

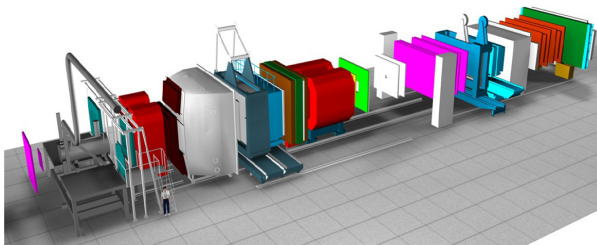
FPGA based data acquisition system for COMPASS experiment

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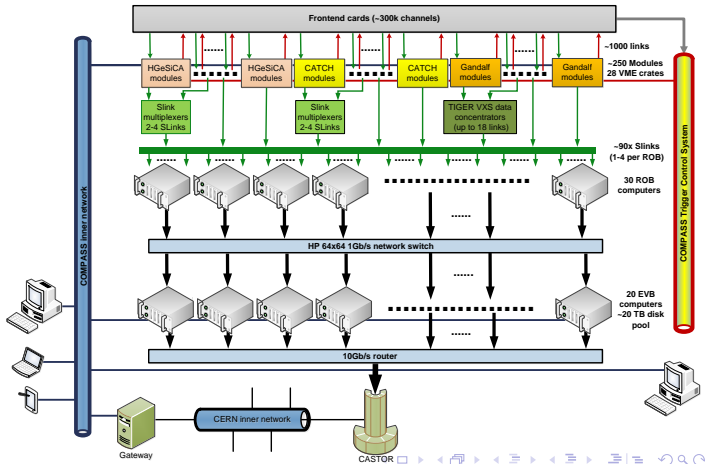
COMPASS experiment

- ▶ 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



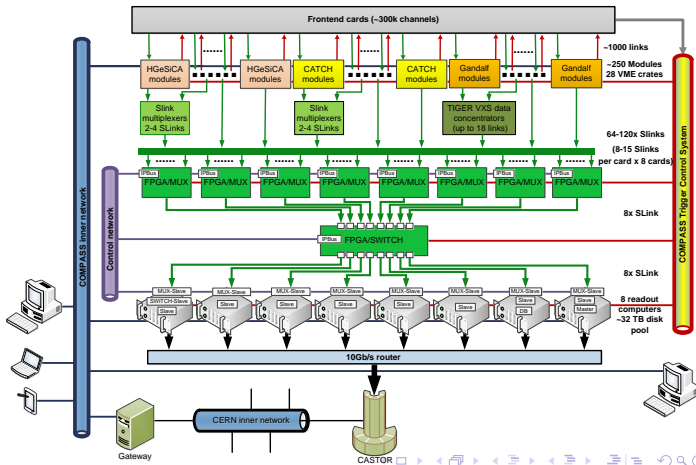
Hardware/Software structure of the old DAQ

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



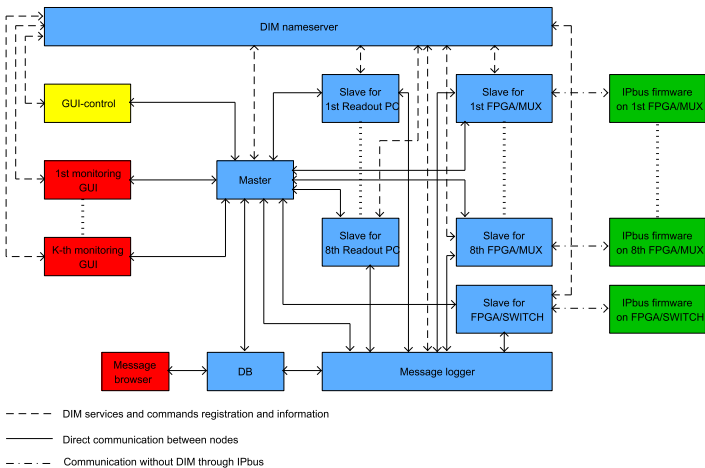
Hardware/Software structure of the new DAQ

