Approach and tools for working with Big Data on the “Govorun” supercomputer

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The studies in this direction were supported by the RFBR special grant (“Megascience – NICA”), № 18-02-40101.

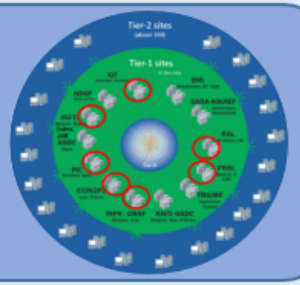
Multifunctional Information and Computing Complex

Engineering Infrastructure

Network Infrastructure
WAN 3x100 Gbps, LAN 2x100 Gbps

DataLake
EOS
7.35 PB

Grid-Tier1:
16 096 cores
14.1 PB disk
11.6+40 PB tape



Grid-Tier2/CICC:
9272 cores
4.9 PB disk

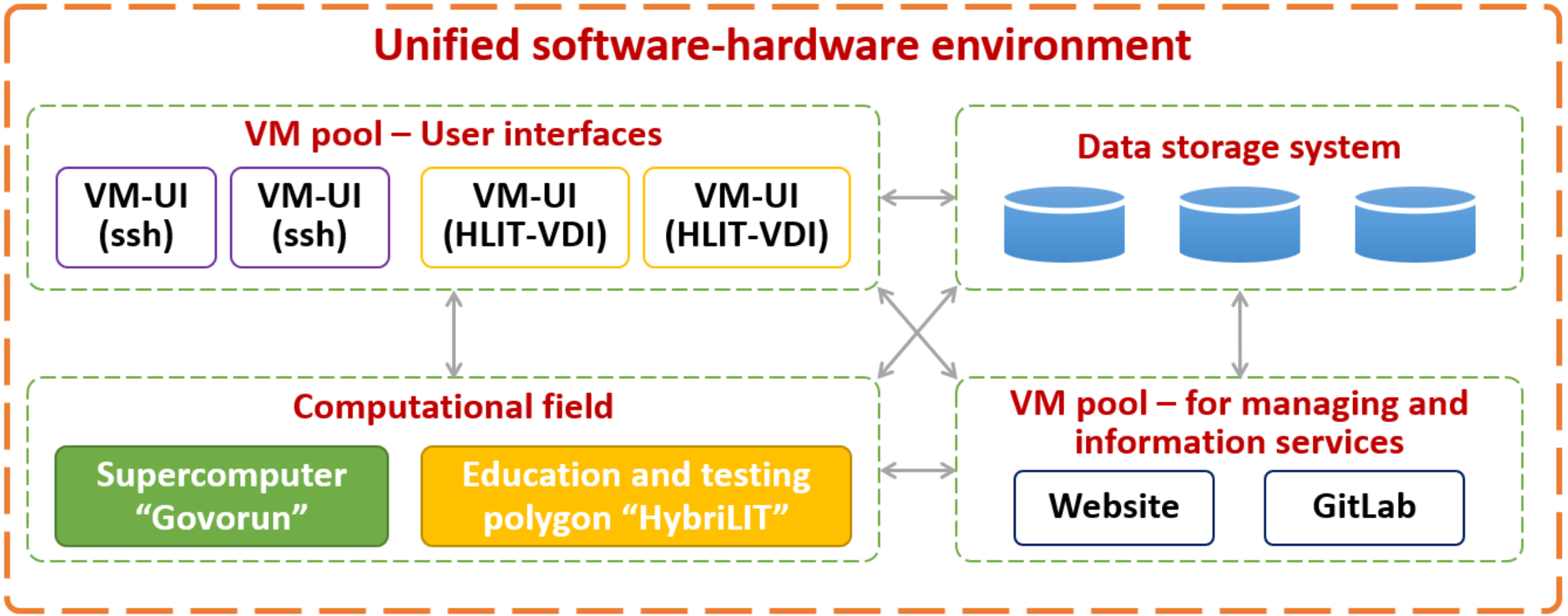
Cloud:
5020 CPUs cores
60 TB RAM
3.1 PB disk

HybriLIT/SC "Govorun":
860 TFlops for
double precision
300 Gbps data I/O rate

MSCN
4x100 Gbps

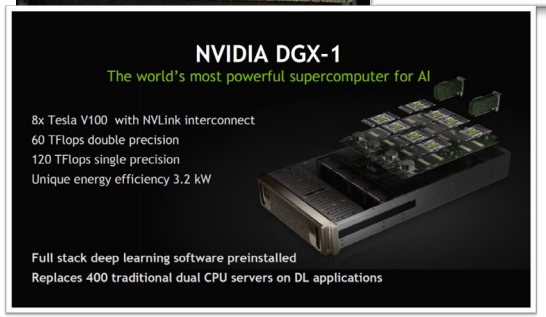
NICA off-line cluster

MICC component: HybriLIT platform



The unified software and information environment of the HybriLIT platform allows users to use the education and testing polygon is aimed at exploring the possibilities of novel computing architectures, IT-solutions, to develop and debug their applications, furthermore, carry out calculations on the supercomputer, which allows them to effectively use the supercomputer resources.

