

Open Source Monitoring Software for Open Source Hardware

Jon Summers

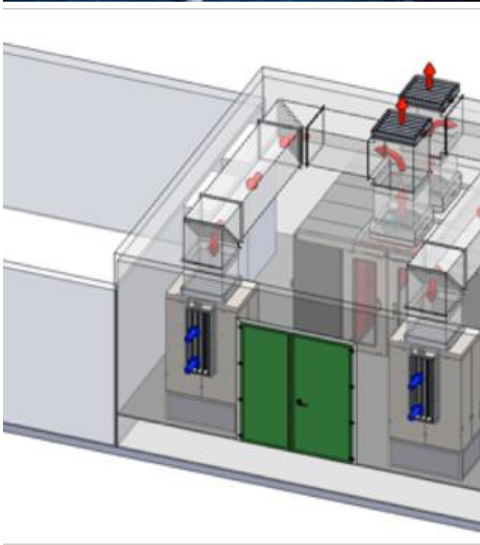
Scientific Leader at RISE SICS North, Sweden

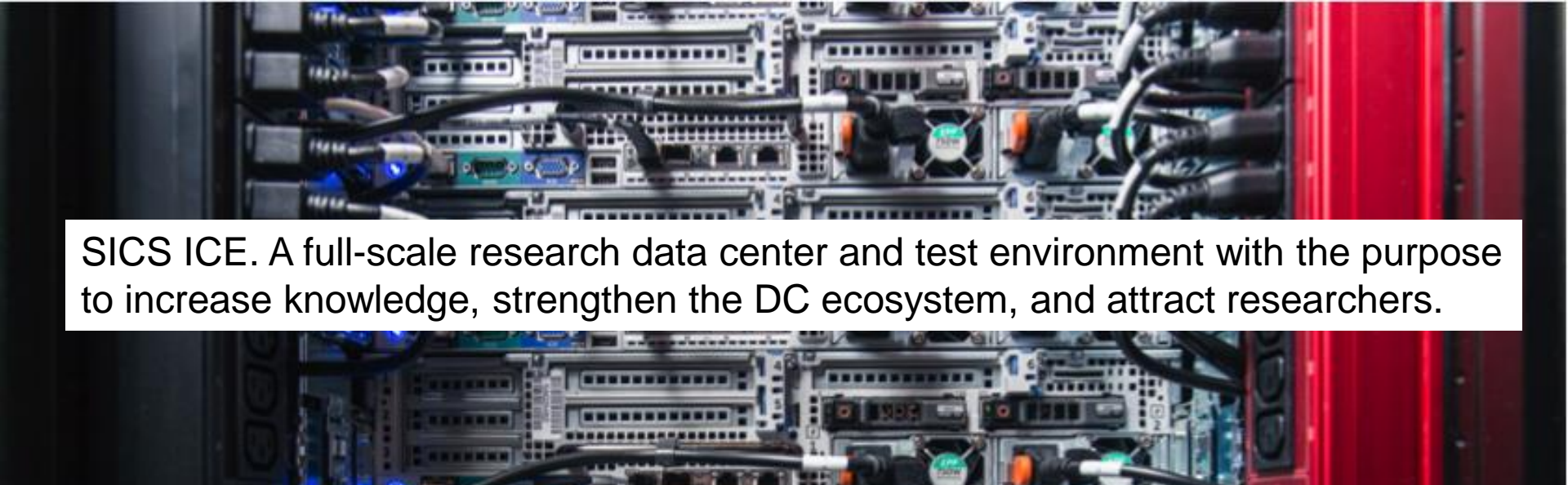
Adjunct Professor in Fluid Mechanics at LTU, Sweden

Senior Academic in Thermofluids, University of Leeds, UK

Agenda

- Introduce RISE ICE
- The BodenType data center project
- Open source monitoring
- Open source hardware
- OCP systems operations
 - Fans
 - Wind Tunnel and results
 - Workloads
- Use case of the monitoring system.
- Summary





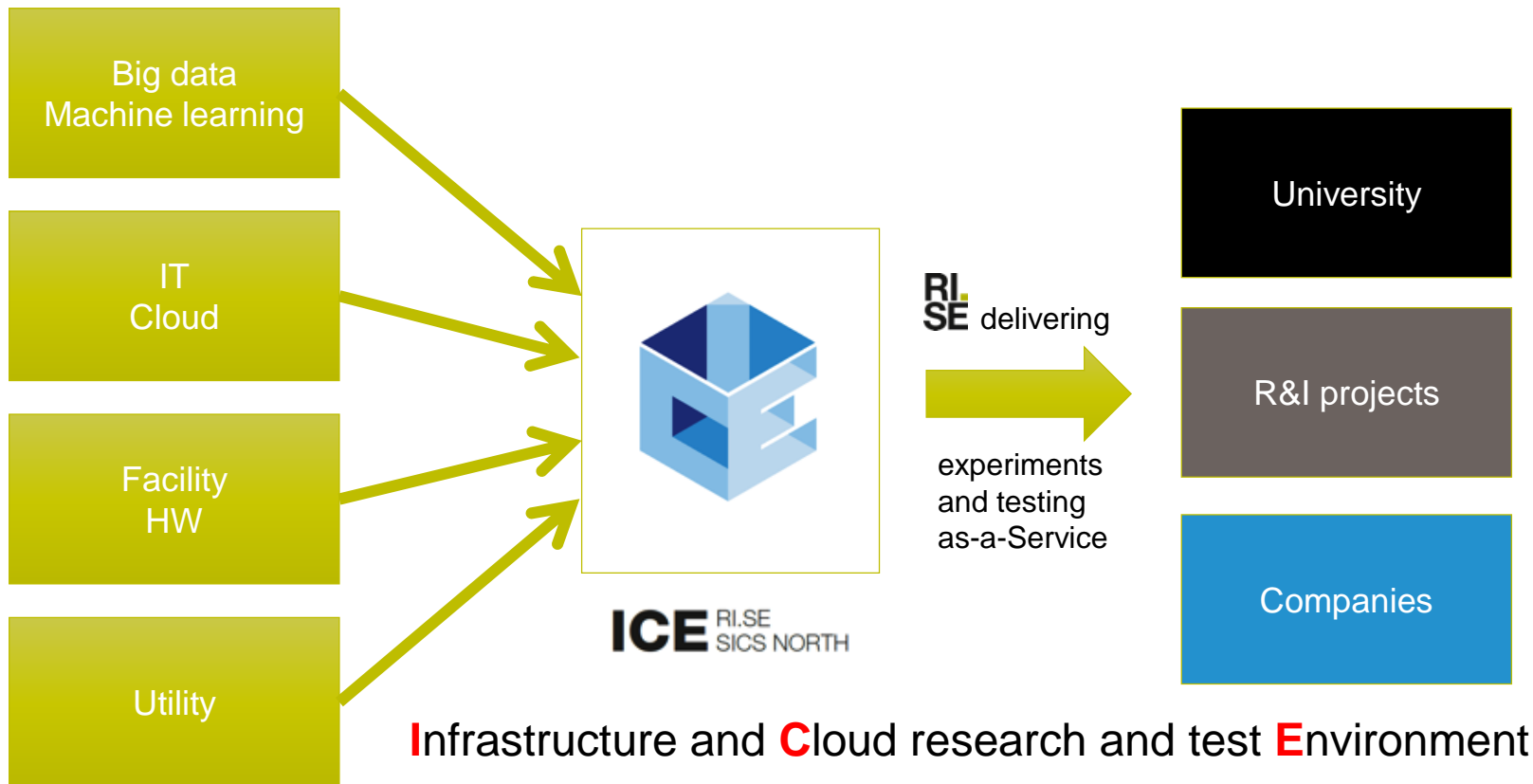
SICS ICE. A full-scale research data center and test environment with the purpose to increase knowledge, strengthen the DC ecosystem, and attract researchers.



