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

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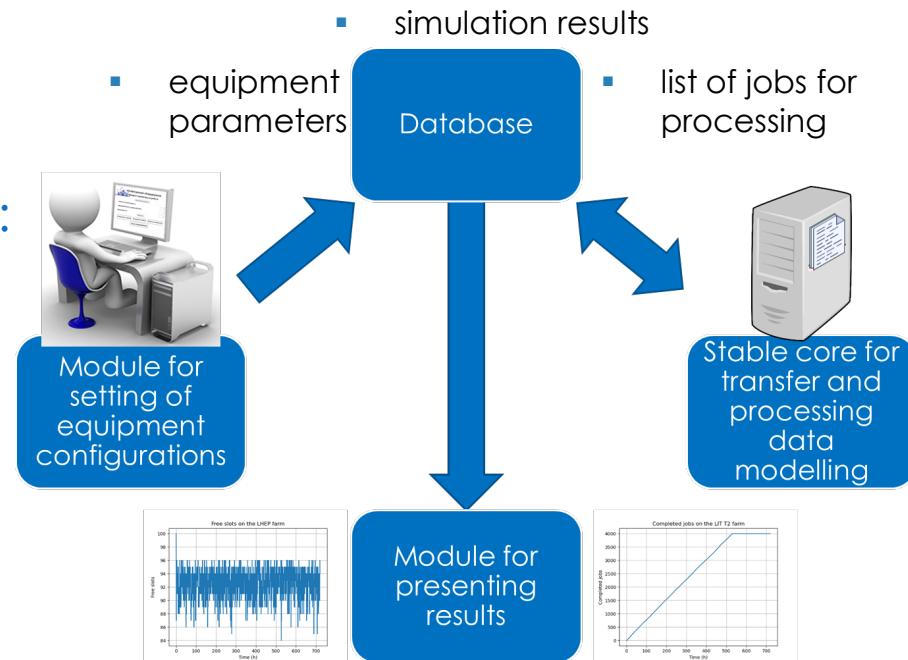
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The software complex

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.

- equipment parameters
- simulation results
- list of jobs for processing

Database

Module for setting of equipment configurations

Stable core for transfer and processing data modelling

Module for presenting results

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

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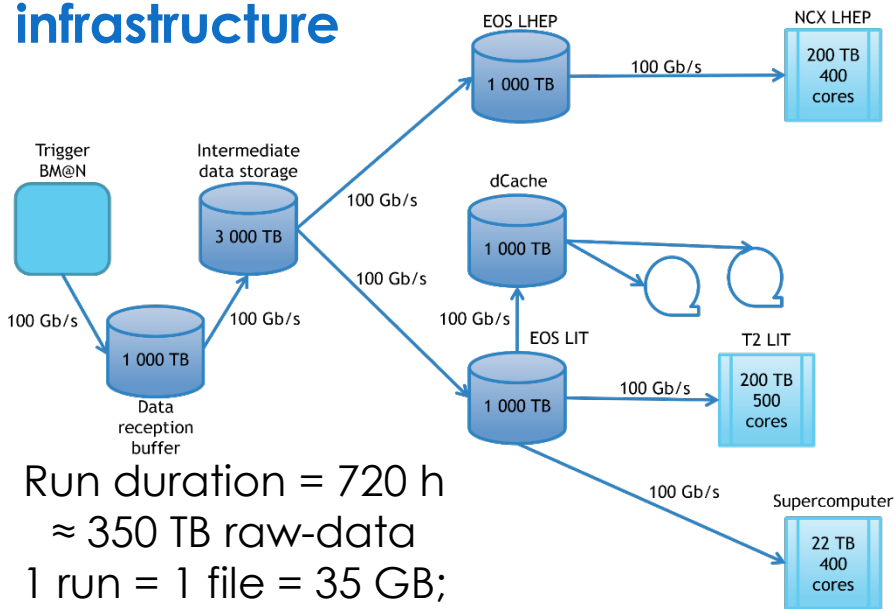
Run duration = 720 h
≈ 350 TB raw-data
1 run = 1 file = 35 GB;
1 event = 0.2 MB

Input parameters for emulation

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

№	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	-

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.

➢ ~ 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.
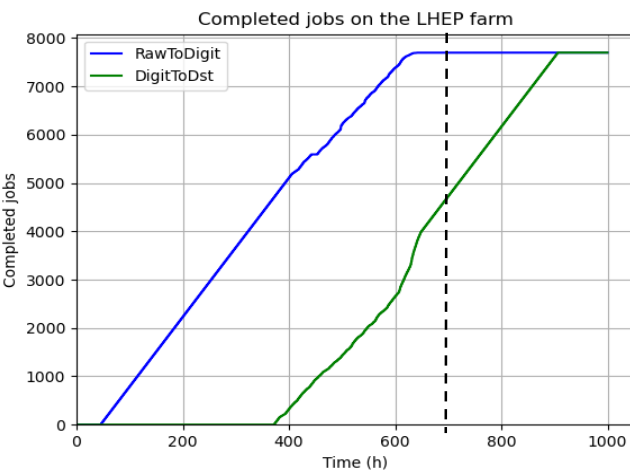
➢ There are not enough resources for data analysis.
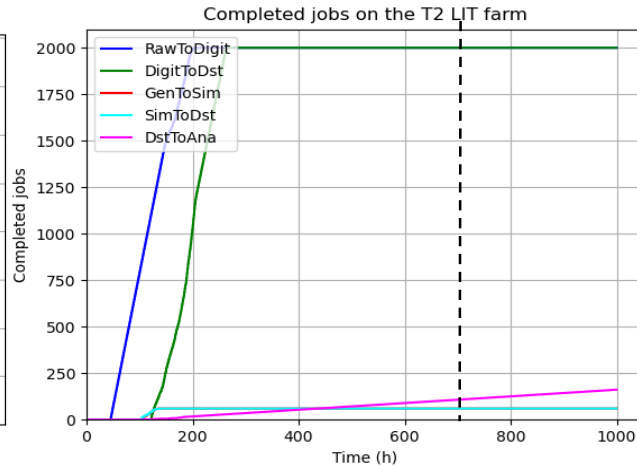
Problem: the result is unsatisfactory…

Start emulation

Outlooks

Completed jobs on the LHEP farm

LHEP farm: **700 slots**

Completed jobs on the T2 LIT farm

T2 LIT farm: **800 slots**

Completed jobs on the Supercomputer

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