

Action follow-up: Latency in consolidated PM system

Status & Benchmarking tests

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Follow-up action from the MPP

workshop: *“Define data volume and latency requirements for XPOC, IQC, and SPSQC use-cases within PM so that it can be used for operation and interlocking.”*

“J. Uythoven commented on the SPS quality check and the required interlocking. He stressed that it is **crucial that the data is available when required**, e.g., in case of an incident. Therefore, one needs a fundamental check, which doesn’t require a complex analysis but makes sure that the data is properly stored. J.-C. Garnier answered that one has to **distinguish between whether the data is correctly stored and whether the data is visible by the users**. V. Kain emphasised that **also for the operation of the machine it is important that the information is readily available**. The required data includes the **XPOC analysis for the new SPS beam dump system**, but even without beam dump analysis, the **quality check data is required for machine operation within a reasonably short time delay**. It has, thus, to be avoided that the data is received only several cycles later, which would reduce its purpose and make the work impractical.”

- Post Mortem architecture consolidation – status update
- PM data flow & benchmarking tests
- PM storage for SPSQC (and eventual interlocking for SPS beam dump) use-case

See as well LIU-SPS Coordination meetings:

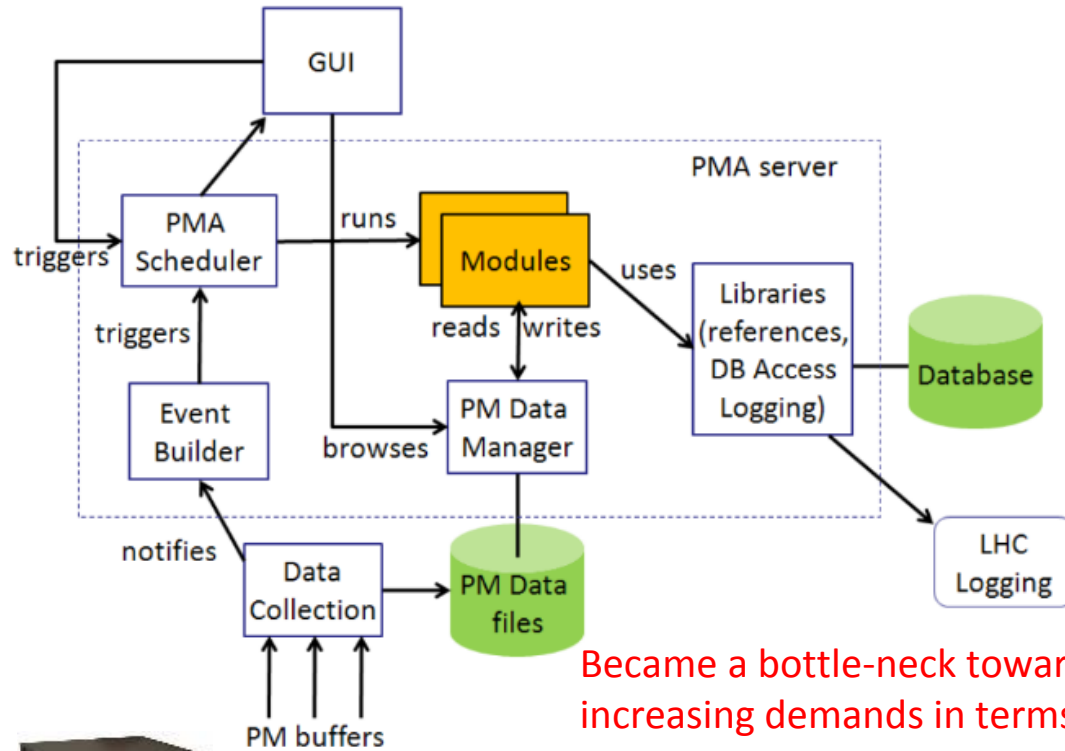
- <https://indico.cern.ch/event/888976/>
- <https://indico.cern.ch/event/864835/>

PM in a nutshell – legacy architecture

GUI
Analysis layer

Data storage layer

Equipment systems



Became a bottle-neck towards end of Run2 due to increasing demands in terms of data rate and volume

