The White Rabbit Project

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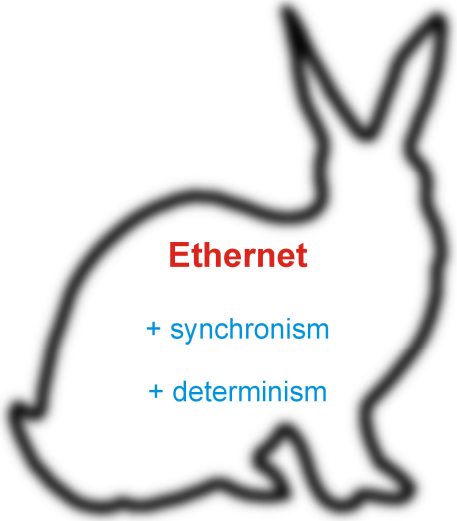
Outline

- What is White Rabbit?
- Technical Concepts used in White Rabbit
- Current work
- Plans for the future
- Summary

"Oh dear! Oh dear! I shall be too late!"
The White Rabbit in charge of the real time,
Alice in Wonderland

Introduction

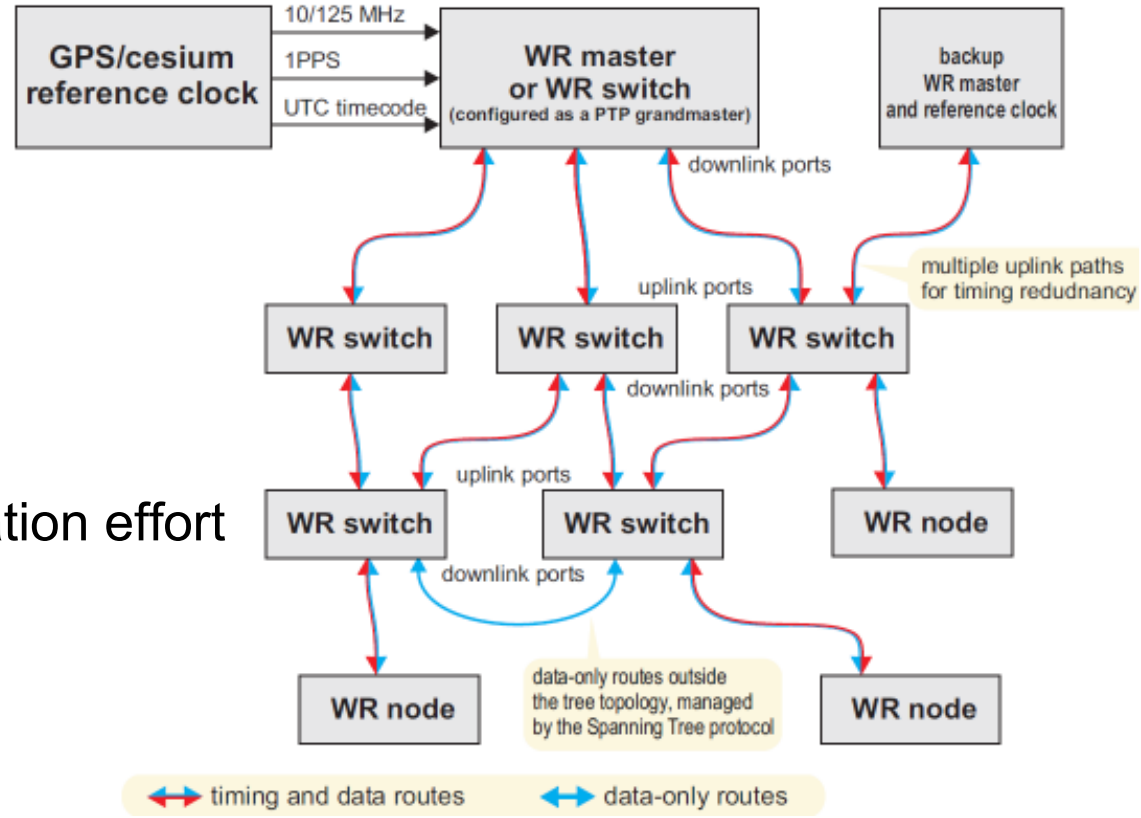
- Evolved from the need to renovate CERN's accelerator timing system
- Main ideas: Synchronism & Determinism
- Design goals
  - Scalability : up to 2000 nodes
  - Range: 10 km fiber links
  - Precision: 1 ns time synchronization accuracy, 20 ps jitter



- An extension to Ethernet which provides:
  - Synchronous mode (Sync-E) – common clock for physical layer in entire network, allowing for precise time and frequency transfer.
  - Deterministic routing latency – a guarantee that packet transmission delay between two stations will never exceed a certain boundary

