

The White Rabbit Project

A (very) brief introduction

T. Włostowski

BE-CO Hardware and Timing section
CERN

October 13, 2009

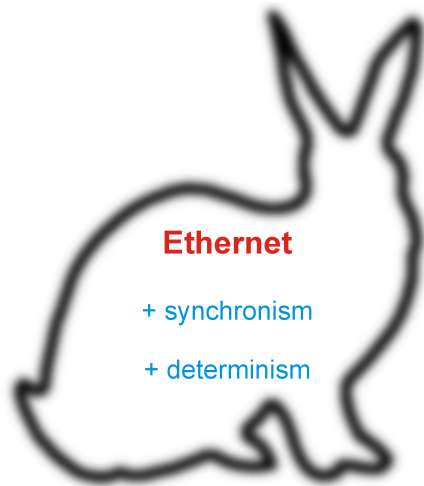


Outline

- 1 Overview
 - What is White Rabbit?
- 2 Technical concepts
 - Synchronous Ethernet
 - PTP Protocol
 - The WR protocol
- 3 Work so far
- 4 Summary



What is White Rabbit?



Design goals

Scalability

Up to 2000 nodes.

Range

10 km fiber links.

Precision

1 ns time synchronisation accuracy, 20 ps jitter.



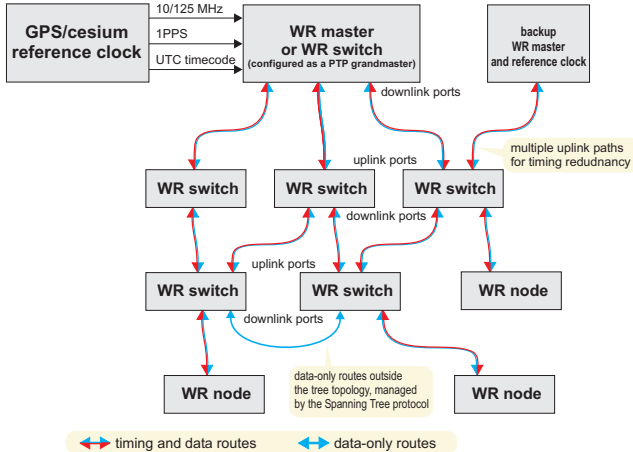
What is White Rabbit?

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.



Network topology



Outline

- 1 Overview
 - What is White Rabbit?
- 2 Technical concepts
 - Synchronous Ethernet
 - PTP Protocol
 - The WR protocol
- 3 Work so far
- 4 Summary



Technical concepts in White Rabbit

- Synchronous Ethernet
- Hardware-assisted PTP (IEEE1588 - Precision Time Protocol)
- Packet preemption and deterministic protocol

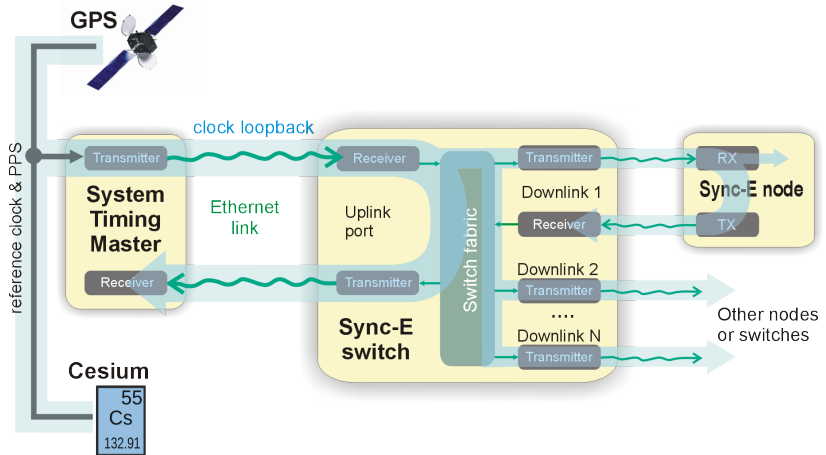


Synchronous Ethernet

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.

