RSC Group
Liquid Cooling Solution: Controls

EE HPC WG
Teleconference
June 18, 2015

Outline

- **RSC Introduction**
- **Liquid cooling technology:**
  - **RSC Tornado, RSC PetaStream,**
  - **Past and Ongoing projects**
- **Controls:**
  - **Climate considerations**
  - **Solution outline**
- **Future work**

RSC

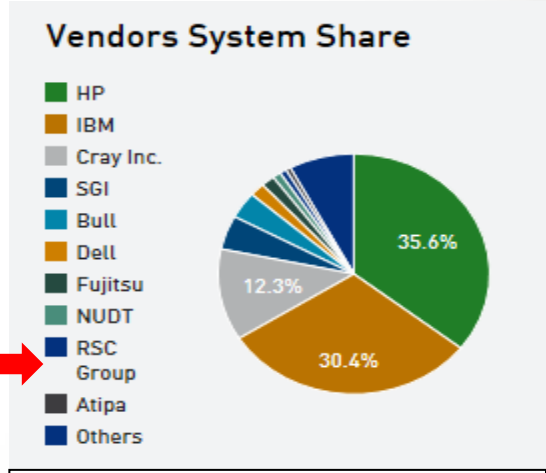
Specialization. Since 2009

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

Cutting-edge supercomputers and data centres for demanding customers

Strong Market Position

- **Leading** HPC solution provider in **Russia/CIS**
- Key installations in Russia according to **local Top50** list - **5 systems** with RSC liquid cooling, **2.5+ PFLOPS** in total
- **One of the key** HPC players in **EMEA**
- In **Top10 worldwide** by Top500 list (#9)
- **First two Intel® Xeon Phi™ projects** in Europe and outside the USA (ranked by Top500)



Source: Top500.org (November, 2014)

RSC: top projects

Saint Petersburg supercomputing Center

- Aggregate performance – более 1,1 ПФЛОПС (РСК Торнадо и RSC PetaStream)
- The most modern and one of the largest supercomputer centres in Russia
- Hybrid cooling with direct liquid cooling technology

Joint Supercomputer Center of Russian Academy of Sciences

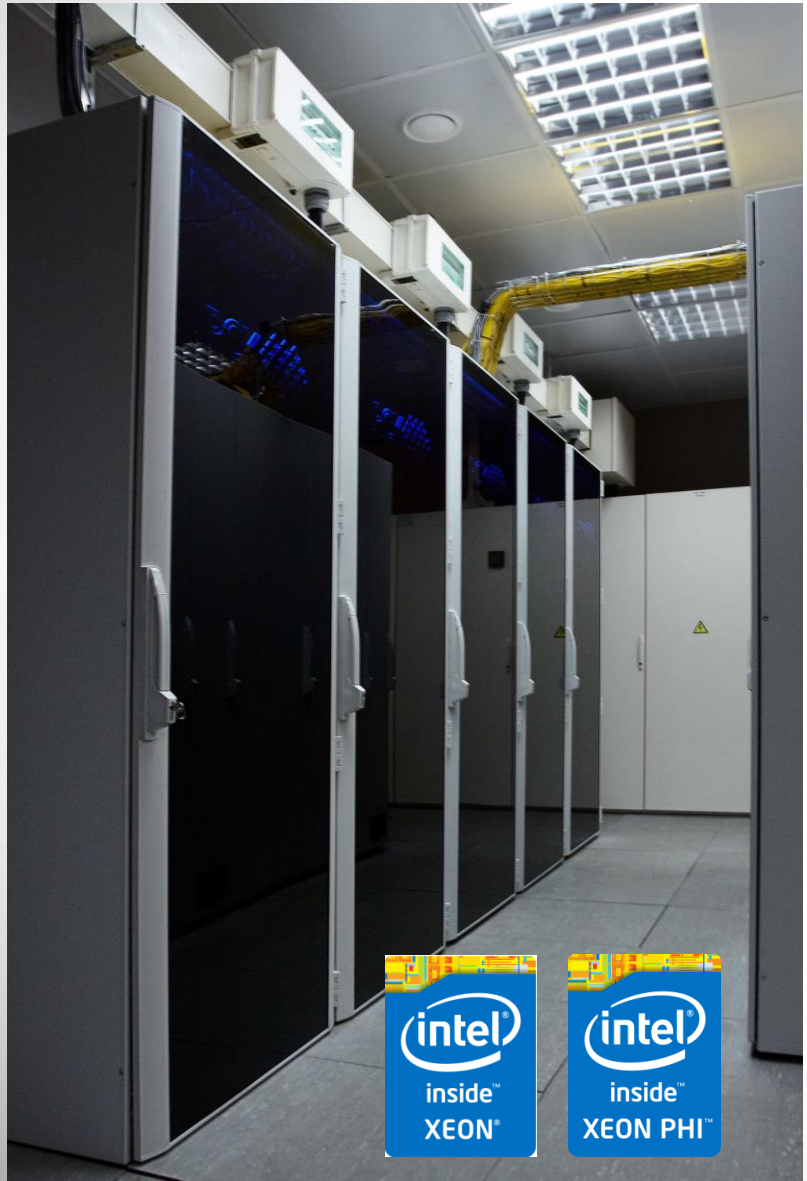
- Aggregate theoretical performance – over 600 TFLOPS
- MVS-10P - Y2012 , first adopter of Intel Xeon Phi outside of USA
- MVS-10P MP – massively parallel RSC PetaStream, Y2014

