MPD time synchronization system based on White Rabbit technology.

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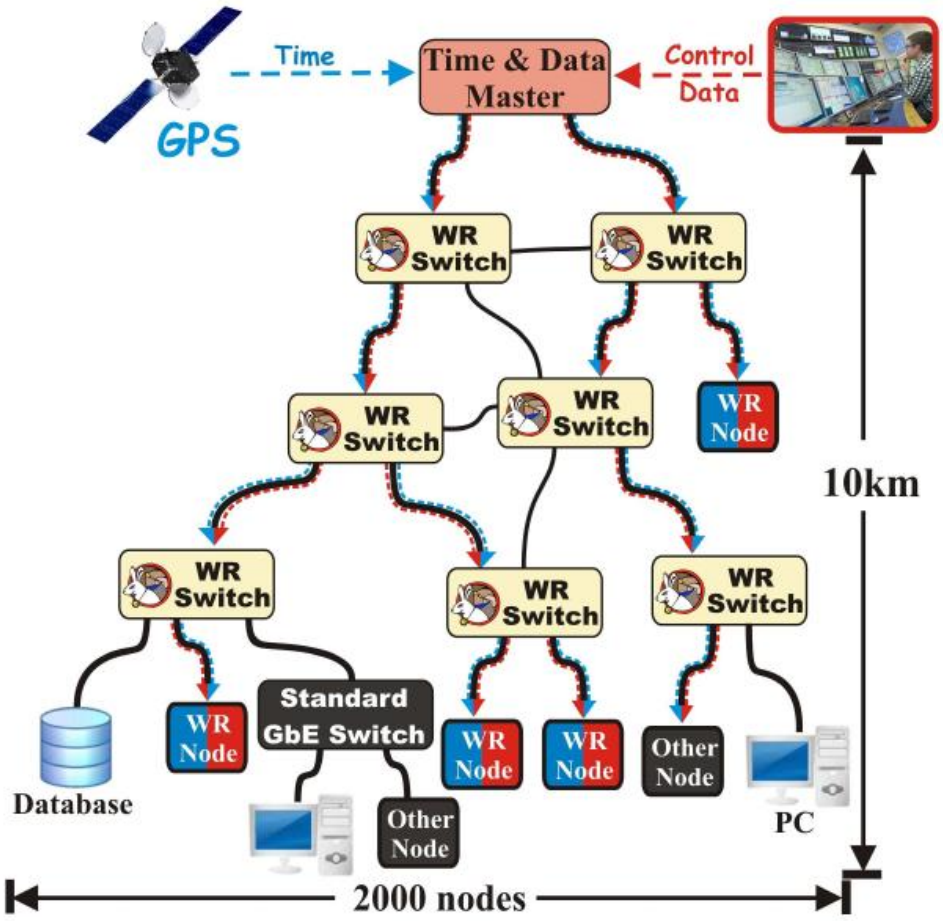
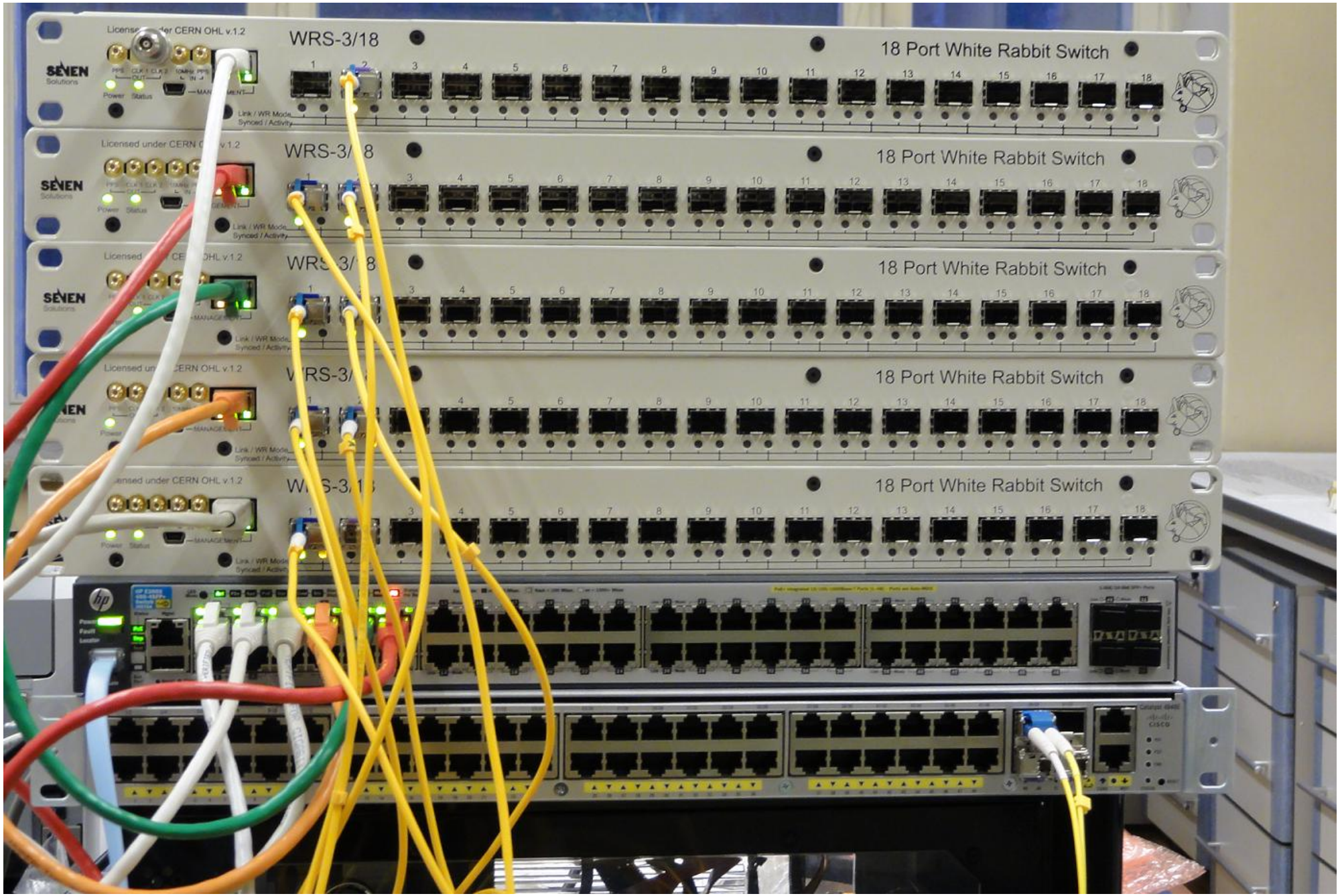
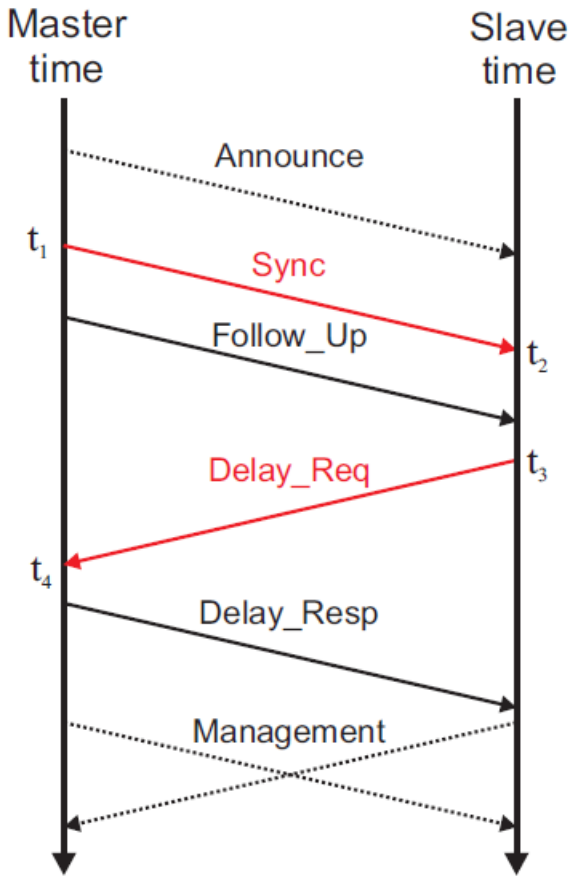
Timing System

