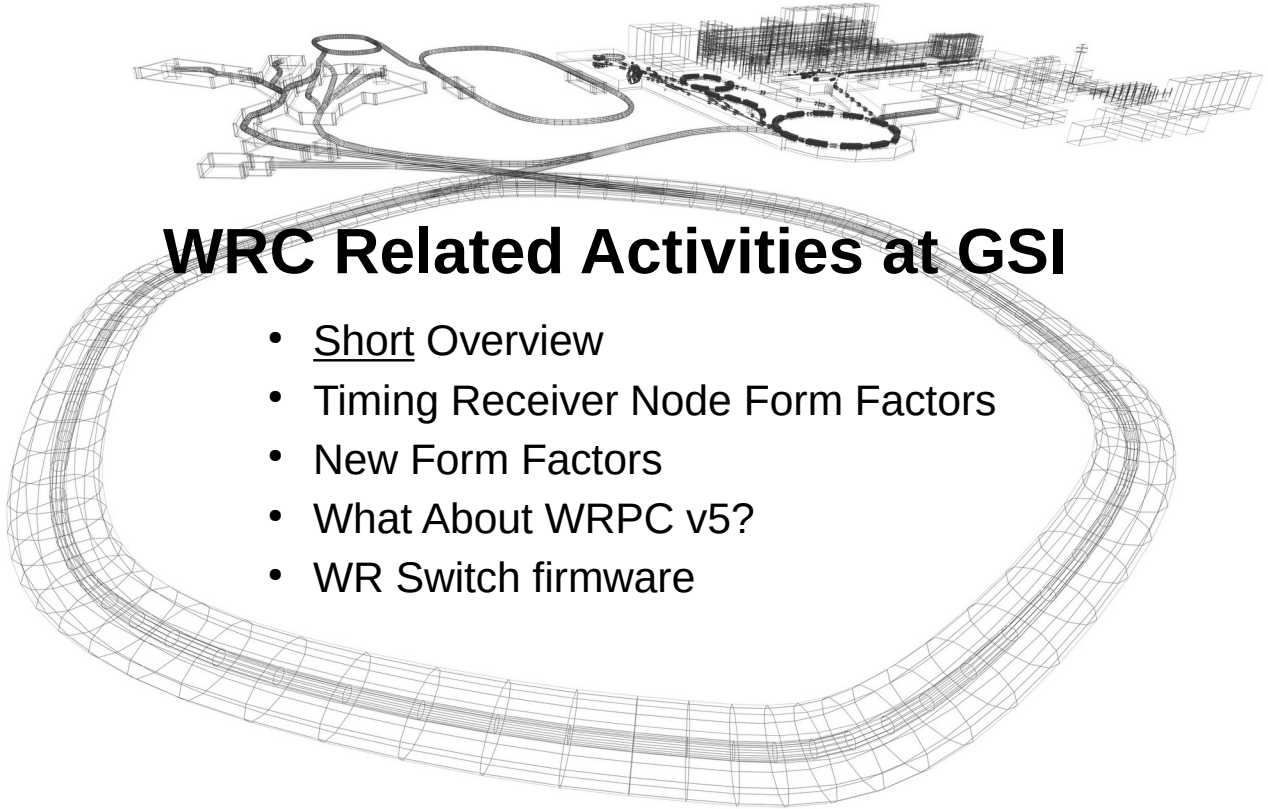
Acknowledgements

- GSI Timing Team: Enkhbold Ochirsuren, Marcus Zweig [1], Stefan Rauch, Mathias Kreider, Martin Skorsky, Dietrich Beck, Frederic Ameil [2], Anna Ranz, Alexander Hahn, Michael Reese
- GSI ACC-IT Team: Maxim Itterman, Peter Pfister, Christoph Handel, Rosemarie Vincelli …
- CERN Team: Greg Daniluk, Maciej Lipinski …
- External: Alessandro Rubini, Adam Wujek …
- ...

