RSC Tornado – hyper-converged solution for future computing

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GRID 2018, JINR, Dubna (Russia)

HPC innovations since 2009

Development of innovative ultra-high dense energy efficient HPC solutions delivering unique features and addressing specific end-user needs

Cutting-edge supercomputers and data centres for demanding customers

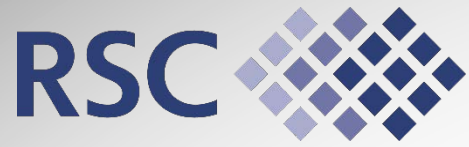# Development directions

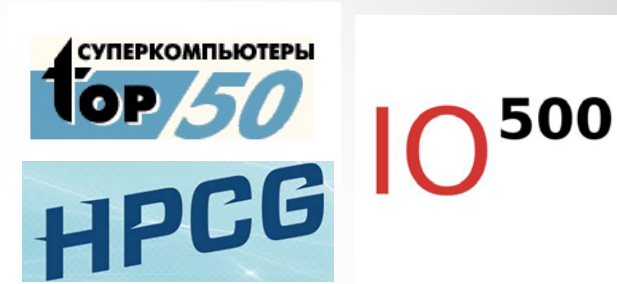Computing density

Power density

Energy efficiency

Reliability

Ease to manage and maintain

Strong market position

- Leading innovative HPC solution provider in Russia/CIS

  - **24% share** in local **Top50** rating (Russia/CIS)

  - **4 supercomputers** in **Top10** there

  - **#9** position in **IO500** list (hyper-converged system at JINR)

  - Over **70%** of all **Russian systems** in **HPCG** rating

- **National Champion rank** by the Russia's Ministry of Economic Development

- One of the leading HPC solution providers in EMEA

- Single Russian company ranked in **Top10 HPC vendors by Top500**

- Over **4.5 PFLOPS** total performance of installed base

- Over 9 years of successful deployments

- **Intel HPC Data Center Specialist** elite status

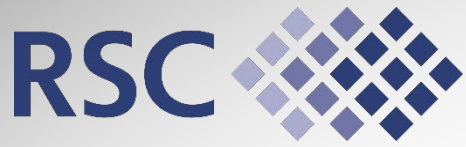- **Intel® Select Solution for Simulation and Modeling**

Vendors System Share

- HP
- IBM
- Cray Inc.
- SGI
- Bull
- Dell
- Fujitsu
- NUDT
- RSC Group
- Atipa
- Others

35.6%
30.4%
12.3%
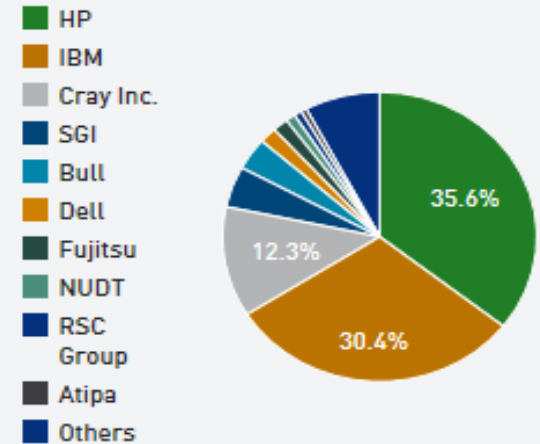
Source: Top500.org (Nov'14)

Track of world records
RSC Tornado cluster solution

Highest computing density per rack* – **1.41 PFLOPS**

Leading performance density – **490 TFLOPS/m^3**

Highest power density per rack – **200 kW**

Leading computing density per rack* – **685.44 TFLOPS****

Highest performance density – **535 TFLOPS/m^3**
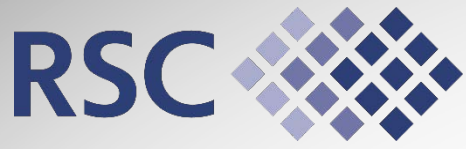
Leading power density per rack – **100 kW**