← Timing event

Original PM architecture with NXCALS storage

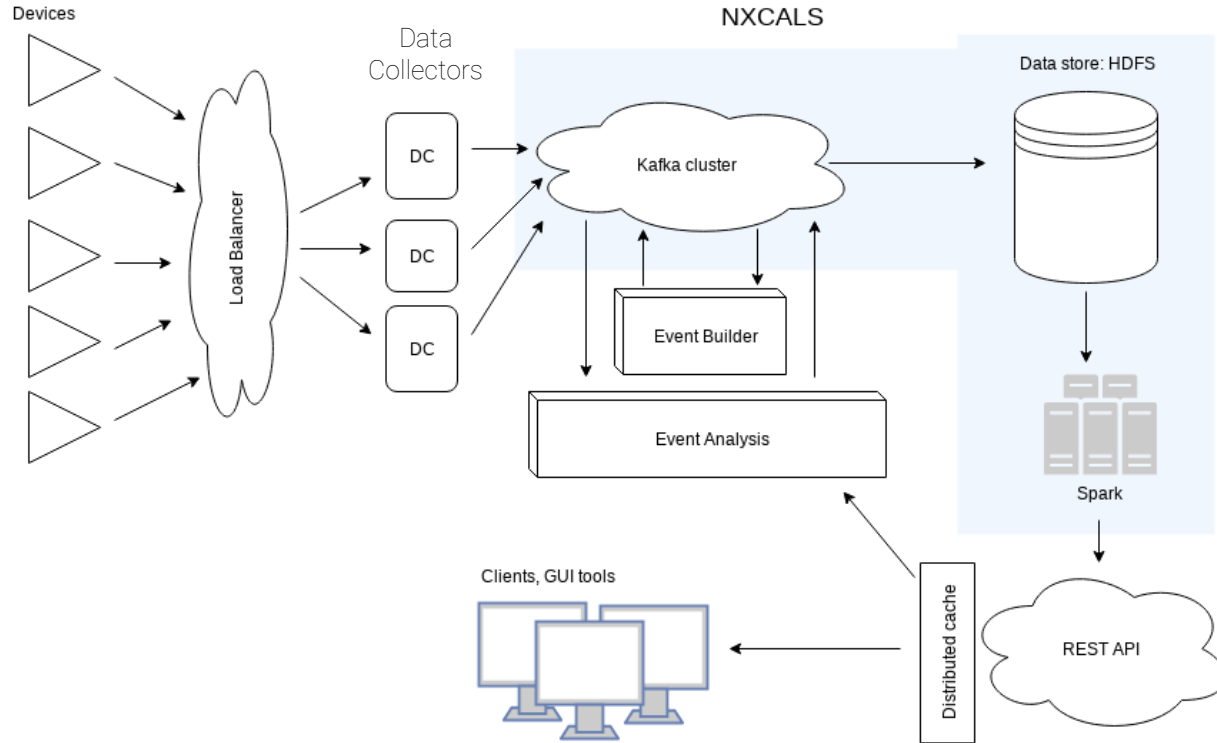
Power Converters



BLMs

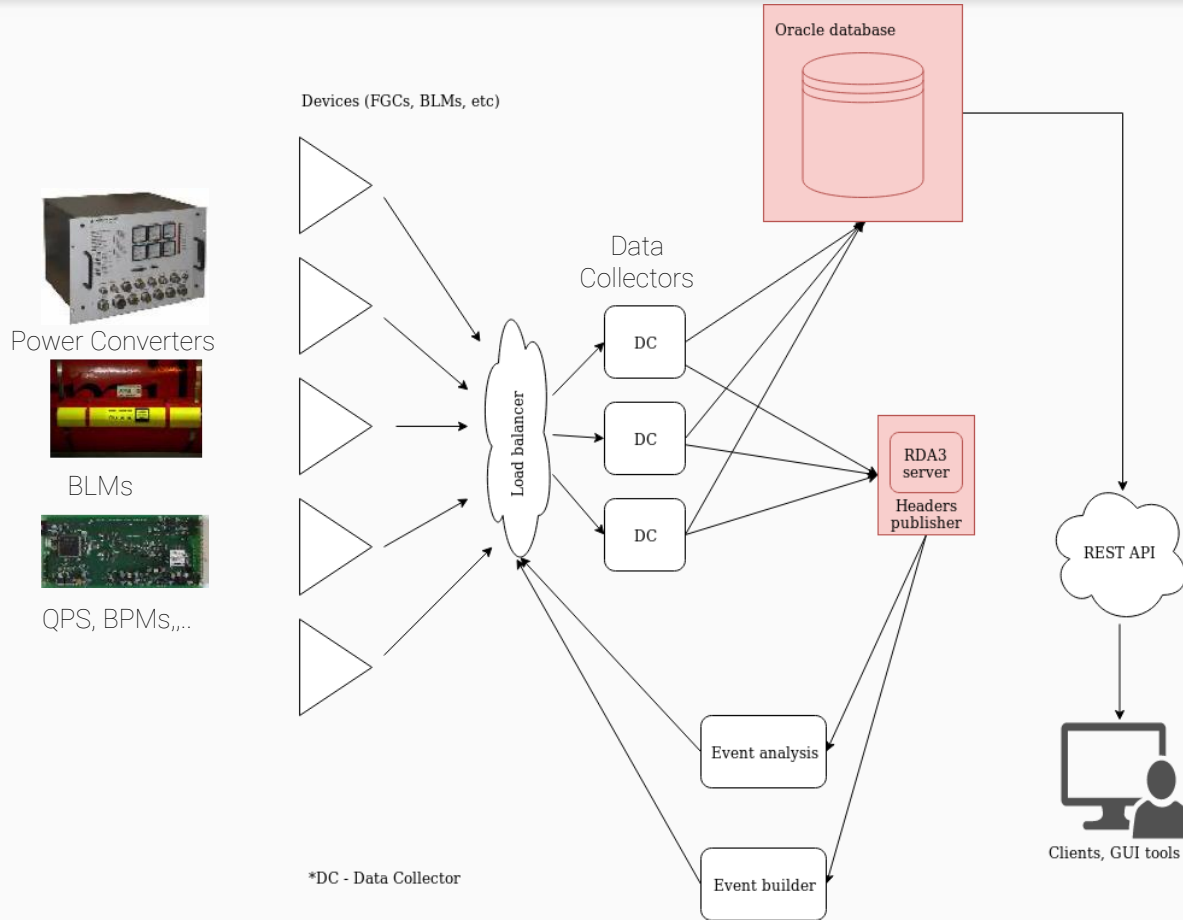


QPS, BPMs,...



- PM storage implementation using NXCALS pipeline is ready, but does not meet the IPOC/XPOC/SPSQC latency constraints
- Mitigated through the implementation of parallel storage - [Oracle database](#)
 - Milestones:
 - implemented database reading and writing for all PM entities - [DONE](#)
 - PRO database for LHC needs is ready - [DONE](#)
 - [Benchmarking tests with the PRO database were performed](#) - [DONE](#)
 - For LHC XPOC, IQC LHC service will be used, separate database for SPSQC to be provided based on the final requirements (storage volume vs retention policy)