- White Rabbit
- Distribution of clock, time and control data
- 1 Gb/s Ethernet fiber links
- Deterministic & reliabile
- Redundant topology
- Sub-ns synchronization




WRS-3/18
18 Port White Rabbit Switch
18 Port White Rabbit Switch
18 Port White Rabbit Switch
18 Port White Rabbit Switch
18 Port White Rabbit Switch

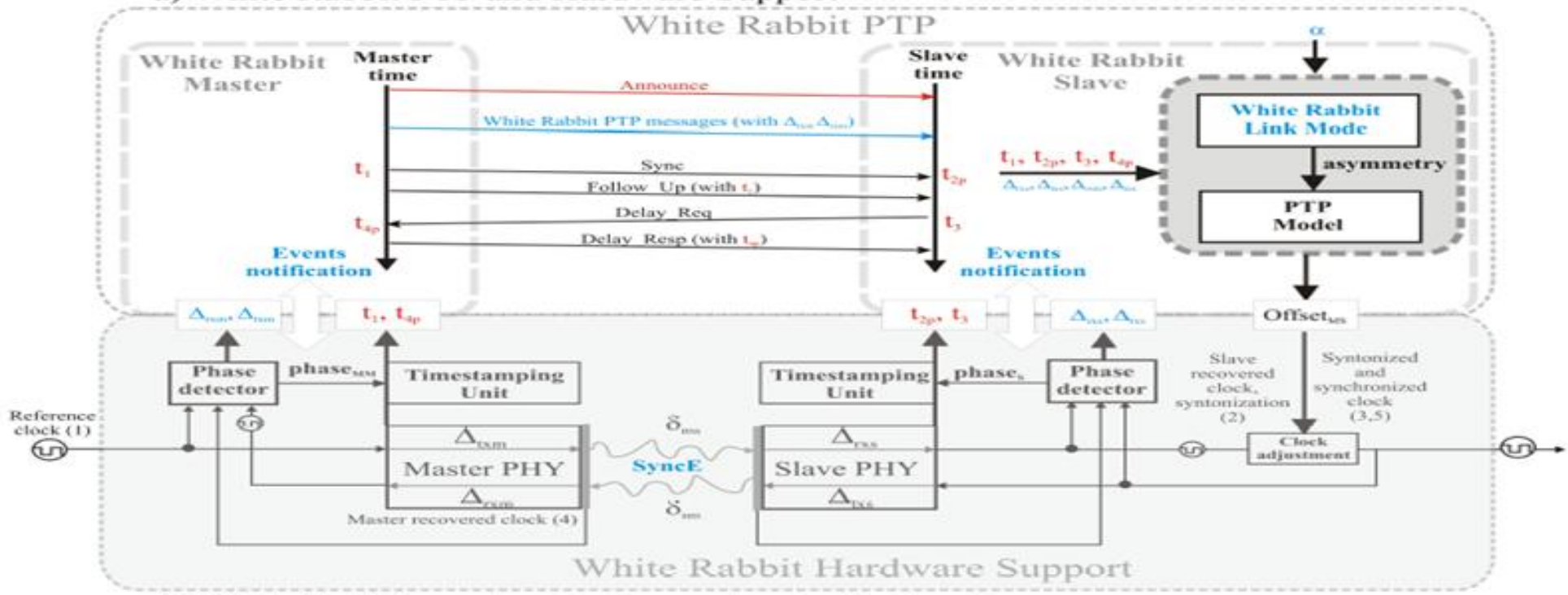
PTP messages used by WRPTP



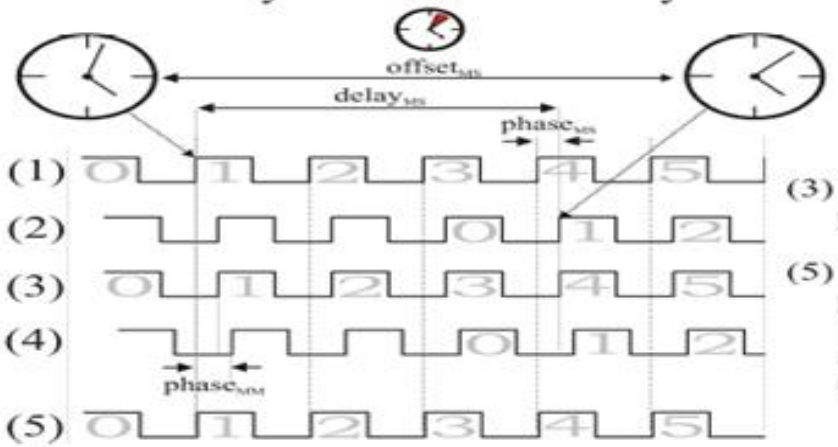
1. The master sends Announce messages periodically.
2. The slave receives the Announce message and uses the BMC algorithm to establish its place in the network hierarchy.
3. The master periodically sends a Sync message (timestamped on transmission, t_1) followed by a Follow_Up message which carries t_1.
4. The slave receives the Sync message sent by the master (timestamped on reception, t_2).
5. The slave receives the Follow_Up message (which carries the Sync transmission time, t_1) sent by the master .
6. The slave sends a Delay_Req message (timestamped on transmission, t_3).
7. The master receives the Delay_Req message sent by the slave (timestamped on reception, t_4).
8. The master sends the Delay_Resp message which carries t_4.
9. The slave receives the Delay_Resp.
10. The slave adjusts its clock using the clock offset and the link delay calculated with timestamps (t_1, t_2, t_3, t_4). This results in the Slave's synchronization with the Master clock.
11. Repeat 1-10.

WR protocol and WR Hardware overview.

