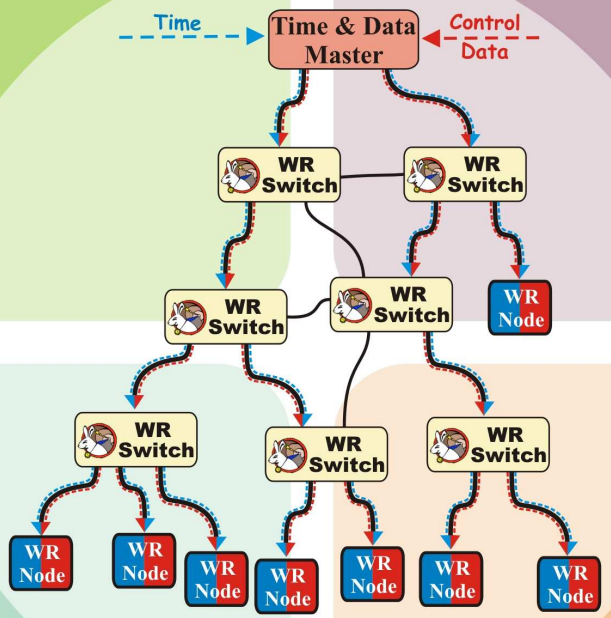


Reliability in a White Rabbit Network (WRN)

Deterministic packet delivery

Synchronization resilience



Topology redundancy

Data resilience

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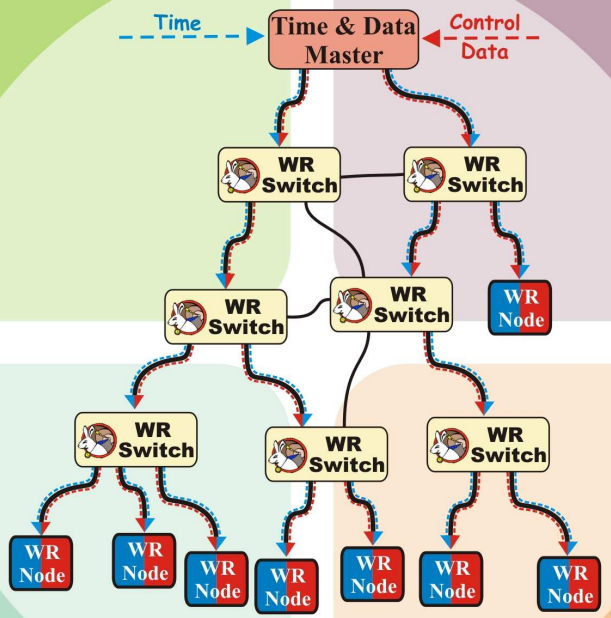


