Data acquisition system of COMPASS experiment - progress and future plans

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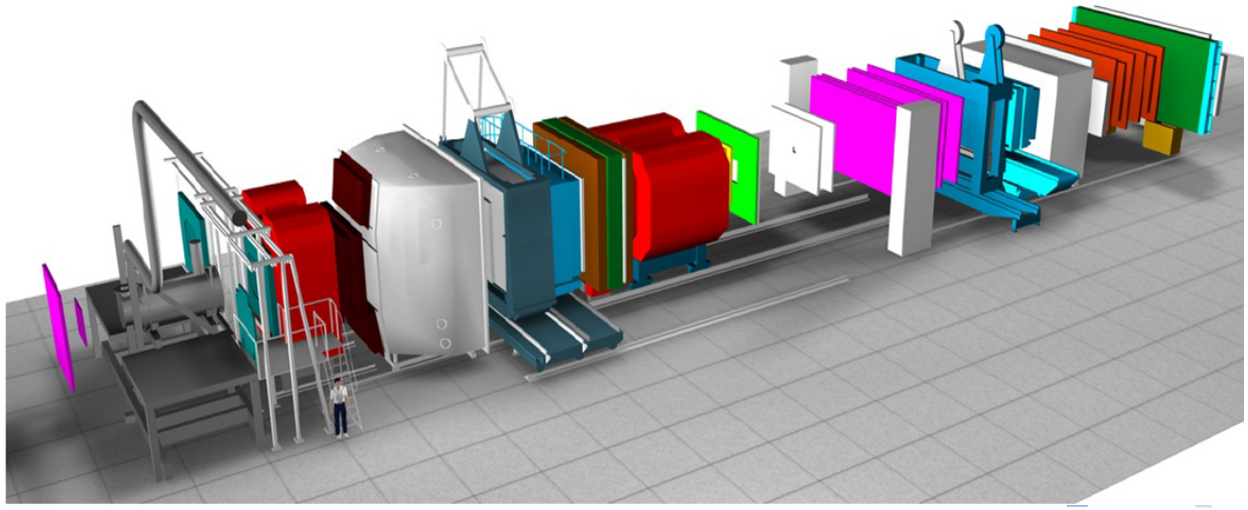
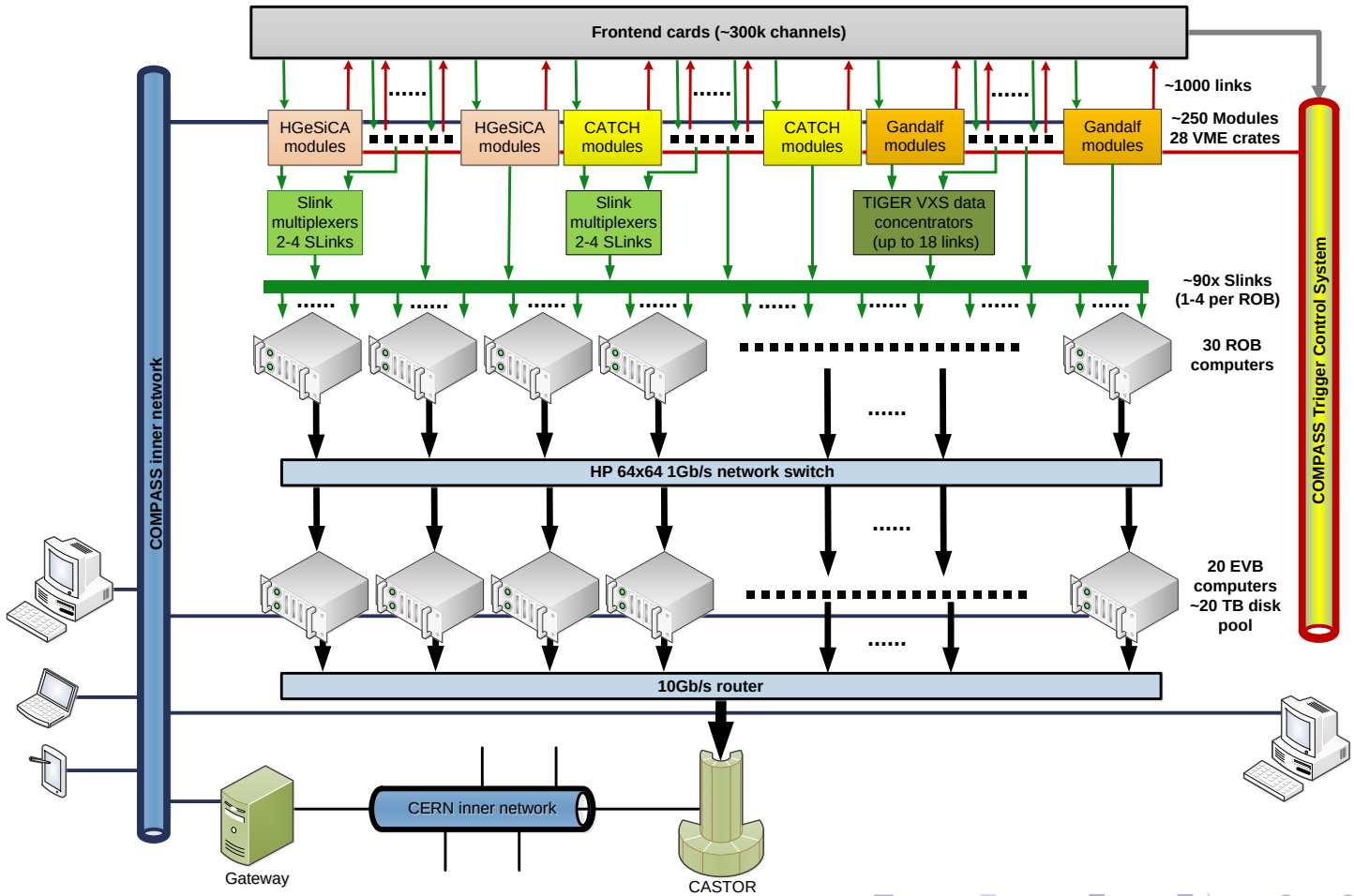
COMPASS experiment

- fixed target experiment at SPS accelerator at CERN
- study of hadron structure and hadron spectroscopy with high intensity muon and hadron beams
- data-taking started in 2002
- trigger rate up to 50 kHz, event size 35 kB average



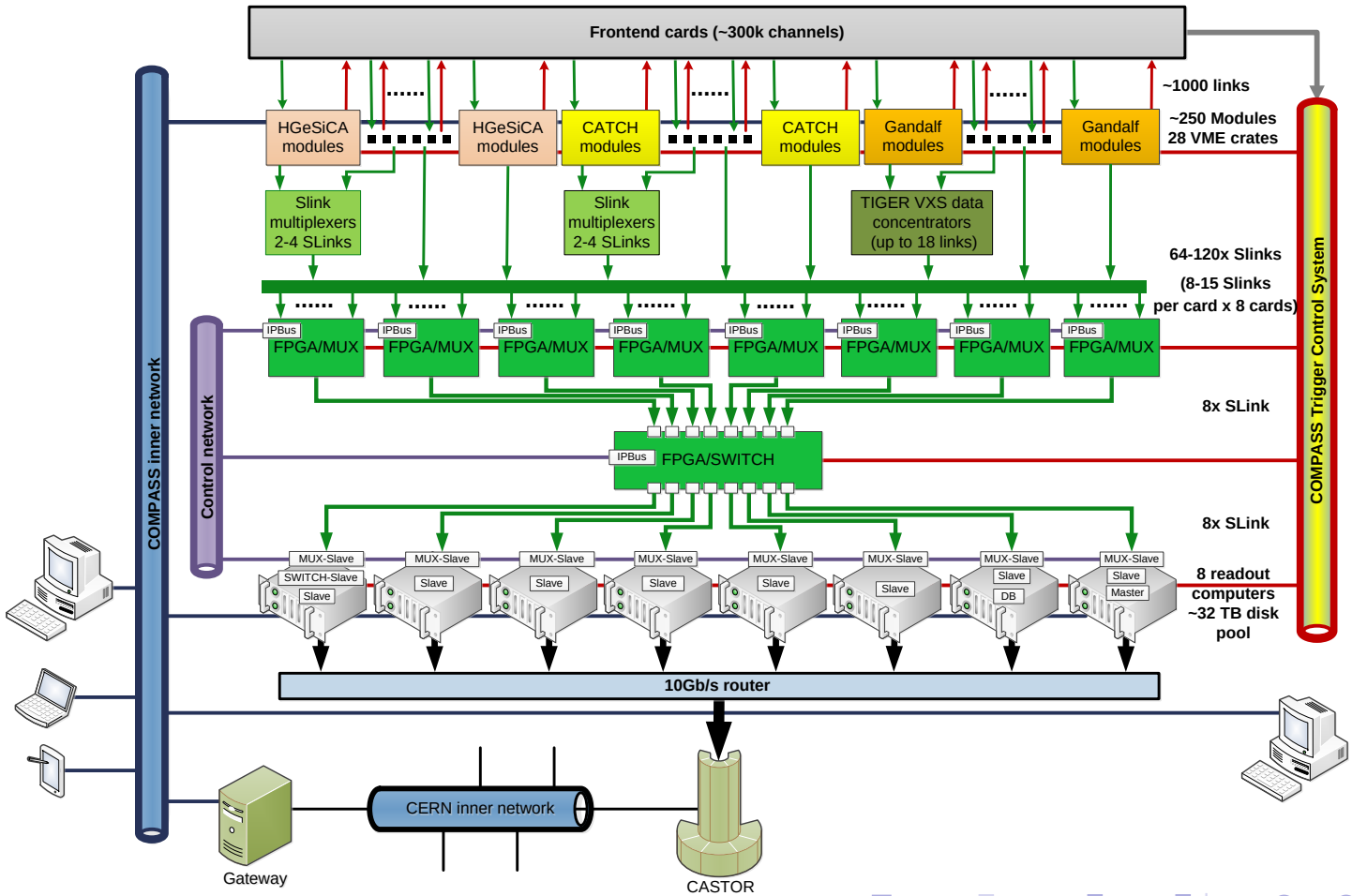
Hardware/Software structure of the old DAQ