“Govorun” supercomputer



The “Govorun” supercomputer is a hyper-converged software-defined system and occupied **26th** and **31st** in the current edition of the **IO500** list (July 2021). For the high-speed data storage system, RSC Group has received the prestigious Russian DC Awards 2020 in “The Best IT Solution for Data Centers” nomination at the awards ceremony held on 10 December 2020 in Moscow.

CPU-component
based on the newest Intel architectures:
Intel Xeon Phi gen.2 and Intel CascadeLake CPUs

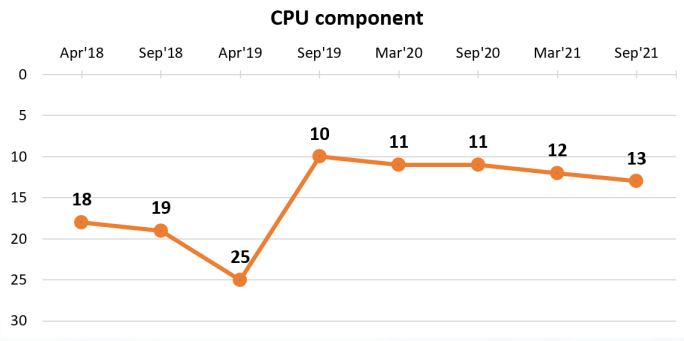
GPU-component based on NVIDIA DGX-1 Volta.

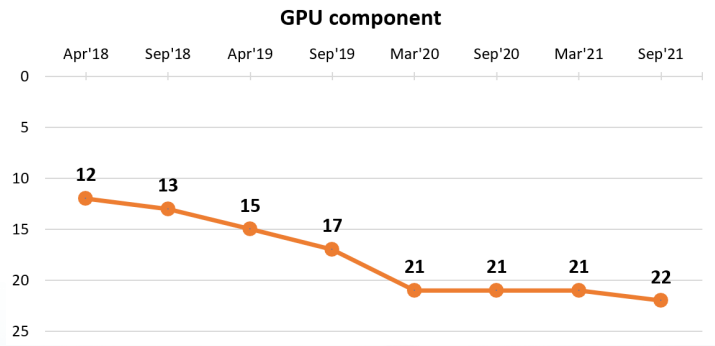
Total peak performance:
1.7 PFLOPS SP
860 TFLOPS DP
300 Gb/s Data IO rate

Current ratings of the “Govorun” supercomputer

№	Site	System	CPU-cores Number of acselerators	Rmax (Tflops/s)	Rpeak (Tflops/s)
1	SberCloud, Moscow	Christofari	3600 1200 NVIDIA Tesla V100	6669.0	8789.76
2	MSU, Moscow	Lomonosov 2	23424 1536 NVIDIA Tesla K40M 320 NVIDIA Tesla P100	2478.0	4946.79
3	MTS, Moscow	MTC GROM	2560 160 NVIDIA A100 40GB	2258.0	3011.84
13	**JINR, Dubna**	**SC “Govorun” CPU-component**	**5192 21 Intel Xeon Phi 7290**	**312.62**	**463.26**
22	**JINR, Dubna**	**SC “Govorun” GPU-component**	**200 40 NVIDIA Tesla V100**	**175.13**	**319.0**

Rank	Institution	System	io500		
			Score	BW GiB/s	MD kIOP/s
1	Pengcheng Laboratory	Pengcheng Cloudbrain-II on Atlas 900	36,850.37	3,421.62	396,872.82
2	Intel	Endeavour	1,859.56	398.77	8,671.65
3	Intel	Wolf	1792.98	371.67	8649.57
26	**JINR**	**Govorun (DAOS)**	**132.06**	**20.19**	**863.69**
27	Joint Supercomputer Center of the Russian Academy of Sciences	MVS10POP2	125.50	45.31	347.61
31	**JINR**	**Govorun (Lustre)**	**90.87**	**35.61**	**231.88**
36	SPbPU	Polytechnic RSC Tornado	64.29	21.56	191.73