Leading PUE*** = **1.027** (measured at the customer site)

* 42U rack 80x80 cm
** for Intel® Xeon® based solutions
** Power Usage Efficiency is less than 6%

RSC TORNADO FLEXIBLE SOFTWARE DEFINED SOLUTIONS

UNIFIED BUILDING UNITS

WORLD RECORDS

60 °C / 140 F
Inlet Water

100%
Water Cooling

96% Eff.
~220V ⁼ 400V

Density

RSC Tornado
Intel® Xeon® based node

- Two **Intel® Xeon® Scalable** (incl. top-bin) and **Intel® Xeon® E5-2600 v4** (incl. top-bin)
- Up to 256GiB DDR4-2400 RAM
- **Intel® Omni-Path**, EDR IB, 10/40/100 GigE
- 2x **Intel® SSDs** SATA and 1x **Intel® SSD** with **NVMe** incl. **Intel® Optane™ SSD DC P4800X**

RSC Tornado Phi
Intel® Xeon Phi™ based node

- **Intel® Xeon Phi™ 7200**(F) (incl. top-bin)
- Up to 192GiB DDR4-2400 RAM + MCDRAM
- **Intel® Omni-Path Fabric**, EDR IB, 10/40/100 GigE
- 2x **Intel® SSDs** SATA and 1x **Intel® SSD** with **NVMe** incl. **Intel® Optane™**

RSC Tornado Unified Cabinet

- Flexible configuration options:
  Up to **153 RSC Tornado servers** [685 TFLOPS]
  Up to **153 RSC Tornado Phi** nodes [528 TFLOPS]
  Mixed RSC Tornado/RSC Tornado Phi nodes
- From 1 to 9 fully independent domains
- 0.64 m² / 6.9 ft² footprint, 2 m / 6.6 ft height

RSC Tornado Expansion Pack

- HPC, BigData, VDI, Security, Machine Learning Expansion Packs and others by request

RSC Tornado Power Supplies

220-400V AC/DC 12 kW
220-12V AC/DC 2.1 kW

- Direct liquid cooling & node-like design
- Thermal and power management
- Flexible redundancy (N+1 to N+N)
- Power conversion efficiency up to 96%
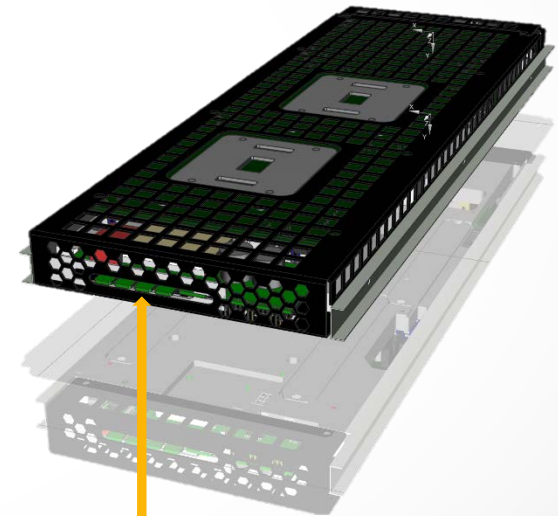
RSC Tornado node

based on the top-bin
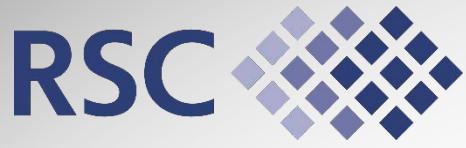### Intel® Xeon® Platinum 8180 Processor ⇛ 4.48 TFLOPS

Easy access to components
Memory replacement windows
Broad range of available components