2000 physical servers
250 kW
200 TB RAM
Upto 10 petabyte storage
40 000 cores
80 GPUs
HDFS clusters
OpenStack ECC
OCP servers

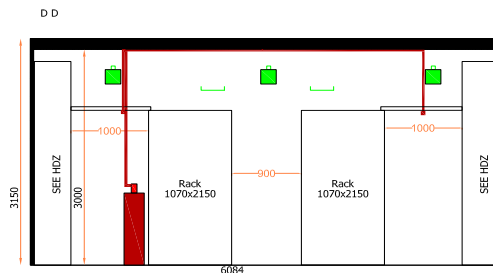
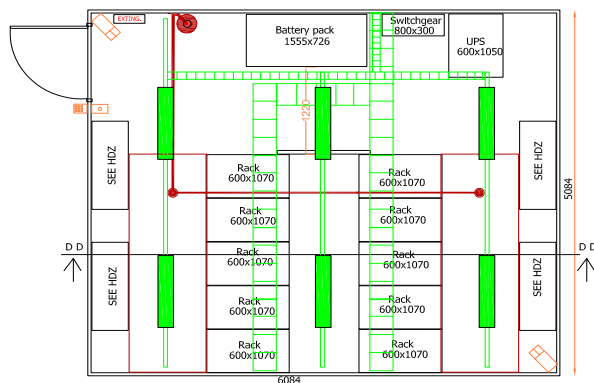


Business model



ICE - Module 1

Web-scale Data Center Lab



"Ordinary" web-scale data center with optimized and stable environmental conditions

Mainly for datacenter monitoring and modeling and testing of data analytics and IT/cloud-related applications

- 7000 cores, Dell R730
- 40TB RAM
- Up to 7PB storage
- 80kW
- 10/40 Gb/s network
- Separate management network
- GPU accelerated Hadoop clusters
- 80 GPUs, 3 Supermicro GPU servers
- Openstack racks for ECC
- One OCP rack with 40 OCP windmill servers

ICE - Module 2

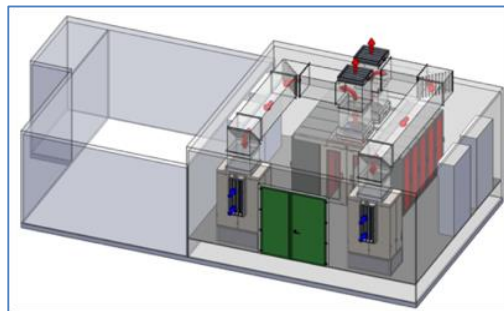
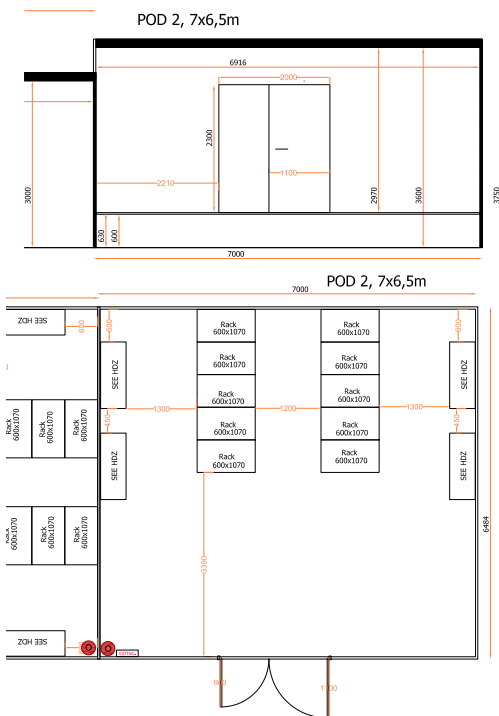
Data Center Facility Lab



A flexible data center facility lab, with unique possibilities to vary environmental conditions

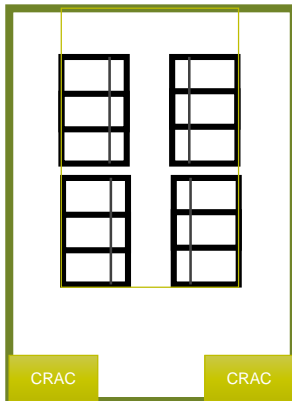
Mainly for testing of data center facility installations and equipment

- Dell servers R530/430
- SICS East HPE cluster, HOPS staging cluster, Nyx Hortonworks cluster
- Prepared for both liquid cooling and free air cooling solutions
- Quick couplings for water, power and fiber
- Flexible raised floor solution to be able to compare with slab floors – reconfigurable.



ICE – Module 3

Open Compute Project Lab



A flexible data center facility lab,
focused on OCP equipment

Mainly for testing of data center
facility installations and OCP
equipment

- OCP windmill servers
- 480 servers / 155 kW
- Prepared for free air cooling
- AC/DC power distribution using Triliogy HPDUs
- OCP Winterfell servers

ICE – Experiment area

Micro grid – Edge – Liquid - Wind tunnels



An experimental area for edge datacenter integration with a smart electrical micro grid and cooling network

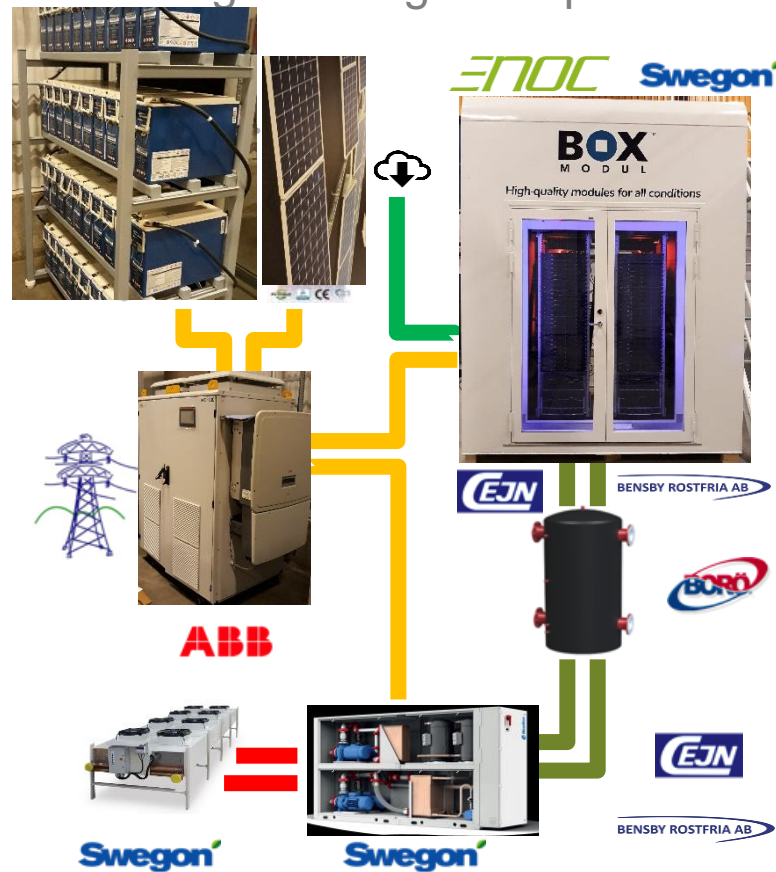
Mainly for testing of data center facility integration, peak shaving, operations

- 10 kW solar panels
- 30 kWh electricity storage
- 22 kW cooling power
- 2 m3 cold water storage
- 10 kW IT-load

Wind tunnel for pressure, temperature and airflow analysis at rack level

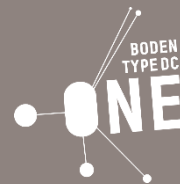
Wind tunnel for pressure, temperature and airflow analysis at server level

Immersion based liquid cooling experimental set-up for LTU



Boden Type Data Center H2020 Project

- The Boden Type Data Center (BTDC) project is funded by the EU
- To build the most cost and energy efficient sub 1MW **probably** prototype data center in the world!