Main features and network topology

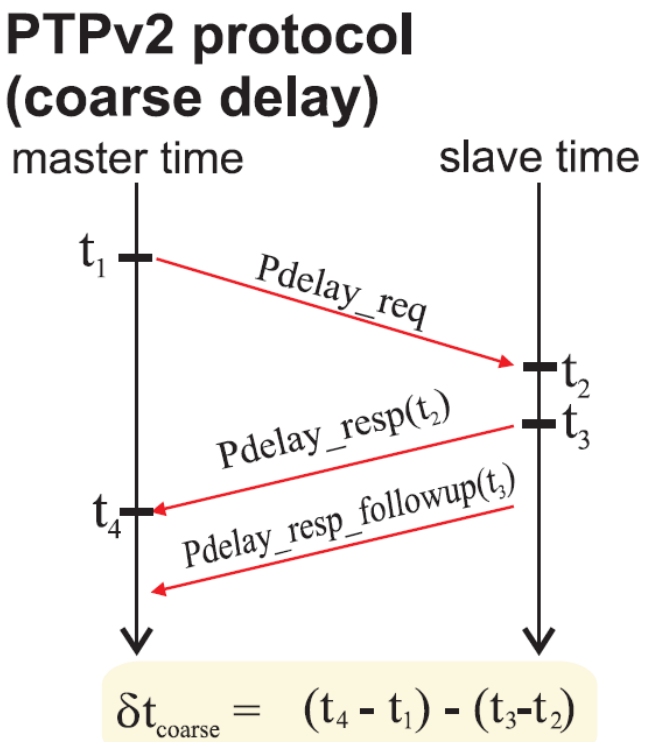
- High bandwidth
- Bidirectional
- Real-time messaging
- Low configuration and calibration effort
- Very responsive (low delay)
- Long-term availability
- Bringing together the benefits of Ethernet and timing for large-scale systems



Technical concepts used in White Rabbit

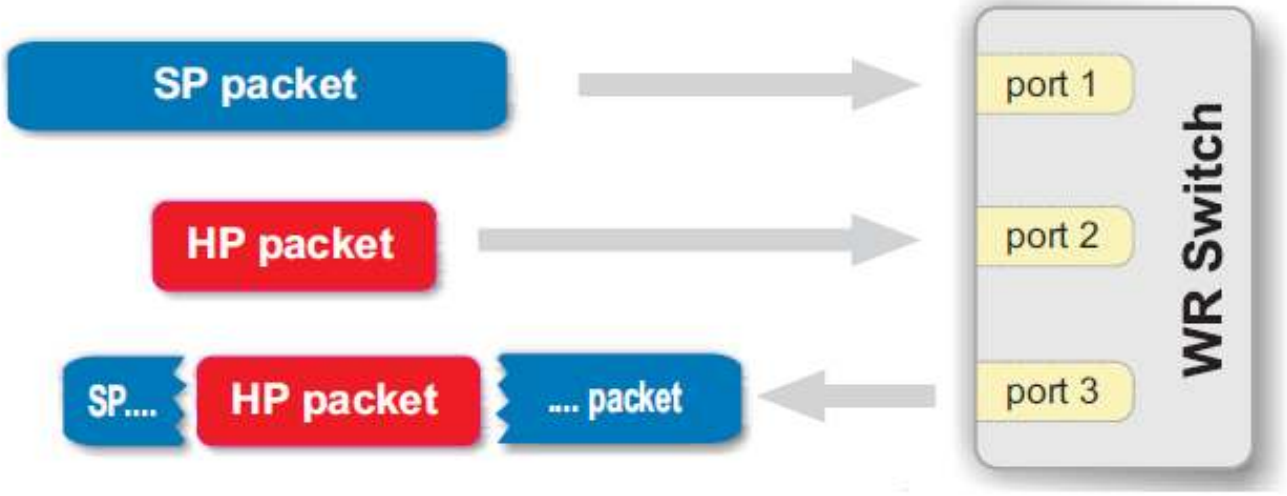
- Synchronous Ethernet - common clock for the entire network
  - All network nodes use the same physical layer clock, generated by the System Timing Master
  - Clock is encoded in the Ethernet carrier and recovered by the PLL in the PHY.

- Precision Time Protocol (IEEE1588)
  - Synchronizes local clock with the master clock by measuring and compensating the delay introduced by the link.



The WR protocol

- Traffic divided into two types of packages:
  - High Priority (HP) packets use a special value in the Ethertype field of the frame.
  - HP packets can preempt other types of packets “on-the-fly”. They carry time critical information
- Preemption mechanism:
  - When a HP packet arrives at the switch, SP packet currently being routed is terminated so the HP packet can be sent out with minimal latency. The remaining part of terminated SP packet is sent later.



White Rabbit Switch for 2010

- White Rabbit Swtich is under construction
- Delivery of a working switch by the end of the year.
- The switch will have the strict minimum functionality in order to support good timing and normal Ethernet switching.
- Full respect of IEEE standards and more exotic functionality will be left for the future.

Plans for the future

„Robustization” - robust delivery of messages over a WR network

- Methods to increase reliability and ensure determinism of message delivery in White Rabbit
- It must answer the question of how to loose 1 message per year at most in a 2000-node network without compromising message delivery latencies

Reliability

- Increase in reliability of the WR system can be done on different levels of abstraction (different layers of OSI model)
  - improvement of Bit Error Rate (BER) caused by the characteristics of transportation medium (fiber optic)
  - appropriate coding scheme implementation (i.e. 8B/10B-like solution)
  - data-corruption-proof redundant coding
  - using existing high level protocols, i.e. Powerlink, Modbus or proposing a new one.

Determinism

- Ensuring determinism:
  - achieving deterministic behavior of various components of the system, i.e. master node, switch, and end nodes
  - It is important to consider the proposed solutions as a part of the whole system and take into account their cooperation in order to increase overall reliability and achieve determinism.

Summary

- Multiple potential applications of WR
- Extends functionality of current timing system

Who are the Rabbits ☺

- CERN (BE-CO-HT)
- Zürcher Hochschule für Angewandte Wissenschaften NationalInstruments (InES, Switzerland)
- GSI Helmholtzzentrum für Schwerionenforschung (Research Institution, Germany)
- University of Brescia (Italy)
- Austrian Academy of Sciences (IISS)
- Cosylab (company, Slovenia)
- Oregano Systems (company, Austria)
- Hirschmann Automation and Control (company, USA)