Simulation results of BM@N computing infrastructure

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Introduction

The software complex for simulation of distributed data processing systems is being developed at the MLIT.

The important task

Predictive modelling of data storage and processing centers.

Simulation goals

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

The simulation software complex

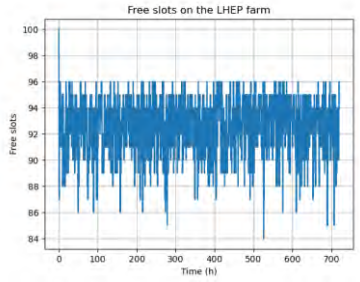
- equipment configuration
- data flow and job flow parameters

Database

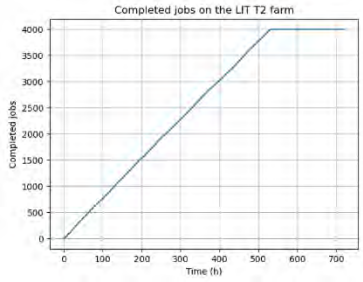
- simulation results

Module for setting of input data for simulation

Stable core for transfer and processing data modelling



Module for presenting results



Modelling the computer infrastructure for data processing of the BM@N experiment at NICA

Goals

1. The assessment of the current and future resource requirements for the data storing and processing, i.e. calculating the volume of data for storing, load on computing components and communication links with the specified parameters of data flows and jobs.

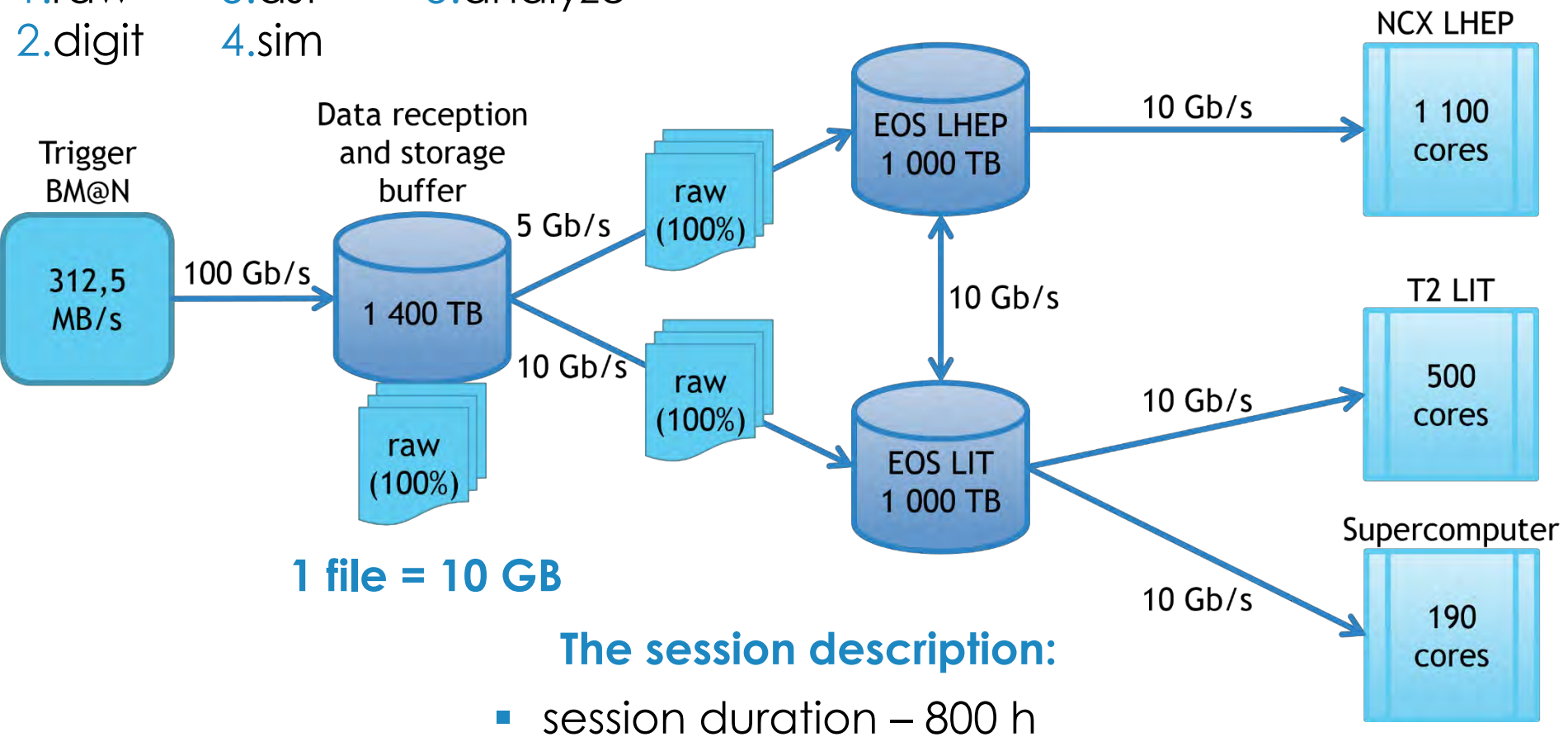
2. Verifying the simulation software complex based on the results of the autumn Run in 2022.