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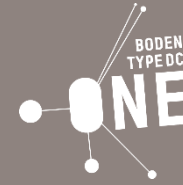
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- Three Data Center PODs
- Designed for 500kW
- OCP Test POD will take contents of RISE North Module 3
- POD2 and 3 are designed for HPC/GPU donors for a target 350kW.



BodenType DC H2020 Project

- Rapid growth in data center energy consumption in Europe from 86TWh in 2013 to an anticipated 104TWh in 2020 (reference P.Bertoldi from the EU JRC).
- Aim of BodenType DC project to build a prototype data center that is energy efficient – needs a **comprehensive monitoring and measurement tool**.
- Efficiency is focussed on reducing power losses – no UPS, reducing cooling power consumption – using direct air (measured comparison with other methods) and better utilization of the IT systems – workload deployment and management.



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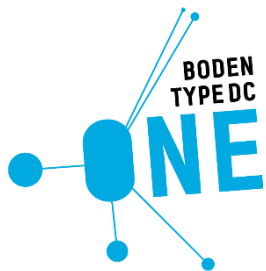
- The Project partners are:



Construction of the Boden Type Data Center



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Time-lapse video of the Data Centre construction



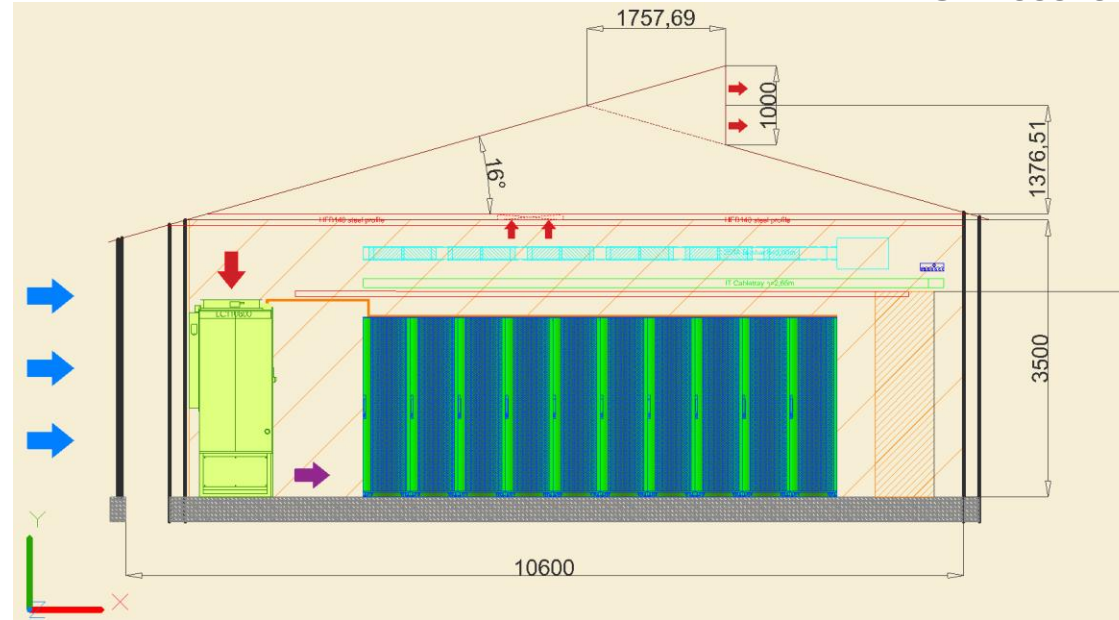
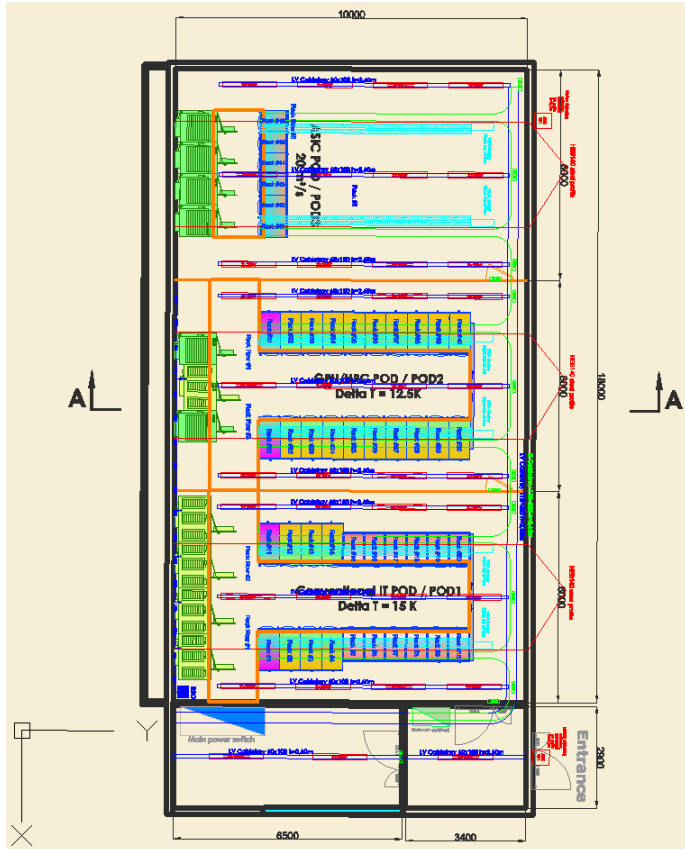
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Conceptual design of the Boden Type Data Center



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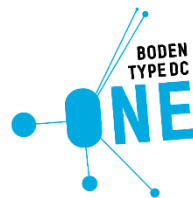