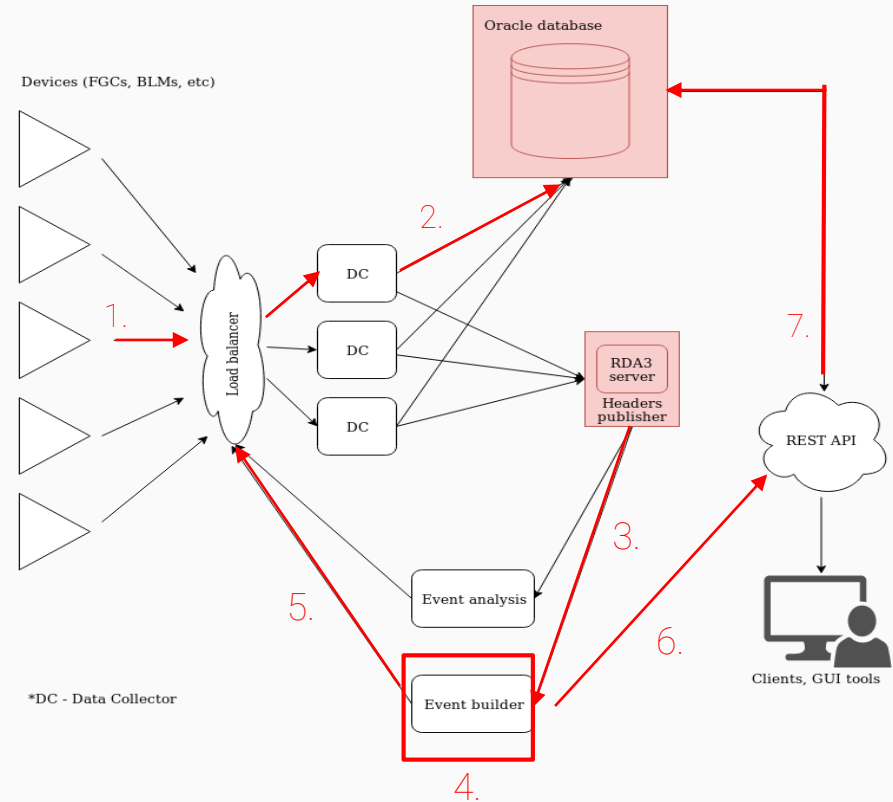
Updated PM architecture with new database storage



PM data flow +
benchmarking tests

Sending of the PM dumps

1. Devices create PM dumps and send them to Data Collectors via RDA3
 - o responsibility of equipment groups
2. PM dump is acknowledged by Data Collectors after the data are persisted in the database
3. Event collection window starts
4. Event building based on PM headers
5. Storage of event into to DB
6. Trigger with PM event info for analysis
7. Analysis reads PM raw data files



SPSQC event + benchmarking

- Number of dumps in typical SPSQC event:
 - 2017: 16-20 data dumps
 - 2018: 23-24 data dumps
- SPSQC data are published between cycle start and cycle end
- We do not have yet exact format and size of all SPSQC data for Run 3, but typical file sizes in the order of 100kB – 2 MB
- Benchmarking tests performed with different number of dumps and data sizes

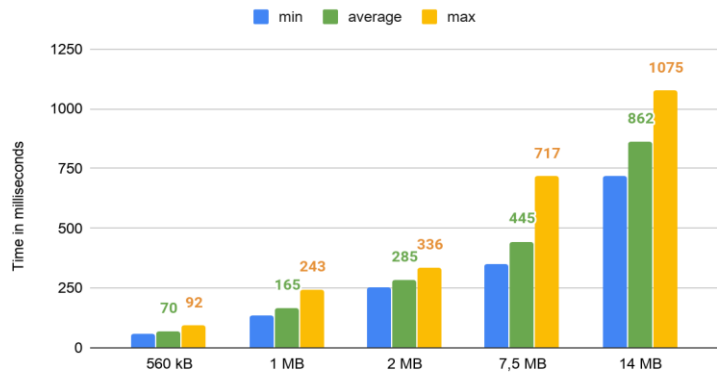
The screenshot shows the 'PM Data Collection and Storage Toolkit' interface. The main window is titled 'SPS Event Data Browser' and displays 'Loaded event data for Fri 1 Jun 2018'. The 'Events' section shows a table with columns for Event time stamp, System, Class, and Source. The 'Selected event' section shows details for a SPSQC event at timestamp 01/06/18 08:08:42.135+000000. Below this, the 'data dumps' section shows a table of data dumps with columns for Event time stamp, System, Class, and Source. A yellow box highlights the 'data dumps' table.