Computations were held on the basis of the Hybrid heterogeneous computing platform.

The simulated structure

Classes of data

1.raw 3.dst 5.analyze
2.digit 4.sim



1 file = 10 GB

The session description:

- session duration – 800 h
- run duration – 30 min
- time between runs – 1 min

Classes of jobs

№	Class	The average amount of input (GB)	The average amount of output (GB)	Job execution time (s)	Number of jobs	Job start frequency (s)
1	RawToDigit	10	0,4	20 000 (NCX, T2)	32 000	90
2	DigitToDst	0,4	0,4	8 600 (NCX, T2)	32 000	90
3	GenToSim	0,084	8	5 000 (HPC) 15 000 (NCX, T2)	5 250	549
4	SimToDst	8	0,4	12 000 (HPC) 35 000 (NCX, T2)	5 250	549
5	DstToAna	0,4	0,05	3 000 (HPC) 10 000 (NCX, T2)	37 250	77

- Each job processes 1 file.
- Each file is processed 1 time.

$$Frequency = \frac{session\ duration\ (s)}{number\ of\ jobs}$$

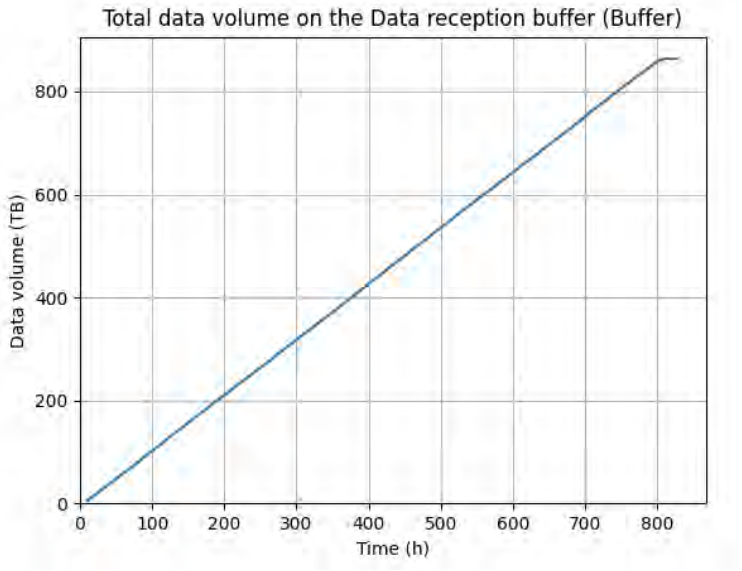
Planned distribution of computing power

№	Class	NCX LHEP	T2 LIT	Supercomp.
1	RawToDigit	350	-	-
2	DigitToDst	150	-	-
3	GenToSim	-	200	90
4	SimToDst	-	200	90
5	DstToAna	600	100	10