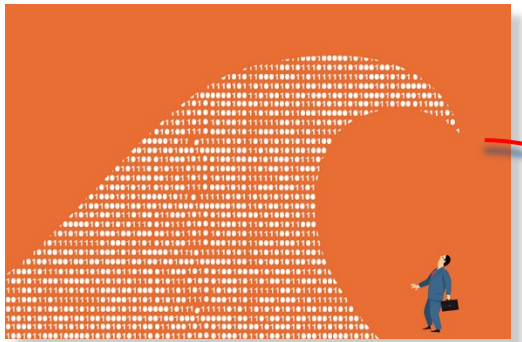




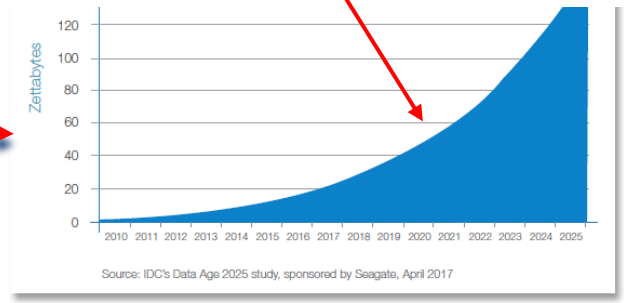
The “Govorun” supercomputer is ranked on the 26nd and 31st place in the current edition of the IO500 list (July 2021) and is the second in terms of the data processing rate among Russian supercomputers. The CPU and GPU components rank 13th and 22nd in the current TOP50 list, respectively

Big Data in Science

In the world there is a constant growth of data generation…



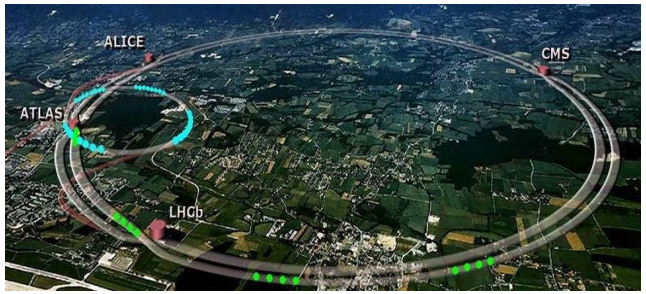
… which is followed to exponential law. In 2021, > 50 ZB data will be created



… although even petabytes scale data relates to the field of Big Data Analytics and technologies

yotta	Y	1000^8	10^{24}
zetta	Z	1000^7	10^{21}
exa	E	1000^6	10^{18}
peta	P	1000^5	10^{15}
tera	T	1000^4	10^{12}
giga	G	1000^3	10^9

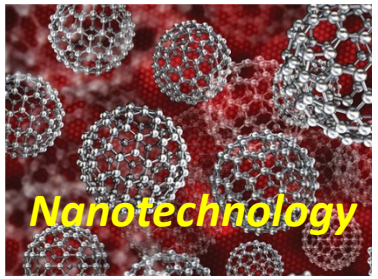
High Energy Physics

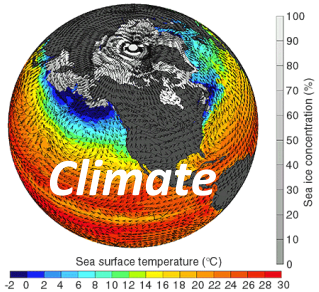


CERN Large Hadron Collider
> 600 Pb/Year

CERN

Science



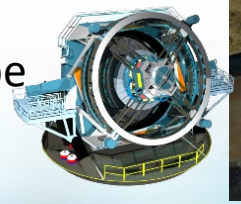


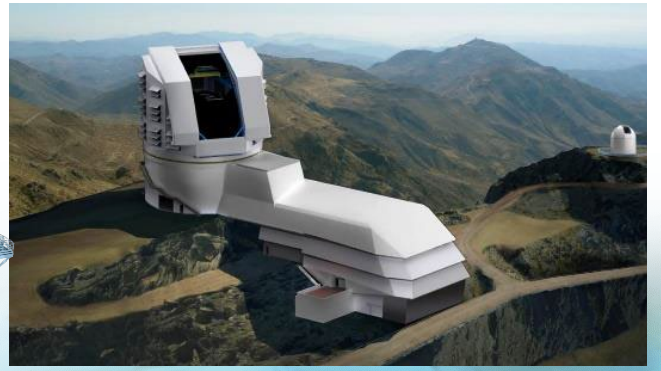
… et cetera

Square Kilometer Array radio telescope
> 1 Eb/Year raw data (estimation)

LSST
Large Synoptic Survey Telescope

Large Synoptic Survey Telescope
> 10 Pb/Year
(estimation)