Roshydromet

- Micro DC solution
- Compact (2 sq.m. datacenter footprint , energy efficient (PUE <1.06)
- Used daily for weather forecast.

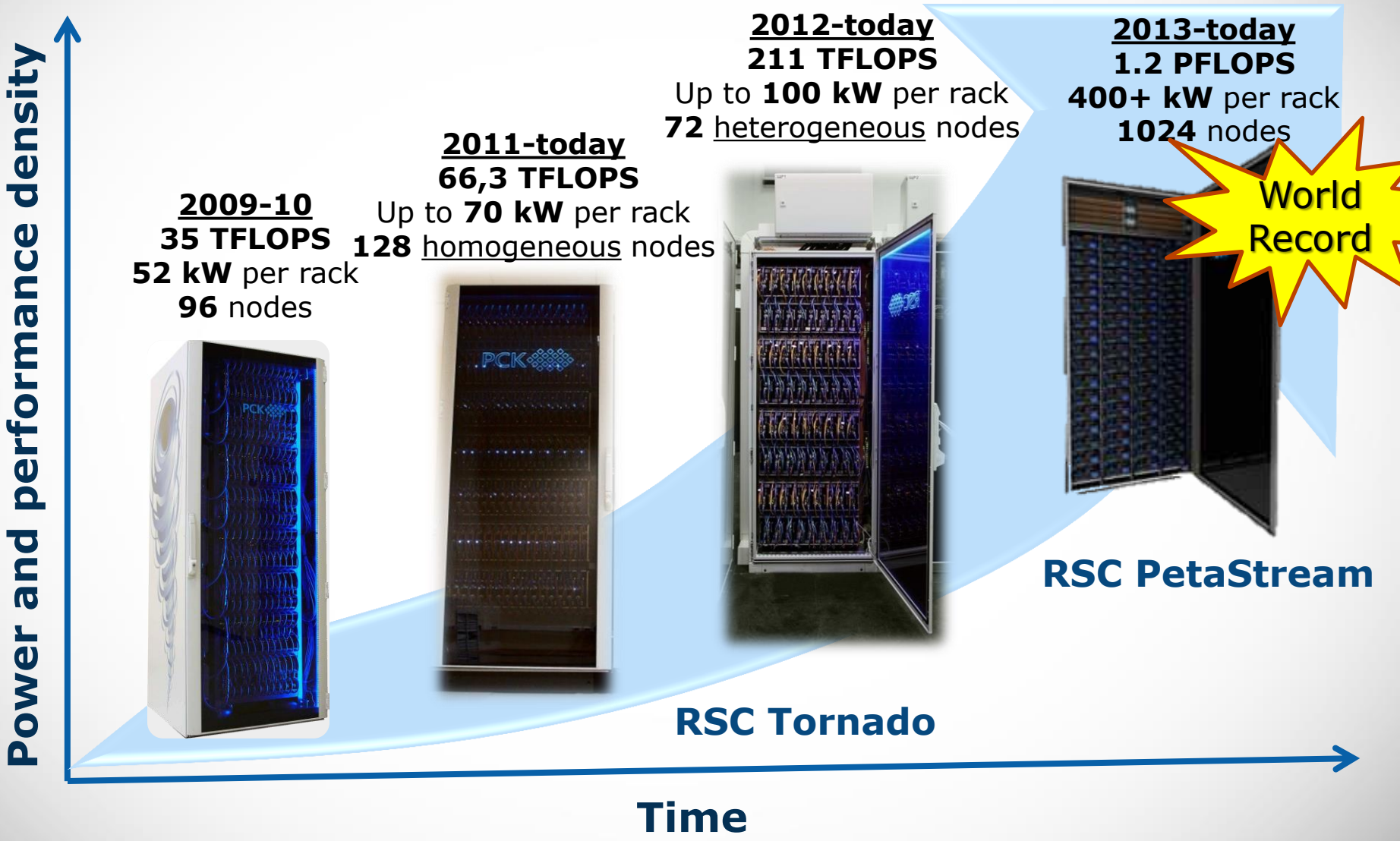
- **and others, incl. customers from aviation, energy sectors, computer graphics, oil&gas**