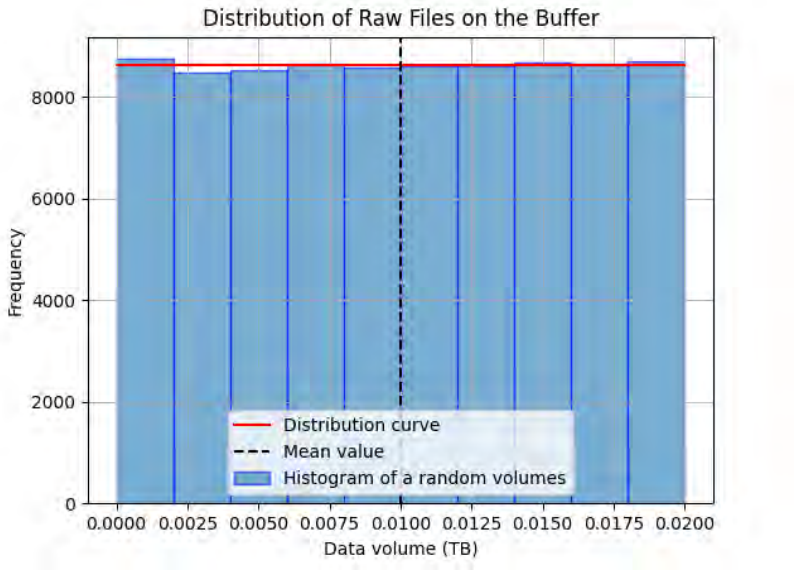
Jobs are run on computing components in a percentage in accordance with the allocated resources.

Results

The amount of data on the buffer



800 hours ≈ 850 TB raw-data ≈ 87 000 raw-files

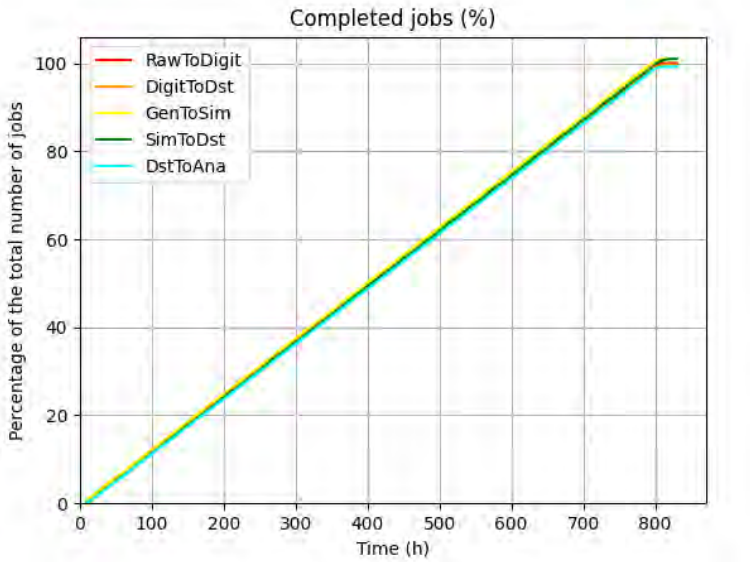


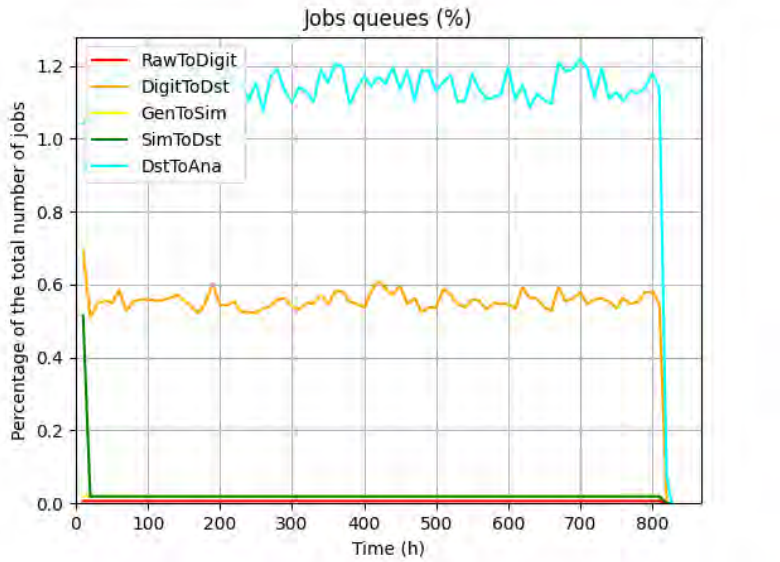
1 file = 10 GB = 0,01 TB

The allocated resources (1 400 TB) for storing all incoming data will be enough.