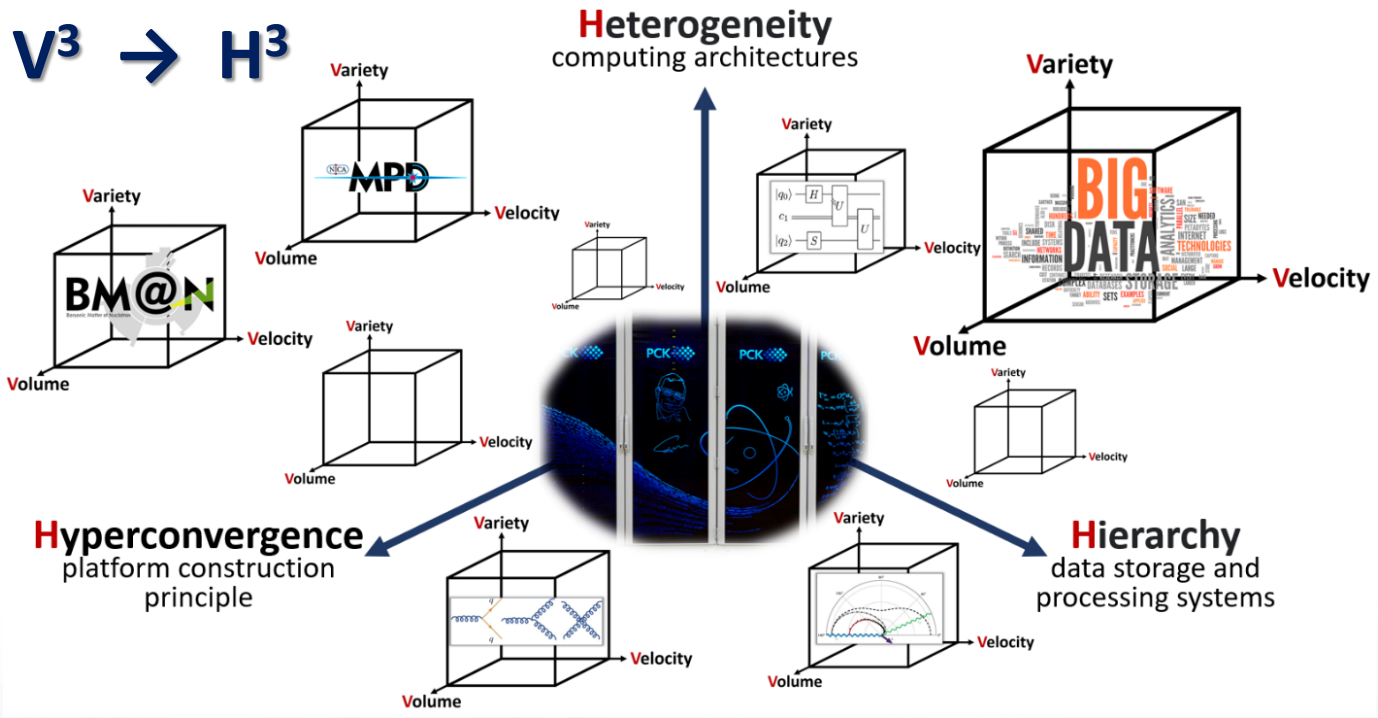
Big Data on the “Govorun” Supercomputer for NICA megaproject

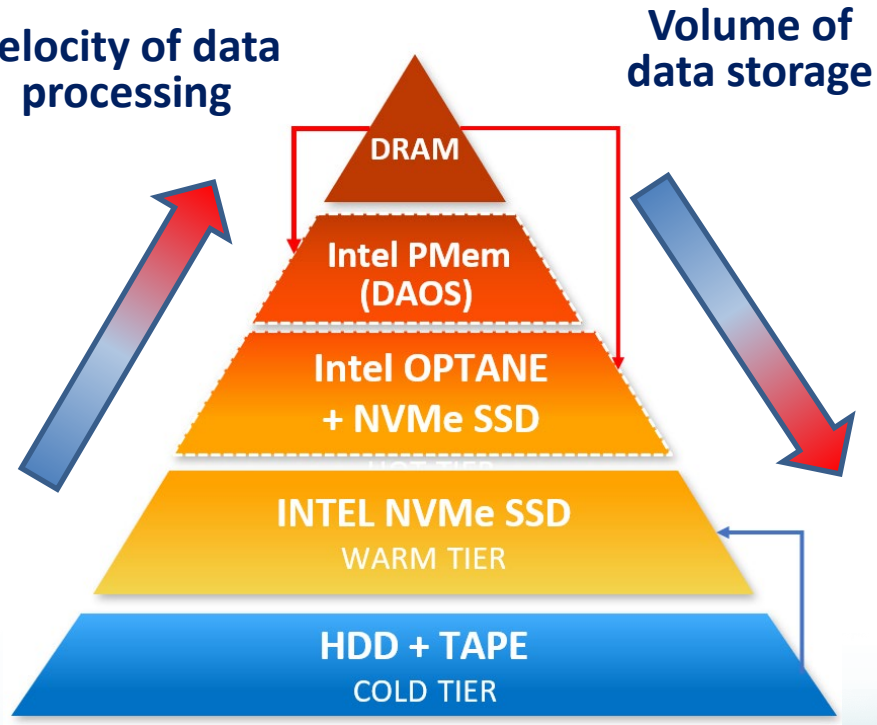
The DAOS polygon of the “Govorun” supercomputer takes the **1st** place among Russian supercomputers in terms of the data processing rate in the current **IO500 list**.