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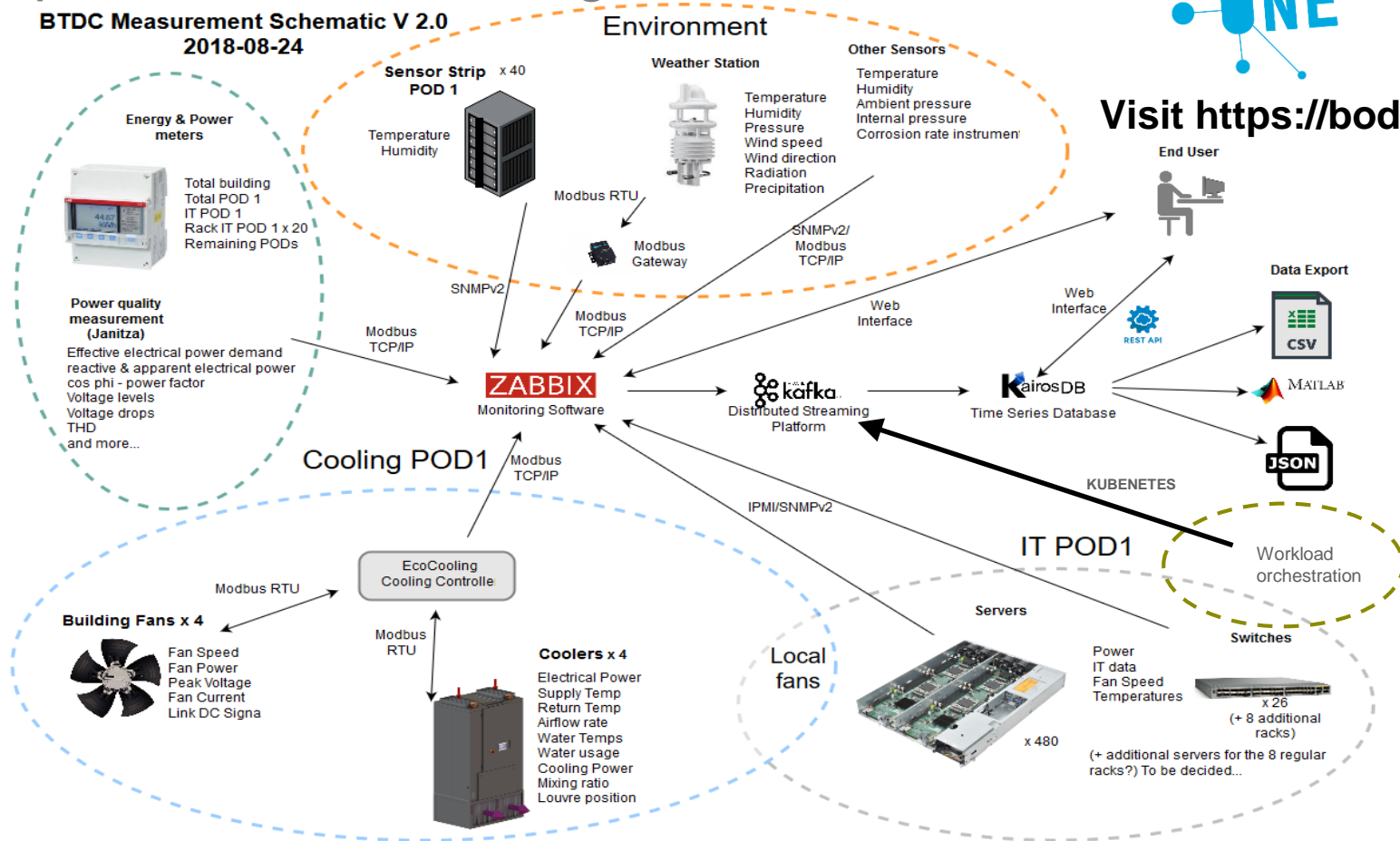
Open source monitoring of BTDC One