Results

Completed jobs & Jobs queues





Completed jobs in 800 hours:

RawToDigit ≈ 99% **GenToSim** ≈ 99%

DigitToDst ≈ 98% **SimToDst** ≈ 98%

DstToAna ≈ 98%

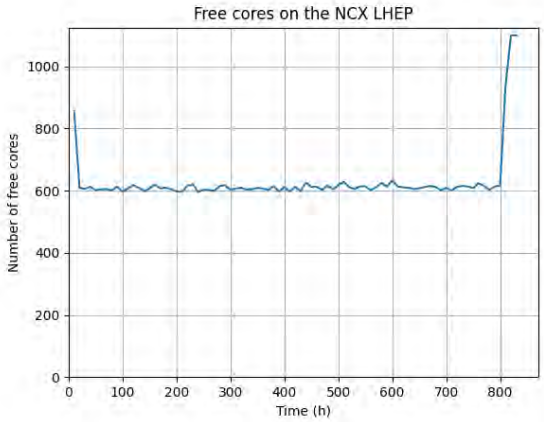
Queues are not formed!

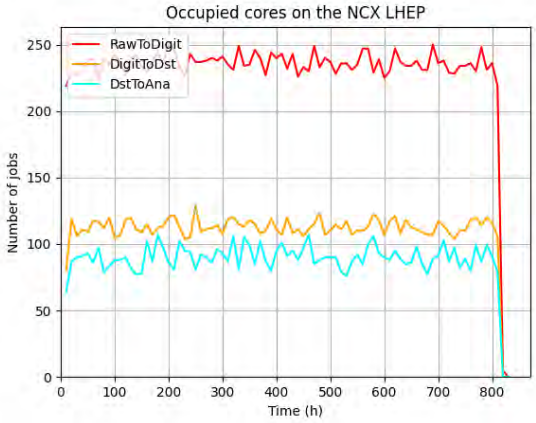
All jobs will be finally completed 30 hours after the end of the experiment.