- 50 servers
- 24 older than 10 years
- Old HDD with poor performance 30 MB/s
- EB network performance 60 MB/s



Hardware/Software structure of the new DAQ

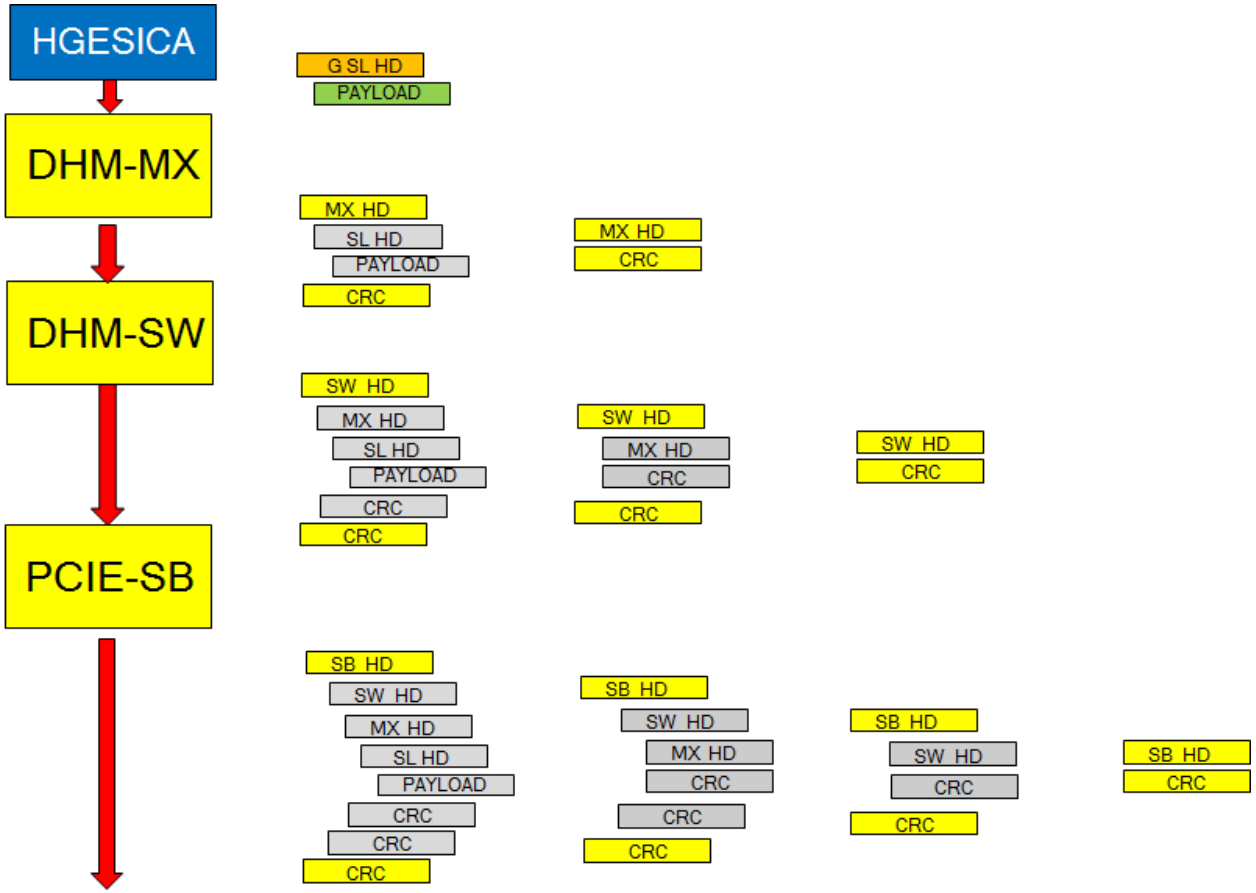
- 8 new servers 2x8 core CPU 3.6 GHz
- 32 TB disk pool
- 8 HDD in RAID 10 per server
- full events received by servers



Hardware functionality

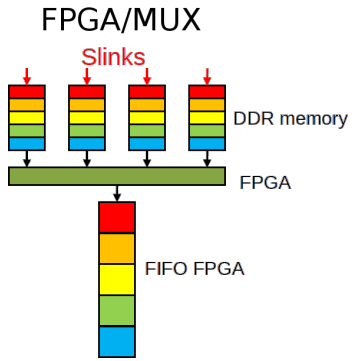
- Hardware Event builder
- HW DAQ components are synchronized by TCS
- Every data stream is checked for consistency in hardware
  - Latency, Data format, Event ID, Block size, CRC
  - OK -> data encapsulated in local Slink header
  - Tolerable error -> Preserve data and add local Slink header with correct event number, size, CRC
  - Fatal error -> Erase data till next spill, send local Slink header and error word instead

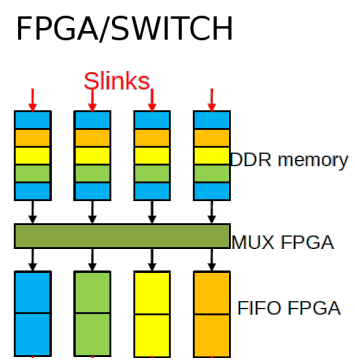
Hardware functionality

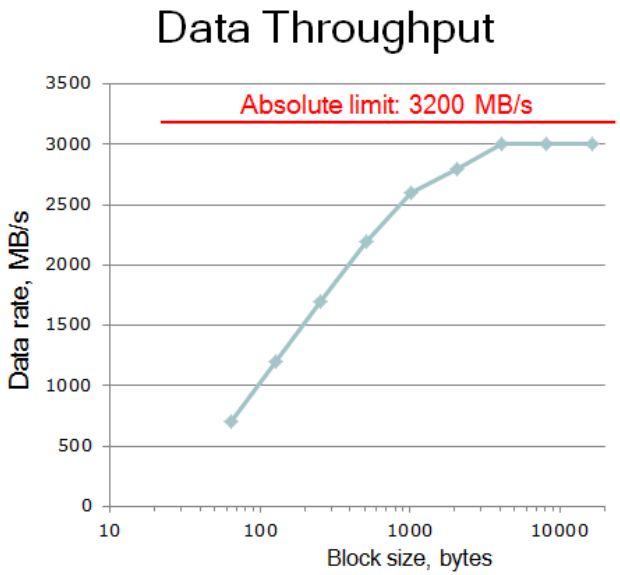


MX/SW module for the new DAQ

- AMC module, ATCA standard
- VIRTEX6 XC6VLX130T FPGA
- 2 GB DDR3
- Module programmed as MX (15:1) or SW (8x8)

