White Rabbit Switch
version 4.x

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CERN BE-CO-HT
Gnudd
7 Solutions

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Outline

1. Introduction
2. Gateware
3. Software
4. Hardware
White Rabbit network

Gateware

Software

Hardware

GPS

Time & Data Master

WR Switch

WR Switch

WR Node

WR Switch

Standard GbE Switch

Other Node

Database

Other Node

PC

2000 nodes

10km

WRS status 4/28
WR Switch - overview

- Central element of WR network
- Gigabit Ethernet switch with WR features
- Designed from scratch
- 18 ports
- 1000Base-BX10 SFPs: up to 10km, single-mode fiber
WR Switch - internals

- Clocking resources
- Xilinx Virtex6 FPGA
- ARM CPU
- 64MB DDR2
- 256MB NAND
- 8MB boot flash
- Power supply 12V DC 80W
- 18 SFP cages

Front panel

Back panel

Debug ports

Cooling FANs

Management ports
WR Switch internals - gateware

- lives inside the Xilinx Virtex-6 FPGA
- controlled from ARM software
- Gigabit Ethernet endpoints with timestamps generation
- forwards Ethernet frames
- keeps WR time, generates 1-PPS, measures phase, disciplines oscillators
WR Switch internals - software

- bootloader (at91bootstrap + Barebox)
- embedded Linux with 2.6.39 kernel
- patches and drivers for HDL modules
- Hardware Abstraction Layer
- RTU daemon
- PPSi daemon - PTP with WR extensions
- management (SNMP, shell tools, web interface, Syslog)
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New features in v4.0 release

- Per-port counters

- collects events from Endpoint and RTU
- TX underruns, RX overruns, giant frames, runt frames, CRC Errors, RTU decisions, and more...
- read by Linux kernel driver
New features in v4.0 release

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  - TX underruns, RX overruns, giant frames, runt frames, CRC Errors, RTU decisions, and more...
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New features in v4.0 release

- Per-port counters
- VLAN support in Endpoints
  - available modes: *Disabled*, *Trunk*, *Access*
  - *Access*: tags untagged ingress traffic
  - *Trunk*: accepts only tagged frames
  - untagging frames on egress
  - configuration through *wrs_vlans* shell tool
New features in v4.0 release

- Per-port counters
- VLAN support in Endpoints
- Improved Ethernet frames switching and latency

<table>
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<th>Frame Size (bytes)</th>
<th>Load (%)</th>
<th>Tx Frames</th>
<th>Rx Frames</th>
<th>Frame Loss (%)</th>
<th>Min Latency (uSec)</th>
<th>Avg Latency (uSec)</th>
<th>Max Latency (uSec)</th>
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New features in v4.0 release

- Per-port counters
- VLAN support in Endpoints
- Improved Ethernet frames switching and latency
- Networking performance tests with *Spirent SmartBits*
New features in v4.0 release

- Per-port counters
- VLAN support in Endpoints
- Improved Endpoint "speed" and frames switching
- Networking performance tests with *Spirent SmartBits*
- Rewritten external channel in SoftPLL
  - improved locking to 10MHz & 1-PPS
  - allow 1-PPS out/in alignment in the future
New features in v4.0 release

- Per-port counters
- VLAN support in Endpoints
- Improved Endpoint ”speed” and frames switching
- Networking performance tests with Spirent SmartBits
- Rewritten external channel in SoftPLL
- vUART to read SoftPLL logs from shell
Ongoing work and plans for future releases

- SDB support with auto-generated metadata instead of HWIU module
- Switching Core improvements
- Holdover and 1-PPS out/in alignment in SoftPLL
- Robustness (TRU and TATSU modules)
- Resources optimization
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New software features in v4.0

- Kconfig for build-time configuration
- PPSi as an alternative to ptp-noposix (preferred)
- Rsylog for network logging, UDP or TCP
- Web interface (by 7S) for run-time configuration
- Unification of Soft pll code between wr-switch and wr-node
- SNMP support, with standard and wr-specific items
- New version of bootloader, with UBI support and more
- UBI/UBIFS: new partitioning and new boot procedure
- New, simpler, procedure for flashing and updating
- Support building under new Ubuntu-14.04 LTS
- The usual details and minor fixes
New software features in v4.1

