

The software complex for emulation of distributed computing infrastructure for the data processing of the NICA experiments

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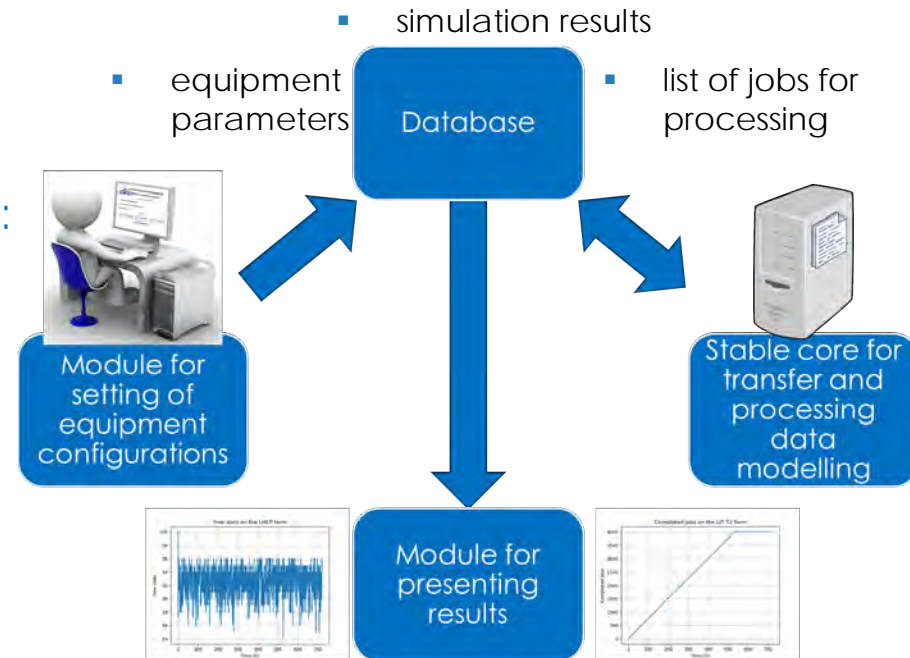


The software complex

The important task: modelling the distributed computing infrastructure for the data processing of the NICA experiment.

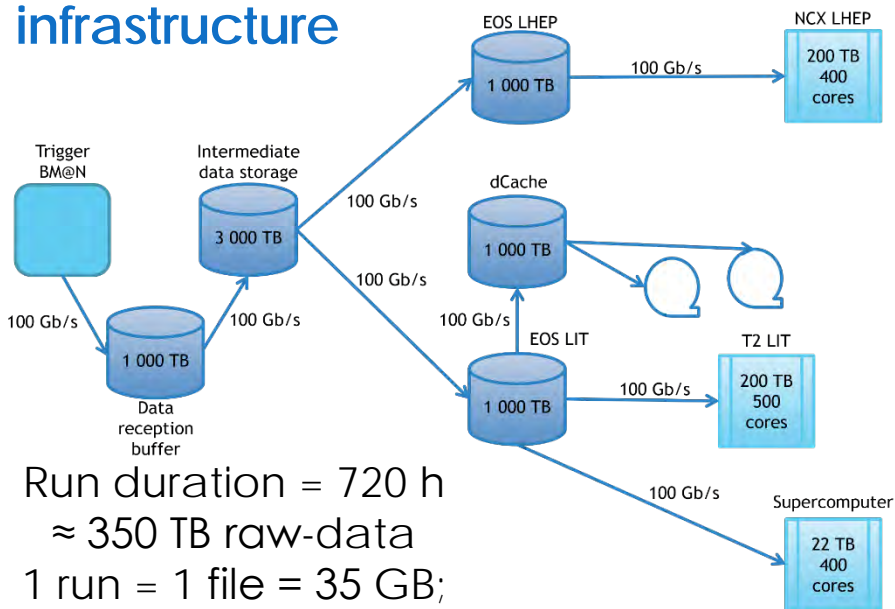
Goal is to develop a tool that will allow:

- to find out how the data storage and processing system will work with the available computing power;
- to calculate the load on computing farms and communication links with the specified parameters of data flows and tasks.



Emulation of computing infrastructure for the data processing of the BM@N experiment

The emulated distributed computing infrastructure



Run duration = 720 h
 ≈ 350 TB raw-data
 1 run = 1 file = 35 GB;
 1 event = 0.2 MB

Input parameters for emulation

Classes of data: raw; digit; dst; sim
 Classes of jobs

No	Class	Event processing time on one processor (ms)	The average amount of input (GB)	Number of events in the file (1 file = 1 job)	Job execution time (s)	The average amount of output (GB)	Number of jobs
1	RawToDigit	350 (HPC) 1 000 (NCX)	35	175 000	61 250 (HPC) 175 000 (NCX)	1	15 552
2	DigitToDst	150 (HPC) 430 (NCX)	1	175 000	26 250 (HPC) 75 250 (NCX)	1	15 552
3	GenToSim	60	0,6	175 000	10 500	8	300
4	SimToDst	30	8	175 000	5 250	1	300
5	DstToAna	10	1	175 000	1 750	0,1	1 000

The goal of emulation: proposing some recommendations for organizing data processing with the available allocated resources for the run in 2022 session.

Emulation results

Scenarios for executing jobs:

distribution of data processing jobs (in %) to computing nodes.