Heterogeneity
Hierarchy
Hyperconvergence

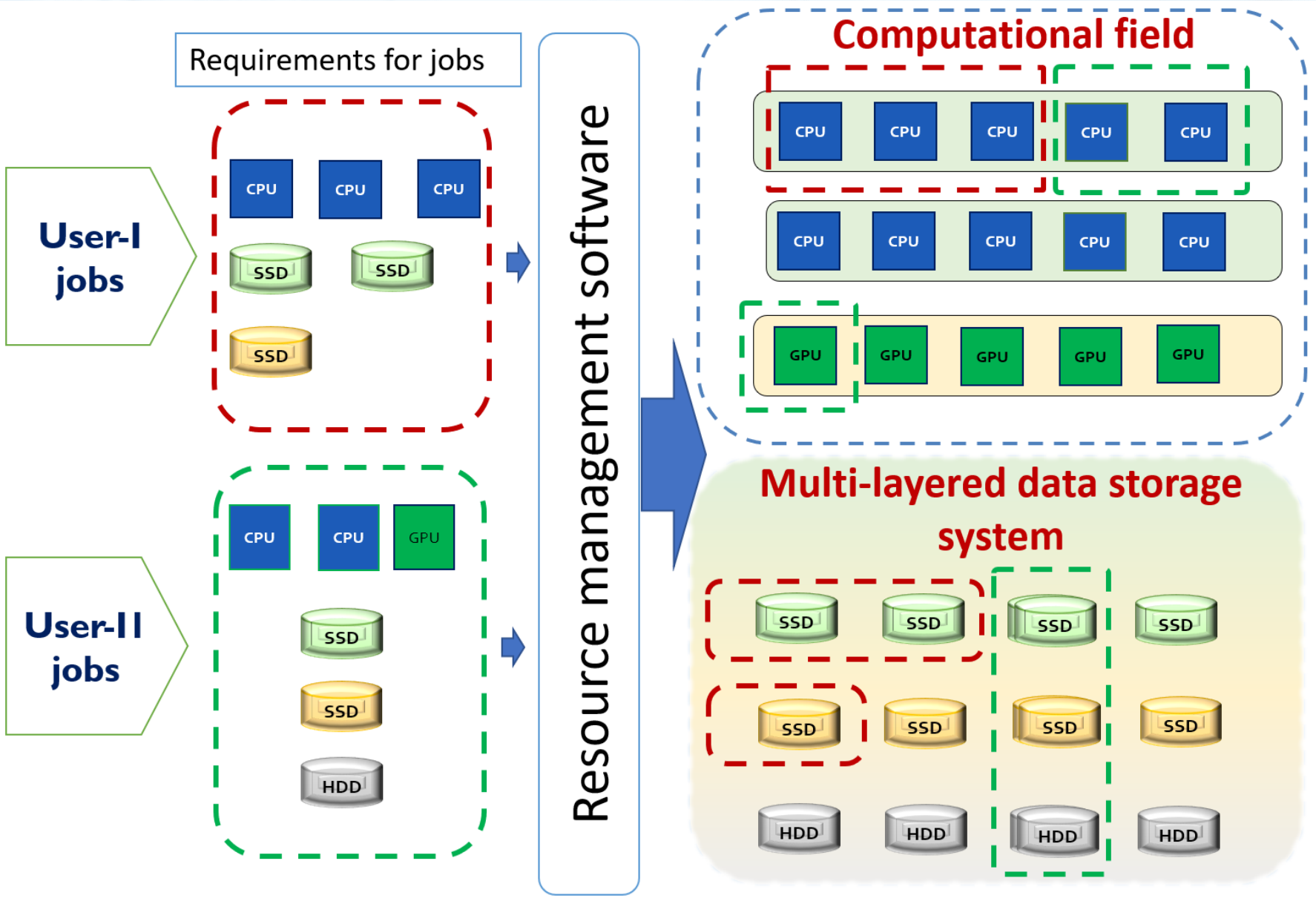
provide

Variety
Velocity
Volume





Orchestration and hyperconvergence on the “Govorun” supercomputer



The “Govorun” supercomputer has unique properties for the flexibility of customizing the user’s job.