- Support new SCB v3.4
- “hwinfo” persistent data, with MAC addresses and more
- Automatically create missing hwinfo when upgrading
- Partial update (kernel/bootloader only) for developers
- Remove ptp-noposix: PPSi is now our only PTP daemon
- The usual details and minor fixes
New partitioning and boot procedure

- Internal flash is now managed by UBI and UBIFS
  - Device-wide wear leveling
  - Much simpler data structures
  - State of the art for flash storage

- Three partitions
  - /boot: kernel and initial ram disk (rootfs)
  - /usr: the bulk of applications
  - /update: a place for new firmware images

- Booting procedure
  - The bootloader runs kernel and ram disk
  - The first boot script checks /update
  - If so requested, updates items in flash
  - If new boot/kernel/initramfs reboot
  - Mount /usr and continue

- This unifies initial flashing and later updates
SNMP WR-specific items

**snmpwalk**

WR-SWITCH-MIB::pstatsDescr.1 = STRING: TX Underrun
WR-SWITCH-MIB::pstatsDescr.2 = STRING: RX Overrun

[...]
WR-SWITCH-MIB::pstatsWR17.38 = Counter32: 50819

[...]
WR-SWITCH-MIB::portLink.15 = INTEGER: up(1)
WR-SWITCH-MIB::portLink.16 = INTEGER: down(0)

[...]
WR-SWITCH-MIB::wrsVersionSw.0 = STRING: v4.1
WR-SWITCH-MIB::wrsVersionGw1.0 = STRING: 7cce708

[...]
WR-SWITCH-MIB::wrsDateTAI.0 = Counter64: 1406623390
...::wrsDateString.0 = STRING: 2014-07-29-08:43:10
Ongoing work and plans for future releases

- Support more flexible configuration, dot-config based)
  - “make menuconfig” creates .config
  - The file is stored in the firmware image
  - The choices are activated at run time

- Picking configuration at boot time (“rack and play”)
  - WRS picks dot-config with dhcp/tftp at boot time
  - The choices are activated at run time
  - It’s an alternative to nfs-root, lighter on cpu/network

- SNMP traps

- Linux-3.14 to replace Linux-2.6.39

- VLAN-awareness in PPSi

- Clean-up and consolidate configuration files

- Clean-up and simplify WR libraries and processes
The WRS is now shipped with a SCB v3.4 with the following main changes:¹

- New dataflash AT45DB641E to replace the obsolete AT45DB642D.
- New configuration of the PLL: \( \text{CLK1} \) can be 10MHz.
- \( \text{CLK2} \) output from FPGA and latched by PLL to improve clock stability.
- PPS input has a configurable 50Ω configuration.
- Correct reset signal for \( \text{CDCM61002} \).

¹The WRS v3.4 is still shipped with minibackplane v3.3
The new SCB v3.4

8 → OUT CLK1: Clock output from PLL; 9 → OUT CLK2: Clock output from FPGA
To support the new SCB v3.4 we have created the new release v4.1. It now supports:

- Detection of new dataflash AT45DB641E in kernel & barebox.

- Setup of the new PLL configuration: *The CLKx outputs are currently desactivated, but we expect to release soon a v4.2 with this modification.*

- New hwinfo saved in Dataflash partition by manufacturer:
  - MAC address of all the ports.
  - SCB: version, serial number, FPGA type, batch.
  - Manufacturer, etc...
Updating with correct HW info

**Important**

Since SCB v3.4, hwinfo is saved by manufacturer. If you want to upgrade from v3.3 to the new v4.1 firmware we suggest you to first update the correct hwinfo.

**The hwinfos.tar.gz package**

Seven Solutions provides a tarball with the correct hwinfo for all v3.3 switches that you can download from:

http://www.ohwr.org/projects/wr-switch-sw/files
Future works

- Add \texttt{CLK1} & \texttt{CLK2} 10MHz outputs.
- Improve the web interface when rebooting.
Thank you

More information:
http://www.ohwr.org/projects/white-rabbit/wiki/Switch