Protective cover

Unified power connectors
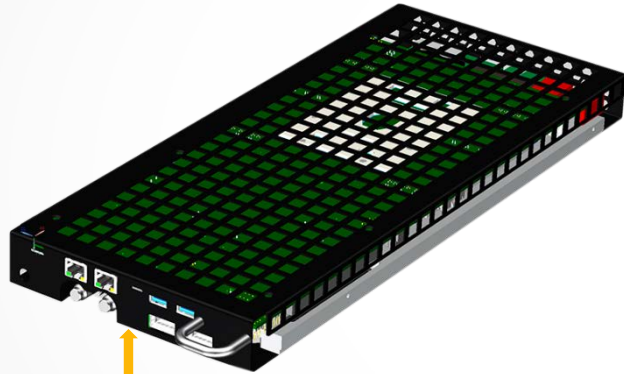for easy upgrade/reconfiguration
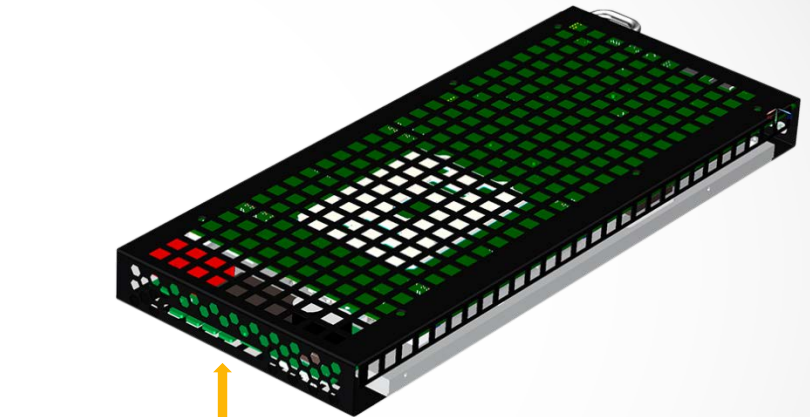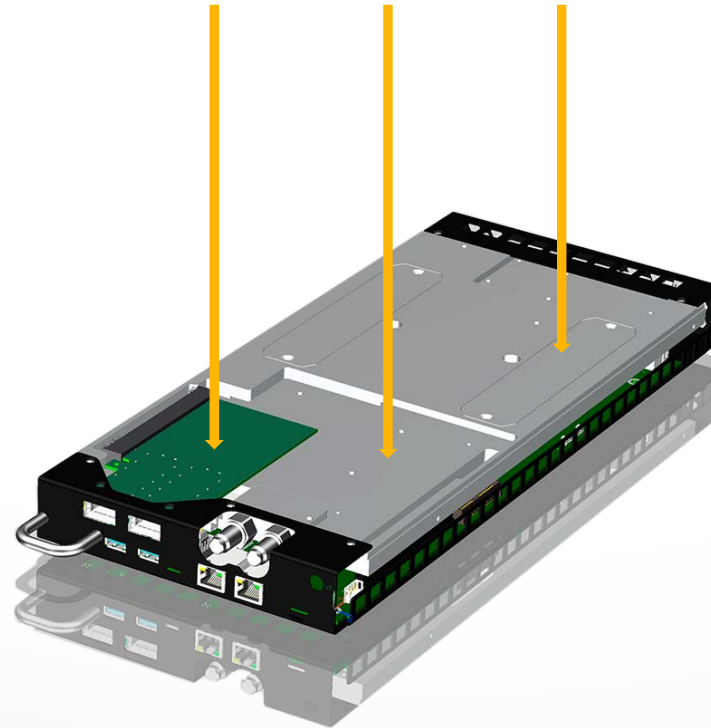
Compact Node Design
based on the top-bin 72-cores
Intel® Xeon Phi™ 7290 Processor ⇛ 3.4 TFLOPS

Easy access to components
Memory replacement windows
Broad range of available components

New protective cover

Unified power connectors for easy upgrade/reconfiguration

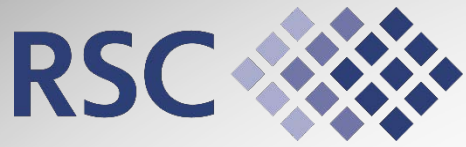# Hot Water Cooled Intel® OPA

World's first 100% 'hot water' liquid cooled
48-port Intel® Omni-Path Edge Switch 100 Series