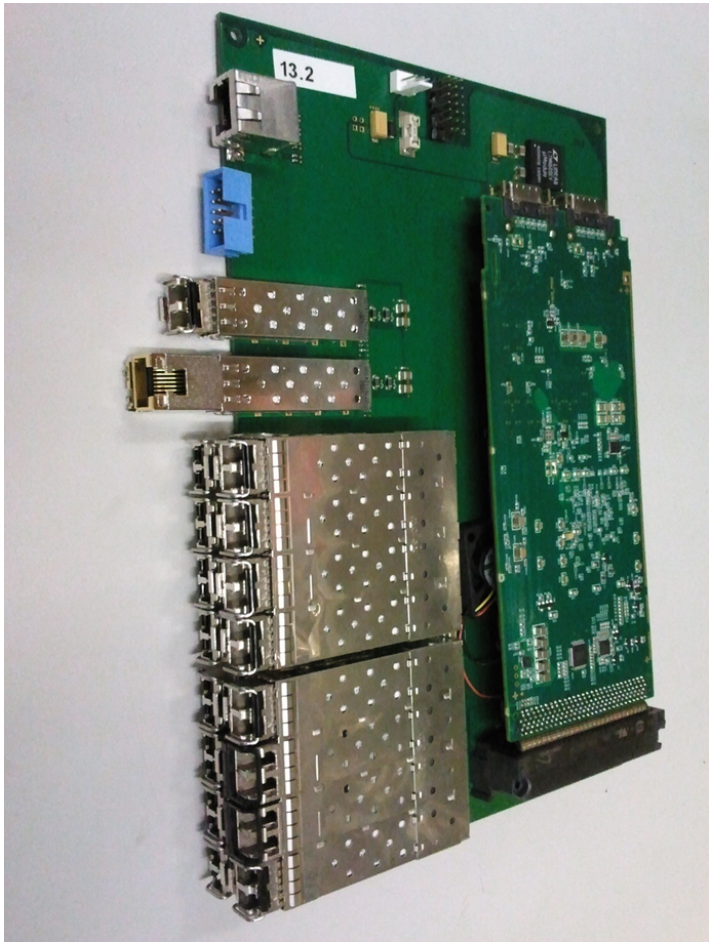






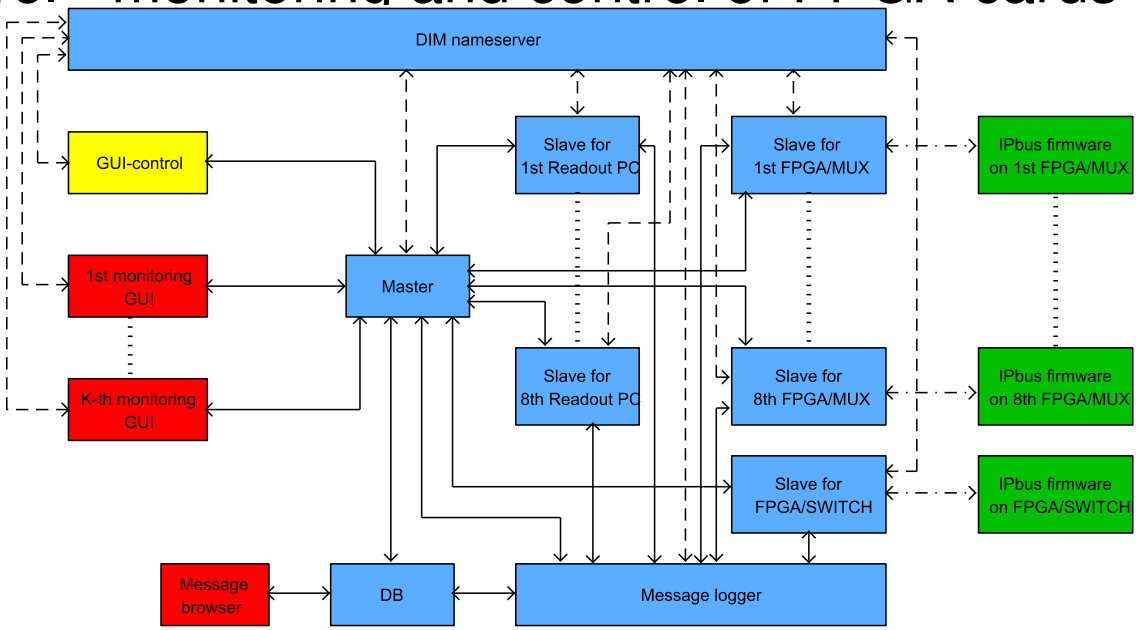
DAQ unit

- JTAG
- TCS receiver
- 1Gb Ethernet
- 16xSerial links
  - Slink (2Gbps)
  - Aurora(6.25 Gbps)
- 6U VME form factor module -> New DAQ fits in one 6U VME crate



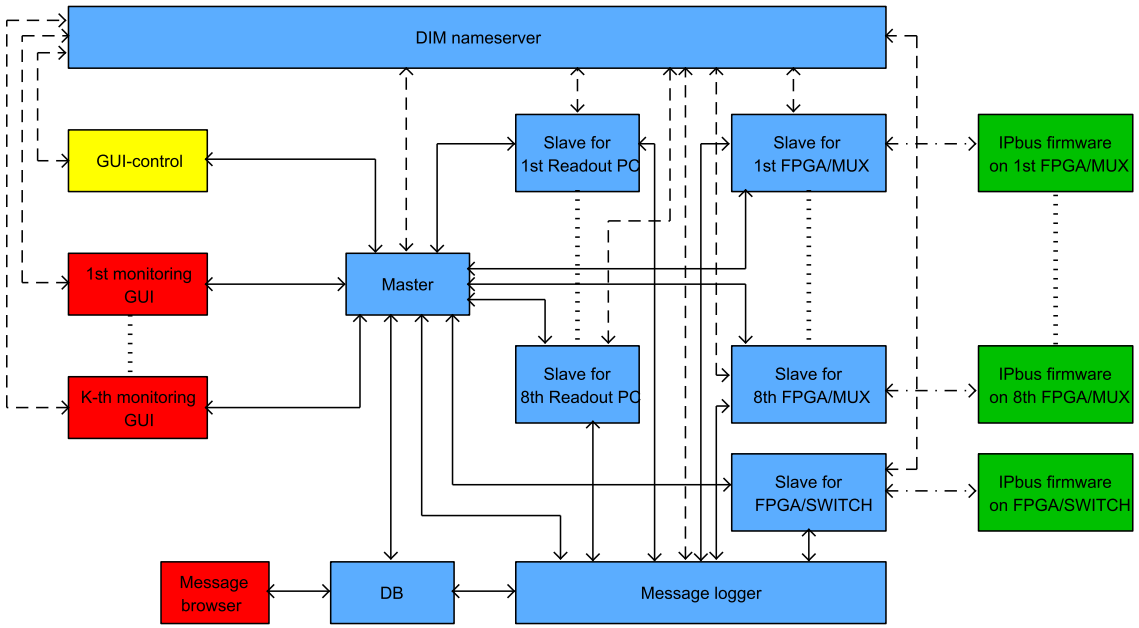
Software parts

- GUI - runcontrol - graphical user interface
- Master - main control process
- SlaveReadout - readout and check data
- Sharing daemon - sharing events to "user" programs
- SlaveControl - monitoring and control of FPGA cards



Software parts

- database - MySQL database with configuration information, system messages ...
- MessageLogger - catching and logging all system messages
- MessageBrowser - browsing message history and online messages

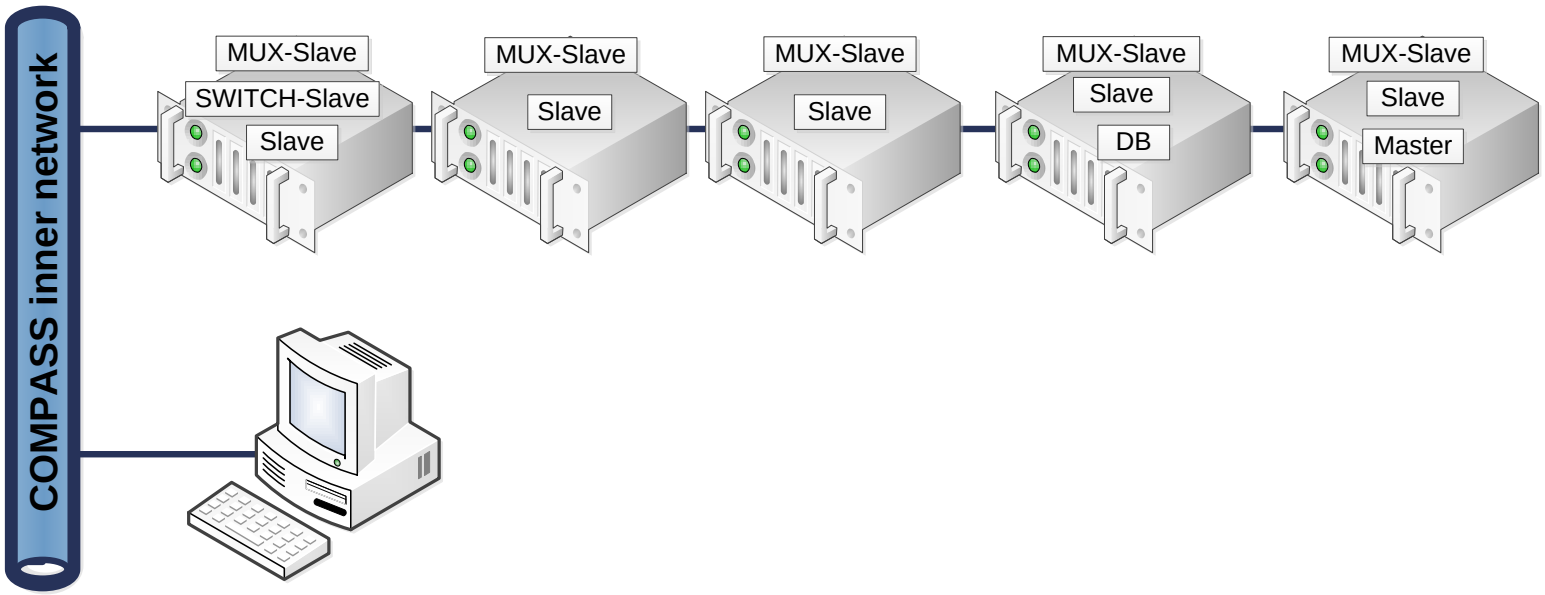


Used technologies

- C++, Python
- Qt framework
- MySQL
- Distributed Information Management System
- DATE (Data Acquisition and Test Environment) data format
- The IPbus suite for communication with FPGAs
- Zabbix package used for computer resources monitoring

