It`s the size of science & research......
....which makes a cluster really big.

It´s the type of management ....which makes clusters really smart.
....which makes a cluster really big.

It´s the type of management
....which makes clusters really smart.

It´s the type of innovative technology
....which makes clusters really cool.
agenda

company and value
    clustervision

innovative cooling technologies
    overview
    principle
    advantages
    considerations
    energy savings & potential management
100% Focus
on HPC Cluster Solutions

customer specific
turnkey
ready for the application
Europe’s **Dedicated Specialist** for Cluster Computing

**Dedicated**
- 100% undivided HPC focus with personal attention to the finest detail

**Complete**
- a rationalised one-stop partnership for all systems, software and services

**Solution**
- a full end-to-end service addressing your complete cluster ownership needs
Europe’s **Dedicated Specialist** for Cluster Computing

**Connected**
- direct access to the widest range of high-quality branded components, networks and partnerships

**Independent**
- truly impartial advice on products, technologies, concepts throughout the whole hpc-market.

**Consultative**
- individually customised solutions to meet specific customer requirements ..
Europe’s **Dedicated Specialist** for Cluster Computing

**Scalable**

- flexible to individual needs but capable for large-scale projects

**Experienced**

- proven success with some of the largest and most complex clusters in Europe, background from research & education, ca. 50 HPC experts in Europe build a big HPC team

**Organised**

- Dutch company, with headquarter in Amsterdam, centrally based to address our customer markets in Europe
Europe’s **Dedicated Specialist** for Cluster Computing

**Scalable**
- flexible to individual needs but capable for large-scale projects

**Experienced**
- proven success with some of the largest and most complex clusters in Europe

**Organised**
- centrally based to address our customer markets in Europe
End-to-End Cluster Solution
Complete Cluster Solution

Design, Build, Manage
Systems, Software, Services
End-to-End Cluster Solution

Benefit

*Upfront consideration of the long-term needs enables qualified decisions about total ownership cost and long-term sustainability*
End-to-End Cluster Solution

Design
Build
Manage
Service

Replacement...
Capability Assessment

Enhancement
New System Design

Repair Escalation
Specification

Maintenance
Compatibility

Education
Proof of Concept

Support
Assembly

Analytics
Configuration

Management
Provisioning

Certification
Benchmarking
Complete Cluster Solution

Benefit

Achieving optimum cluster performance requires the harmonious combination of a complex mix of systems, software and service components.
**Complete Cluster Solution**

- Systems
- Software
- Services

- Support, Maintenance
- Skills Training
- Administration
- Start-up
- Applications
- Analytics
- Bright Cluster Manager
- Development Tools
- SW Environment
- CPU Processors
- GPU/Accelerators
- Servers (white)
- Servers (branded)
- Interconnect
- Storage (GPFS, Lustre, FhGFS)
- Racking
- Power, Cooling
- Cabling, Peripherals

ZKI-März-2013
High-Quality, Cutting Edge Technology Components

CPU Processors
GPU Accelerators
Servers – Proprietary
Servers – White-box
Switching, Interconnect
Storage & File-systems
Racking systems
Power, Cooling
Peripherals
Leading Brand Manufacturers

Benefit
• Trusted brands
• High-quality
• Proven capability
• Compatible components
• Reliable & Robust
• Active Warranty..
Customers — Academia

[Logos of various universities and research institutions]
Energy Efficient HPC Cluster at the Technical University Ilmenau, Germany

“Together, Dell and ClusterVision offered the specialised expertise we needed, and were able to provide a customised, detailed proposal.”

Hennig Schwanbeck, IT Manager of Datacentre Administration

TU Ilmenau, Germany

49 Dell PowerEdge R815 servers

AMD Opteron™ 6134 Processors

192 terabytes storage capacity

Reduced Consumption by 10-15%
Immersion cooling

Status Quo
• Most PUE factors of traditional datacenters are often near to 2.
• Energy factor for cluster is GFlop/Watt
• Traditional datacenter air cooled
• Todays HPC cluster air cooled in water cooled racks for high density
• Usual Water temperatures are 6-9 °C, 12-18 °C, 15-20 °C.
• Cooled by compressors/chillers
• Free cooling only possible at 14-16 °C outside temperature

General tendencies in HPC datacenters
• Increasing Rack-Server input temperatures up to 45 °C
• Direct water cooled servers
• Immersion cooling. (hot-oil)
Immersion cooling

Goal:

• Save compute server energy

• Enabling free cooling at all times.

• Save investment for compressed chiller environment

• Best is reuse the heat for house-heating or warm water supply.

This demands a higher level of water temperature up to 55 °C
Immersion cooling

Air-cooling at 45 °C within water cooled racks
- Servers are operated at an input temperature of 45°C, output 60°C
- Water cooled racks. (side-cooler, housing, backdoors).
- Output of 60°C degrees is a challenge for HPC system
- Water cooled racks can be integrated in every traditional datacenter.

Direct water cooled servers (CPU and/or memory)
- Available from a few special vendors
- Cooling infrastructure is integrated and directly linked to the server & lifetime.
- Cost of server,
- water-quality and handling.