Results

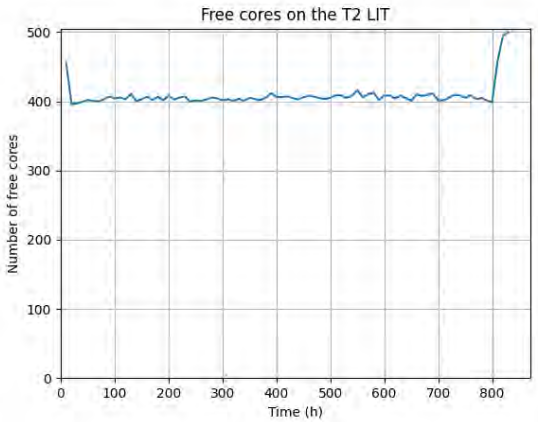
Computing resources usage

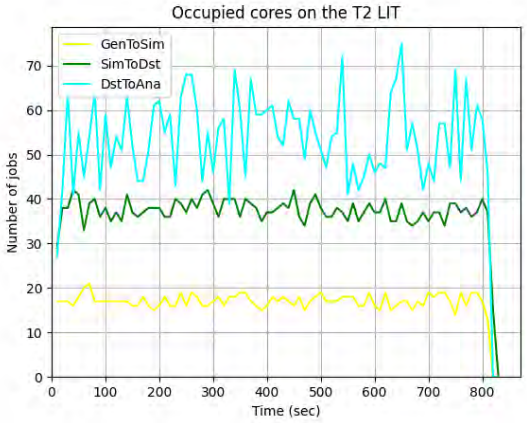
NCX LHEP



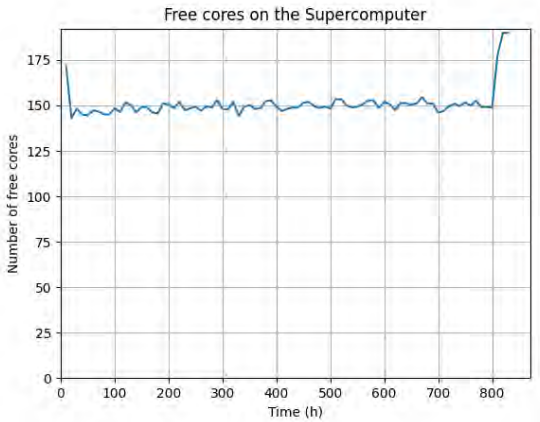


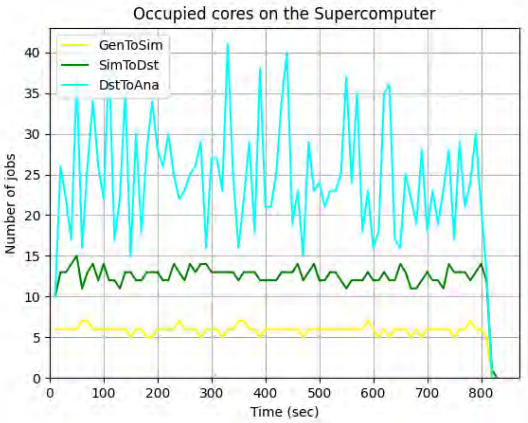
T2 LIT





Supercomputer

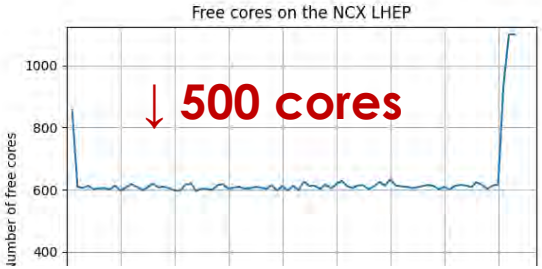




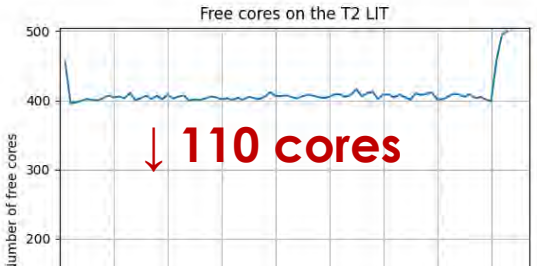
Results

Computing resources usage

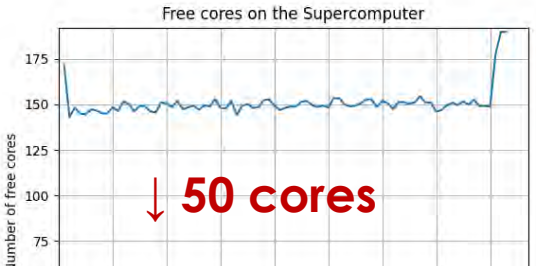
NCX LHEP



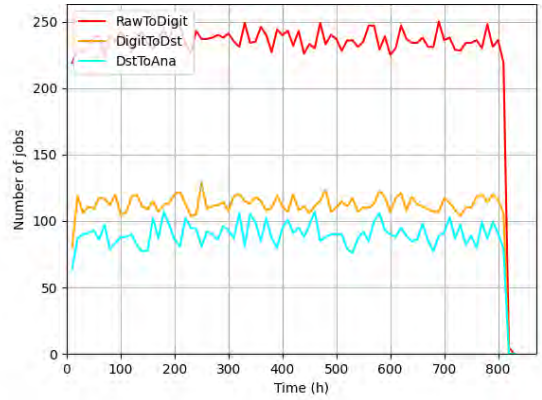
T2 LIT

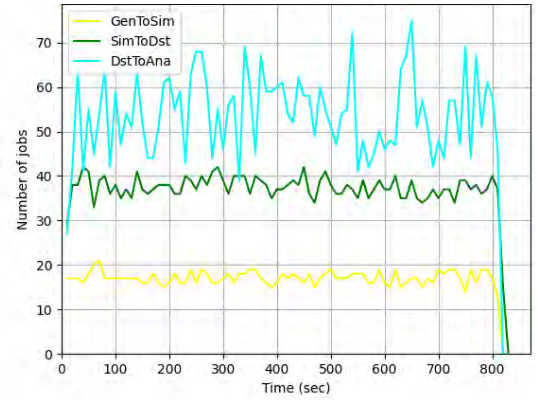


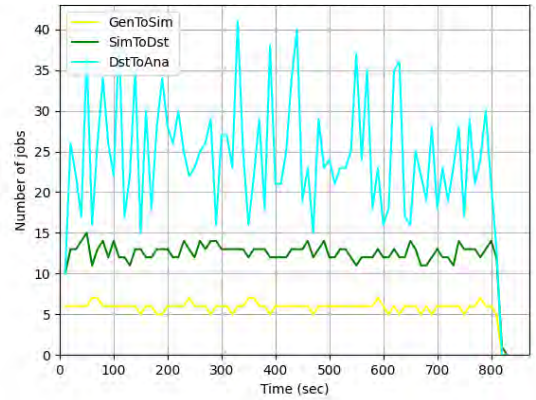
Supercomputer