[1] Michael, Martin and Marcus left; job opportunity https://www.gsi.de/en/jobscareer/job_offers

[2] Frederic is our new team leader :-)



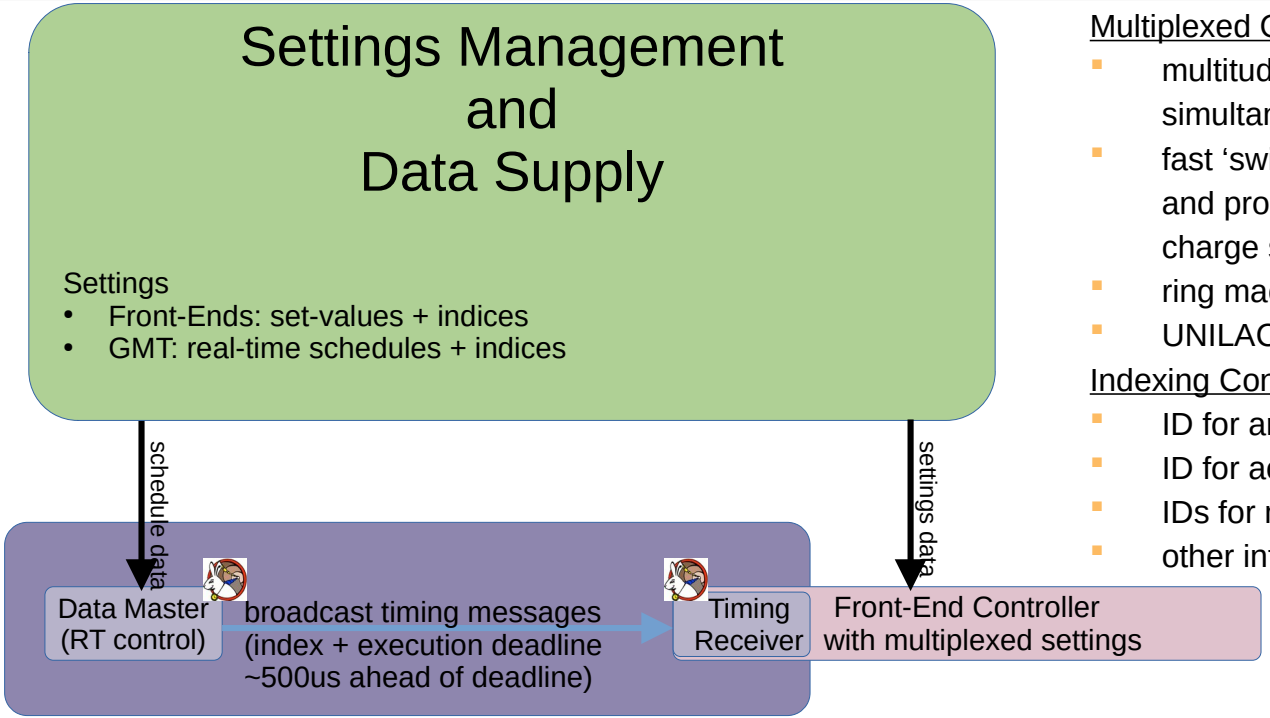
WRC Related Activities at GSI

- Short Overview
- Timing Receiver Node Form Factors
- New Form Factors
- What About WRPC v5?
- WR Switch firmware

GSI from the Control System Perspective

- ‘FAIR Control System’ including GMT (White Rabbit) @ GSI campus
- since 2016: CRYRING, (ring, ions-sources, Linac)
- since 2018: SIS18, ESR, all beamlines
- since 2022: synchronization of transfers between all ring machines
- fall 2024: machine experiment - beam production at UNILAC

Multiplexed Operation, Control System Stack and General Machine Timing



General Machine Timing System:
trigger Front-Ends with multiplexing index on-time

Multiplexed Operation

- multitude of beams for many experiments simultaneously
- fast ‘switching’ between beam destinations and properties (element, neutron number, charge state, energy, intensity, focus …)
- ring machines: 1Hz switching
- UNILAC: 50 Hz switching

Indexing Concept

- ID for area, location (‚where‘)
- ID for action (‚what to do‘)
- IDs for multiplexing context (‚which beam‘)
- other information

Common Features for Timing Receiver Nodes ’Everything Happens in the FPGA’

no application specific VHDL!

instead:

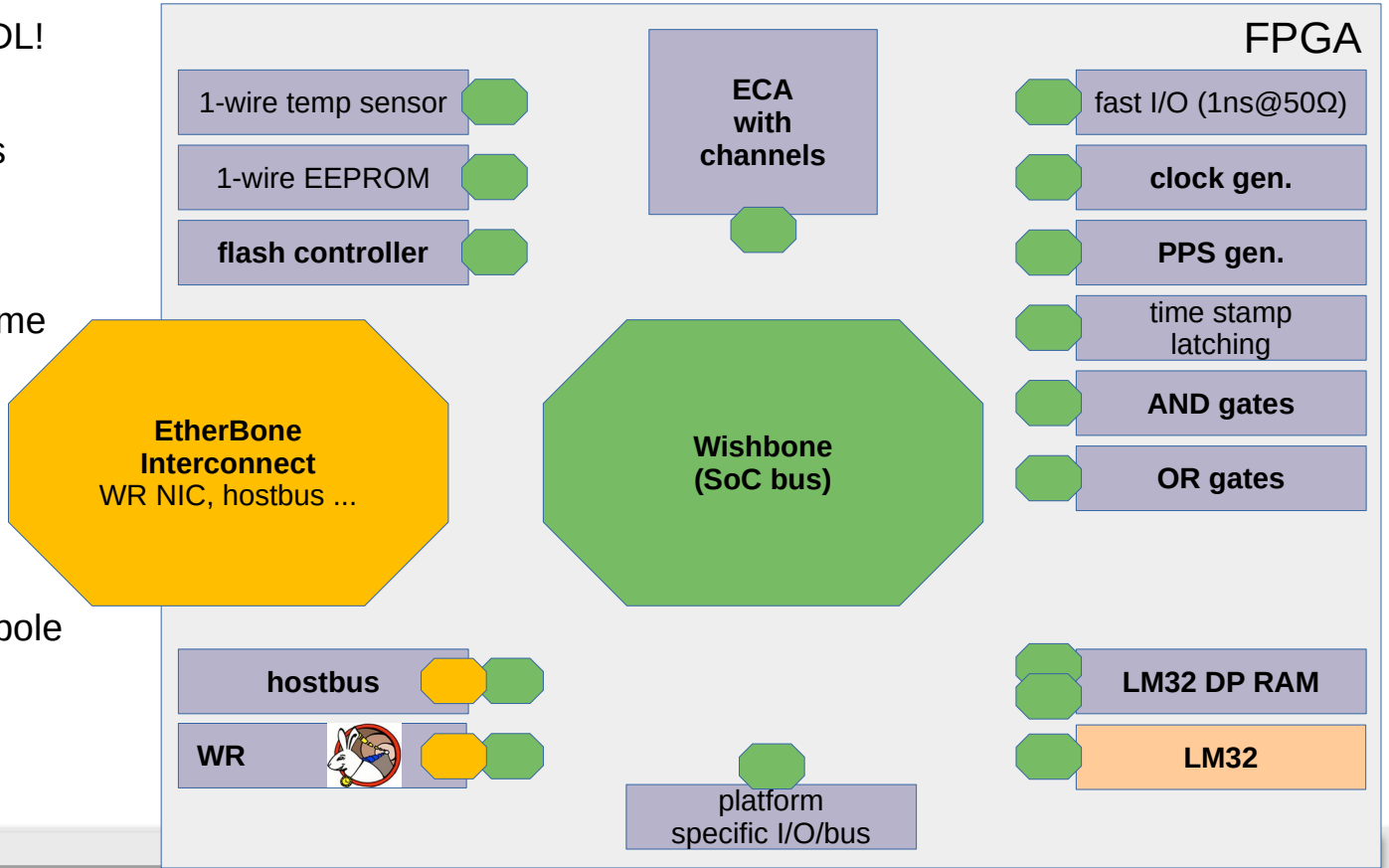
- configuration of IP cores
- ECA
- LM32 user softcore:

  upload binaries at run-time (c-code, OS-less)