Topology redundancy

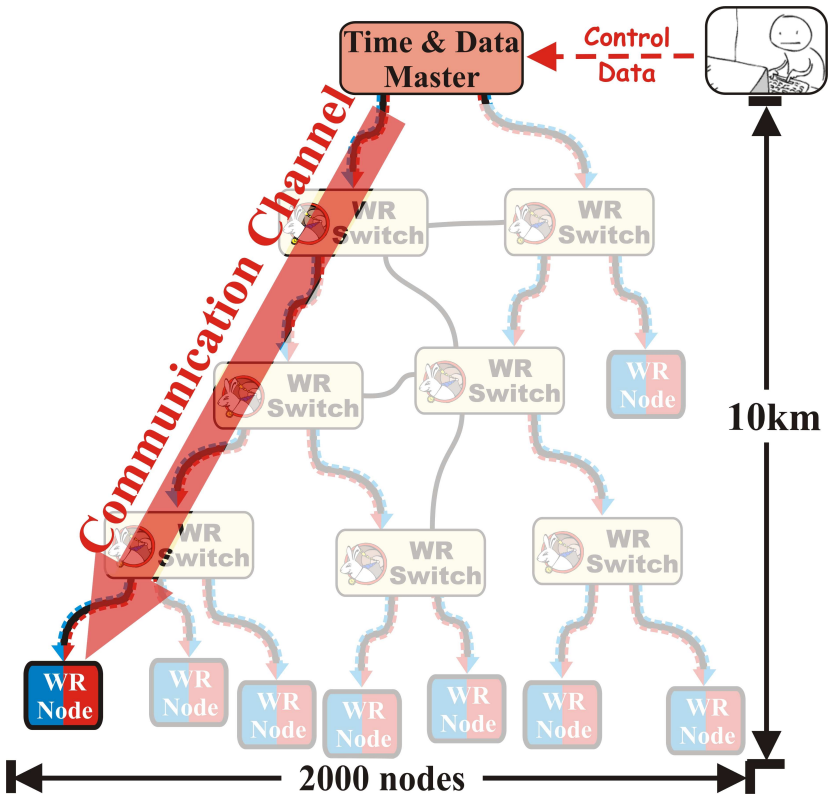
Data resilience

WRN is functional if ...

... it provides **all** its services to **all** its clients at **any** time.

Control Data

- Two types of data:
  - **Control Data** (High Priority, HP)
  - Standard Data (Best Effort)
- Characteristics of **Control Data**
  - Sent in Control Messages
  - Sent by Data Master(s)
  - Broadcast (one-to-alot)
  - Deterministic and low latency
  - Reliable delivery

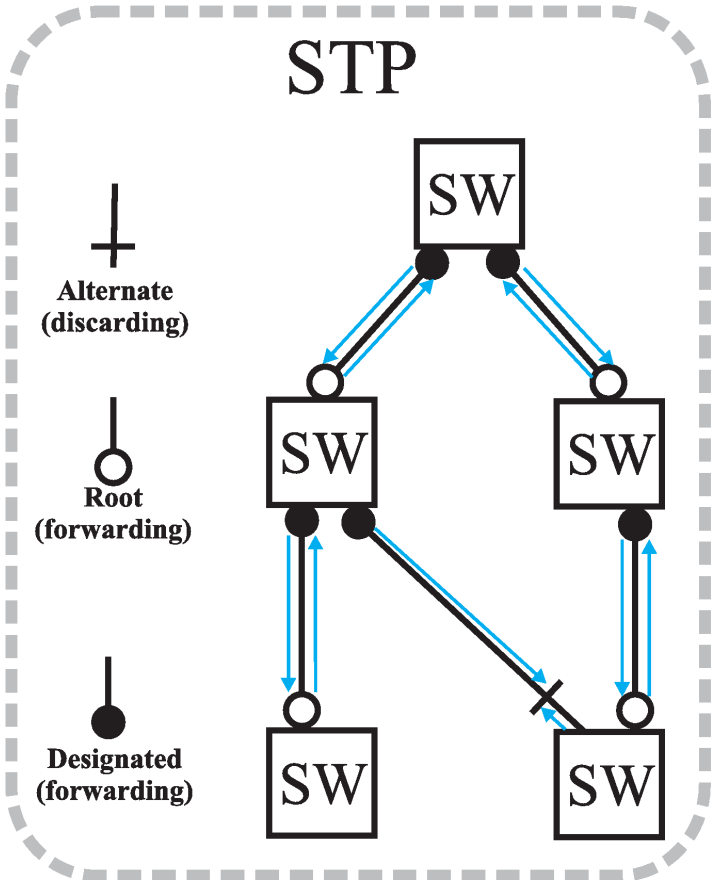


Data Redundancy: Forward Error Correction (FEC)

- Re-transmission of Control Data not possible
- **Forward Error Correction** – additional transparent layer:
  - One Control Message encoded into N Ethernet frames,
  - Recovery of Control Message from any M (M$<$N) frames
- FEC can prevent data loss due to:
  - **bit error**
  - **network reconfiguration**