BTDC Measurement Schematic V 2.0
2018-08-24

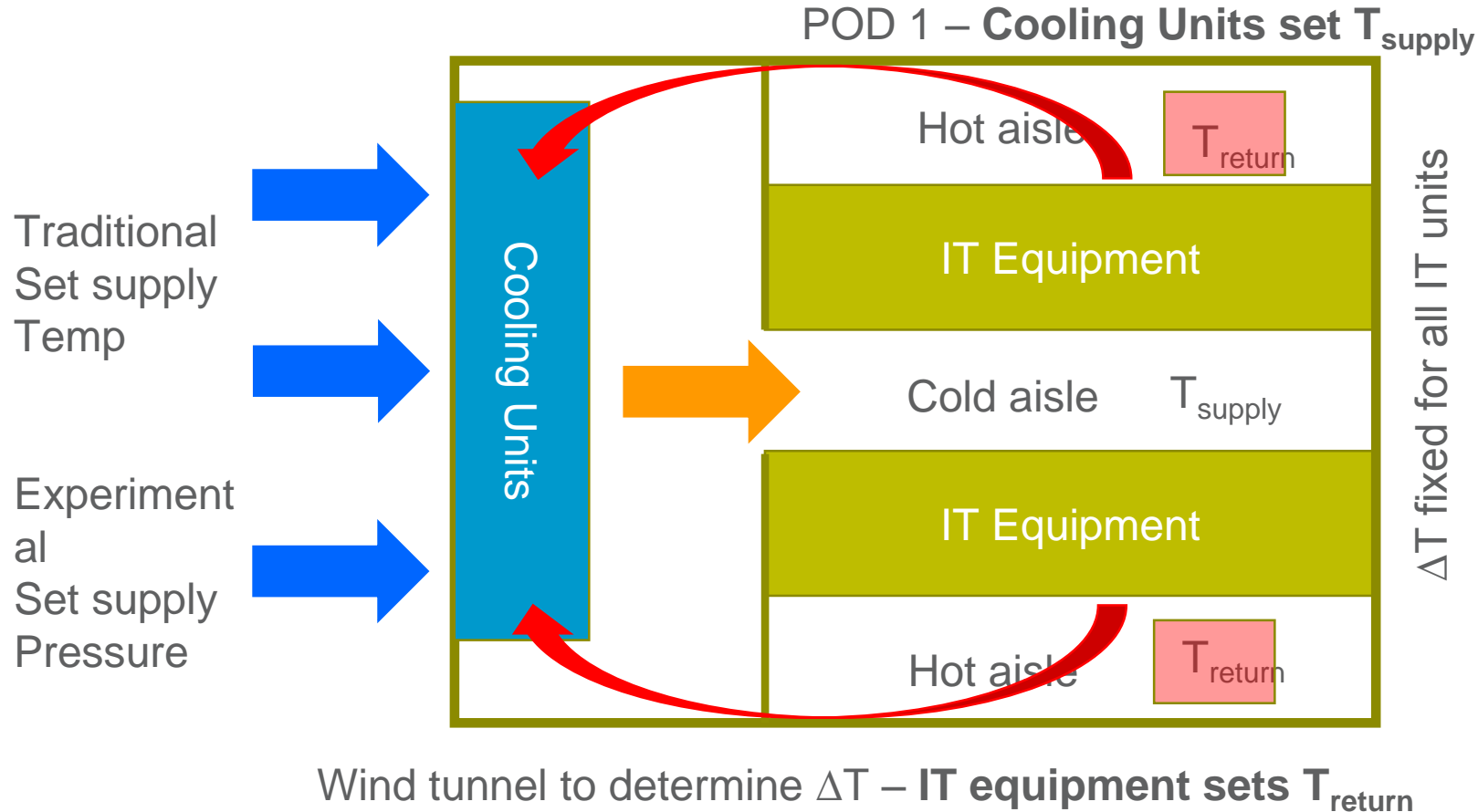


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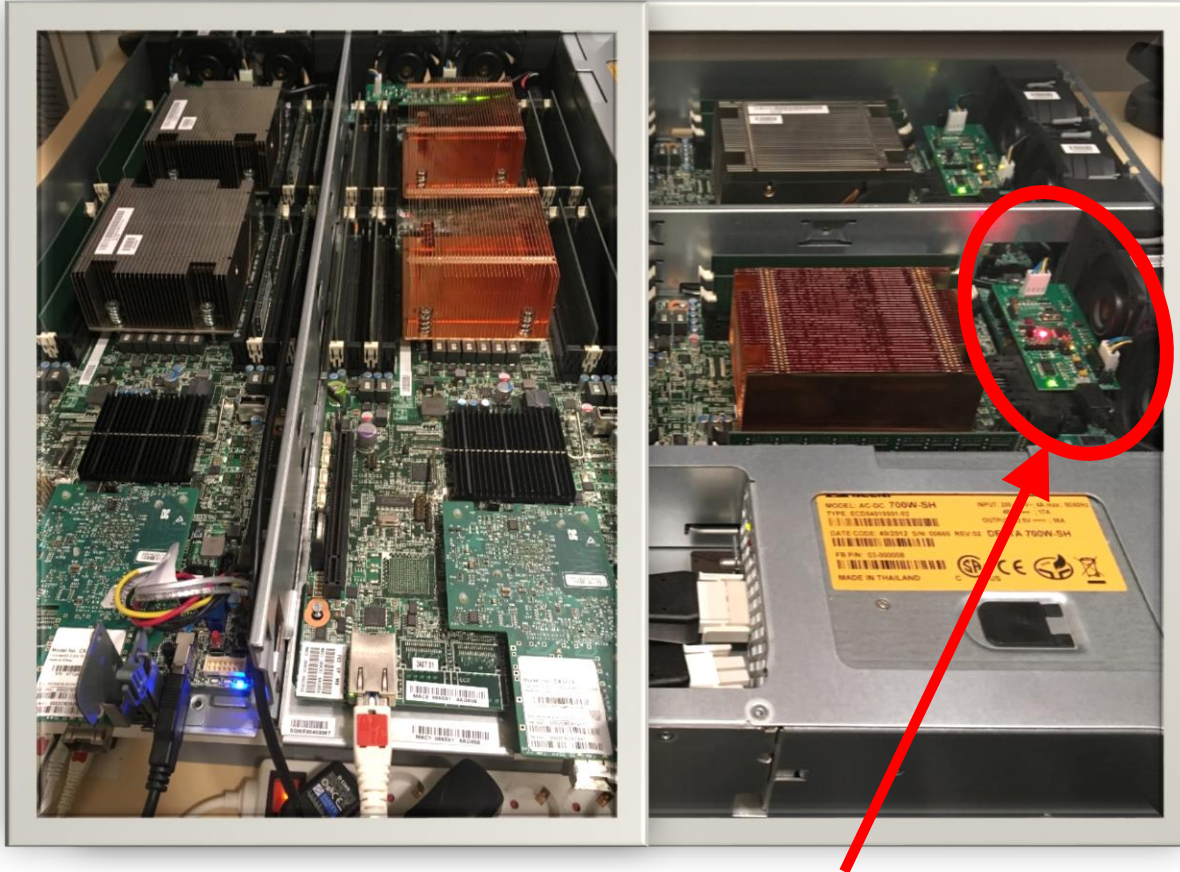
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Cooling innovation with the fan controllers



Heat sinks in OCP Servers

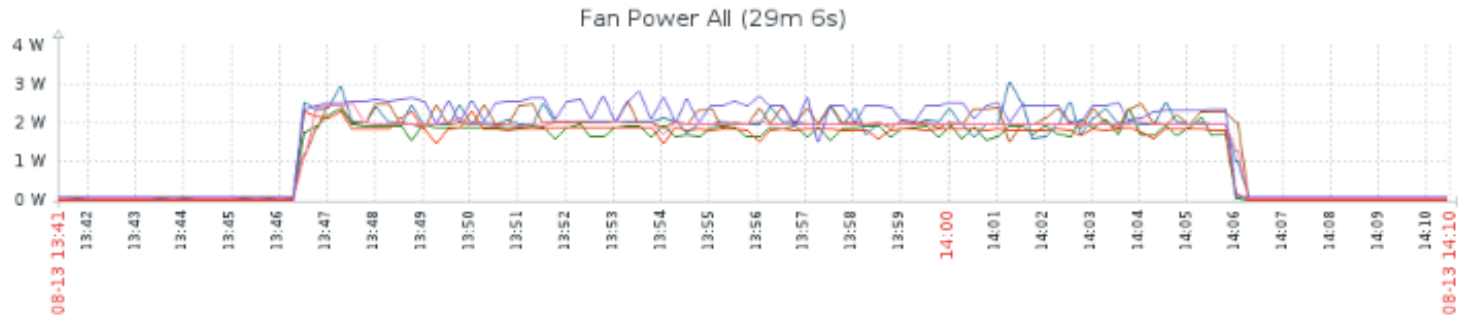
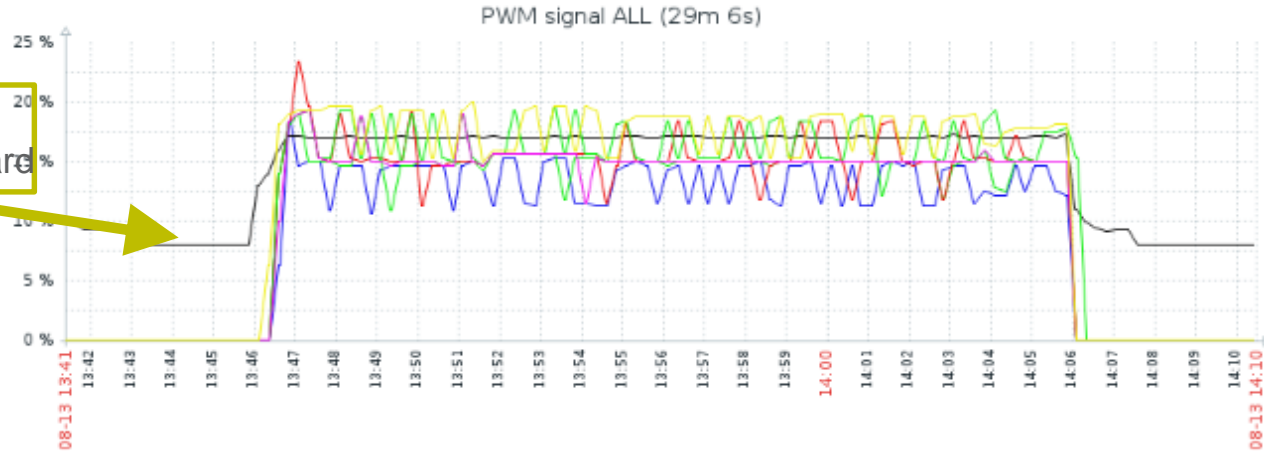


LOCALLY DEVELOPED FAN CONTROLLER

- Replaced aluminium heat sinks containing embedded heat pipes with copper heat sinks.
- Aim to achieve lower flow rates and higher delta temperature across the Windmill servers.
- Flowrate control is also achieved by the use of some developed fan controller cards.