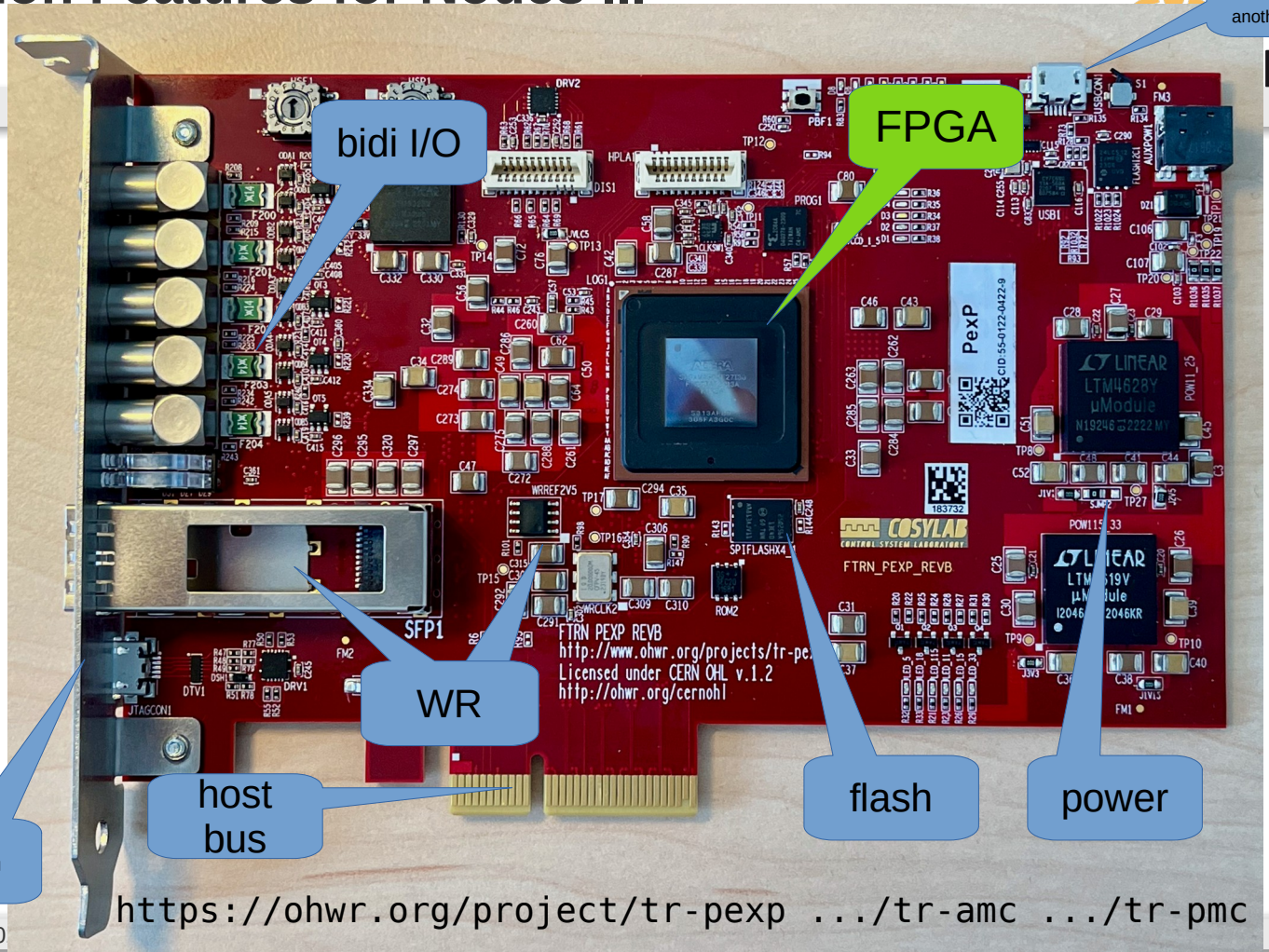
  hard real-time

  synchronosly at many nodes

  example: ramping up dipole magnet current or rf-cavity frequency



Common Features for Nodes ...