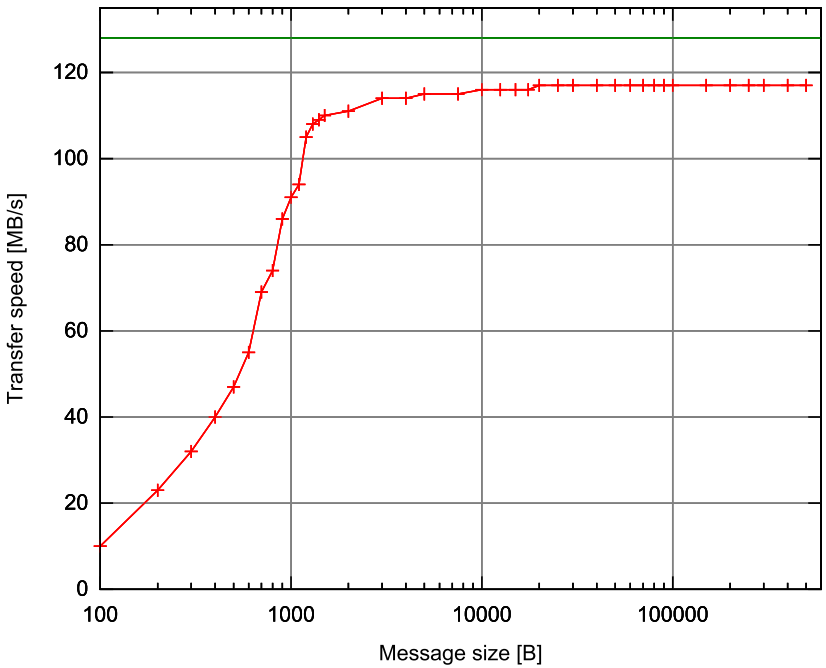
System tests phase 1 - communication tests

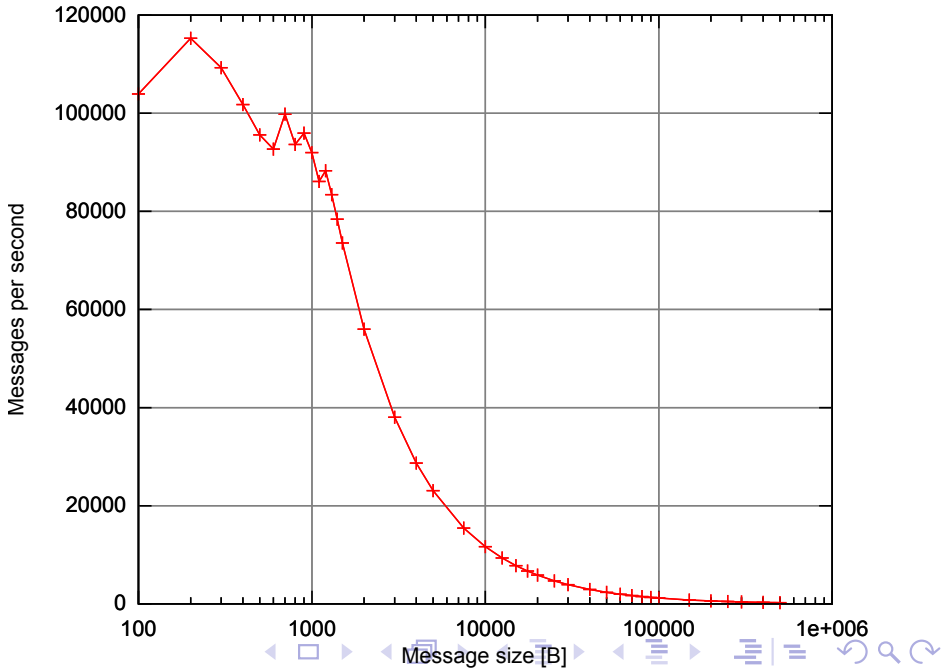
- DIM communication tests
- basic GUI design
- state machine design



DIM speed test

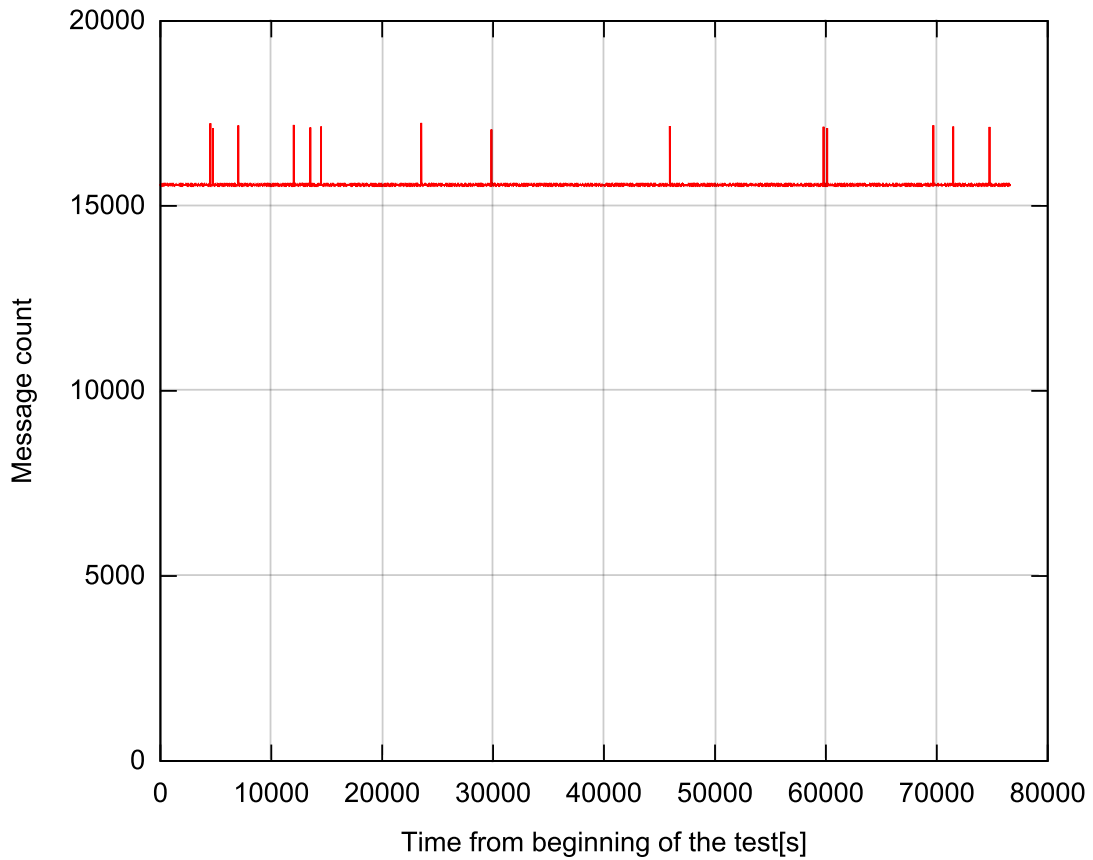
- new DAQ message format and random payload
- more than sufficient performance
- 1 kB messages $\rightarrow$ 92 kHz rate





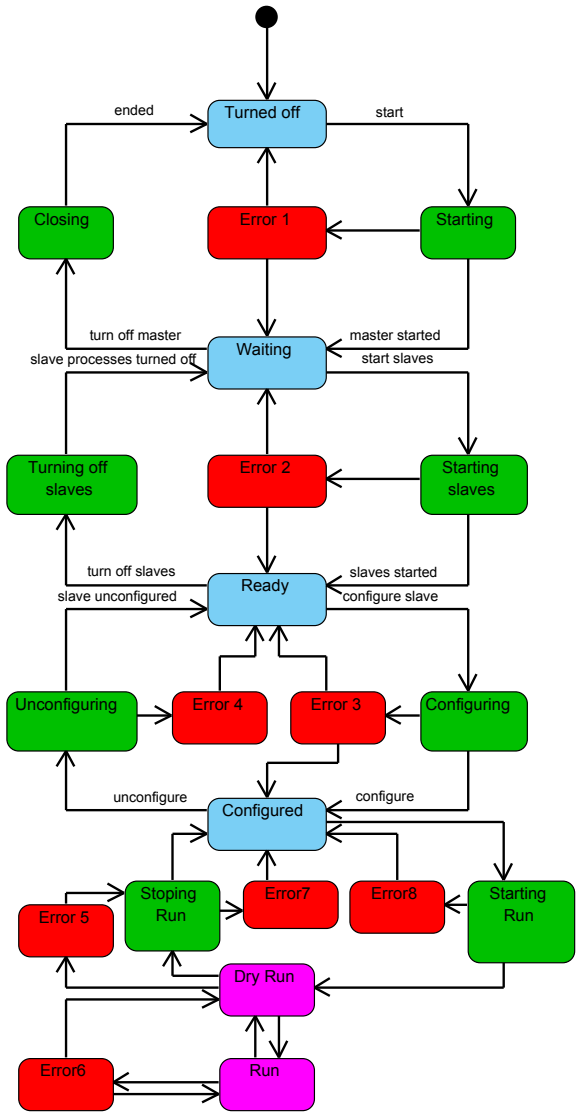
DIM stability test

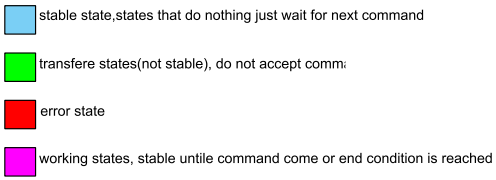
- 24-hours test
- maximum message exchange rate
- 2 DIM clients/producers
- 1 DIM server/consumer



State machine design

- reworked state machine design
- four types of states
- error tolerant run state