FAN Controller results – taking control over the BIOS

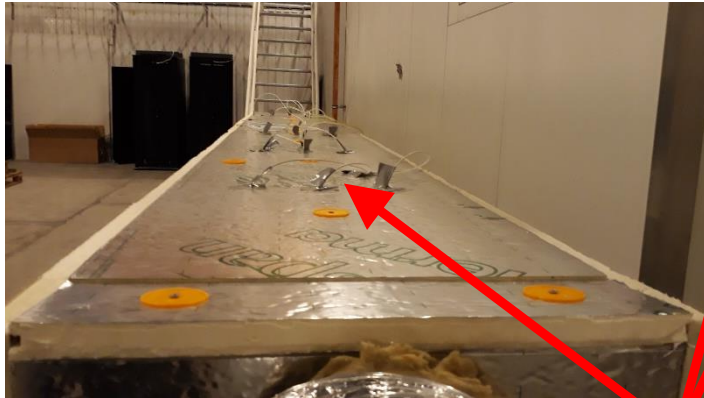
Fan signal from
OCP motherboard



Server wind tunnel

HEX

RADIAL FAN

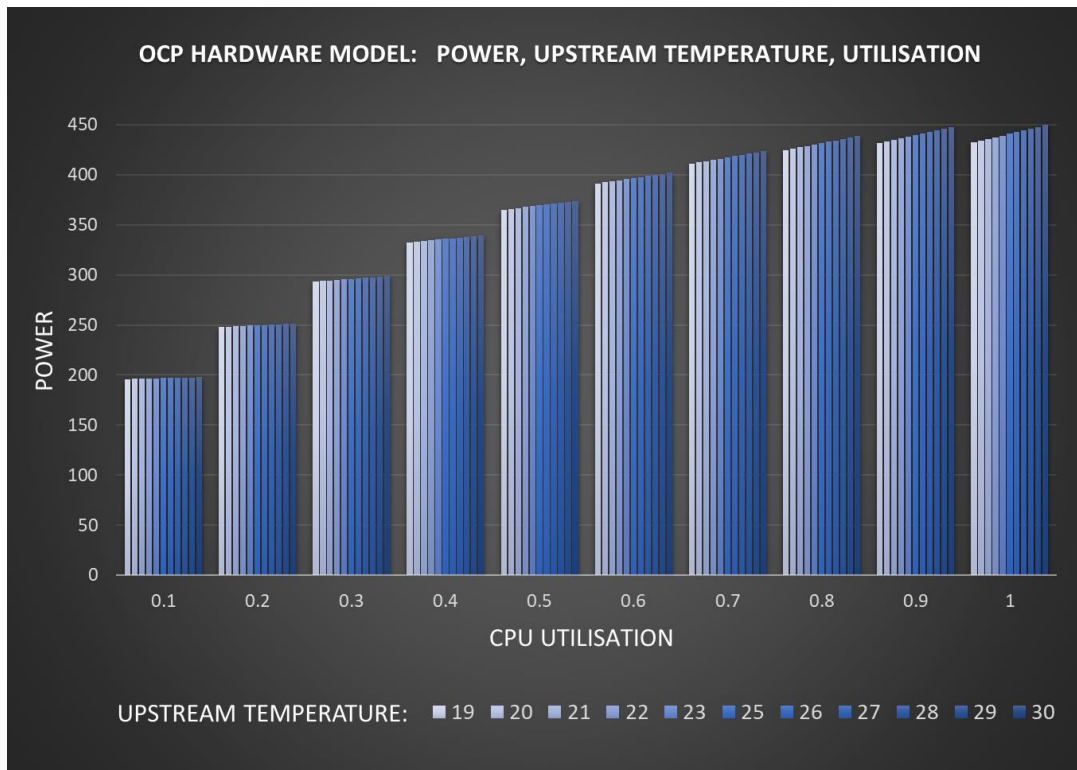


TEMP and FLOW sensors

- Set temperature with the HEX
- Flow rate with the FAN – can pressurize the cold aisle.
- Humidity?
- Upstream and downstream temperature measurements.
- Can support between 1U and 4U.

Results with the OCP Windmill Server

- Wind tunnel results are captured using the same data center monitoring tools.

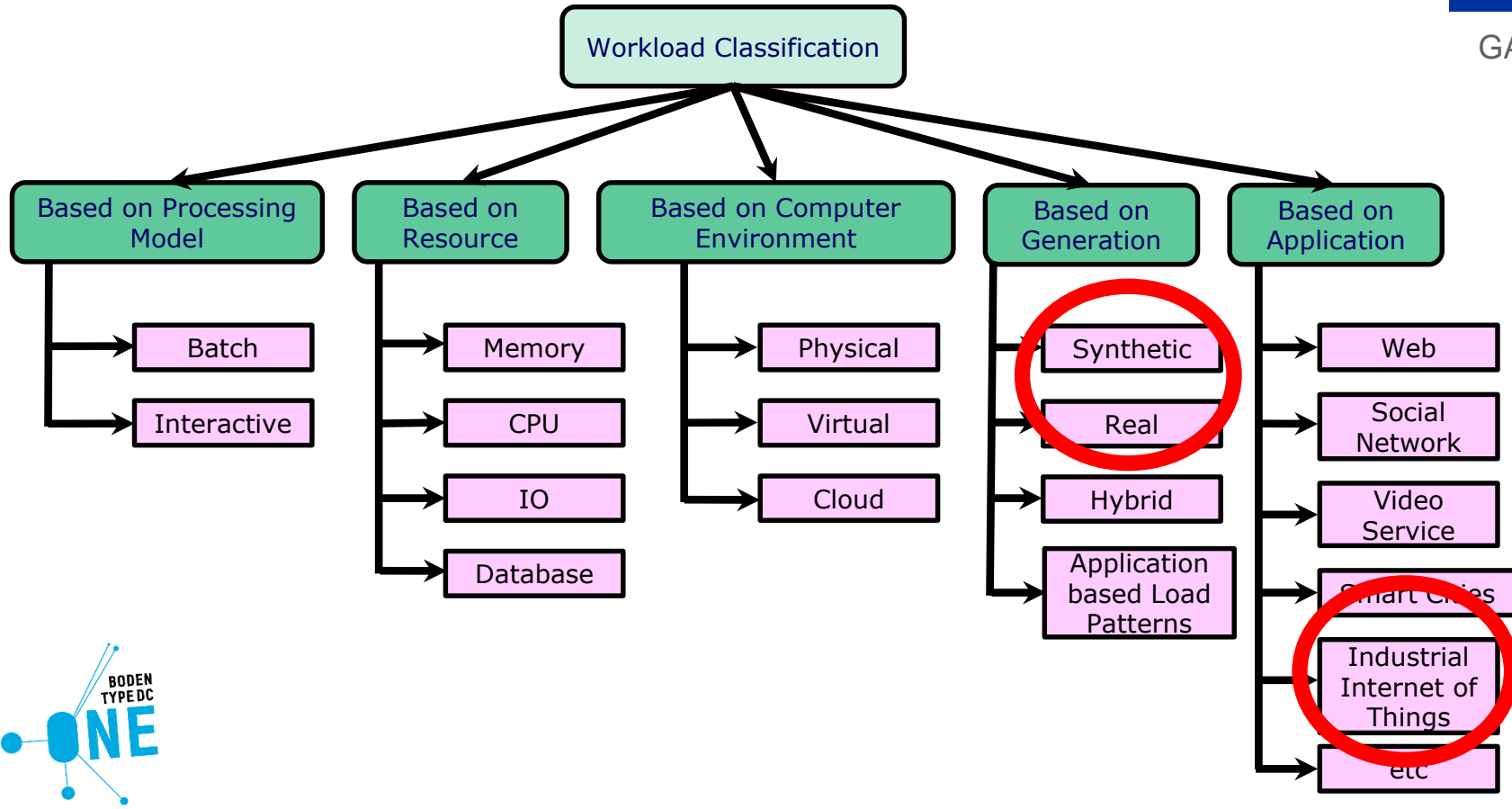


- Uses the same monitoring system as the data center modules
- Enables remote access and control.
- Temperatures are in °C