https://ohwr.org/project/tr-pexp .../tr-amc .../tr-pmc

WR @ GSI, Status

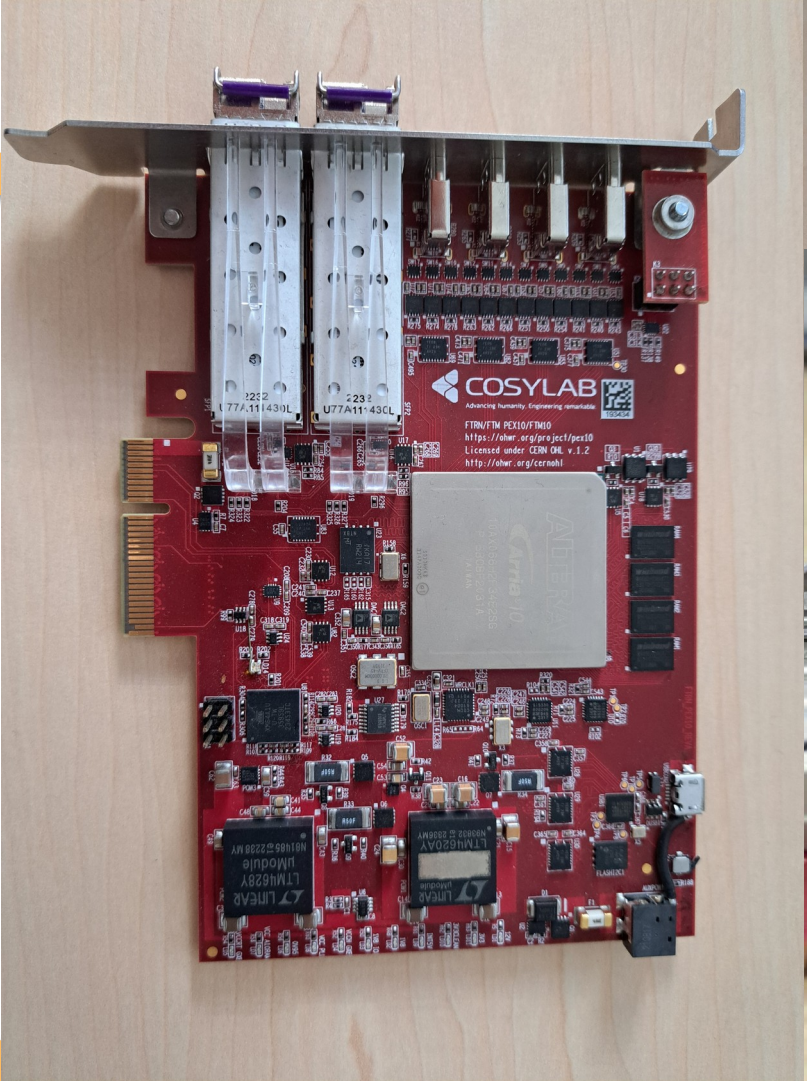
- ~~67~~ 69 (~~104~~ 107) [333] WR switches for facility operation (in use) [on-site]
  - mainly Creotech and Seven Solutions, some SyncTechnology
  - v6.1 for all operational WRS
  - SFP, mainly CBO with DDM
- 332 (416) [2296] WR nodes for facility operation (in use) [on-site]
  - OHWR: TR-PMC, TR-AMC, TR-PEXP; in-house: **SCU** (**S**calable **C**ontrol **U**nit, workhorse)
  - Arria V GX, Arria II GX
  - wrpc-v4.2
  - https://github.com/GSI-CS-CO/bel_projects, current release v6.3.1 ‚fallout‘
- host systems
  - SCU: COM Express
  - non-SCU: uTCA, VME, IPC (1U), Server-PC, other
  - PXE boot of ‚ACO-Ramdisk‘ for **A**ccelerator **CO**ntrol system
  - other

New Timing Receiver (TR) Nodes I

- Arria II – about 1/3 of TR at GSI, mainly SCU3; old FPGA type
- Arria V – about 2/3 of TR; formfactors 2x PCIe, AMC, PMC, standalone
  - availability on the market is bad (feels like it becomes deprecated)
  - maintaining gateware releases (FPGA images) requires a lot of effort
  - many units and functionality inside our images
  - use ‚seed mining‘ to make the fitter happy somehow
  - synthesis only possible with additional flip-flops and clock crossings
  - not yet: dedicated platform for Data Master
- A 10 – next generation Timing Receivers
  - SCU5
    - successor of SCU3, standard front-end controller for FAIR
    - in-house development
  - Pexarria10, two versions with different FPGA sizes
    - small: node version with one SFP/White Rabbit interface, 2 user soft cores
    - large: "Data Master" version with two SFPs/White Rabbit interfaces, 8+ user soft cores
    - same FPGA footprint for both
    - open source project on OHWR/GitHub/GitLab

