

Reliability in White Rabbit Network

Maciej Lipiński

Hardware and Timing Section / Institute of Electronic Systems
CERN / Warsaw University of Technology

February 8 & 9, 2013
Wilga Symposium
Warsaw



Outline

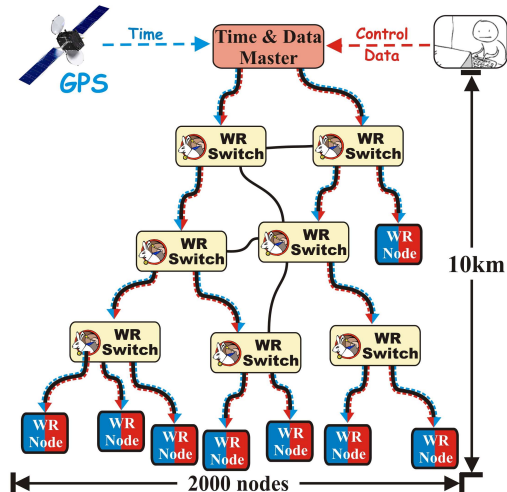
- 1 Reliability in WRN
- 2 Redundancy
- 3 Determinizm
- 4 Standardization
- 5 Status and Plans



White Rabbit: Time + Data

White Rabbit provides:

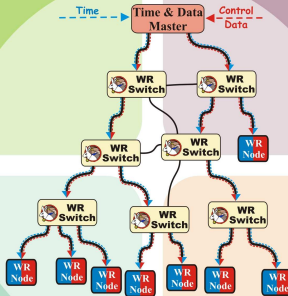
- High accuracy/precision synchronization
- Deterministic, reliable and low-latency Control Data delivery



Reliability in a White Rabbit Network

**Deterministic
packet
delivery**

**Synchronization
resilience**



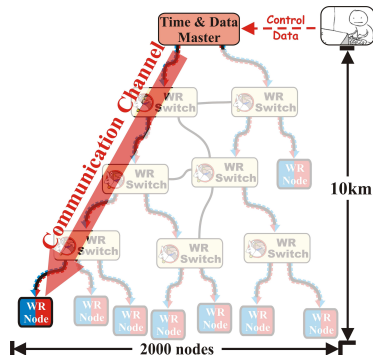
**Topology
redundancy**

**Data
resilience**



Control Data

- Two types of data:
 - **Control Data** (High Priority, HP)
 - Standard Data (Best Effort)
- Failure of **Control Data** delivery:
 - medium imperfection
 - network element failure
 - exceeded latency



Data Redundancy

- **Forward Error Correction (FEC)** – additional transparent layer:
 - One Control Message encoded into N Ethernet frames,
 - Recovery of Control Message from any M ($M < N$) frames



Data Redundancy

- **Forward Error Correction (FEC)** – 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:



Data Redundancy

- **Forward Error Correction (FEC)** – 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**



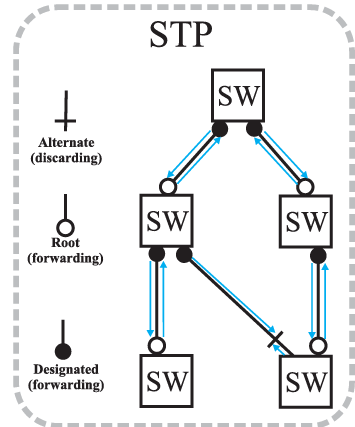
Data Redundancy

- **Forward Error Correction (FEC)** – 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**



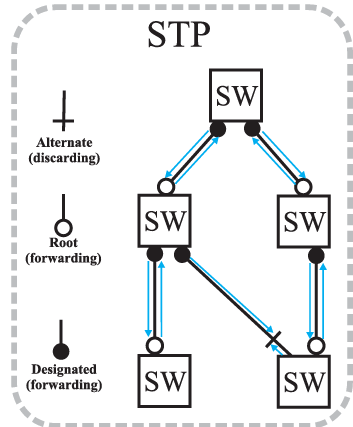
Topology Redundancy

- Standard Ethernet solution:
Spanning Tree Protocol (STP)



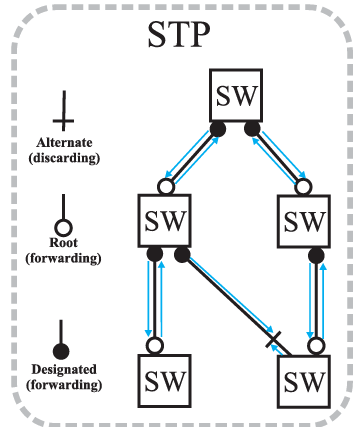
Topology Redundancy

- Standard Ethernet solution:
Spanning Tree Protocol (STP)
- Reconfiguration time: $\approx 1s$
(best: milliseconds)