№	Class	Scenario 1			Scenario 2			Scenario 3		
		NCX LHEP	T2 LIT	Super-comp.	NCX LHEP	T2 LIT	Super-comp.	NCX LHEP	T2 LIT	Super-comp.
1	RawToDigit	50	15	35	80	20	-	-	10	90
2	DigitToDst	50	15	35	80	20	-	-	10	90
3	GenToSim	-	20	80	-	-	100	100	-	-
4	SimToDst	-	20	80	-	-	100	100	-	-
5	DstToAna	-	20	80	70	10	20	80	20	-

- ~ 30% raw data will be converted to reconstruction data (during session – 30 days).
- ~ 60% of simulation data will be converted to reconstruction data by 720 h.
- We will have to wait several more months until the end of processing all the raw data after the end of the session.
- There are not enough resources for data analysis.

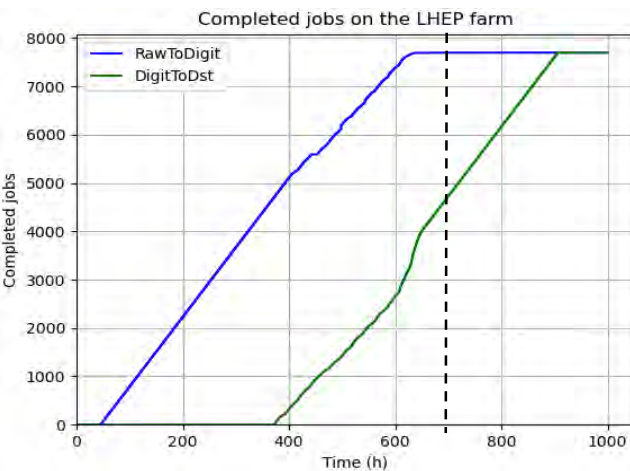
Problem: the result is unsatisfactory...



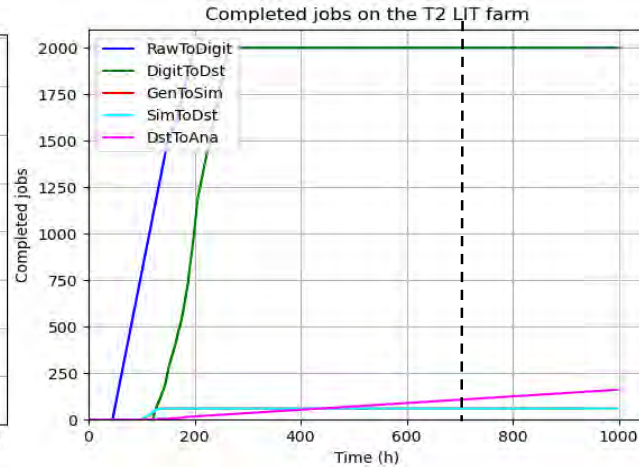
Possible solutions

- To increase the number of cores on computing nodes.
- Do not occupy computing resources with other jobs until the jobs of primary data processing (RawToDigit) begin to free up the cores.

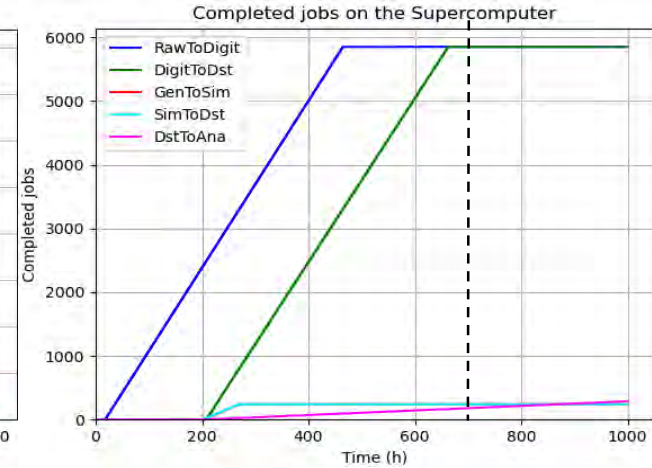
Outlooks



LHEP farm: 700 slots



T2 LIT farm: 800 slots



Supercomputer: 400 slots

By end of the Run (30 days):

- 100% raw data will be converted to digit data;
- 90% of raw data will be converted to reconstruction data.

We will have to wait after the end of the session 1 week until the end of processing all the raw data to reconstruction data.

Conclusions

- Developed a tool for modeling the distributed computing infrastructure for data processing.
- Based on the emulation results, we can predict problems that may appear during the experiment and data processing.
- 3 scenarios for executing jobs are modeled. Some problems were found: a small amount of experimental data can be processed by the end of the session.
- Increase the number of cores on computing nodes and adjust the start time of jobs. Result: 90% of all raw data will be processed by 720 h.

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Next steps:

- developing module like pilot for starting jobs;
- conducting computational experiments taking into account the fact that the equipment does not have absolute reliability (calculating probability of equipment failure and recovery times);
- find the optimal number of cores to perform all jobs, taking into account their updated parameters;
- calculating the costs of equipment.

Publications

- [1] Priakhina D., Trofimov V., Ososkov G., Gertsenberger K. **Data center simulation for the BM@N experiment of the NICA project** // AIP Conference Proceeding, v. 2377 (2021) – 040007-1–040007-5 – ISBN: 978-0-7354-4132-3.
- [2] Priakhina D., Korenkov V., Gertsenberger K., Trofimov V. **Simulation of data processing for the BM@N experiment of the NICA complex** // CEUR Workshop Proceedings, Vol-3041 (2021). – C. 483–487. – ISSN 1613-0073