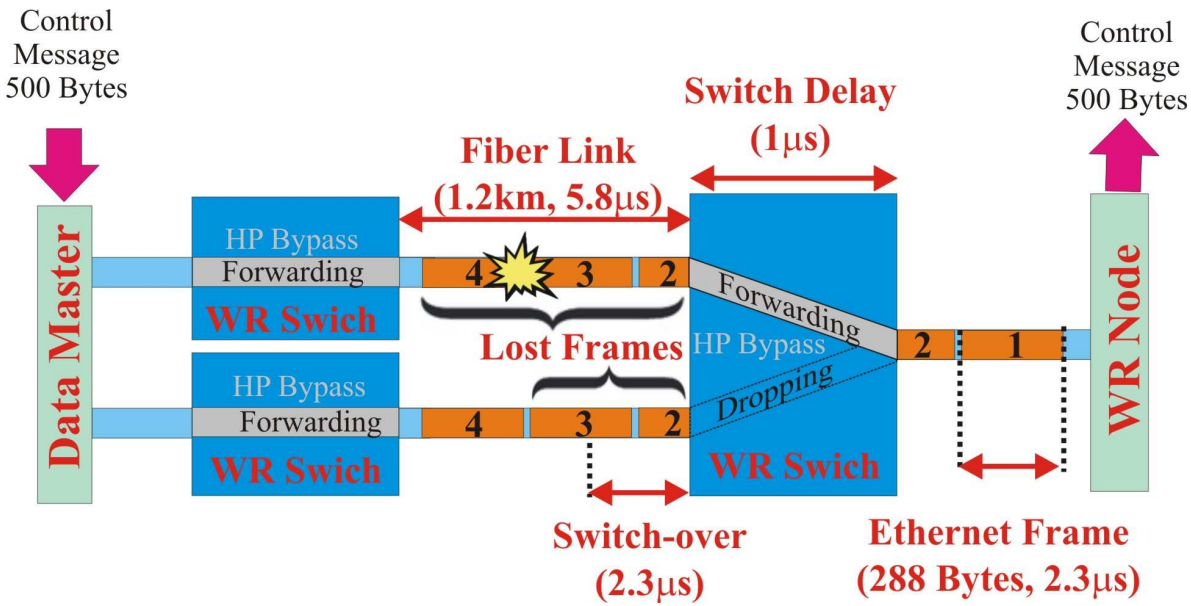
Topology Redundancy

- Standard Ethernet solution:
  Rapid/Multi Spanning Tree Protocol
- Reconfiguration time: $\approx$ **1s**
  (best: milliseconds)
- **1s =** $\approx$ **82 000** Ethernet Frames lost
- Extensive research:
  - existing standards
  - academic experts
  - expert companies
- Solution:
  - take advantage of FEC
  - speed up (R/M)STP$->$**eRSTP**