- ▶ 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





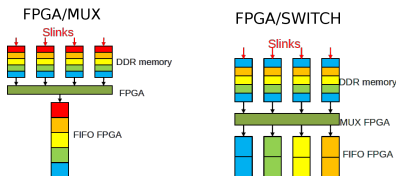
Communication diagram



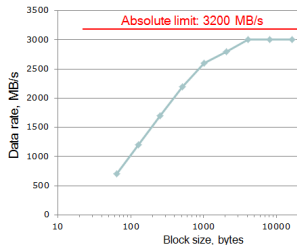


MX/SW module for the new DAQ

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



Data Throughput

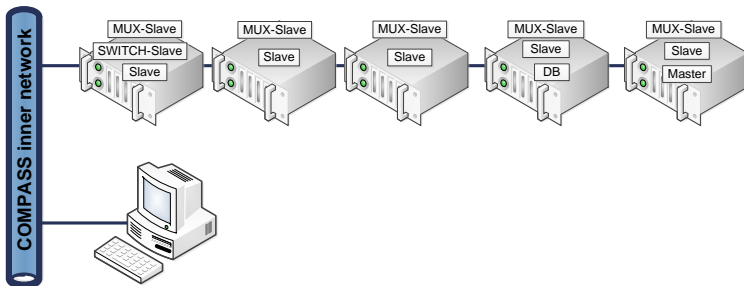


Used technologies

- ▶ C++, Python
- ▶ Qt framework
- ▶ MySQL
- ▶ Distributed Information Management System
- ▶ DATE (Data Acquisition and Test Environment) data format

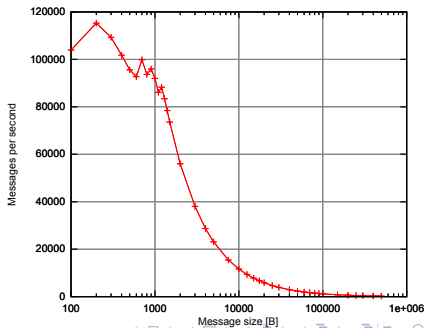
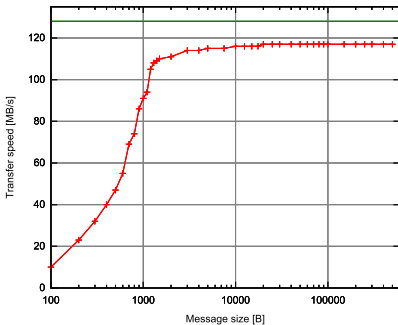
System tests phase 1 - communication tests

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



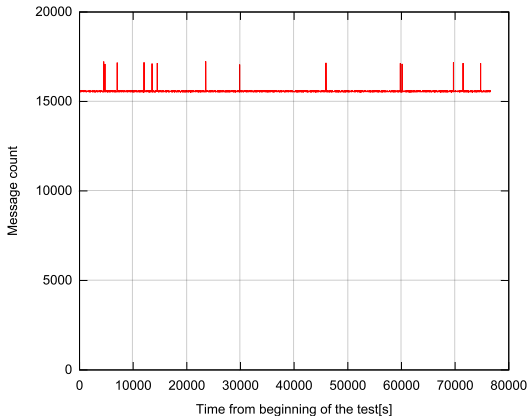
DIM speed test

- ▶ new DAQ message format and random payload
- ▶ more than sufficient performance
- ▶ 1 kB messages → 92 kHz rate