a) White Rabbit PTP and Hardware Support



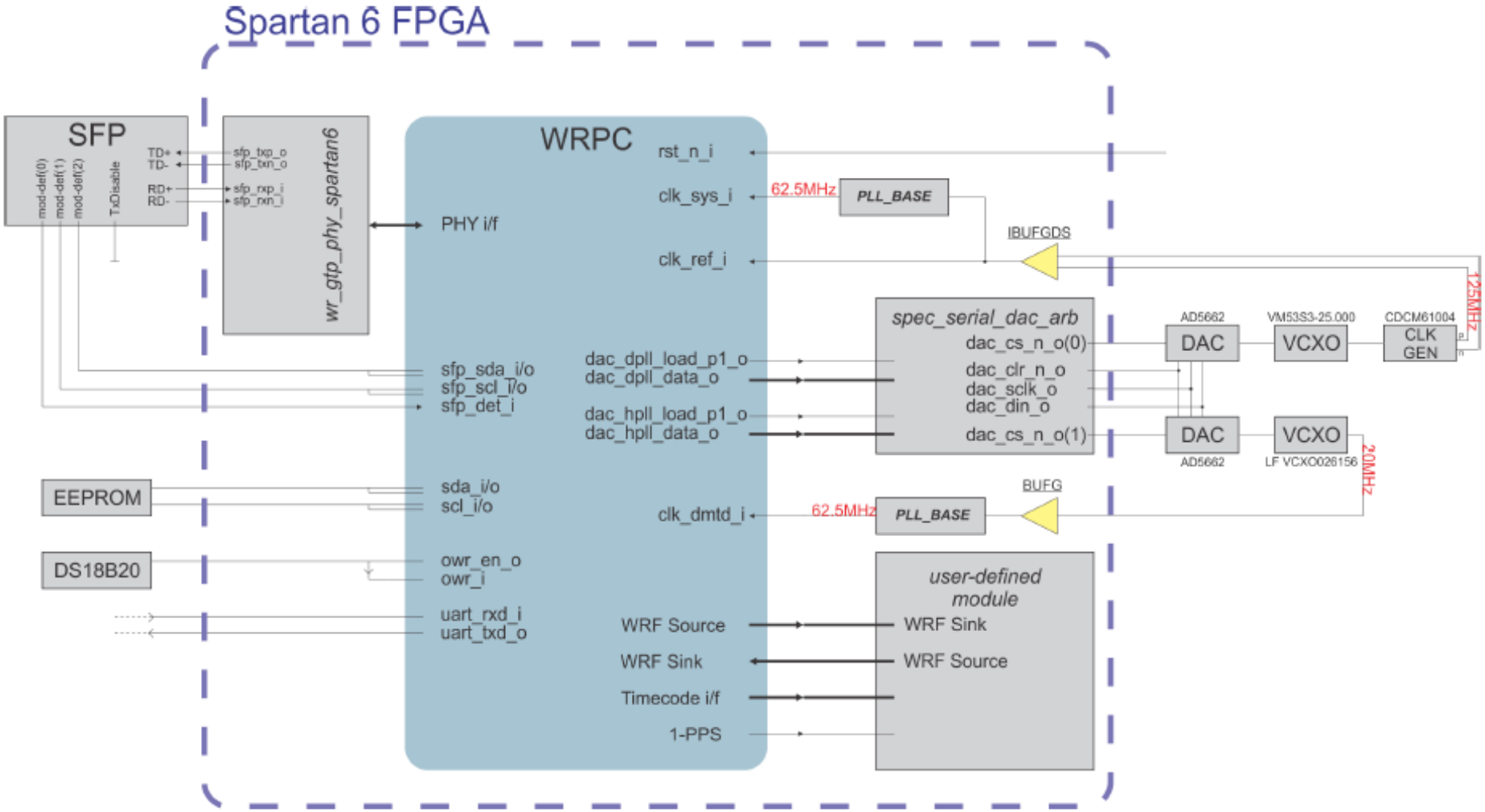
b) White Rabbit synchronization and syntonizatin scheme



(3) Without Master-to-Slave phase compensation

(5) With Master-to-Slave phase compensation using loopback recovered clock measurement with Phase detector