Immersion
- uncomplex cooling and operating environment
- reusable for 2-3 lifecycles.
- open for many vendors
- Simple handling of servers, but strange on the first view
- Integration and feasibility in datacenter has to be checked and evaluated
Air 45 C in water cooled racks
Direct water cooled systems
The CarnotJET™ System

4 x 60U CarnotJET™ configuration
The CarnotJET™ System
System Configuration

**OEM Server**
- several vendor servers available
- standard chassis and motherboards
- identical CPU und Memory, SSD`s and cables (copper or fiber-optic)

**CarnotJet™ 42U Rack**
- Rack Container with immersion fluid
  - 100% heat handling
  - reusable rack
  - no air-cooling
  - non toxic und natural cleanable mineral oil

**Quadro Configuration**
- Intelligent Monitoring/Managing system
  - alarm/Monitoring Software
  - connection to fire protection system
Heat rejection schema

- 25° - 50° C Water
- Pumps and Control
- CarnotJet™ Rack
  - OEM Servers

Outdoors

Indoors
Saving potentials

Data Center Cooling + Server Power: Air-Cooling vs. Green Revolution Cooling

- Air-Cooling Power
- Free cooling
- Rack-fans

Existing Data Center
- Server Power with Fans and components at high heat

The CarnotJet System
- Server Power without Fans and components at lower heat

- GRC Total Cooling Power

Deutschland, Hamburg

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Deutschland, Paderborn

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Deutschland, München

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clustervision

ZKI-März-2013
Immersion cooling

Features

- Heat capacity and transfer 1200 x higher than air
- Server operation and cooling at high temperatures of 45 °C and greater.
- Temperature and thermal load of server components lower than 45 °C air
- Standard server or components available for immersion cooling
- Diskless or SSD
- Uncomplex and simple technology with low requirements and operation cost
- Oil capacity is used for buffering in case of cool water outage
- Redundant oil pumps

- Normal repair after drain off the oil
- 100% cleaning with ultrasonic device
- Integration in existing datacenter like water-cooled racks
- 10-20% savings due to no fans and lower component temperatures
- Proven cooling technology in electric transformers since 20 years
Immersion cooling

Checkpoints & challenges

- Oil regulations in Germany
- Fire extinguish system
- Combustion point 177 °C - 200 °C, if an external fire exists.
- No internal fire source of servers
- No paste between heat sinks.
- Oil reduces flexibilizer of cables
- Professional cable management
- Datacenter environment
  - Retention basin
  - Elevated tracks, floor load
  - Bridgework
  - Pumps near rack container
  - 600 Watt/rack air heat
  - Oil exhalation
  - Others?
Immersion cooling

More advantages

Server-reliability
• improved memory dimm contact
• no vibrations
• no Hot-Spots
• lower heat load of components

Speed
• internal cpu overclocking is more likely
• external cpu overclocking for high frequent trading usual

Space
• high number of server-chassis per rack per qm²
• very high number of servers in motherboard only configurations
• quad configuration with 60U Racks und 65 KW available
• datacenter space optimisation
Datacenter space partitioning

- **Side cooler**
  - 672 Server in 336U
  - 24 m² (28)

- **Back-Door**
  - 672 Server in 336U
  - 20 m² (31,6)

- **Immersion**
  - 720 Server in 360U
  - 880 Server in 440U
  - 24-28 m² (31-44)
Cluster Management Integration

Cluster Management

ProvisioningNode01  ProvisioningNode02  FabricNode01  LoginNode01  LoginNode02  LoginNode03  LoginNode04  node001  node002  node003  node004  node511  node512

Storage001  Storage002  Storage015  Storage016  HeadNode02  HeadNode01  node001  node002  node003  node511  node512

MonitoringNode01  MonitoringNode02

SNMP
Bright Cluster Manager
Advanced HPC cluster management made easy

Cluster provisioning from bare metal
System monitoring & healthcare
Automated recovery alerts and actions
Integration with workload managers
User group management
HPC development environment
Automated cluster security
Cloud bursting for Amazon EC2
Case Study: CGGVeritas
Case Study:

Facts:

Size:
- 24 racks installed, 24 more in next year
- Servers in production since 6/2010
- 13U evaluation unit: 11/2010

Total Cooling Power:
- <10% of server power

Servers:
- Submersion-ready servers from Supermicro®
- Modified upward facing cables
- 18% lower server power w/ fan removal

January
Evaluation Unit installed at CGGVeritas

June
Six Racks and two Pump Modules installed in first data center

November
Four Racks and one Pump Module installed in second data center

2011

April
Evaluation period ends, CGGVeritas orders pilot system

August
Two Racks added to original six, now four Racks per Pump Module
References

- TU Vienna (trial) ongoing since January 2012
- Intel evaluation 6 month in 2011
- CSCS in Lugano 12 month 2010/11
- Industry customer in Amsterdam 2012 (nda)
Conclusion

Less expensive to buy, less expensive to own

- Less expensive than air cooling, upfront *and* long-term
- Reduce cooling power by 95%, overall data center power by 50%
- Cool dense loads up to 60-100kW per rack