New Timing Receiver Nodes II

- A10 TR to be contributed to WRC; relevant repos general-cores, wrpc-sw, wr-cores
- issues
  - when the large FPGA is used, heating is a major issue
  - dual White Rabbit kills PCIe, hard to fix, according to Intel/Altera problems inside the transceiver banks
  - 1ns LVDS IOs do not work yet
    - prime feature for TR nodes at GSI/FAIR (we don’t use ‚fine-delay‘ modules)
    - 1ns granularity achieved by using differential 1GBit transceivers
    - time stamping
    - pulse generation
  - porting from Quartus 18 to Quartus 23 requires a new hardware revision (clocking)
  - only one 3V bank (not 3.3V!) -> level shifter madness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JTAG
USBC1
USBC2
USBC3
USBC4
SFP 2
PPS
WR
PPS
WR

WRPC v5 @ GSI

- works on Arria2 and Arria10
- ArriaV: WR unreliable – frequent loss of lock
- Etherbone partially broken
- to be contributed to WRC; relevant repos general-cores, wrpc-sw, wr-cores
- requires a major gateware release
  - for all (lots!) form factors used at GSI
  - not only WR, but other GSI/FAIR specific things too
- lower priority than development of A10 Timing Receivers
- not for 2025, 2026 maybe …

WRS Firmware Upgrade

- 21-22 Nov 2024: firmware update of all 107 White Rabbit switches from v6.1 to v7.0
- required changes in dot-config and new calibration parameters
- worked out very well
- only issue so far
  - „Error wrsSwcoreStatus: Endpoint TX frames number (462775) on port 10 (wri 10) does not match the number of frames forwarded from other ports (134005) and NIC (1090), some frames got lost... Difference is **more than 5**, since last check (293s)"
  - false positive
  - issue shows up only in a dedicated network with frame rates 1.5 … 2.5 kHz
  - v6.1: less than 10 occurences per **week**
  - v7.0: more than 100 occurences per **hour**
  - proposal: configurable limit via dot-config (presently fixed limit of 5 frames)

- BTW: are there new calibration values for the fanless WRS from SynchTech?

Discover: TOS ALL: WRS Warnings - aco logging — Mozilla Firefox

Netdisco | Host Groups :: Icinga Web | Discover: TOS ALL: WRS Wa

https://logging.acc.gsi.de/app/data-explorer/discover/#/view/7f7e7720-885b-11ee-8e0d-d5c08ff3491d?_q=(filters:!(),query:(language:kuery,query:'host:nwt* and message:"Error wrsSwcoreStatus" and not (host:nwt0082m66)'))&_g=(filters:!(),refreshInterval:(pause:!t,value:0),time:(f

OpenSearch Dashboards

Discover | TOS ALL: WRS Warnings | New | Save | Open | Share | Inspect

logstash

Search field names | Filter by type 0

Selected fields
- t host
- t message

Popular fields
- @timestamp
- t level
- # pid
- t program

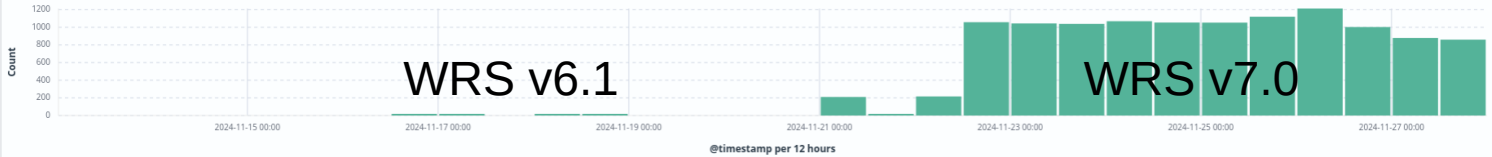
Available fields
- t _id
- t _index
- # _score
- t _type
- t @version
- t facility
- t source_host
- t type

host:nwt* and message:"Error wrsSwcoreStatus" and not (host:nwt0082m66) | DQL | Refresh