ISC'17 (Frankfurt, Germany)

SC'17 (Denver, USA)

New: RSC Tornado HYPEr-converged

RSC Tornado node:

- **2 x Intel® Xeon® Scalable (Skylake-SP)** processors **up to 205W** with **28 cores** each
- **Intel® Server Board S2600BP** with two **10GigE** ports on-board and (optional) Intel Quick Assist support
- **RSC Management Module** with dedicated Ethernet fabric
- Up to **12 hot-swap NVMe SSDs**, for example each can be:
  - **Intel® SSD DC P4511 (NVMe, M.2) 1-2TB** configured as disk
  - or **Intel® Optane™ SSD DC 4801X (M.2) 375GB** as disk or memory via IMDT
- Memory per node – up to 768GiB DDR4 Reg ECC up to 2666
- **2 x Intel® Omni-Path 100 Gb/s adapter (or EDR InfiniBand or Ethernet)** providing up to 200Gbps external fabric bandwidth
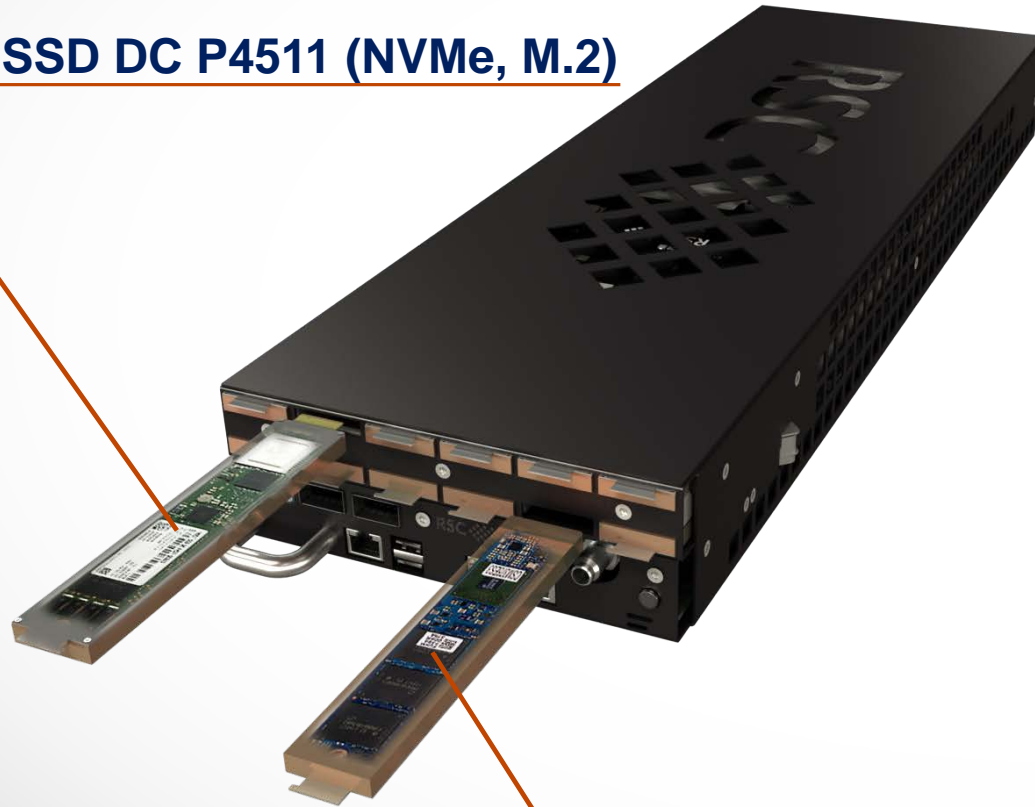
NVMe-attached SSDs can provide:
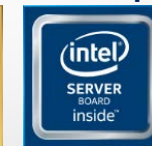
- **Large and fast storage:** up to 24TB+ per node today
- **Large Memory Capacity** node via **Intel Memory Drive Technology (IMDT)** with up to 4.2TB of RAM today
- **Many combination of previous two options, e.g. 3TB RAM and 8TB disk**