The allocated resources are sufficient to perform all jobs.
Most of the resources are not used.
The number of cores on computing components can be reduced.

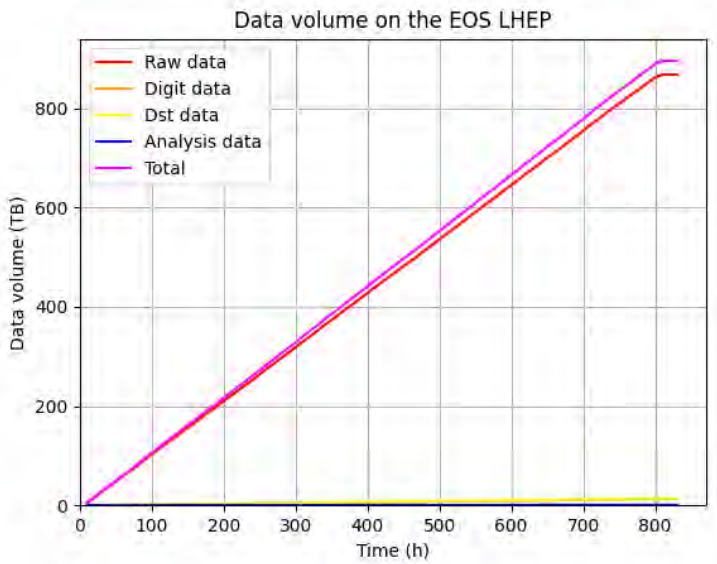


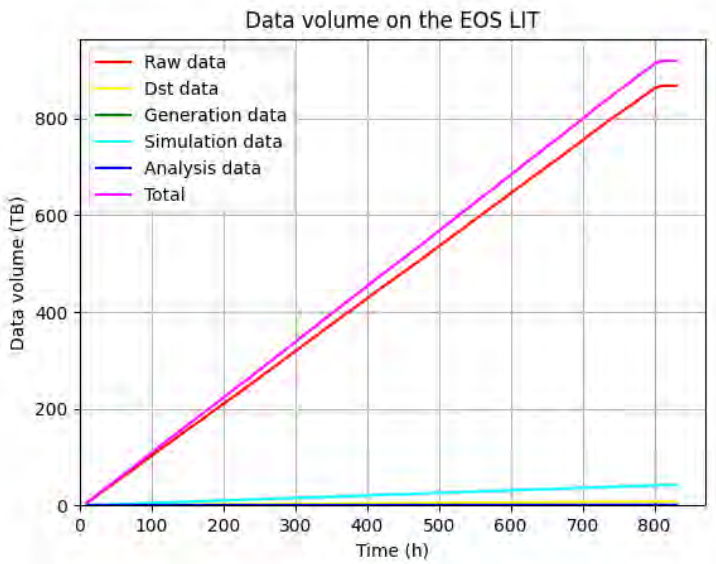




Results

Data volume on storages





Total volume on the EOS LHEP: 900 TB

EOS LHEP capacity: 1 000 TB

Total volume on the EOS LIT: 900 TB

EOS LIT capacity: 1 000 TB

The allocated resources on the EOS LHEP and the EOS LIT are enough to store all types of files in full.
The storage will be filled by 90%.