Simple top design with WRPC



Ready and Tested Modules

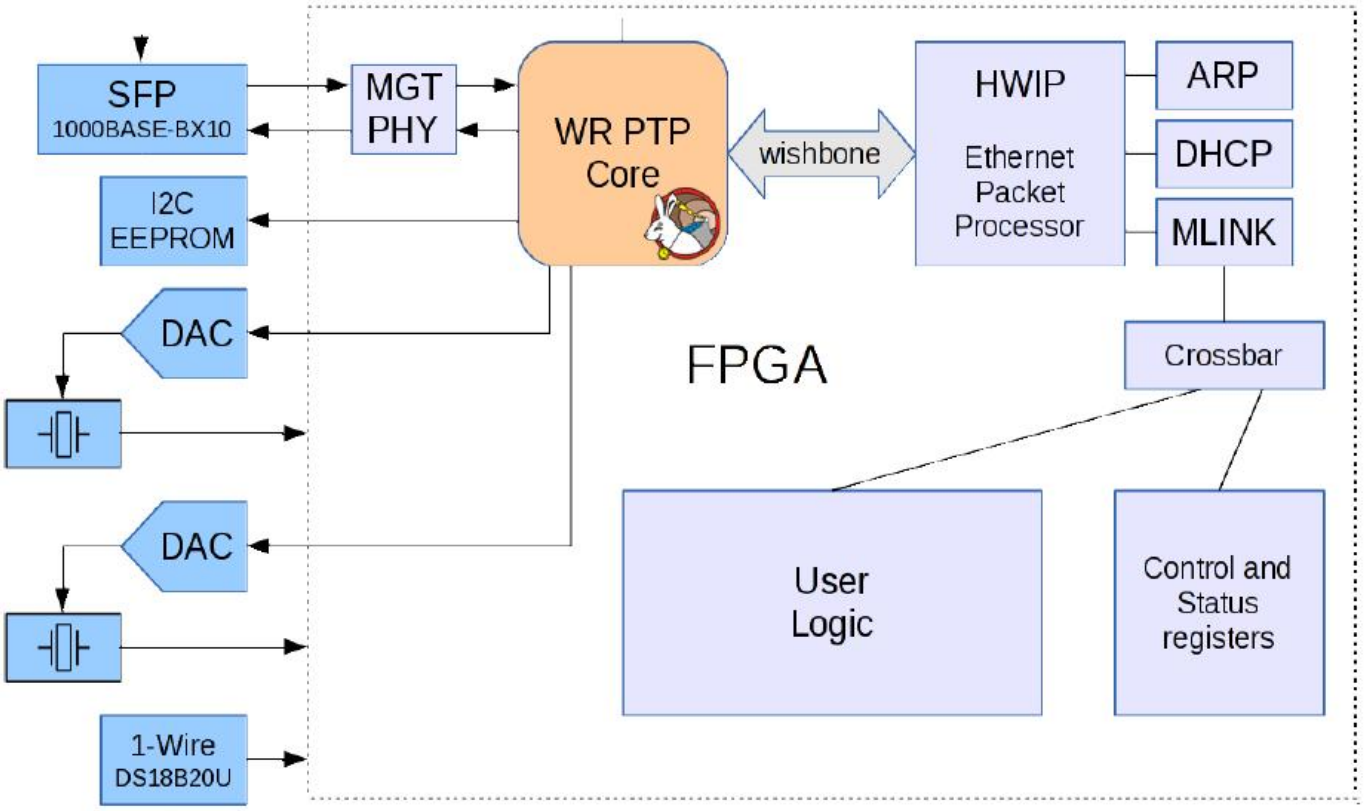
TDC72VHL