DIM stability test

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

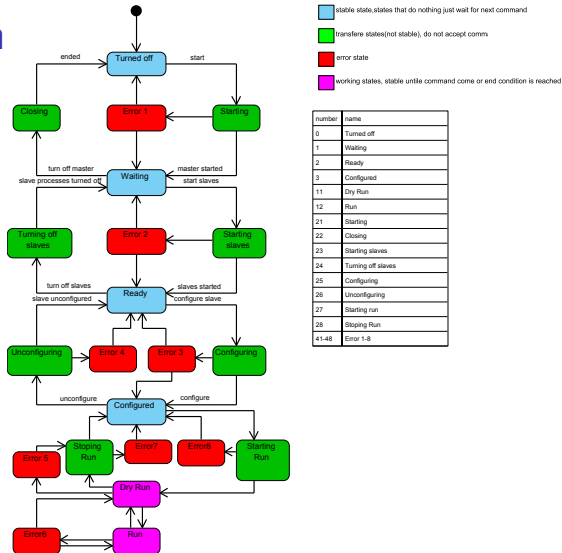




System tests phase 1 - communication tests

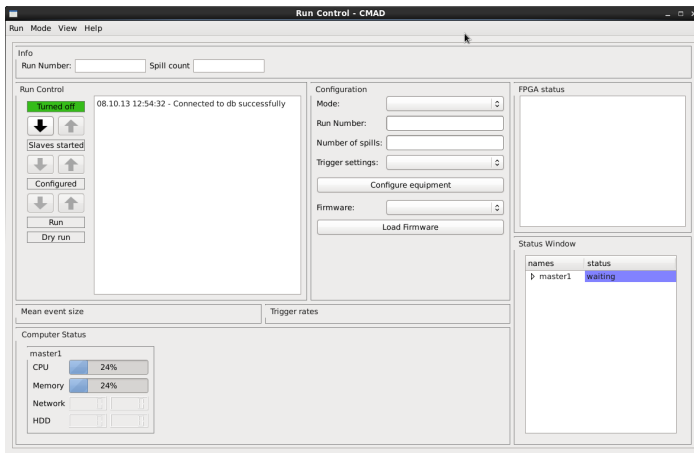
State machine design

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





Run control GUI prototype





System tests phase 1 - communication tests

MessageBrowser

MessageBrowser interface showing a table of log entries and a filter panel.

Column filter: id tm dt sender severity runNum spillNum eventNum text

id	tm	dt	sender	severity	runNum	spillNum	eventNum	text
1	12:30 AM	11/11/11	8	FATAL ERROR	1000	5	5	Random text 2 6
2	1:00 AM	11/11/11	9	ERROR	1004	7	9	Random text 2 9
3	1:01 AM	11/11/11	9	ERROR	1004	13	9	Random text 2 9
4	1:01 AM	11/11/11	9	INFO	1004	13	12	Random text 0 9
5	1:02 AM	11/11/11	8	WARNING	1004	15	17	Random text 1 6
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	2:02 AM	11/11/11	6	WARNING	1005	5	5	Random text 1 6
9	2:03 AM	11/11/11	2	FATAL ERROR	1005	14	4	Random text 2 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	18	18	Random text 0 10
13	2:04 AM	11/11/11	8	WARNING	1005	14	22	Random text 1 6
14	2:05 AM	11/11/11	10	FATAL ERROR	1005	24	7	Random text 0 10
15	2:06 AM	11/11/11	8	FATAL ERROR	1005	21	2	Random text 2 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	3:12 AM	11/11/11	8	FATAL ERROR	1014	38	2	Random text 1 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	19	3	Random text 2 4
31	4:14 AM	11/11/11	2	WARNING	1016	38	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	3	FATAL ERROR	1016	21	10	Random text 2 3
34	4:15 AM	11/11/11	9	ERROR	1016	21	19	Random text 2 9
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	4	11	Random text 2 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	8:15 AM	11/11/11	1	ERROR	1041	10	7	Random text 0 1
42	8:17 AM	11/11/11	5	FATAL ERROR	1041	17	8	Random text 2 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

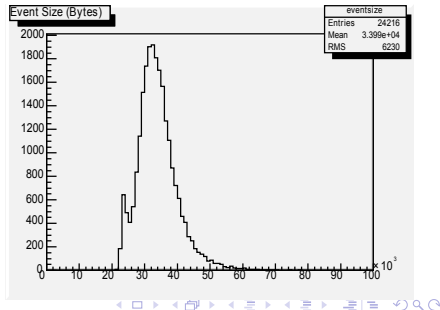
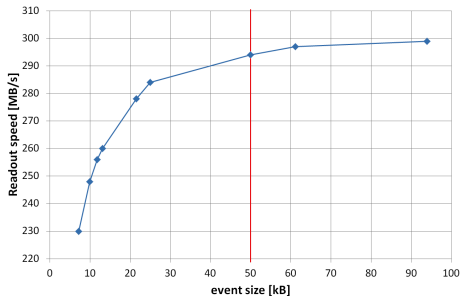
Message filter:

- Severity
 - Info
 - Warning
 - Error
- Sender
 - test001
 - test002
 - test003
- Run number
 - Exact
 - Range From To
- Spill number
 - Exact
 - Range From To
- Event number
 - Exact
 - Range From To
- Data - time
 - From
 - To
- Error text



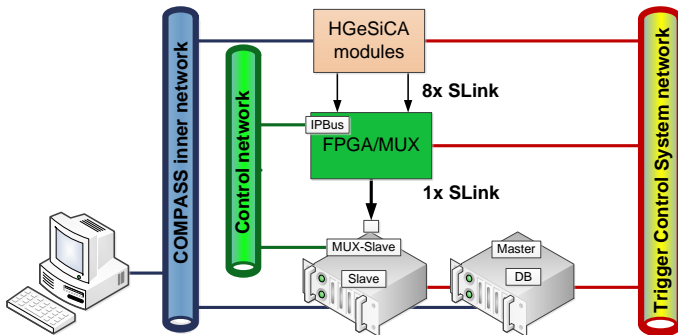
Readout speed test

- ▶ 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



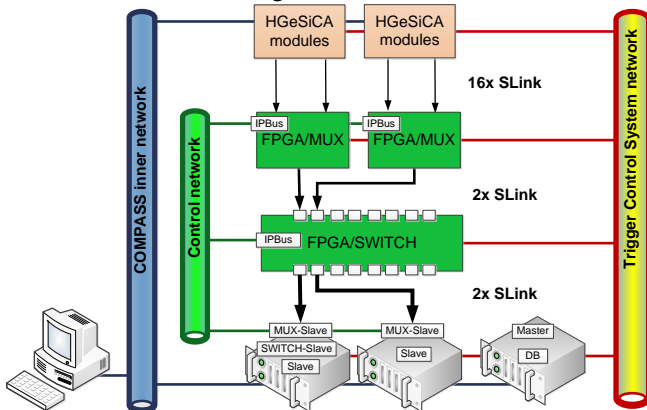
System tests phase 3

- ▶ new hardware module
- ▶ new input data format



System tests phase 4

► hardware event building



- ▶ System tests phase 1 - communication tests → DONE
- ▶ System tests phase 2 - readout tests → DONE
- ▶ System tests phase 3 - FPGA/MUX test → autumn 2013
- ▶ System tests phase 4 - FPGA/SWITCH test → winter 2013
- ▶ Full scale system test → spring 2014
- ▶ Pilot run → autumn 2014

References



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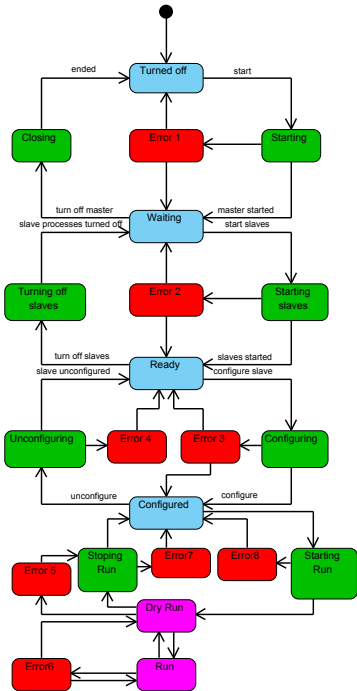
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- stable state, states that do nothing just wait for next command
- transference states(not stable), do not accept comm:
- error state
- working states, stable until command come or end condition is reached

number	name
0	Turned off
1	Waiting
2	Ready
3	Configured
11	Dry Run
12	Run
21	Starting
22	Closing
23	Starting slaves
24	Turning off slaves
25	Configuring
26	Unconfiguring
27	Starting run
28	Stopping Run
41-48	Error 1-8