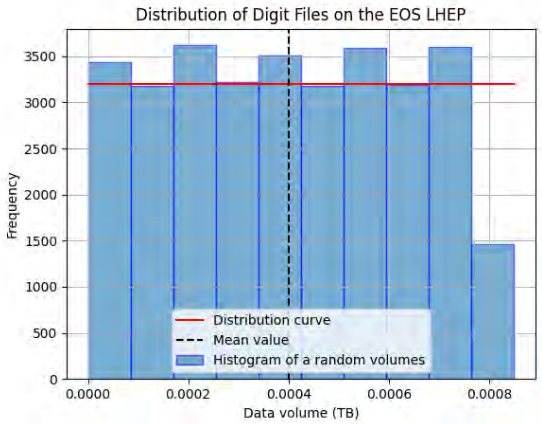
Results

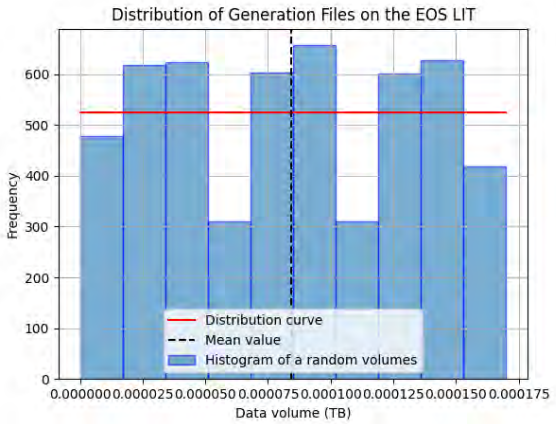
Uniform distribution of file volumes in storage