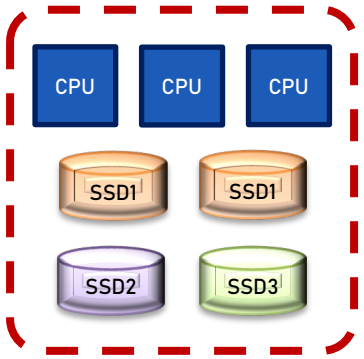
For his job the user can allocate the required number and type of computing nodes and the required volume and type of data storage systems.

This property enables the effective solution of different tasks, which makes the “Govorun” supercomputer a unique tool for research underway at JINR.

Research results obtained using the SC “Govorun” resources in 2020 are presented in 65 publications, 6 of them in Q1, 7 in Q2.

System-on-demand for MPD

MPD jobs



Computation field

Special computation nodes with huge amount RAM

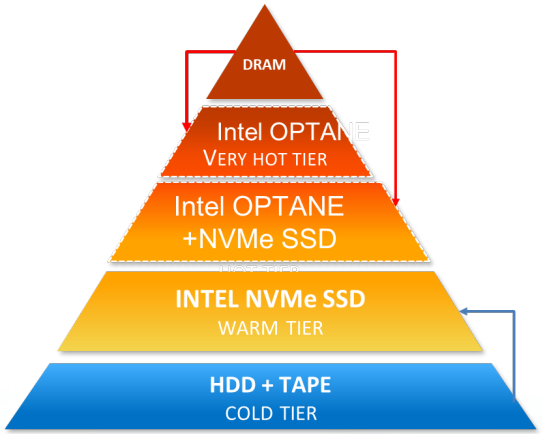