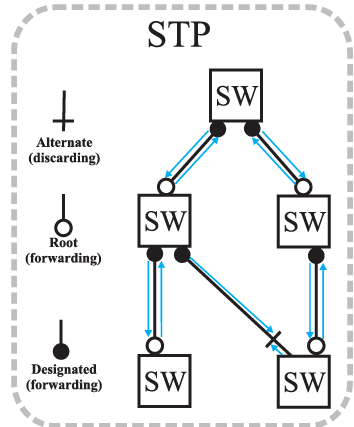
Topology Redundancy

- Standard Ethernet solution:
Spanning Tree Protocol (STP)
- Reconfiguration time: $\approx 1s$
(best: milliseconds)
- $1s = \approx 82\ 000$ frames lost



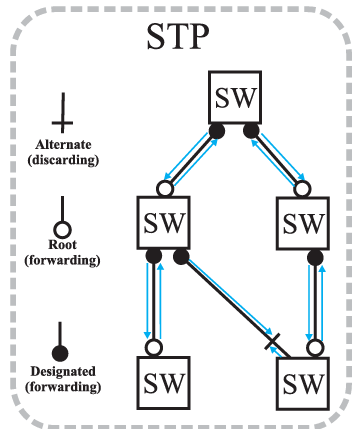
Topology Redundancy

- Standard Ethernet solution:
Spanning Tree Protocol (STP)
- Reconfiguration time: $\approx 1\text{s}$
(best: milliseconds)
- $1\text{s} = \approx 82\ 000$ frames lost
- Extensive research



Topology Redundancy

- Standard Ethernet solution:
Spanning Tree Protocol (STP)
- Reconfiguration time: $\approx 1s$
(best: milliseconds)
- $1s = \approx 82\ 000$ frames lost
- Extensive research
- Solution:
 - take advantage of FEC
 - speed up STP – \rightarrow **eRSTP**



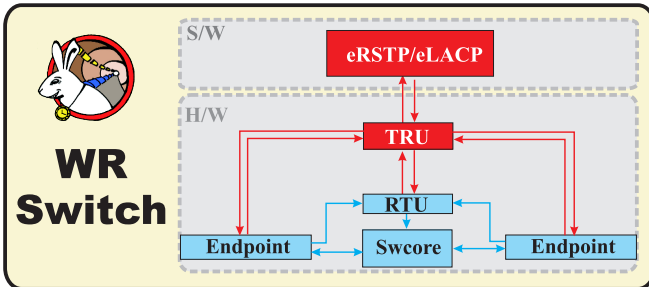
Reliable Data Distribution

- eRSTP+FEC=seamless redundancy \Leftrightarrow max 2 frames
- 500 bytes message (288 byte FEC) – max re-conf \approx **2.3us**
- Requires:
 - hardware support
 - protocol modification

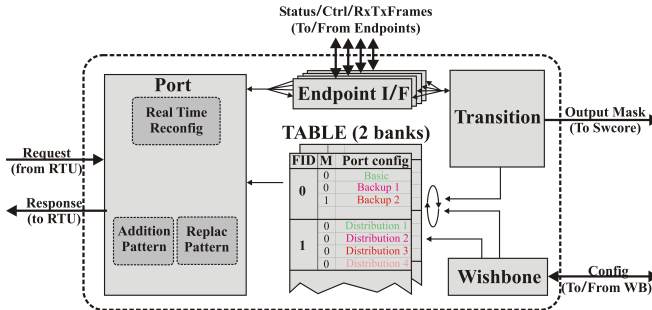


Reliable Data Distribution

- Two solutions considered:
 - enhanced Rapid Spanning Tree Protocol (eRSTP)
 - enhanced Link Aggregation Control Protocol (eLACP)
- Common gateway: universal and decoupled HDL unit
- Specific software: daemon+protocol



Topology Resolution Unit (TRU)



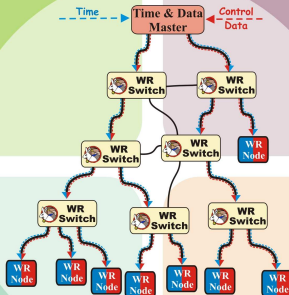
- universal unit for topology resolution protocol
 - port switch-over between redundant ports (eRSTP)
 - traffic distribution between redundant ports (eLACP)
- fully pipelined (3 cycles to answer, each cycle new request)



Determinism and low latency

**Deterministic
packet
delivery**

**Synchronization
resilience**



**Topology
redundancy**

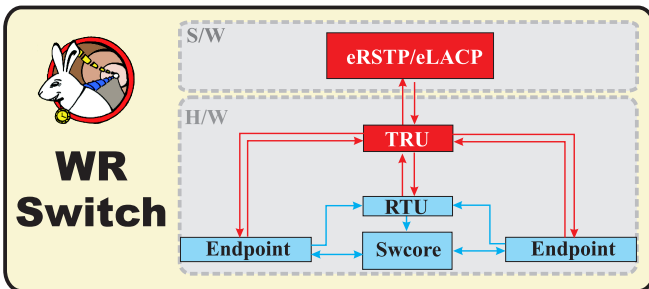
**Data
resilience**



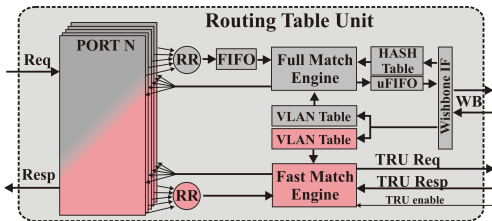
Determinism and low latency

Key switch modules require:

- Deterministic behavior
- Ultra low latency for **Control Data**



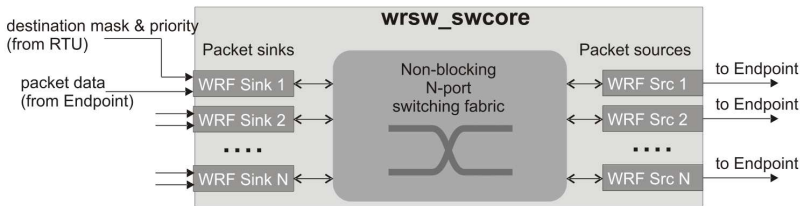
Routing Table Unit



- Fully deterministic and non-dropping for **Control Data**
- Fast Match Engine
 - PTP/broadcast/Link-limited/configurable MACs traffic
 - configurable hardware support for **Control Data**
 - response in max (N+5) cycles
 - interface with TRU



Switching Core



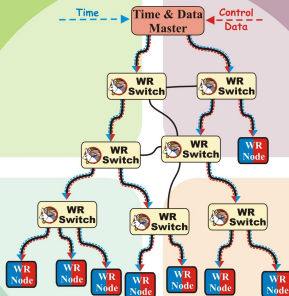
- optimization (wire speed)
- separation resources for **Control Data**
- improvement output queues scheduling (decoupled)
- implementation of time-triggered output scheduling
- interface with TRU



Reliability in a White Rabbit Network

**Deterministic
packet
delivery**

**Synchronization
resilience**



**Topology
redundancy**

**Data
resilience**



White Rabbit and Standards

- We want to be as standards as possible (eRSTP)
- We want to standardize (WRPTP)
- Many possibilities:
 - ITU-T
 - IEEE
 - AVB gen2
- Standardization Group
 - John Eidson
 - ITU-T people
 - Companies



ISPCS2012 IEEE Conference in San Francisco

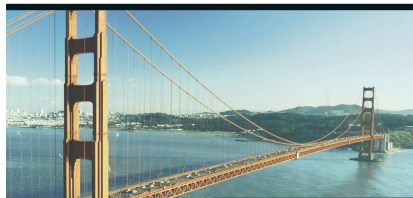
- All about PTP
 - Implementations
 - Innovations
 - Standard issues
- Consists of
 - PlugFest
 - Paper Presentation
 - Special Session



ISPCS

2012 International IEEE Symposium on
Precision Clock Synchronization for
Measurement, Control,
and Communication

September 23 - 28, 2012 || San Francisco, California, USA



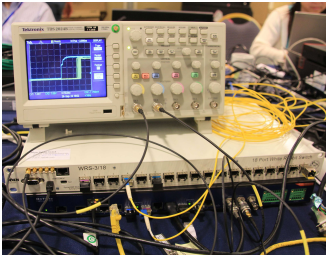
WR @ ISPCS2012

PlugFest

- Individual tests
- PTP network tests
- Bug-fixes

Paper Presentations

Special Session



WR @ ISPCS2012

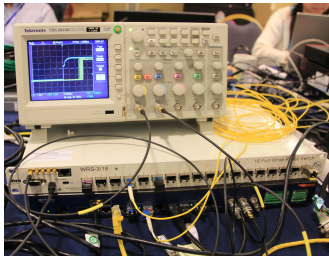
PlugFest

- Individual tests
- PTP network tests
- Bug-fixes

Paper Presentations

- WR Session
- 2 papers
- 1 poster

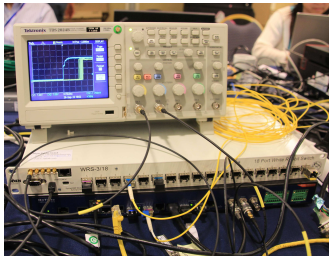
Special Session



WR @ ISPCS2012

PlugFest

- Individual tests
- PTP network tests
- Bug-fixes



Paper Presentations

- WR Session
- 2 papers
- 1 poster



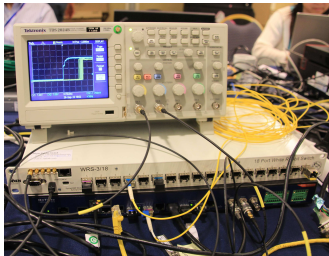
Special Session



WR @ ISPCS2012

PlugFest

- Individual tests
- PTP network tests
- Bug-fixes



Paper Presentations

- WR Session
- 2 papers
- 1 poster



Special Session

- WR Proposal
- Warm reception
- Strong support



Standardization Plans

WRPTP

- strongly supported by many
- 2-3 April – IEEE meeting to start working on PTP revision
 - Project Authorization Request
 - interest from many companies


eRSTP

- consultancy
- similar to newest developments of IEEE (e.g. AVGgen2)




Status


Deterministic Packet Delivery

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

Topology redundancy

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

Data Resilience

- ✓ FEC Encoder - more work
-  FEC Decoder



Questions and answers