EOS LHEP

EOS LIT

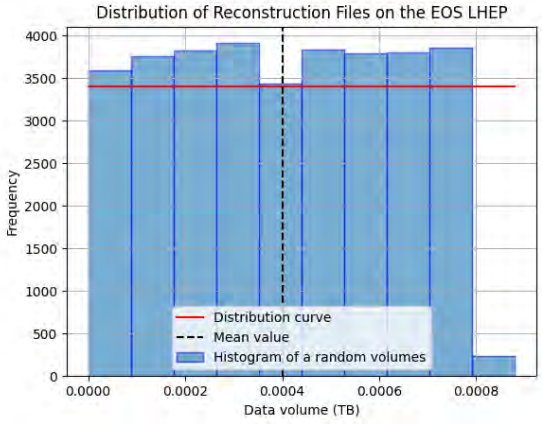
1 digit-file
= 0,4 GB
= 0,0004 TB

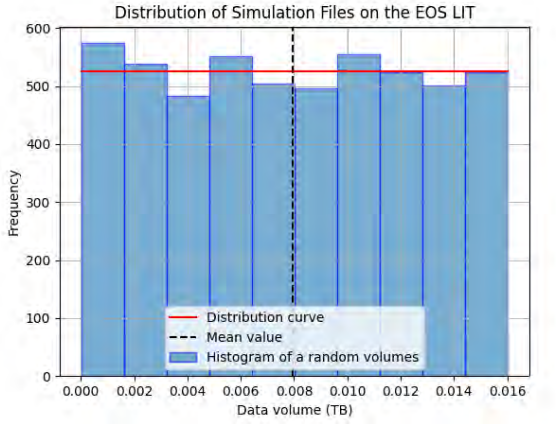




1 gen-file
= 0,084 GB
= 0,00008 TB

1 dst-file
= 0,4 GB
= 0,0004 TB



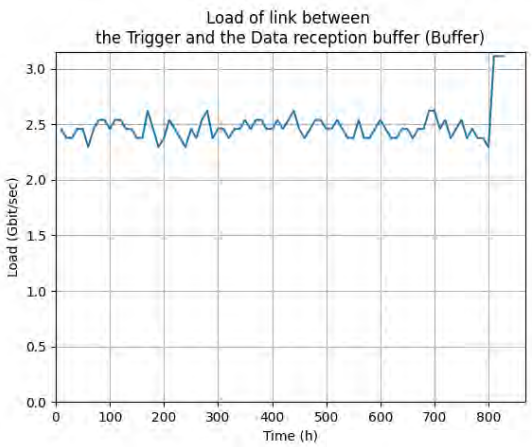


1 sim-file
= 8 GB
= 0,008 TB

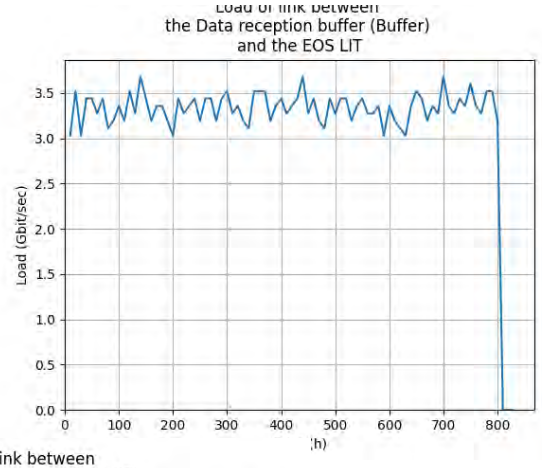
Results

Loading communication links

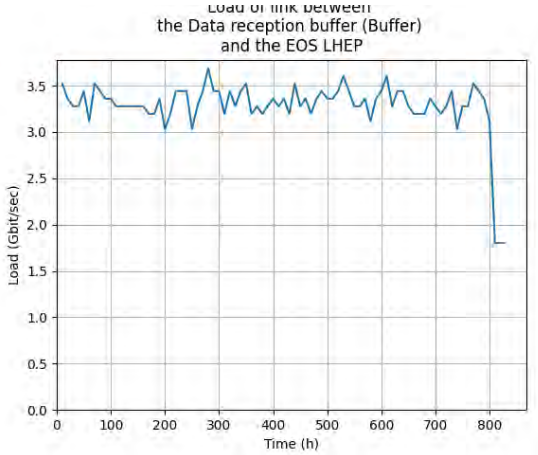
Trigger – Buffer



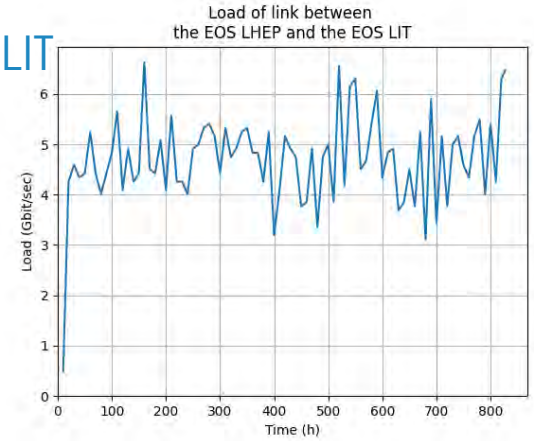
Buffer – EOS LIT



Buffer – EOS LHEP



EOS LHEP – EOS LIT



The available bandwidth of communication links is sufficient to ensure the transmission of information according to the parameters of the planned data flows and jobs.

Conclusions

Simulation results of BM@N computing infrastructure with the planned parameters of the equipment and with the specified characteristics of data flows and jobs:

- completed almost all jobs in 800 hours

≈ 99% RawToDigit jobs; ≈ 98% DigitToDst jobs;

≈ 99% GenToSim jobs; ≈ 98% SimToDst jobs; ≈ 98% DstToAna jobs;

- all jobs will be completed after 30 hours after the end of the experiment;
- most of the resources on the computing components are not used; the number of cores can be reduced:

NCX LHEP – up to 500, T2 LIT – up to 110, Supercomputer – up to 50;

- the data reception and storage buffer will be filled by 60%;
- EOS LHEP and EOS LIT will be filled by 90%, which may lead to storage overflow;
- the available bandwidth of communication links is sufficient.

Further plans

- **Verifying the simulation software complex based on the results of the autumn Run in 2022.**
- Finding optimal equipment parameters that will ensure data processing according to the specified requirements.
- Using of probabilistic distributions of significant data acquisition processes (for example, the probability of loss of incoming data).
- **Obtaining predictive values for a number of necessary computing resources within the perspective of the development of the BM@N computing infrastructure for 2023-2030.**

Thank you for the attention!

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