Event time stamp	System	Class	Source
01/06/18 08:08:18.135+000000	PME	SPSQC	PM.BE-SPS
01/06/18 08:08:21.735+000000	PME	SPSQC	PM.BE-SPS
01/06/18 08:08:32.535+000000	PME	SPSQC	PM.BE-SPS
01/06/18 08:08:38.535+000000	PME	SPSQC	PM.BE-SPS
01/06/18 08:08:42.135+000000	PME	SPSQC	PM.BE-SPS

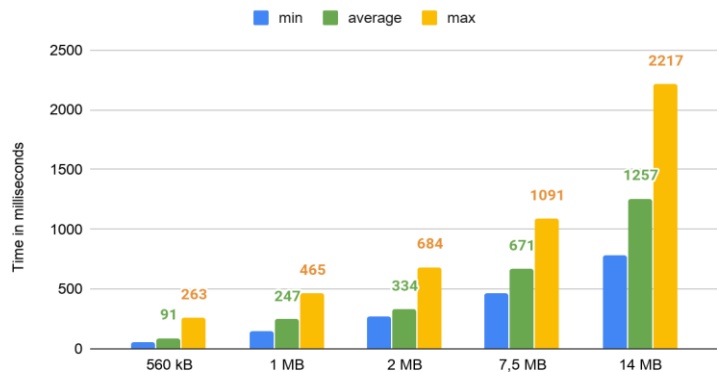
Event time stamp	System	Class	Source
01/06/18 08:08:42.135+238525	SPS	FTURN	BPMOPOSIOC
01/06/18 08:08:43.138+362380	SPS	OasisChannel	SR.SCOPE10.CH01
01/06/18 08:08:43.140+343062	SPS	OasisChannel	SR.SCOPE11.CH01
01/06/18 08:08:43.140+343062	SPS	OasisChannel	SR.SCOPE11.CH02
01/06/18 08:08:43.140+371528	SPS	OasisChannel	SR.SCOPE09.CH01
01/06/18 08:08:43.140+371528	SPS	OasisChannel	SR.SCOPE09.CH02
01/06/18 08:08:43.140+371528	SPS	OasisChannel	SR.SCOPE09.CH03
01/06/18 08:08:43.140+371528	SPS	OasisChannel	SR.SCOPE09.CH04
01/06/18 08:08:43.150+363525	SPS	ORBIT	BPMOPOSIOC
01/06/18 08:08:45.321+363525	SPS	INJ_TUNE	DamperDiag_H
01/06/18 08:08:45.321+363525	SPS	INJ_TUNE	DamperDiag_V
01/06/18 08:08:45.321+363525	SPS	INJ_PERF	SPSInjectionPerformance
01/06/18 08:08:46.321+363275	SPS	BIS_INT	MKD.BA1.BISINT
01/06/18 08:08:46.321+363525	SPS	TELEGRAM	TelegramPublisher_SPS
01/06/18 08:08:46.336+424725	SPS	TUNE	SPSBQSB_CONT
01/06/18 08:08:46.352+259725	SPS	CYCLE_LOSSES	BLRSPS_LSS6
01/06/18 08:08:46.352+273425	SPS	CYCLE_LOSSES	BLRSPS_LSS2
01/06/18 08:08:46.352+279875	SPS	CYCLE_LOSSES	BLRSPS_BA3
01/06/18 08:08:46.492+000000	SPS	CYCLE_INTENSITY	SPS.BCTDC.41435
01/06/18 08:08:46.492+000000	SPS	CYCLE_INTENSITY	SPS.BCTDC.51895
01/06/18 08:08:46.492+000000	SPS	CYCLE_INTENSITY	SPS.BCTDC.31832
01/06/18 08:08:46.492+000000	SPS	CYCLE_INTENSITY	SPS.BCTDC.51897
01/06/18 08:08:49.236+000000	SPS	BETS_BEM	MKD.BA1.MKCBM.R