South Ural State University

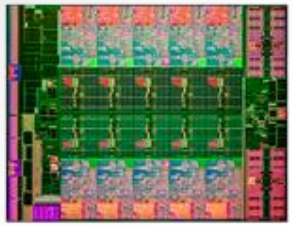


- **First deployed in 2009, upgraded in 2011-2013**
  384 Nodes
  - 2x Intel Xeon X5680 @ 3.33GHz (130W TDP)
  - 1x Intel Xeon Phi coprocessor SE10X (300W)
  - 24/48GB DDR3R-1333 RAM
  - QDR Infiniband, Fat-tree. Lustre FS
  - Panasas (including native mount on MIC)
- **Ratings**
  - #127 in Top500 (Nov'13)
  - #64 in Green500 (Nov'13), max #40
  - #2 in Russia by energy efficiency level
  - #4 in Top50 (Russia/CIS)
- **Sizing**
  - 7 compute racks, 3 support racks
  - 50 sq. m./350KW
  - 473.6 TFLOPS Rpeak,
  - 288.2 TFLOPS Rmax (HPL)
  - 980 MFLOPS/W

RSC Technology Evolution



RSC Tornado cluster solution



Processor
- Intel® Xeon® E5-2600 v3
- Up to 18 cores x86 with 36 threads
- 0.66 TFLOPS (Peak)
- 68 GB/s peak mem. BW
- 45 MB shared cache

Compute node
- Two compute chips
- Up to 128GB of DDR4-2133 RAM
- 1 integrated IB (FDR/QDR) up to 56 Gb/s
- 1 addon PCIe Gen3 x16 IO card
- Direct liquid cooling of all components
- OS: Linux, Windows
- Virtualization: Hyper-V, VNware, Xen, KVM

+

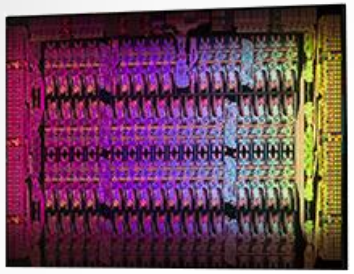
RSC Tornado Expansion Pack:
- HPC Expansion Pack
- BigData Expansion Pack
- VDI Expansion Pack
- Security&Protection Expansion Pack
- Connectivity Expansion Pack
- SDM Expansion Pack
- and more, available by request