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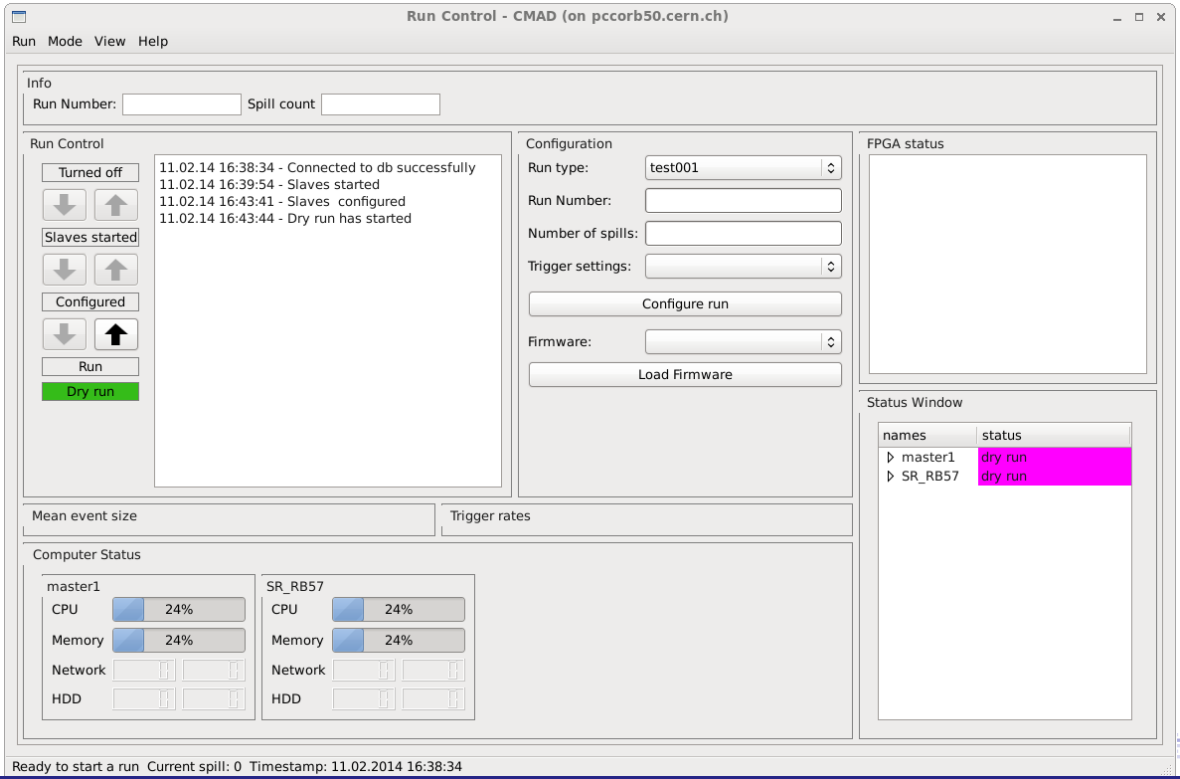
Run control GUI prototype

- basic design
- basic run control
- many separate configuration windows



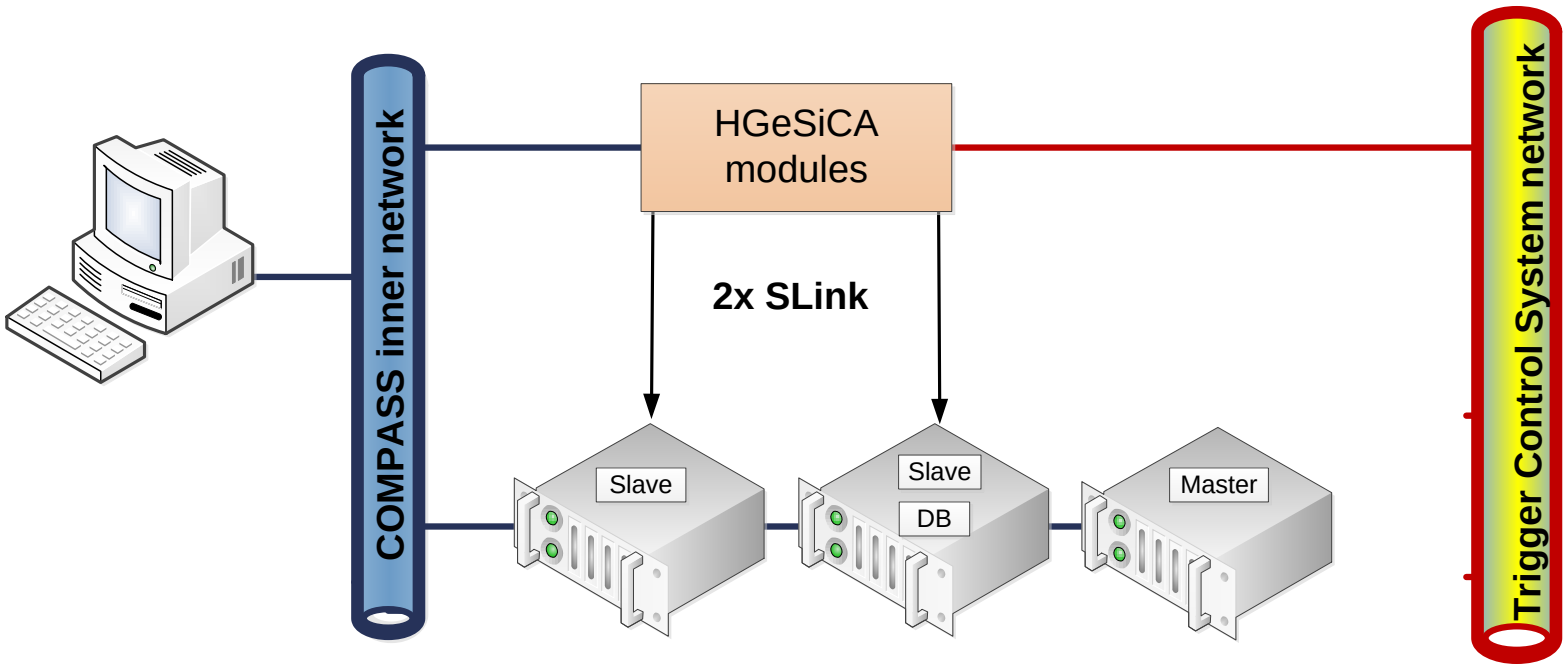
MessageBrowser, MessageLogger

- framework for logging, showing and filtering of messages

id	tm	dt	sender	severity	runNum	spillNum	eventNum	text
1	12:00 AM	11/11/11	6	FATAL ERROR	1000	1	5	Random text 3 6
2	1:00 AM	11/11/11	9	ERROR	1004	7	9	Random text 2 9
3	1:01 AM	11/11/11	8	ERROR	1004	13	3	Random text 2 8
4	1:01 AM	11/11/11	9	INFO	1004	13	12	Random text 0 9
5	1:01 AM	11/11/11	8	WARNING	1004	13	17	Random text 1 8
6	1:02 AM	11/11/11	7	INFO	1004	14	6	Random text 0 7
7	1:03 AM	11/11/11	8	WARNING	1004	22	9	Random text 1 8
8	2:03 AM	11/11/11	6	WARNING	1005	5	5	Random text 1 6
9	2:04 AM	11/11/11	2	FATAL ERROR	1005	14	4	Random text 3 2
10	2:04 AM	11/11/11	7	INFO	1005	14	7	Random text 0 7
11	2:04 AM	11/11/11	1	INFO	1005	14	14	Random text 0 1
12	2:04 AM	11/11/11	10	FATAL ERROR	1005	14	18	Random text 3 10
13	2:04 AM	11/11/11	8	WARNING	1005	14	22	Random text 1 8
14	2:05 AM	11/11/11	10	FATAL ERROR	1005	24	7	Random text 3 10
15	2:06 AM	11/11/11	4	FATAL ERROR	1005	31	3	Random text 3 4
16	2:06 AM	11/11/11	3	WARNING	1005	31	7	Random text 1 3
17	2:06 AM	11/11/11	7	WARNING	1005	31	10	Random text 1 7
18	3:06 AM	11/11/11	6	ERROR	1014	7	1	Random text 2 6
19	3:07 AM	11/11/11	10	WARNING	1014	12	9	Random text 1 10
20	3:08 AM	11/11/11	1	INFO	1014	19	10	Random text 0 1
21	3:09 AM	11/11/11	9	WARNING	1014	25	3	Random text 1 9
22	3:09 AM	11/11/11	9	ERROR	1014	25	10	Random text 2 9
23	3:09 AM	11/11/11	7	ERROR	1014	25	14	Random text 2 7
24	3:10 AM	11/11/11	4	INFO	1014	31	2	Random text 0 4
25	3:11 AM	11/11/11	9	ERROR	1014	37	4	Random text 2 9
26	4:11 AM	11/11/11	8	FATAL ERROR	1016	10	1	Random text 3 8
27	4:12 AM	11/11/11	7	ERROR	1016	12	10	Random text 2 7
28	4:12 AM	11/11/11	9	ERROR	1016	12	13	Random text 2 9
29	4:13 AM	11/11/11	10	WARNING	1016	17	9	Random text 1 10
30	4:14 AM	11/11/11	4	ERROR	1016	18	3	Random text 2 4
31	4:14 AM	11/11/11	2	WARNING	1016	18	4	Random text 1 2
32	4:15 AM	11/11/11	2	WARNING	1016	21	5	Random text 1 2
33	4:15 AM	11/11/11	9	FATAL ERROR	1016	21	10	Random text 3 9
34	4:15 AM	11/11/11	6	ERROR	1016	21	18	Random text 2 6
35	5:15 AM	11/11/11	5	INFO	1023	10	6	Random text 0 5
36	6:15 AM	11/11/11	9	INFO	1027	8	6	Random text 0 9
37	6:16 AM	11/11/11	9	ERROR	1027	15	4	Random text 2 9
38	6:16 AM	11/11/11	4	FATAL ERROR	1027	15	11	Random text 3 4
39	7:16 AM	11/11/11	3	INFO	1036	7	7	Random text 0 3
40	7:16 AM	11/11/11	3	ERROR	1036	7	11	Random text 2 3
41	8:16 AM	11/11/11	1	ERROR	1041	10	7	Random text 2 1
42	8:17 AM	11/11/11	5	FATAL ERROR	1041	17	8	Random text 3 5
43	8:18 AM	11/11/11	1	INFO	1041	19	5	Random text 0 1
44	8:18 AM	11/11/11	9	INFO	1041	19	14	Random text 0 9
45	9:18 AM	11/11/11	9	WARNING	1043	3	6	Random text 1 9