100% 'hot water' liquid cooled solution for stable operation and high safety of components

Intel® SSD DC P4511 (NVMe, M.2)

Intel® Optane™ SSD DC 4801X (M.2)

Variety of Hyper-converged node types

Nodes with large memory
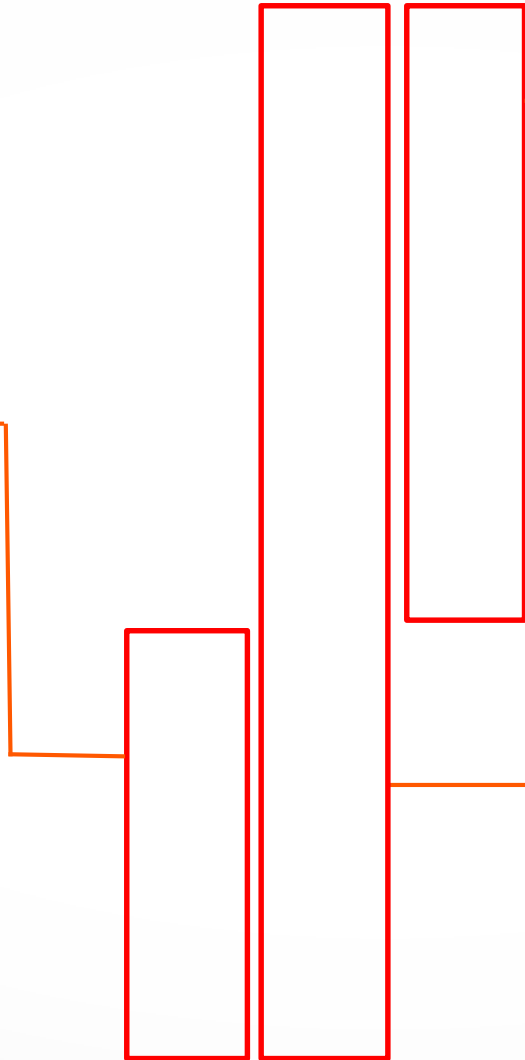
Nodes servicing fast scalable parallel file system (Lustre, BeeGFS etc.)
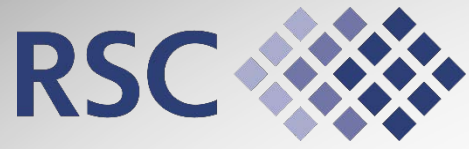
Standard compute nodes

RSC Tornado Storage-on-Demand

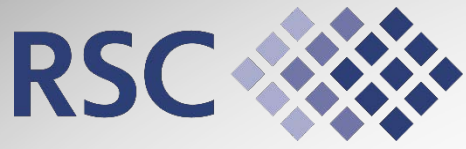Software Defined

High Performance Storage

On Demand

It provides outstanding performance at 5% of traditional parallel file system cost (TCO)

World first 100% hot water cooled and hyper-converged system at JINR

Hyper-Converged Solution at JINR

RSC Tornado nodes based on Intel® Xeon® Scalable:
- **Intel® Xeon® Gold 6154** processors (18 cores)
- **Intel® Server Board S2600BP**
- **Intel® SSD DC S3520** (SATA, M.2), **2 x Intel ® SSD DC P45xx (NVMe, M.2) 1TB**
- Memory per node – 192GB DDR4 2666 GHz
- **Intel® Omni-Path 100 Gb/s adapter**

Intel Omni-Path

100% 'hot water' liquid cooled Intel Omni-Path switch:
- **48-port Intel® Omni-Path Edge Switch 100 Series**
- Intel® Omni-Path optical cables