Intel Cluster Ready

Complete solution
- Scales to many PFLOPS
- Modular: tailored to customer's needs
- Flexible network options
- Based on COTS components

Compute cabinet
- Up to 269 TFLOPS Peak performance or 128 fastest servers
- Intel Xeon E5-2600 v3 family processors, v4 family upgrade ready
- Fully integrated software stack for HPC and Cloud "RSC BasIS"
- Single System Management and Monitoring Point
- 0.64m2 / 6.9 ft^2 footprint

RSC PetaStream outline



Processor
- Intel® Xeon Phi™
- 61 x86 cores / 244 threads
- > 1.2TFLOPS peak perf.
- 352 GB/s peak mem. BW
- 30 MB shared cache

Compute node
- Intel® Xeon Phi™ 7120D
- One compute chip
- 16GB of RAM
- 64Gbps IO bandwidth
- Linux µOS

Compute module
- 8 compute nodes
- Over 200 Gbps external IO bandwidth
- Direct liquid cooling of all components
- Integrated node management
- Effective DC 400V power system

System
- Path to ExaScale
- Proven RSC Direct Liquid Cooling Technology
- Scalable/modular: tailored to customer's needs
- Flexible network options
- Based on COTS components

Cabinet
- Over 1.2PFLOPS peak performance
- 250K threads / 1024 nodes
- Up to 400 kW
- Integrated management
- $1 m^2$ / $10.8 ft^2$ space

Controls problems

- Russia climate:

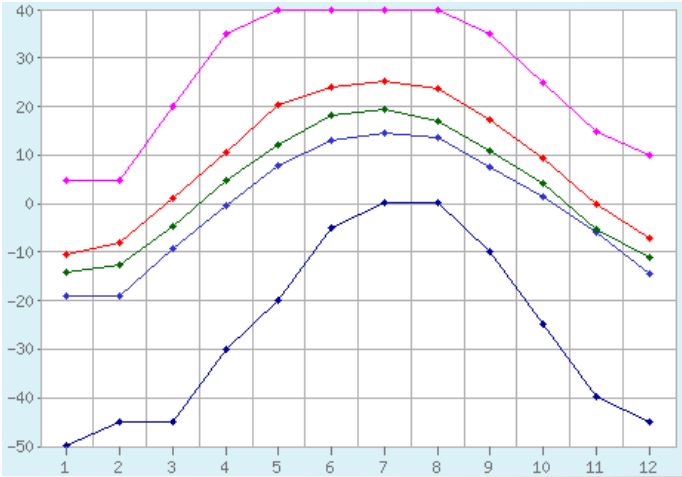
  +40 / -40 Celsius during the year

  (e.g. Chelyabinsk)