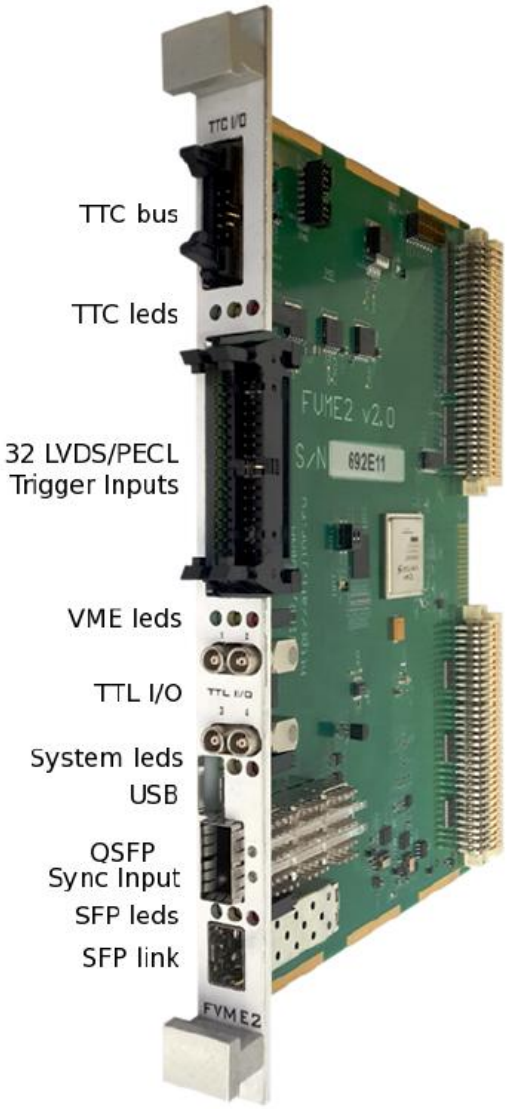
ADC64s2

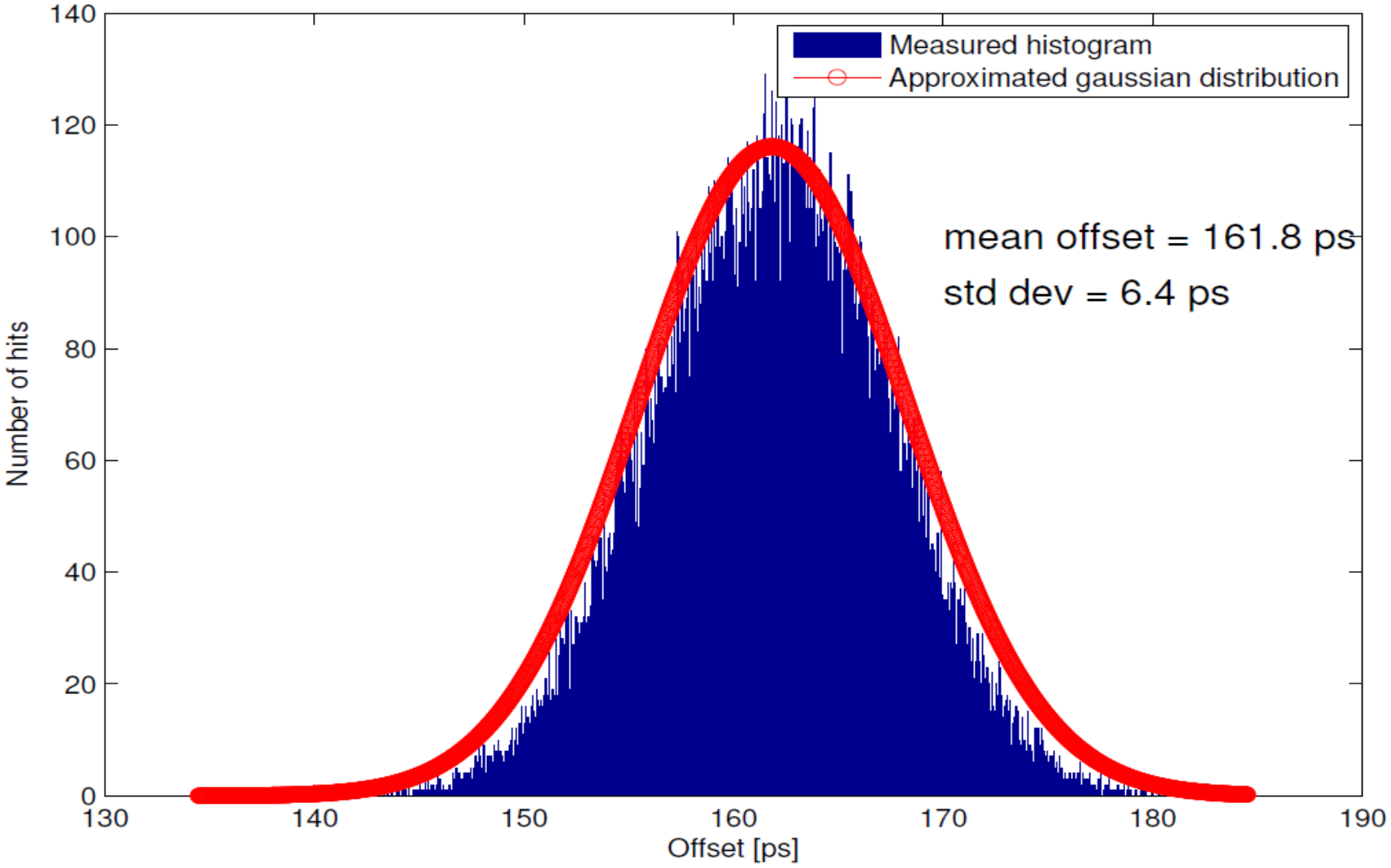
FVME2TMWR – Trigger and Clock Distribution