RSC Tornado nodes based on Intel® Xeon Phi™:
- **Intel® Xeon Phi™ 7190** processors (72 cores)
- **Intel® Server Board S7200AP**
- **Intel® SSD DC S3520** (SATA, M.2)
- Memory per node – 96GB DDR4 2400 GHz
- **Intel® Omni-Path 100 Gb/s adapter**

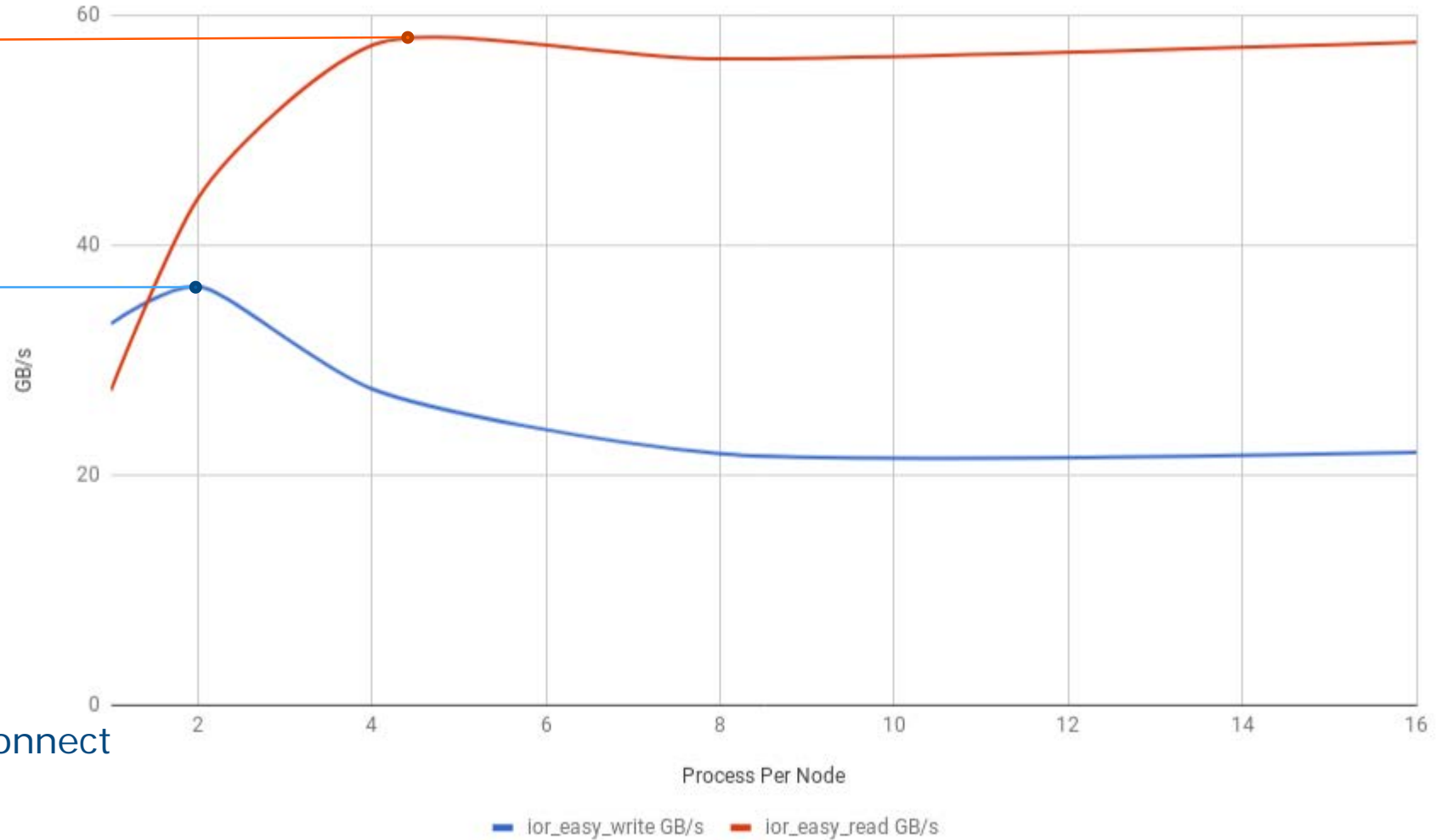**RSC BasIS integrated software stack for system monitoring and management**
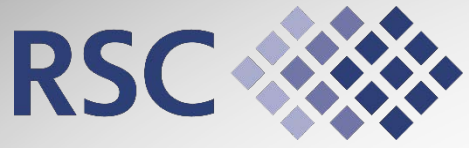
RSC Lustre Storage-on-Demand io500 benchmark results