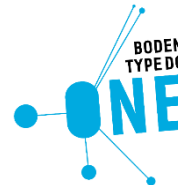
Types of workloads that will operate in the BTDC POD



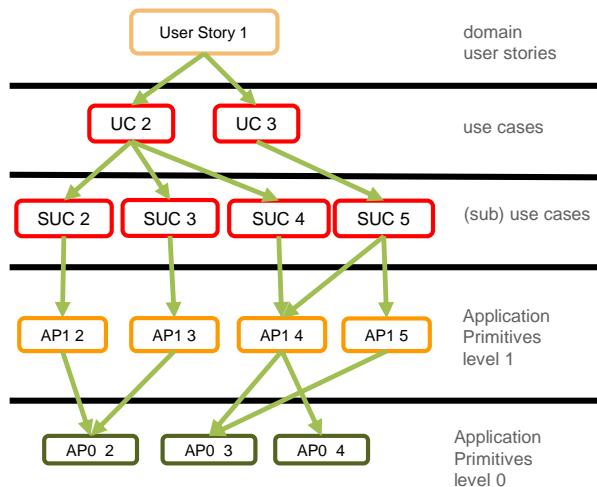
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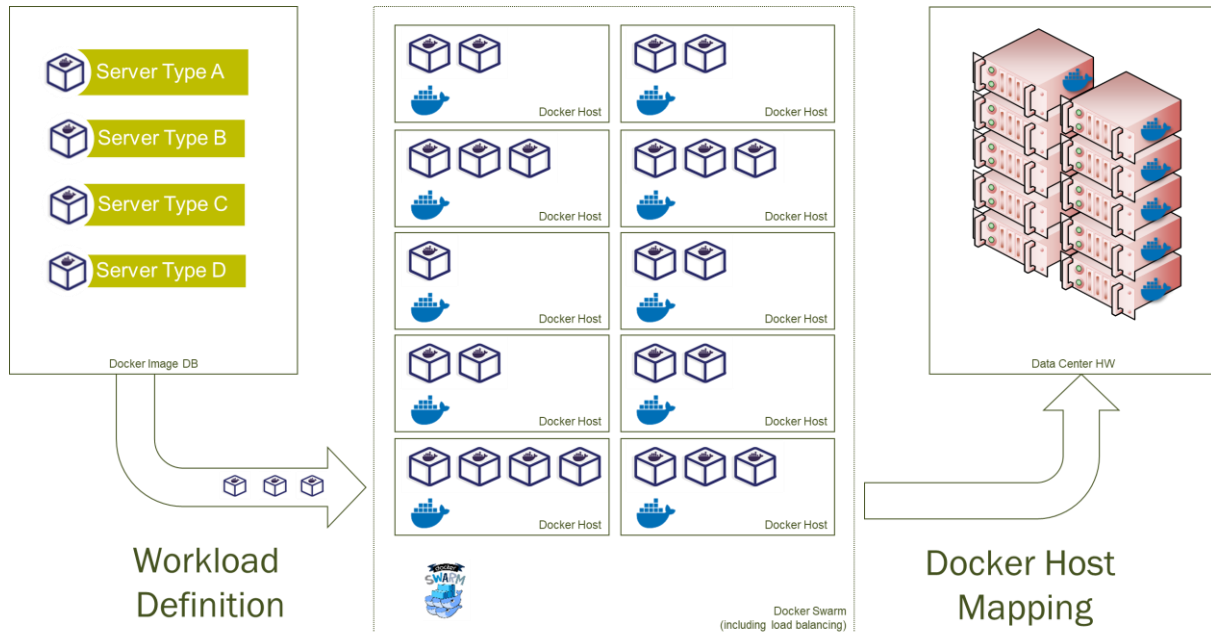
Building realistic workloads for BTDC project



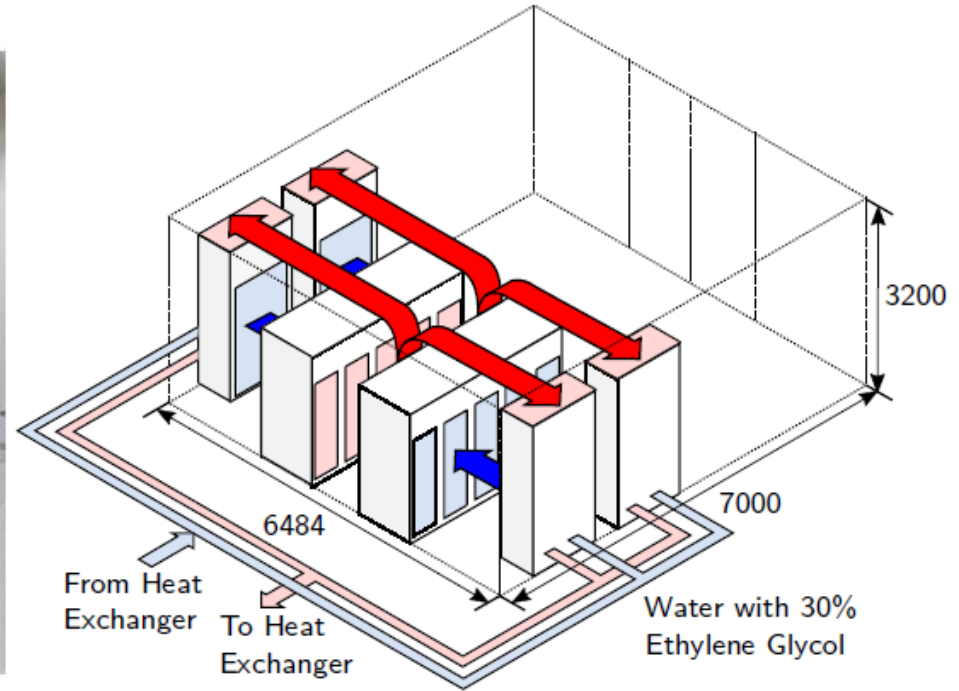
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Building IOT equivalent workloads