Writing time for PM data dumps

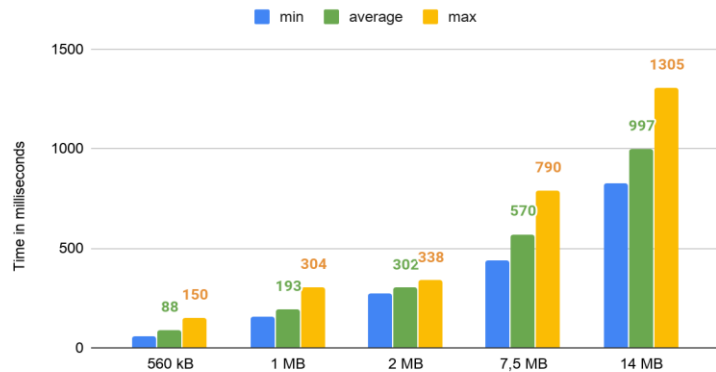
Writing 1 entry



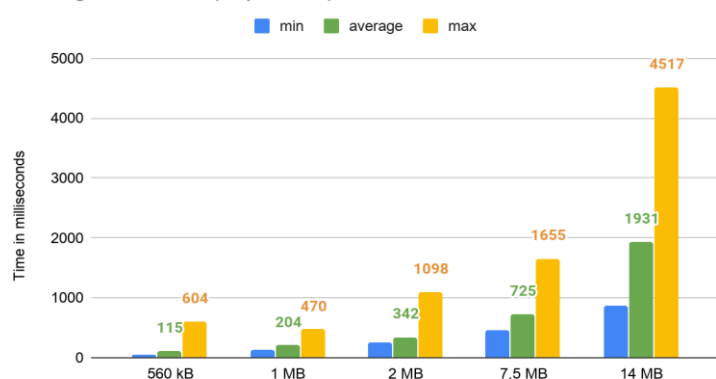
Writing 10 entries (in parallel)



Writing 5 entries (in parallel)

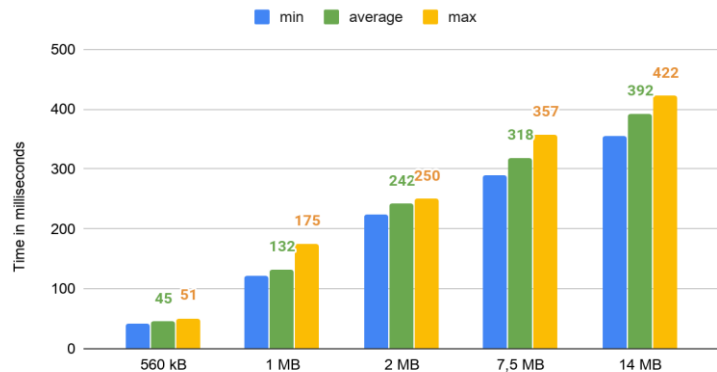


Writing 30 entries (in parallel)