Synchronous Ethernet

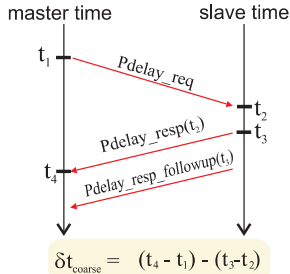


PTP Protocol (IEEE1588)

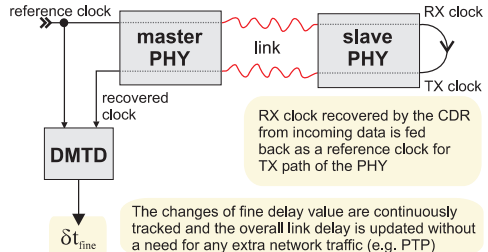
PTP

Synchronizes local clock with the master clock by measuring and compensating the delay introduced by the link.

PTPv2 protocol (coarse delay)



digital DMTD (fine delay)

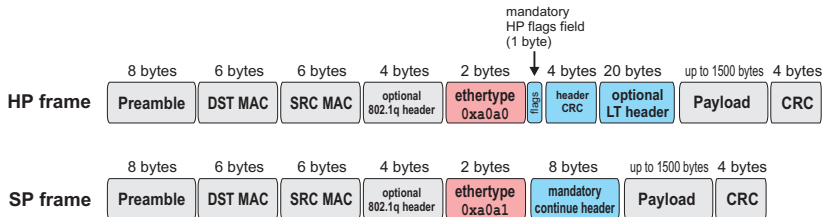


Enhanced PTP

- Monitor phase of bounced-back clock continuously.
- Non-invasive: piggy backs on any type of traffic, including an idle link.
- Every 125 MHz tick is put to good use: performance is equivalent to PTP with messages exchanged every 8 ns.
- Compatibility: works with any PTP-enabled network, but with superior performance.



The WR protocol



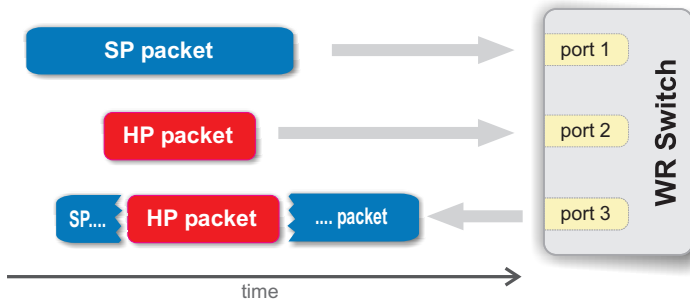
- Traffic divided into High Priority (HP) packets and Standard Priority (SP) packets.
- HP packets use a special value in the Ethertype field of the frame.
- HP packets can preempt other types of packets “on-the-fly”.



The WR protocol

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.



Outline

- 1 Overview
 - What is White Rabbit?
- 2 Technical concepts
 - Synchronous Ethernet
 - PTP Protocol
 - The WR protocol
- 3 Work so far
- 4 Summary



Goals achieved...

- Prototype proof-of-concept switch has been built.
- Preliminary measurements: 80ps accuracy over 5km fiber point-to-point link.
- Network simulations proved that HP packets and preemption allow for high throughput bulk transfers and deterministic routing simultaneously.



The switch prototype



Outline

- 1 Overview
 - What is White Rabbit?
- 2 Technical concepts
 - Synchronous Ethernet
 - PTP Protocol
 - The WR protocol
- 3 Work so far
- 4 Summary



Summary

- A data link fulfilling all our needs in **synchronization** and determinism.
- Fully based on **standards** like Synchronous Ethernet and PTP.
- A successful **collaboration** including institutes and companies.

- Outlook
 - Make it an EU Project.
 - Deliver working prototypes by the end of 2010.