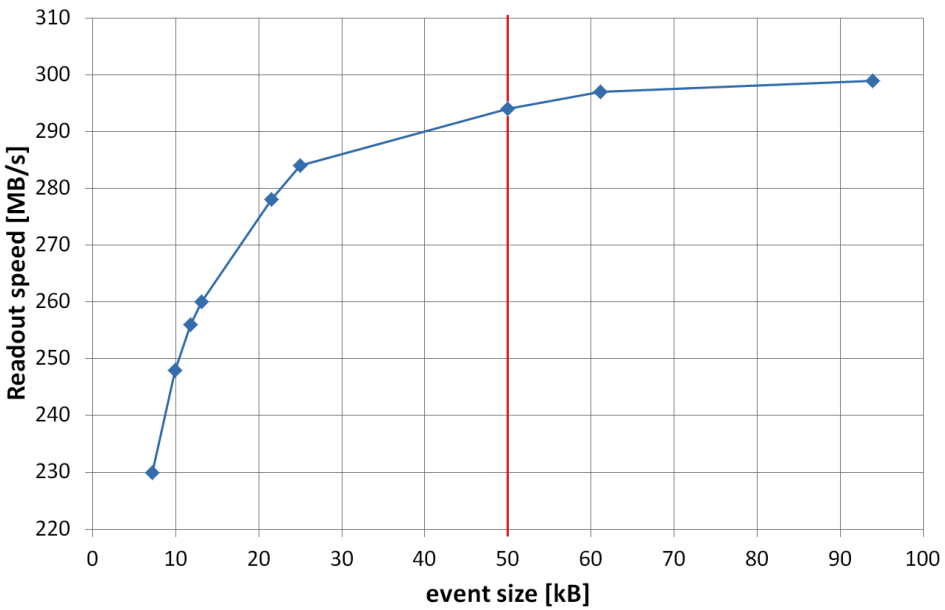
System tests phase 2 - readout tests

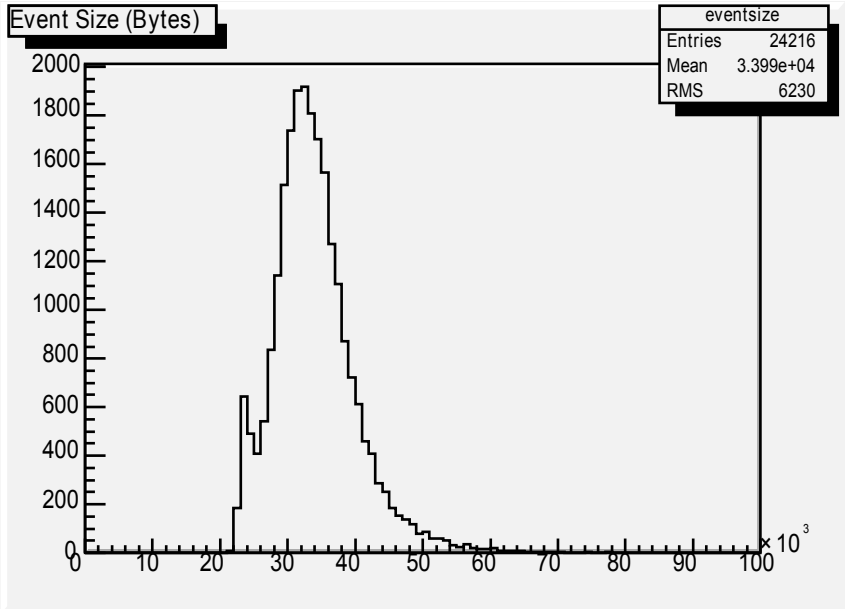
- 2xPCI-express spillbuffers
- fixed size events generated by HGeSiCa



Readout speed test

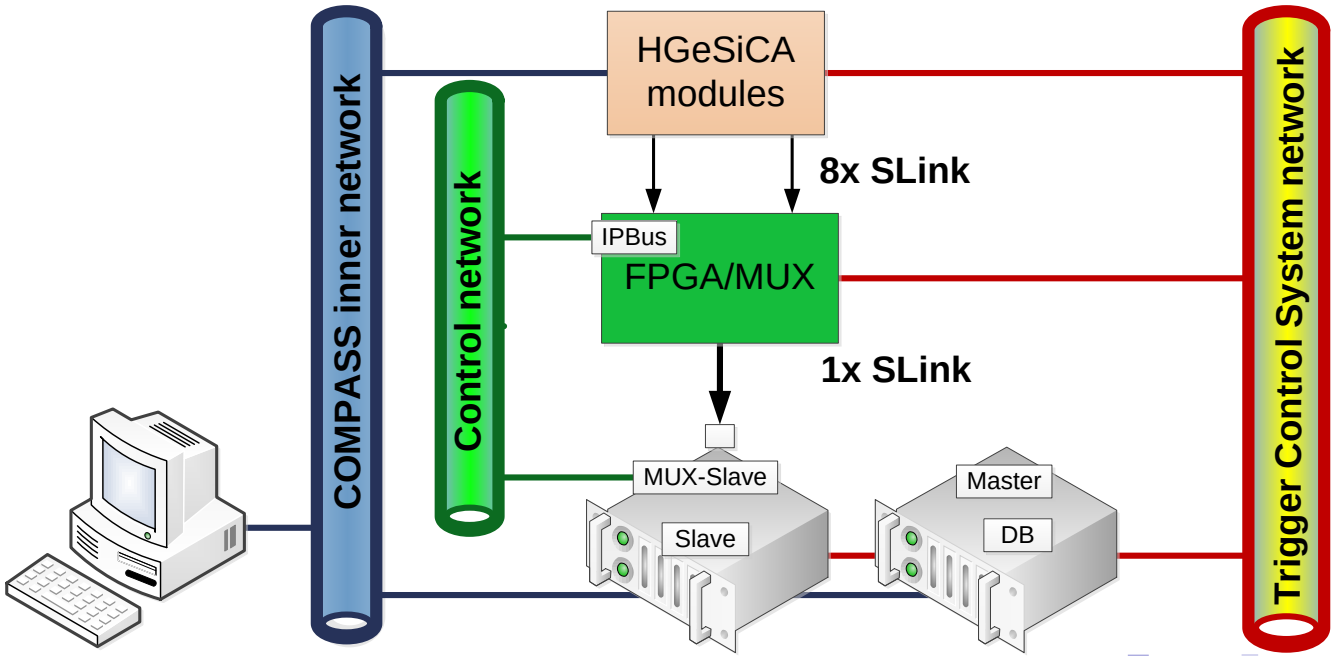
- readout speed limited by SLink transfer speed
- final DAQ with 8 spillbuffer cards speed up to 1200 MB/s
- maximum CPU usage around 40% with 4 core 2 GHz Xeon E5405