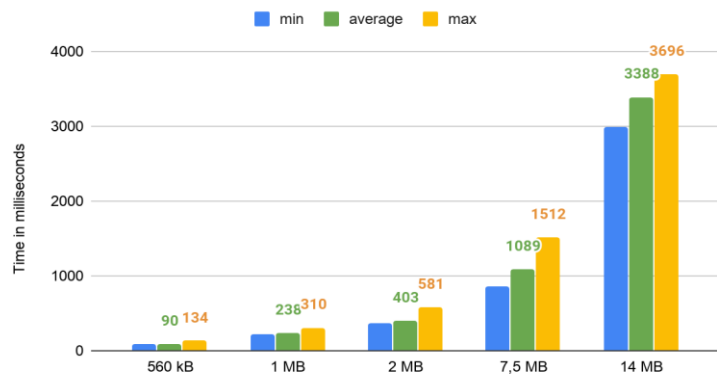


Reading time for PM raw data values

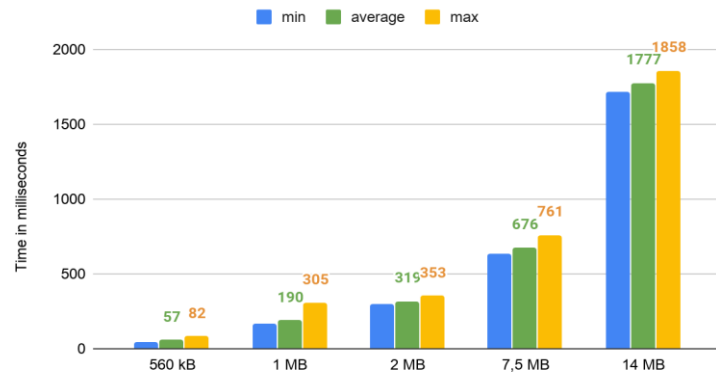
Reading 1 entry



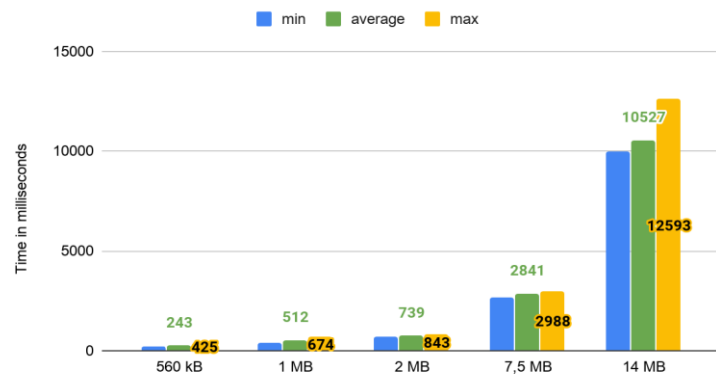
Reading 10 entries



Reading 5 entries



Reading 30 entries




- Overall latencies imposed by database reading & writing for 'typical' event:

Component	Step	Example for 1 MB dumps
Devices	Writing 30 data dumps	470 ms
Event builder	Writing event info	118 ms
Analysis modules	Reading event info	42 ms
	Reading 30 data dumps	674 ms
	Writing 8 analysis results	200 ms
		*1504 ms

- ***not included:** PM dump generation, event building, analysis time, network delays, other factors...

Important things to consider for ALL low latency use cases (IQC, XPOC, SPSQC, SPSBD)

- Total time to produce analysis results can only be measured with final SW stack in place
 - Delay for raw data sending by clients + analysis to be carefully considered
 - Pre-LS2 events showed PM dumps with send time difference of ~4 seconds
 - Tests with final SPSQC data dumps needs to be performed
- DB reading and writing speed depends (strongly) on the number and size of data dumps (recommend not to exceed 1-2 MB per dump file)
- Clearly defined use-cases – SPSQC = Performance and analysis != XPOC for SPSBD. Separate analysis processes!
- PM Event builder is waiting specified time window until the data dumps arrive
 - Dedicated SPSQC event builder as for IQC, XPOC
- Optimize reading of data dumps by analysis modules
 - Read multiple raw data values much more efficient than 1 by 1

- Proposal for SPSQC low-latency pipeline
 - Separate database  no impact on LHC service
 - Separate data collectors
 - Periodical cleaning of the stored data
 - for example 50TB database is estimated by IT at 80kCHF initial cost (+ HW renewal every 4-5 years), BC required from BE-OP
 - Analysis framework - needs to be adapted & tested by BE-CO and BE-OP

- Performance of **low-latency pipeline for PM confirmed to meet XPOC/IQC requirements** and implementation being finalized
- Latencies of data sending by clients and analysis process largely exceed **the latency for data persistence** and need to be carefully considered for each use-case
- **Provision and correctness of (critical) data is responsibility of client,** event builders or dedicated analysis module can be used to **confirm presence of file** for each event

- If anybody wants to try out the new system please take a look: <http://docs.pm.cern.ch/pm-docs/>
- In case of any questions do not hesitate to contact te-dep-mpe-ms@cern.ch

Thank you

Any questions?