Standard computational nodes

Luster (ZFS) -on-demand

DIRAC THE INTERWARE

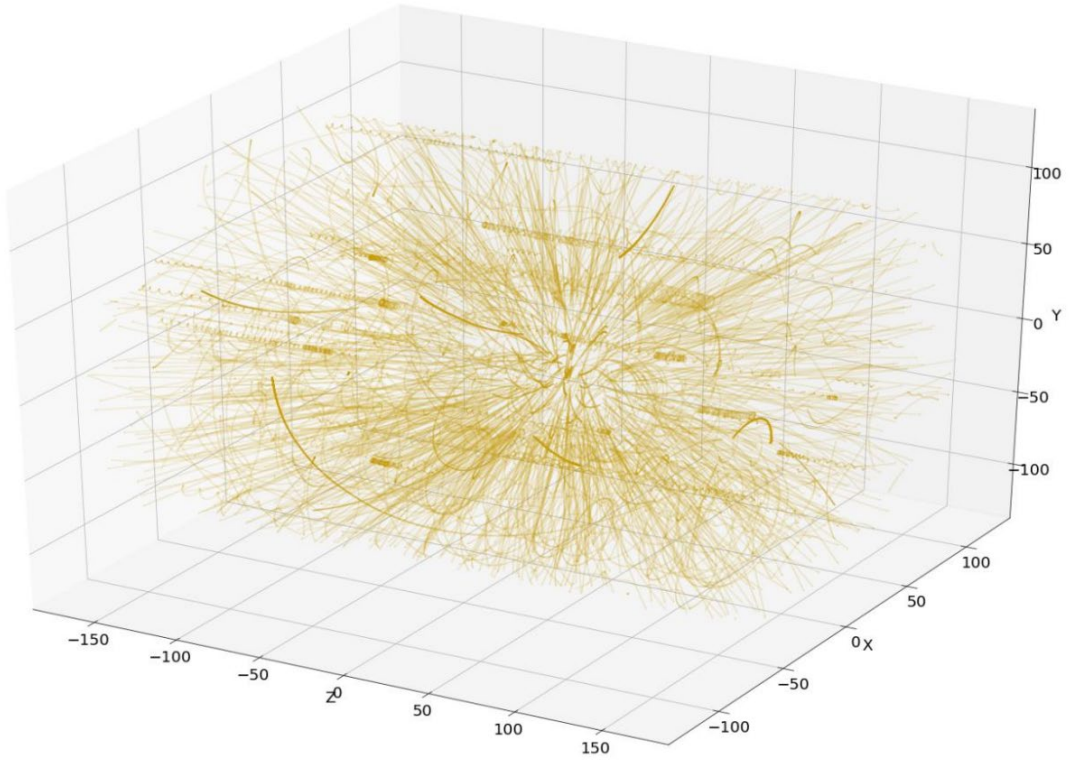
Distributed computing resources

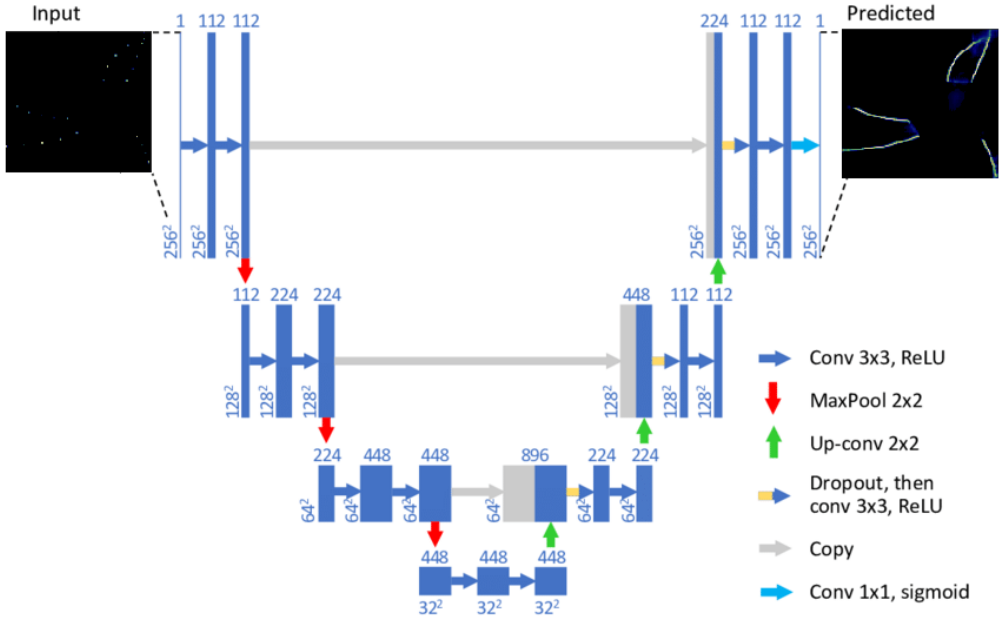
Multilevel Storage System

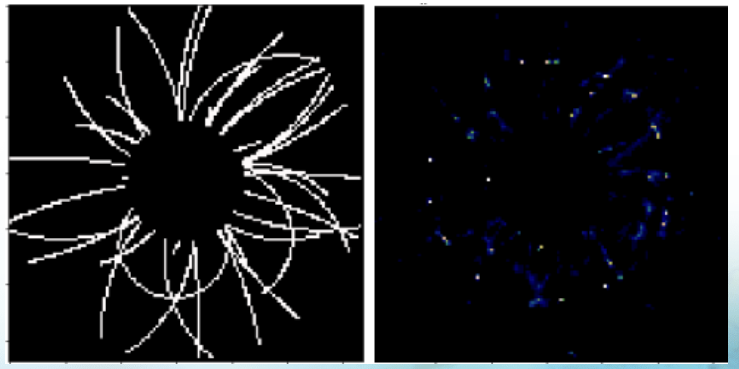


Computing for the NICA megaproject
Machine learning for MPD tracking tasks

A large number of tracks in events requires the development of approaches that have constant computational complexity regardless of the number of tracks in an event. The use of deep neural network architectures allows developing tracking one-pass algorithms that work in just single step.