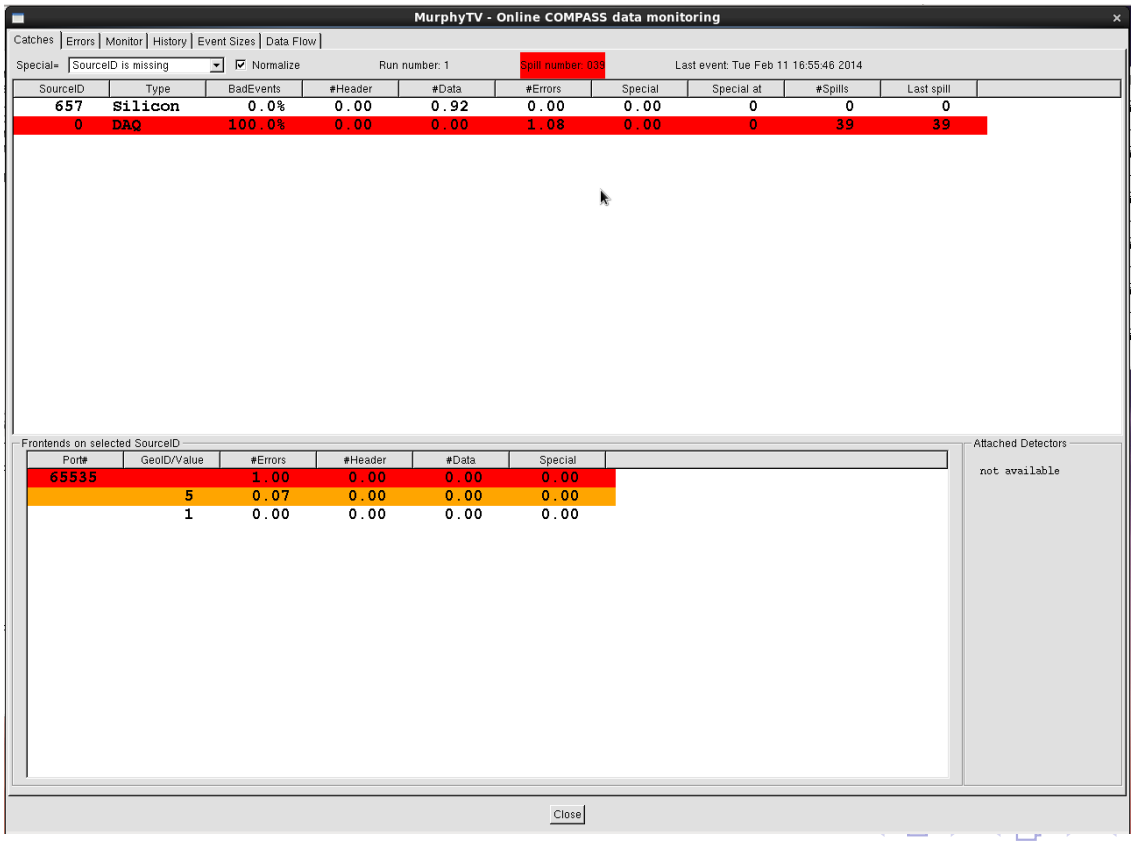
System tests phase 3

- new hardware module
- new input data format
- new PCIe driver
- connection to "user" programs



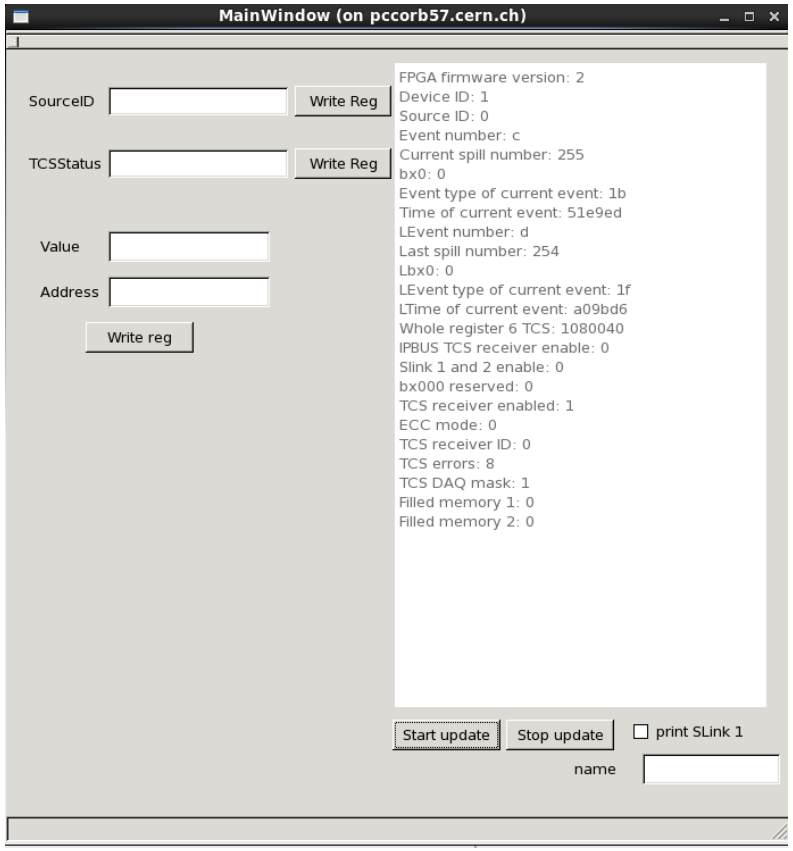
System tests phase 3 - sharing daemon

- sharing daemon prepared and tested with MurphyTv
- more extensive test to be done



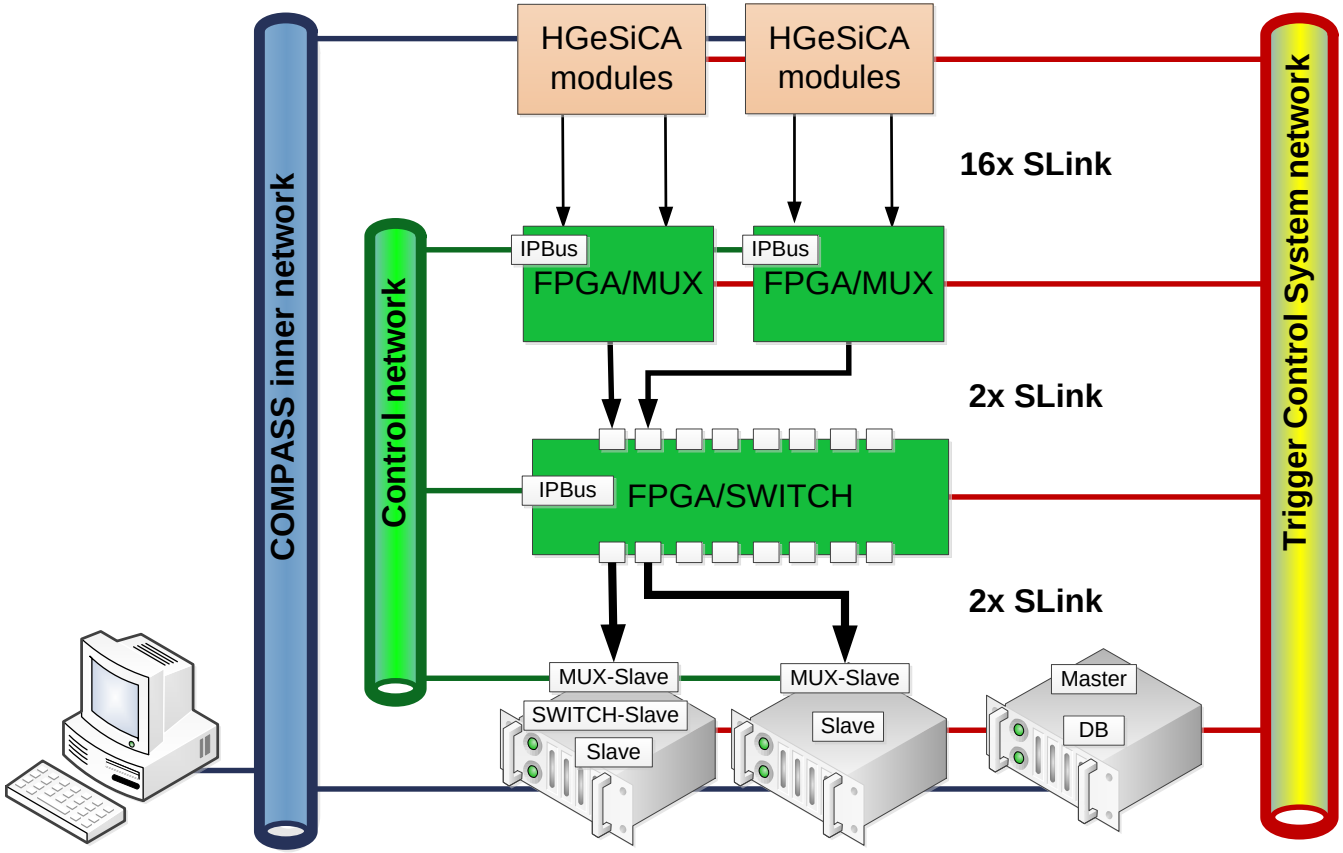
System tests phase 3 - IPbus control

- framework for communication with FPGA cards, Master, and MessageLogger
- tool to access, read, and change registers