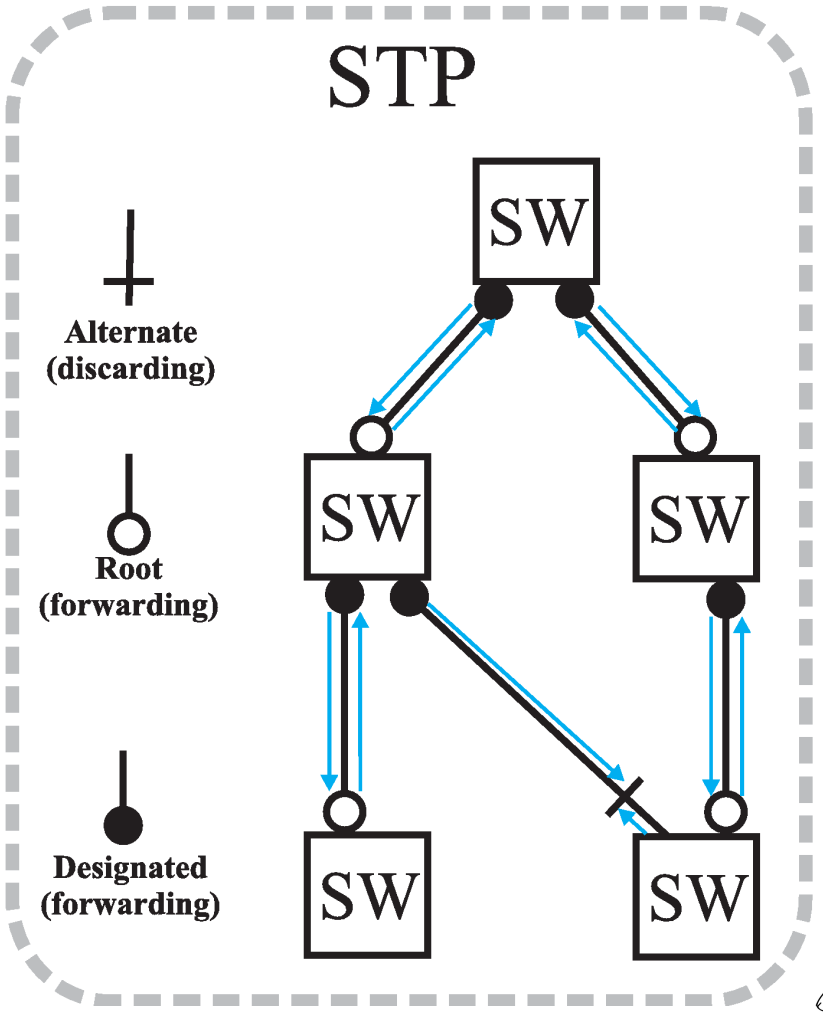
eRSTP + FEC

- eRSTP+FEC=seamless redundancy <=> max 2 frames
- 500 bytes message (288 byte FEC) – max re-conf ≈**2.3us**



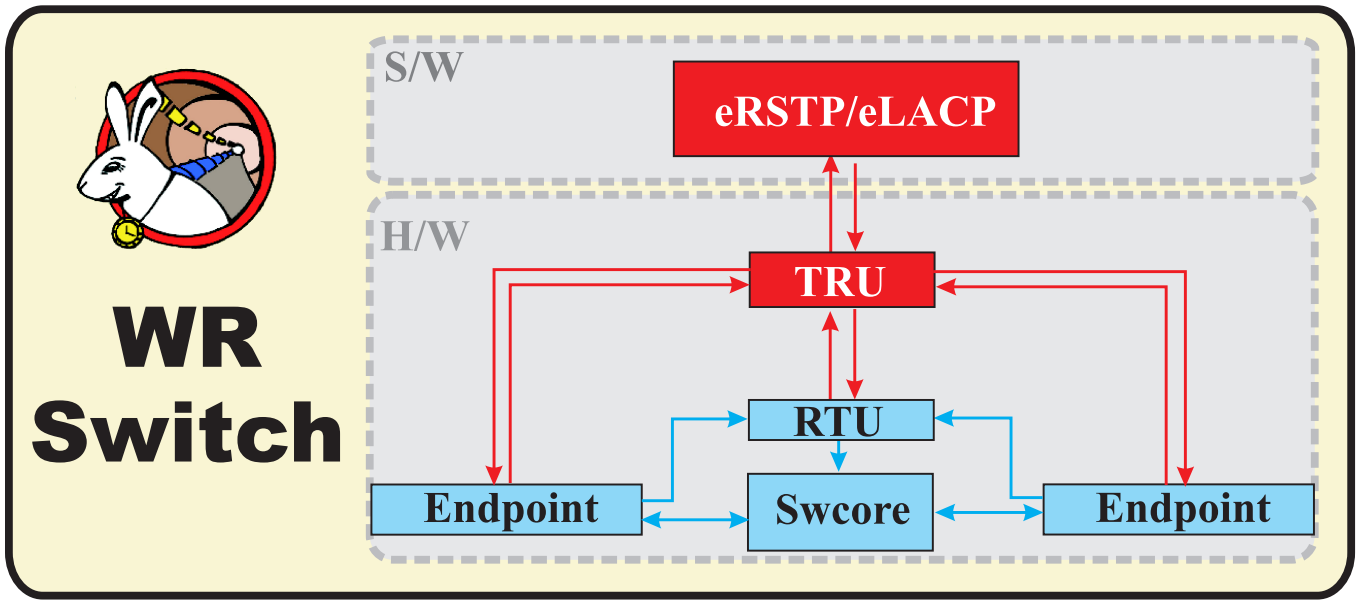
enhanced Rapid Spanning Tree Protocol (eRSTP)

- RSTP's a priori information (alternate/backup)
- Limited number of topologies
- Drop only on reception – within VLAN, except self-sending
- **Take advantage of broadcast characteristic of Control Data**
- Do it in hardware !!!