  -- absolute minimum – -48,7C

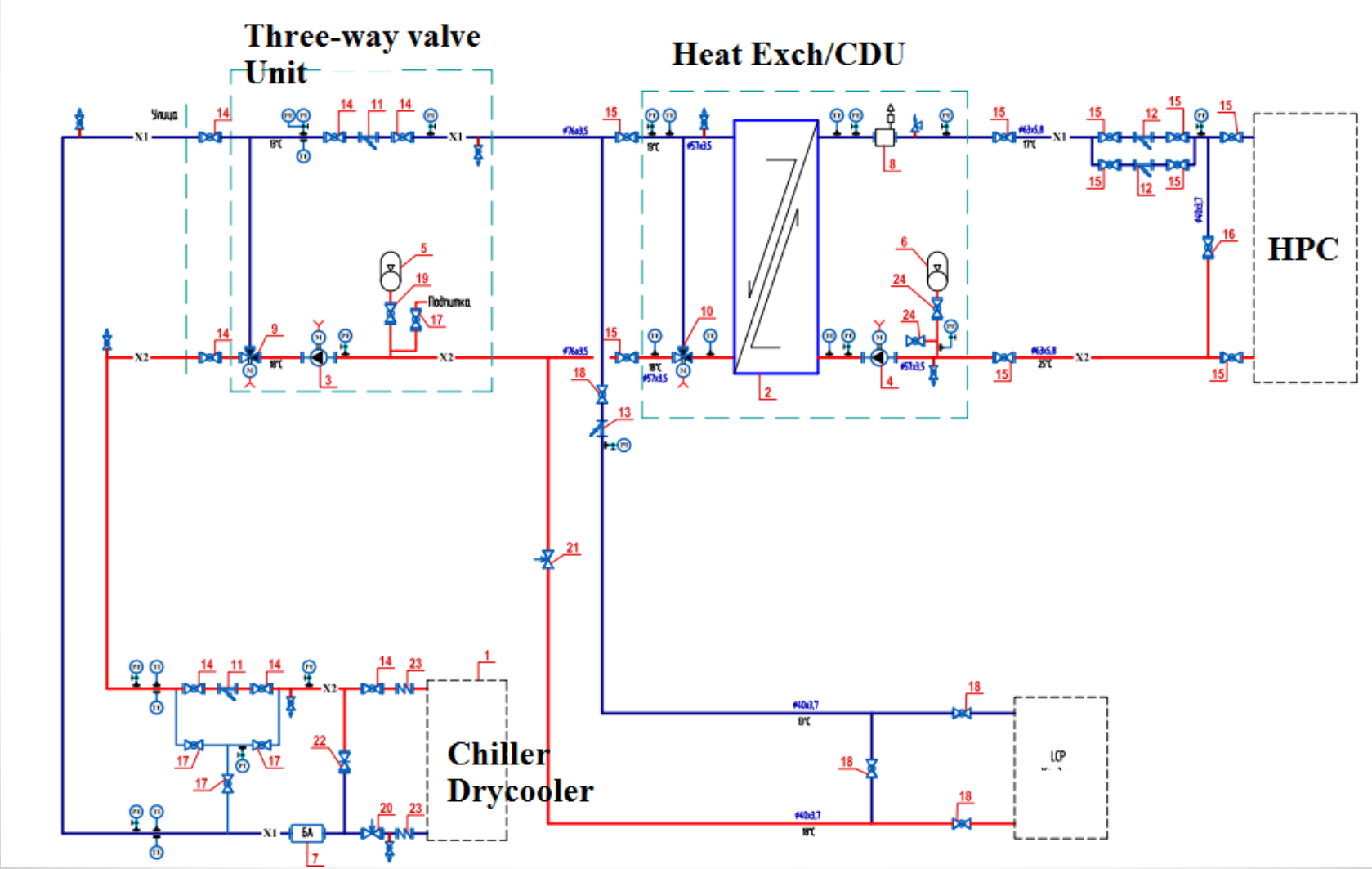
  -- absolute maximum – +39.2C

- Freecoling problems:
  - Freezing temperatures
  - Avoid dew point



- **Leakage containment**

Basic system design



Example: start at -40C

- **Cannot start outdoor loop – will freeze inner water loop**
- Start indoor loop first
  - Expect some load/heat from HPC
- Start outdoor loop
- Use three-way valve to add cold (outdoor) liquid to heat exchanger
- Manage indoor loop temperature to avoid dew point
  - Add cold liquid as necessary
- Avoid overheat in inner cycle

Future work

- Next generation liquid cooling platform (follow announcements)
  - “Hot” water – no adiabatic process is needed
  - Peer-to-peer network for ad-hoc management
- “Graceful” degradation as a response to infrastructure component failures (e.g. power capping)
- Power capping for energy efficient application execution

Thanks

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