Backup slides



PM consolidation status summary

Storage	NxCALS	Ready
	Oracle DB for LHC	Ready
	Oracle DB for SPSQC	To be provided based on final requirements
	Data collector	Ready
Client API	Event builder	Ready for NxCALS, under development for DB
	Java Client	Ready for NxCALS, under development for DB
	C++ Client	Ready
	REST API	Ready for NxCALS, under development for DB
Headers Publisher	Kafka (NxCALS)	Ready
	RDA server (DB)	Ready
Data Migration	Offline	Ready
	Online	Ready
	Visualisation tools	Need to be adapted to the new storage

Analysis session time

PM Data Collection and Storage Toolkit

SPS Analysis Data Browser SPS Event Data Browser

Loaded session info data for Fri 1 Jun 2018

Started at	Started by	Confirmed by	Analyzed event	Event stamp
23:59:50 31/05/2018	PMSP5QC-ONLINE-PRO	PMSP5QC-ONLINE-PRO	SP5QC	31/05/18 23:59:50.535+000000
00:00:01 01/06/2018	PMSP5QC-ONLINE-PRO	PMSP5QC-ONLINE-PRO	SP5QC	01/06/18 00:00:01.335+000000
00:00:04 01/06/2018	PMSP5QC-ONLINE-PRO	PMSP5QC-ONLINE-PRO	SP5QC	01/06/18 00:00:04.935+000000
00:00:24 01/06/2018	PMSP5QC-ONLINE-PRO	PMSP5QC-ONLINE-PRO	SP5QC	01/06/18 00:00:24.135+000000
00:00:27 01/06/2018	PMSP5QC-ONLINE-PRO	PMSP5QC-ONLINE-PRO	SP5QC	01/06/18 00:00:27.735+000000
00:00:38 01/06/2018	PMSP5QC-ONLINE-PRO	PMSP5QC-ONLINE-PRO	SP5QC	01/06/18 00:00:38.535+000000
00:00:42 01/06/2018	PMSP5QC-ONLINE-PRO	PMSP5QC-ONLINE-PRO	SP5QC	01/06/18 00:00:42.135+000000
00:01:01 01/06/2018	PMSP5QC-ONLINE-PRO	PMSP5QC-ONLINE-PRO	SP5QC	01/06/18 00:01:01.335+000000
00:01:04 01/06/2018	PMSP5QC-ONLINE-PRO	PMSP5QC-ONLINE-PRO	SP5QC	01/06/18 00:01:04.935+000000
00:01:15 01/06/2018	PMSP5QC-ONLINE-PRO	PMSP5QC-ONLINE-PRO	SP5QC	01/06/18 00:01:15.735+000000
00:01:19 01/06/2018	PMSP5QC-ONLINE-PRO	PMSP5QC-ONLINE-PRO	SP5QC	01/06/18 00:01:19.335+000000
00:01:38 01/06/2018	PMSP5QC-ONLINE-PRO	PMSP5QC-ONLINE-PRO	SP5QC	01/06/18 00:01:38.535+000000
00:01:42 01/06/2018	PMSP5QC-ONLINE-PRO	PMSP5QC-ONLINE-PRO	SP5QC	01/06/18 00:01:42.135+000000
00:01:52 01/06/2018	PMSP5QC-ONLINE-PRO	PMSP5QC-ONLINE-PRO	SP5QC	01/06/18 00:01:52.935+000000
00:01:56 01/06/2018	PMSP5QC-ONLINE-PRO	PMSP5QC-ONLINE-PRO	SP5QC	01/06/18 00:01:56.535+000000

Started by: Confirmed by: Analyzed event:

Selected session
User comments

Analysis results Session info

```
Session ID      : PMSP5QC-ONLINE-PRO_20180601000024151_892f66a7-b2a1-4359-a159-d5a3abcac55d
Started by     : PMSP5QC-ONLINE-PRO
Started from   : cs-ccr-pm3.cern.ch
Started at    : 00:00:24.151 01/06/18
Analysis time  : 0.0 sec
Analysed on   : PMSP5QC-ONLINE-PRO_20e7deba-bb69-43e3-82e1-bedcc76423df
Confirmed at  : 00:00:30.927 01/06/18
Confirmed by   : PMSP5QC-ONLINE-PRO
Confirmed from : cs-ccr-pm3.cern.ch
Event ID      : 1527804024135000000_bf5714d8-61aa-4072-b50e-394e7a88e983
Event class   : SP5QC
Event type    : SP5QC
Event stamp   : 01/06/18 00:00:24.135+000000
Overall result : NOT OK
Classification : N/A
```

Show event analyzed in selected session

New PM architecture - with NxCALs