Topology Resolution Unit (TRU)

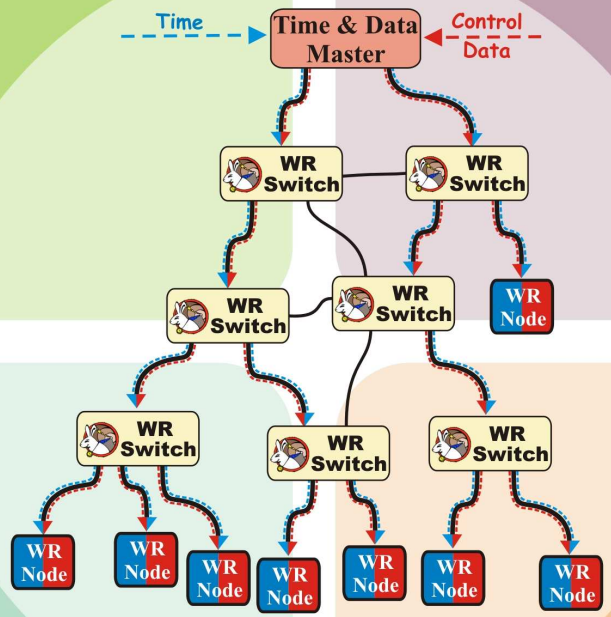
- Universal and decoupled unit for topology resolution
- Common firmware base for many different solutions
- Two solutions considered:
  - enhanced Rapid Spanning Tree Protocol (eRSTP)
  - enhanced Link Aggregation Control Protocol (eLACP)



Status

Deterministic packet delivery

Synchronization resilience



Topology redundancy

Data resilience

Status

Deterministic Packet Delivery

- ✓ Cut-through
- ✓ Separate resources
- ✓ Output queuing
-  Optimization

Synchronization Resilience

- ✓ WRPTP support - improvements for further study
-  Hardware support

Topology redundancy

- ✓ Extensive study
-  Hardware(eRSTP)
-  Software(eRSTP)

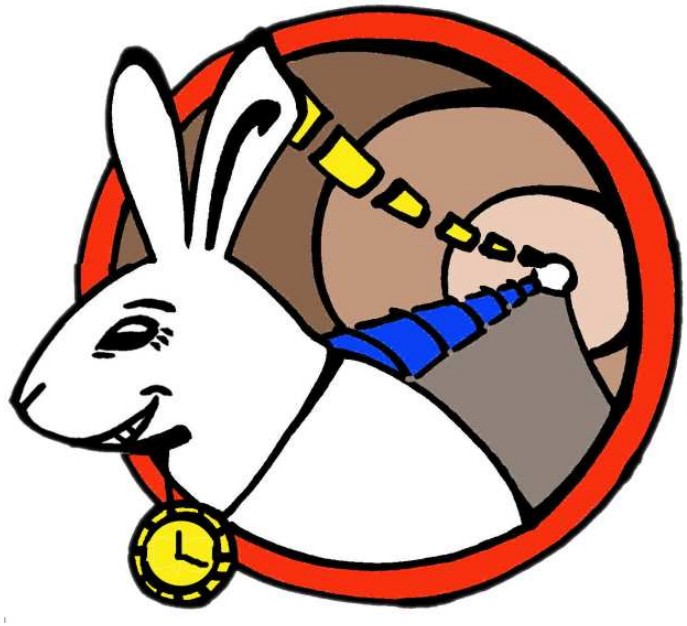
Data Resilience

- ✓ FEC Encoder - more work
-  FEC Decoder

Conclusions

- Timing-wise WR is working now **focus on data**
- Interest of standardization bodies: WR presented to **ITU-T** and **IEEE**
- **First deployment** at CERN of WR timing and control network **for AD**
- Increasing number of applications
- First commercially available WR switch by the end of 2012

Questions and answers



[One more slide after Q&S]

Piotr Doniec
(1987-2012)