+ Add filter

11,839 hits | Reset search

Nov 13, 2024 @ 00:26:02.630 - Nov 28, 2024 @ 00:00:00.000 per Auto



Time	host	message
Nov 27, 2024 @ 23:59:20.023	nwt0285m66	SNMP: Error wrsSwcoreStatus: Endpoint TX frames number (458646) on port 7 (wri 7) does not match the number of frames forwarded from other ports (326488) and NIC (1085), some frames got lost... Difference is more , since last check (291s)
Nov 27, 2024 @ 23:59:20.022	nwt0285m66	SNMP: Error wrsSwcoreStatus: Endpoint TX frames number (458628) on port 3 (wri 3) does not match the number of frames forwarded from other ports (391997) and NIC (1095), some frames got lost... Difference is more , since last check (291s)
Nov 27, 2024 @ 23:59:20.020	nwt0285m66	SNMP: Error wrsSwcoreStatus: Endpoint TX frames number (458598) on port 2 (wri 2) does not match the number of frames forwarded from other ports (391997) and NIC (1065), some frames got lost... Difference is more , since last check (291s)
Nov 27, 2024 @ 23:58:56.653	nwt0291m65	SNMP: Error wrsSwcoreStatus: Endpoint TX frames number (468202) on port 14 (wri 14) does not match the number of frames forwarded from other ports (270519) and NIC (1075), some frames got lost... Difference is mor , since last check (296s)
Nov 27, 2024 @ 23:57:55.486	nwt0292m66	SNMP: Error wrsSwcoreStatus: Endpoint TX frames number (460481) on port 6 (wri 6) does not match the number of frames forwarded from other ports (393861) and NIC (1084), some frames got lost... Difference is more , since last check (292s)
Nov 27, 2024 @ 23:57:10.249	nwt0100m65	SNMP: Error wrsSwcoreStatus: Endpoint TX frames number (462440) on port 10 (wri 10) does not match the number of frames forwarded from other ports (395829) and NIC (1075), some frames got lost... Difference is mor , since last check (293s)
Nov 27, 2024 @ 23:57:10.248	nwt0100m66	SNMP: Error wrsSwcoreStatus: Endpoint TX frames number (462452) on port 9 (wri 9) does not match the number of frames forwarded from other ports (395829) and NIC (1087), some frames got lost... Difference is more , since last check (293s)
Nov 27, 2024 @ 23:54:29.781	nwt0285m66	SNMP: Error wrsSwcoreStatus: Endpoint TX frames number (393225) on port 6 (wri 6) does not match the number of frames forwarded from other ports (457677) and NIC (1084), some frames got lost... Difference is more , since last check (290s)
Nov 27, 2024 @ 23:54:00.340	nwt0291m65	SNMP: Error wrsSwcoreStatus: Endpoint TX frames number (468289) on port 14 (wri 14) does not match the number of frames forwarded from other ports (336132) and NIC (1085), some frames got lost... Difference is mor , since last check (297s)
Nov 27, 2024 @ 23:52:17.582	nwt0100m65	SNMP: Error wrsSwcoreStatus: Endpoint TX frames number (462834) on port 10 (wri 10) does not match the number of frames forwarded from other ports (199618) and NIC (1072), some frames got lost... Difference is mor , since last check (293s)
Nov 27, 2024 @ 23:52:17.581	nwt0100m66	SNMP: Error wrsSwcoreStatus: Endpoint TX frames number (462836) on port 9 (wri 9) does not match the number of frames forwarded from other ports (265154) and NIC (1074), some frames got lost... Difference is more , since last check (293s)
Nov 27, 2024 @ 23:52:03.643	nwt0292m66	SNMP: Error wrsSwcoreStatus: Endpoint TX frames number (455127) on port 6 (wri 6) does not match the number of frames forwarded from other ports (388524) and NIC (1067), some frames got lost... Difference is more , since last check (288s)

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Summary

- GSI joined WRC in November 2024
- working on new hardware platforms based on Arria 10 FPGAs
- working on migration to WRPC v5 (low priority)
- updated all WRS to v7.0

Thank You For Your Attention