U40VE – Logic and Service

White Rabbit Node Core in Trigger Module – FVME2TMWR

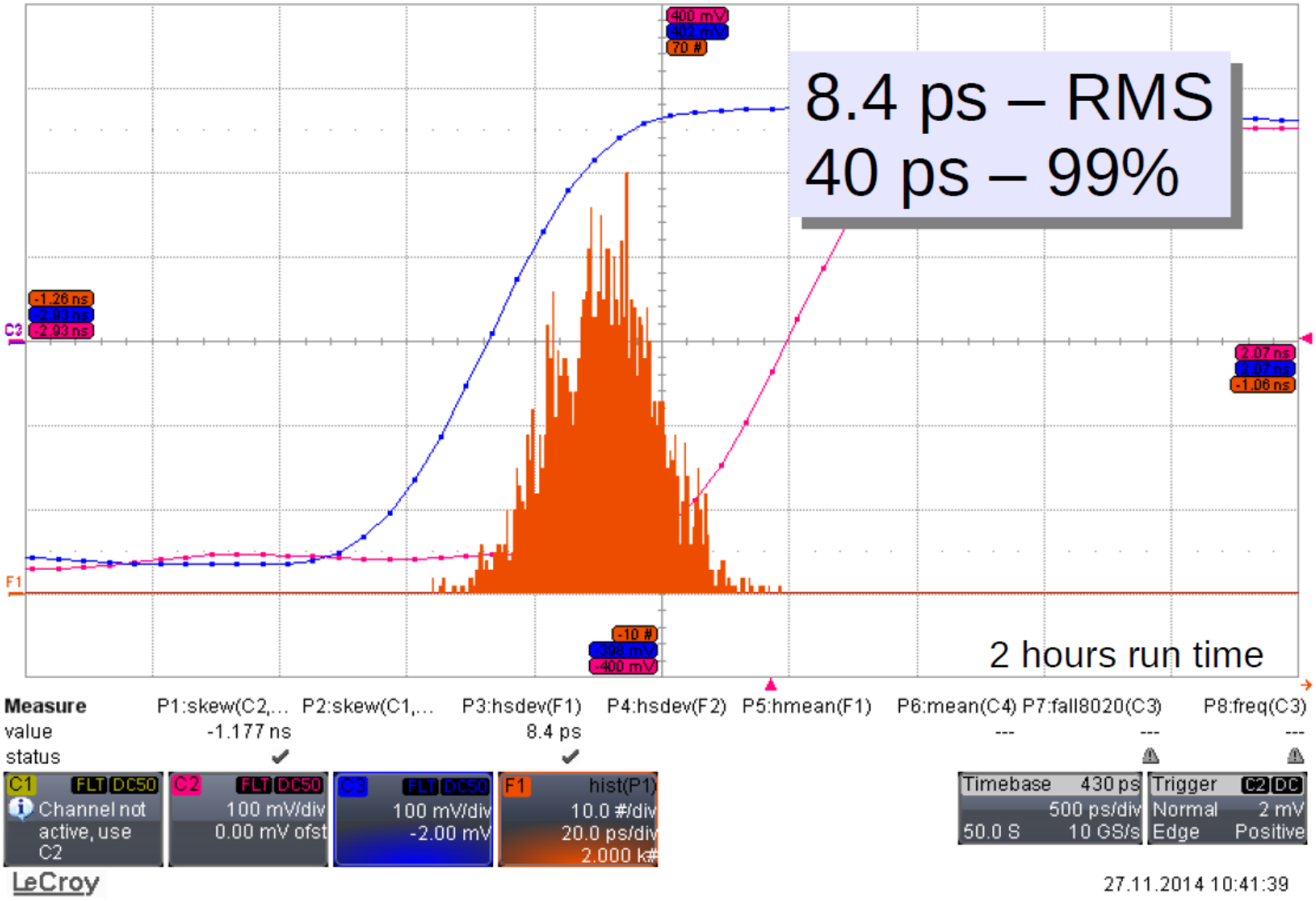






Measured histogram of master-slave PPS offset.

WR Time Accuracy



THANK YOU

THE END