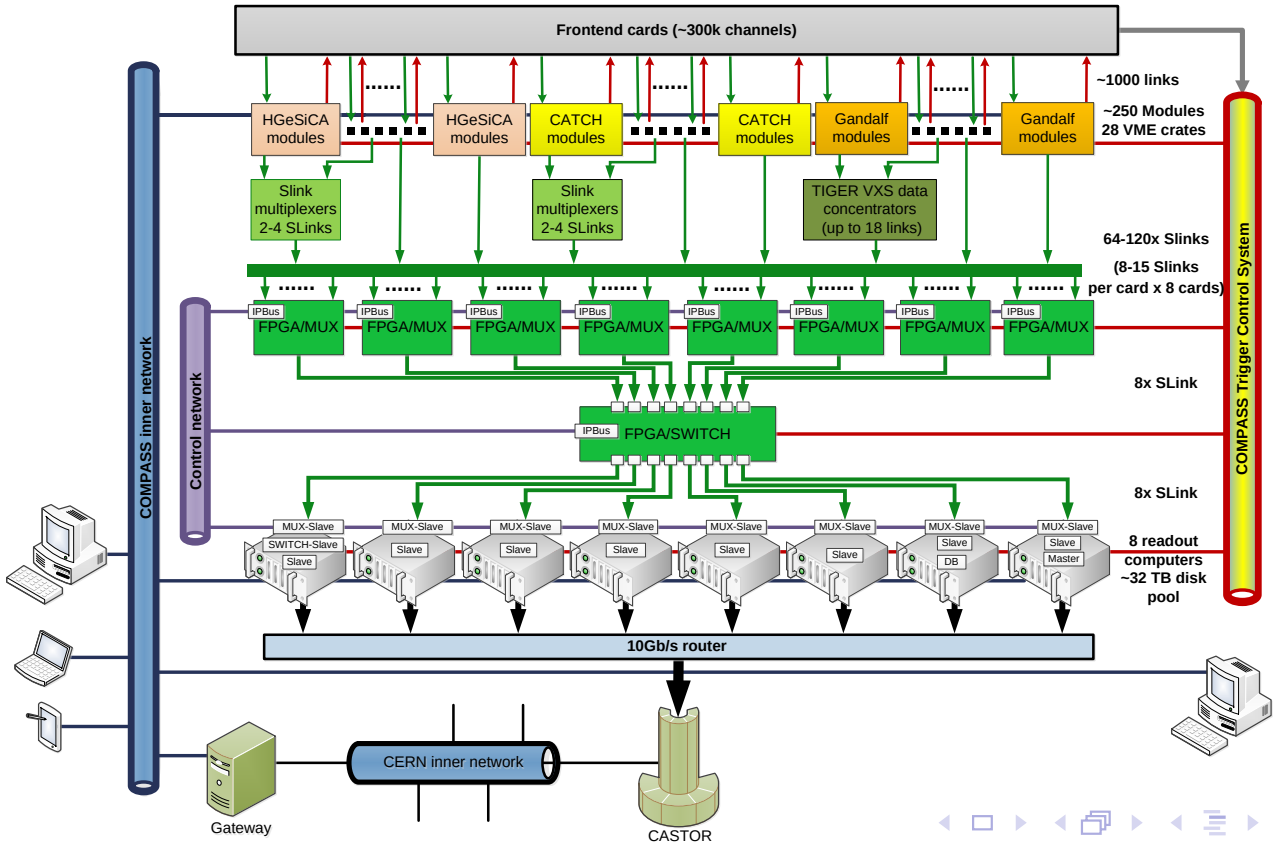
System tests phase 4

- hardware event building



Full scale system test

- final software debugging
- error handling tests



Summary

- System tests phase 1 - communication tests → DONE
- System tests phase 2 - readout tests → DONE
- System tests phase 3 - FPGA/MUX test → underway
- System tests phase 4 - FPGA/SWITCH test → March-April 2014
- Full scale system test → May 2014
- Cosmic run → June-July 2014
- Pilot run → autumn 2014

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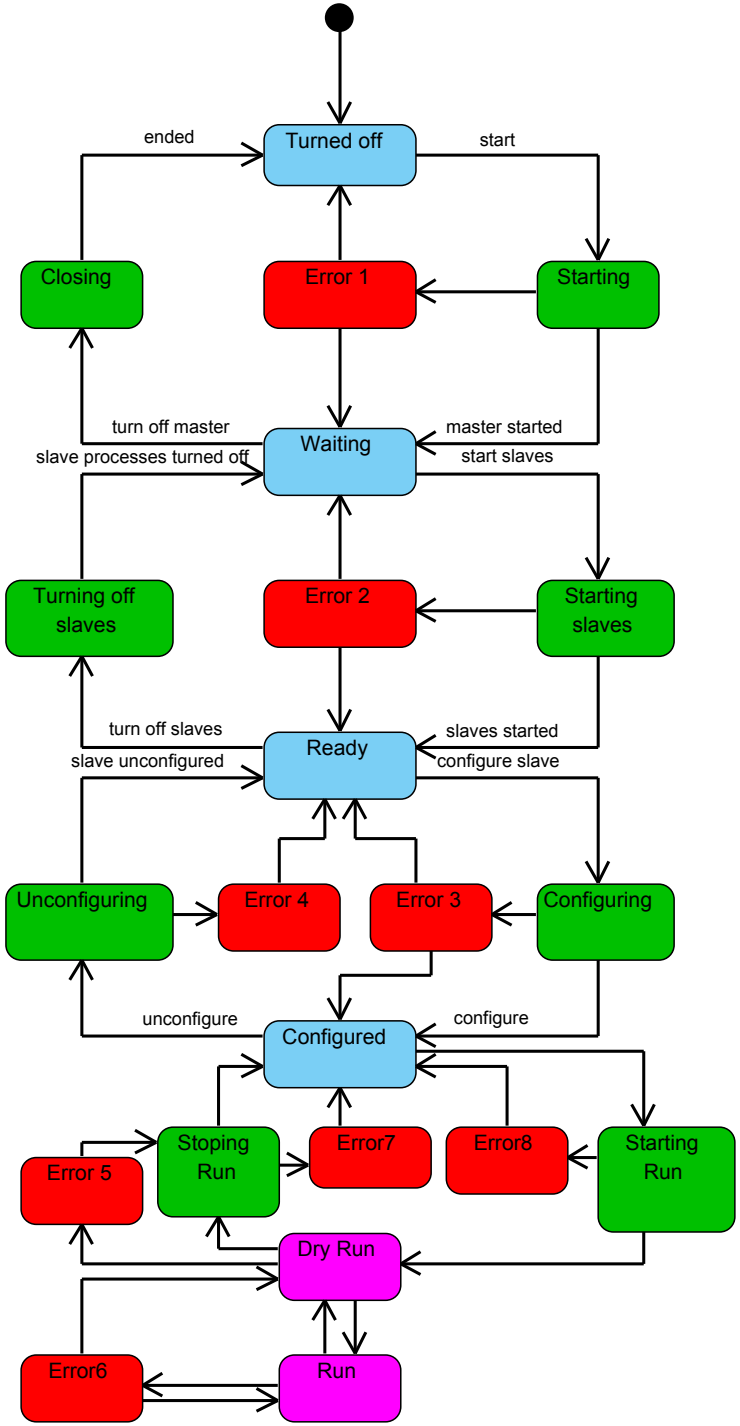

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transfere states(not stable), do not accept comm

error state

working states, stable untile command come or end condition is reached

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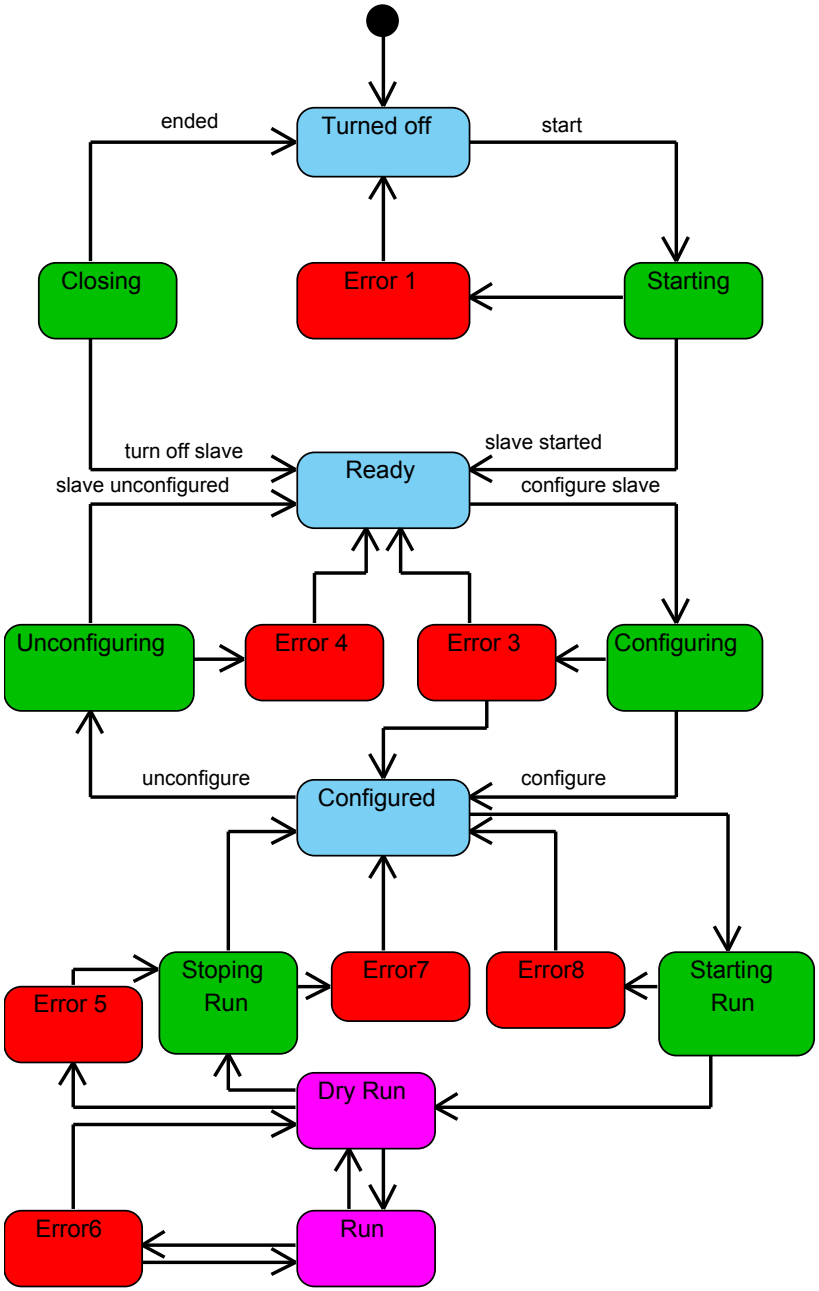

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