56 GB/s easy_read ior test

36 GB/s easy_write ior test

Configuration:

- 1 x MDS
- 12 x OSS (6 x 1TB NVMe SSD)
- 24 Clients to load Lustre
- 100GBps Intel Omni-Path interconnect

JINR system in IO500 rating results

RSC

vl4lo — Virtual Institute for I/O

| Lists | Call for Submission | News | Radar Chart | Submission |

IO-500

This is the official list from 🌐 ISC-HPC 2018. The list shows the best result for a given combination of system/institution/filesystem.

IO500

#	information						io500		
	system	institution	filesystem	storage vendor	client nodes	data	score	bw	md
								GiB/s	kIOP/s
1	Oakforest-PACS	JCAHPC	IME	DDN	2048	zip	137.78	560.10	33.89
2	ShaheenII	KAUST	DataWarp	Cray	1024	zip	77.37	496.81	12.05
3	ShaheenII	KAUST	Lustre	Cray	1000		41.00*	54.17	31.03*
4	JURON	JSC	BeeGFS	ThinkparQ	8		35.77*	14.24	89.81*
5	Mistral	DKRZ	Lustre2	Seagate	100		32.15	22.77	45.39
6	Sonasad	IBM	Spectrum Scale	IBM	10	zip	24.24	4.57	128.61
7	Seislab	Fraunhofer	BeeGFS	ThinkparQ	24		16.96	5.13	56.14
8	Mistral	DKRZ	Lustre1	Seagate	100	zip	15.47	12.68	18.88
9	Govorun	Joint Institute for Nuclear Research	Lustre	RSC	24	zip	12.08	3.34	43.65
10	EMSL Cascade	PNNL	Lustre		126		11.12	4.88	25.33
11	Serrano	SNL	Spectrum Scale	IBM	16		4.25*	0.65	27.98*
12	Jasmin/Lotus	STFC	PanFS	Panasas	64	zip	2.33	0.26	20.93

Values with indicate that a value for the computation was missing.*

Further lists with more detail can be found on the navigation menu. For example, a list with radar chart and configurable scoring.

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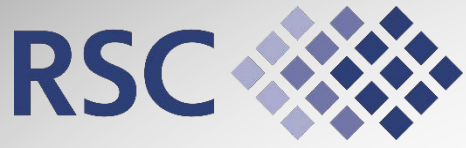
Top projects

- **Joint Institute for Nuclear Research** (JINR)

- **Saint Petersburg Polytechnic University** (SPbPU)

- **Russian Academy of Sciences** (JSCC RAS)

- **Siberian Supercomputer Center** (SSCC SB RAS)

- **South Ural State University** (SUSU)

- **Institute of Oceanology of Russian Academy of Sciences** (IO RAS)

- **Russian Weather Forecast Agency** (Roshydromet)

- **Moscow Institute of Physics and Technology** (MIPT)

- **Aviation Industry, Energy sector, Computer Graphics, Oil&Gas**

- … and many others

Over 4.5 PFLOPS
of installed base of innovative liquid cooled supercomputers

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