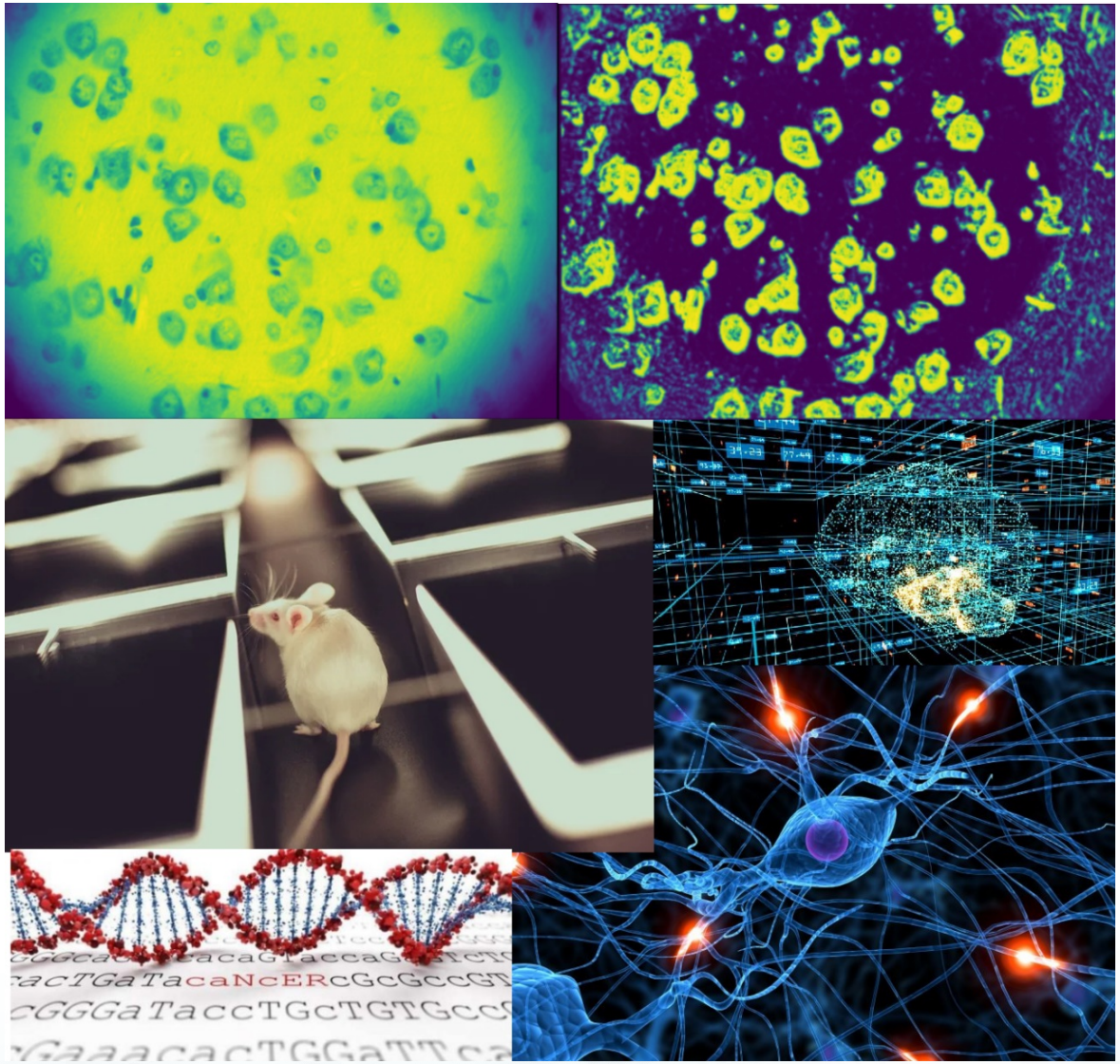






Model experiments show that neural network models are capable of both interpolating tracks and creating an internal model to represent the results in the phase space of the track parameters.

Information System for the tasks of radiation biology



The studies are carried out using all the capabilities of the HybriLIT platform

The joint project of MLIT and LRB is focused on creating an Information System (IS) for analyzing behavioral and pathomorphological changes in the central the nervous system when studying the effects of ionizing radiation and other factors on biological objects.

IS is based on:

- computer vision algorithms on the basis of machine and deep learning technologies (ML/DL);
- modern IT solutions for data storage, processing and visualization.

IS will allow one to simplify and accelerate:

- accelerate the processing of experimental data through automation of morphological classification of neural cells;
- data analysis techniques using the latest neural network algorithms based on ML/DL;
- work with experimental data for different research groups;
- systematize experimental data and develop effective methods for preventing and countering the negative effects of ionizing radiation.

Conclusion

- From 2020 to the present, for the MPD experiment a total of **744 million events** were generated and **222 million events** were reconstructed. About **30%** of this work was done on the “Govorun” supercomputer. The **acceleration of computations** on the supercomputer in comparison with the previous configuration was **1.15 – 2.0 times** depending on the computation cores.
- With the support of the RSC, a procedure for creating a system-on-demand based on hyperconverged nodes at the request of various configurations has been developed and integrated to BasIS.
- At the moment we are able to create special a specific system-on-demand for users tasks.
- Active work is underway to adapt the workflow of the MPD experiment to the DAOS storage prototype on the “Govorun” supercomputer.

Thanks for your attention!

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