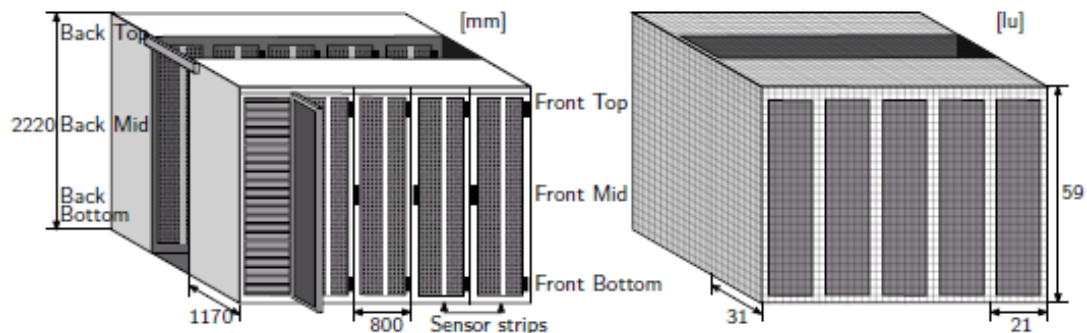
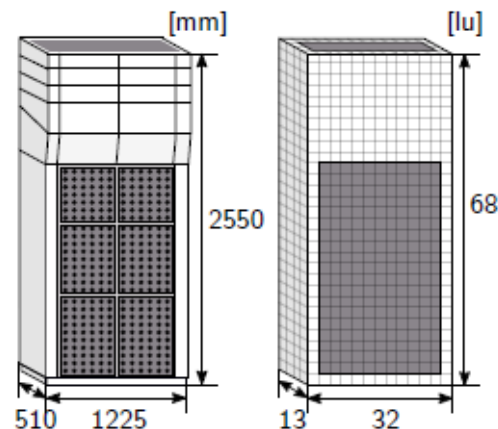
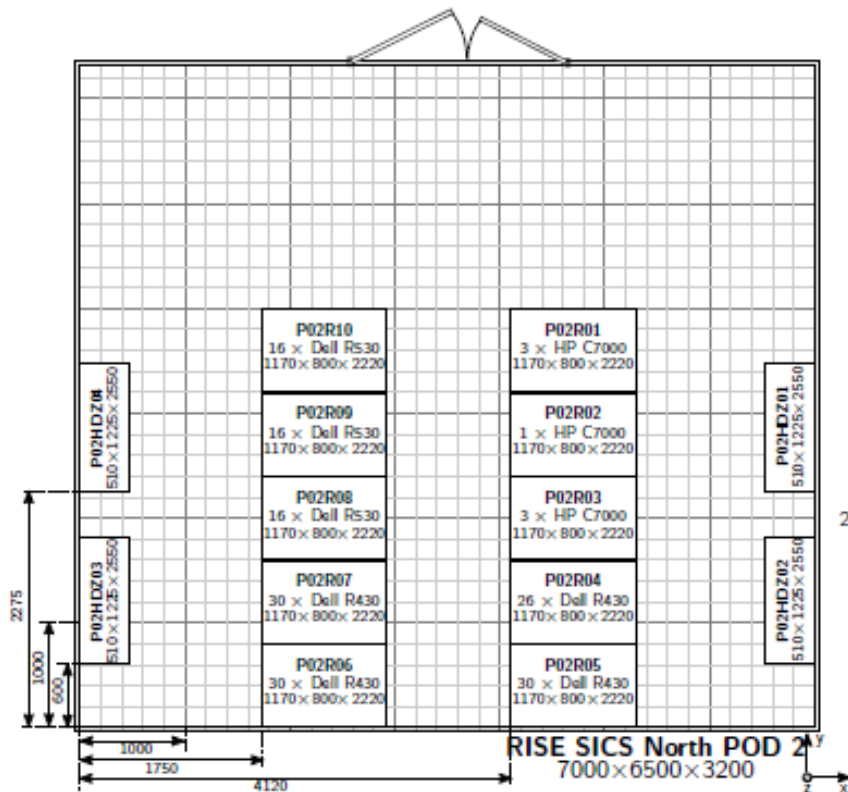


Example of using open source monitoring in RISE Module 2

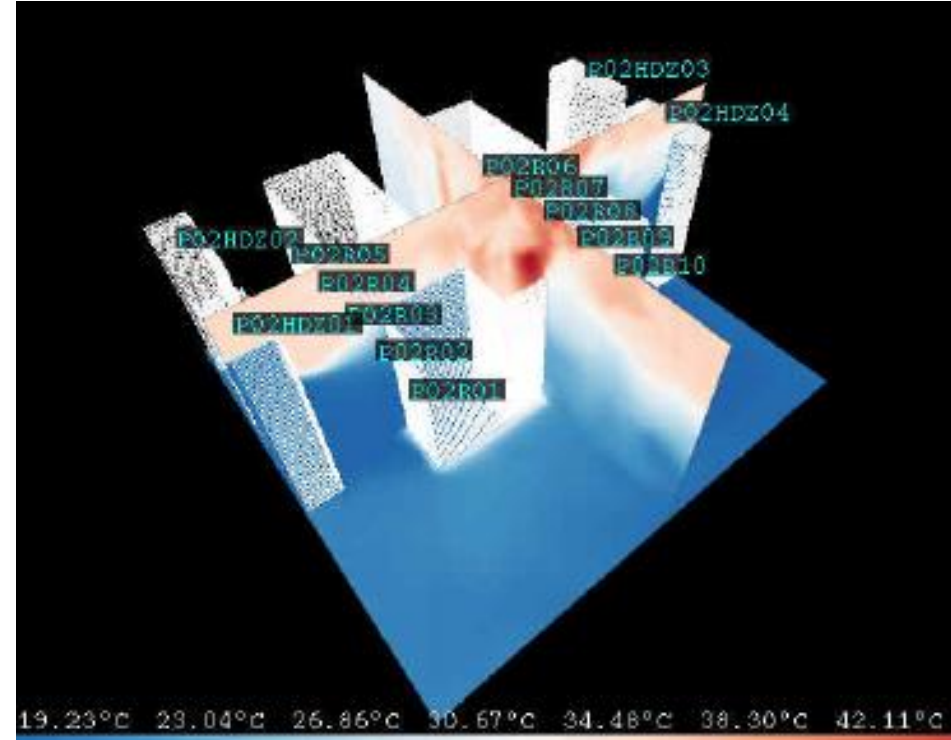
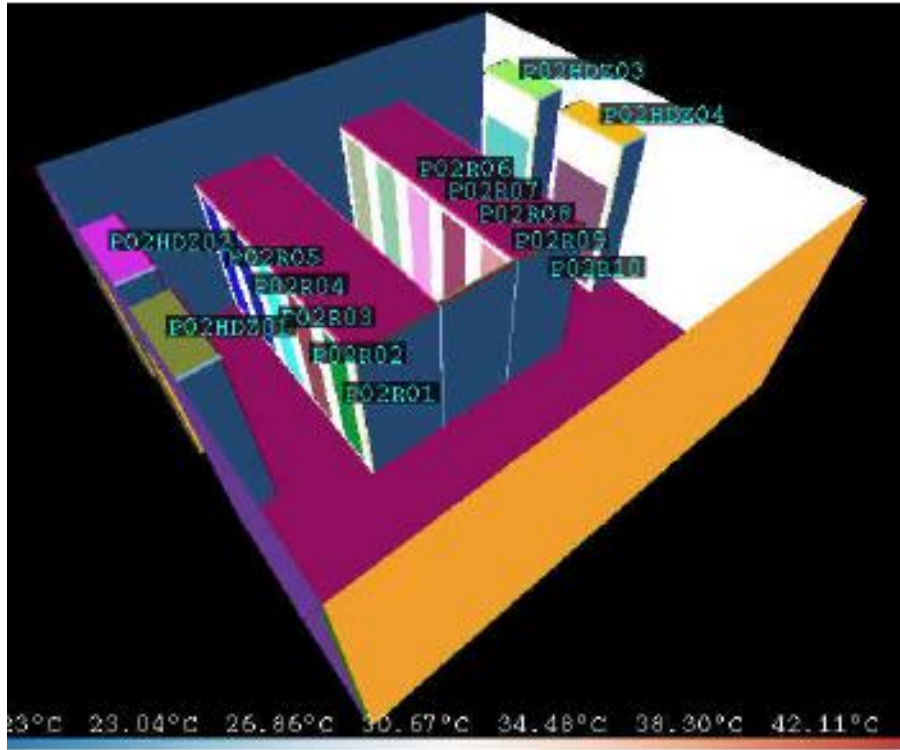


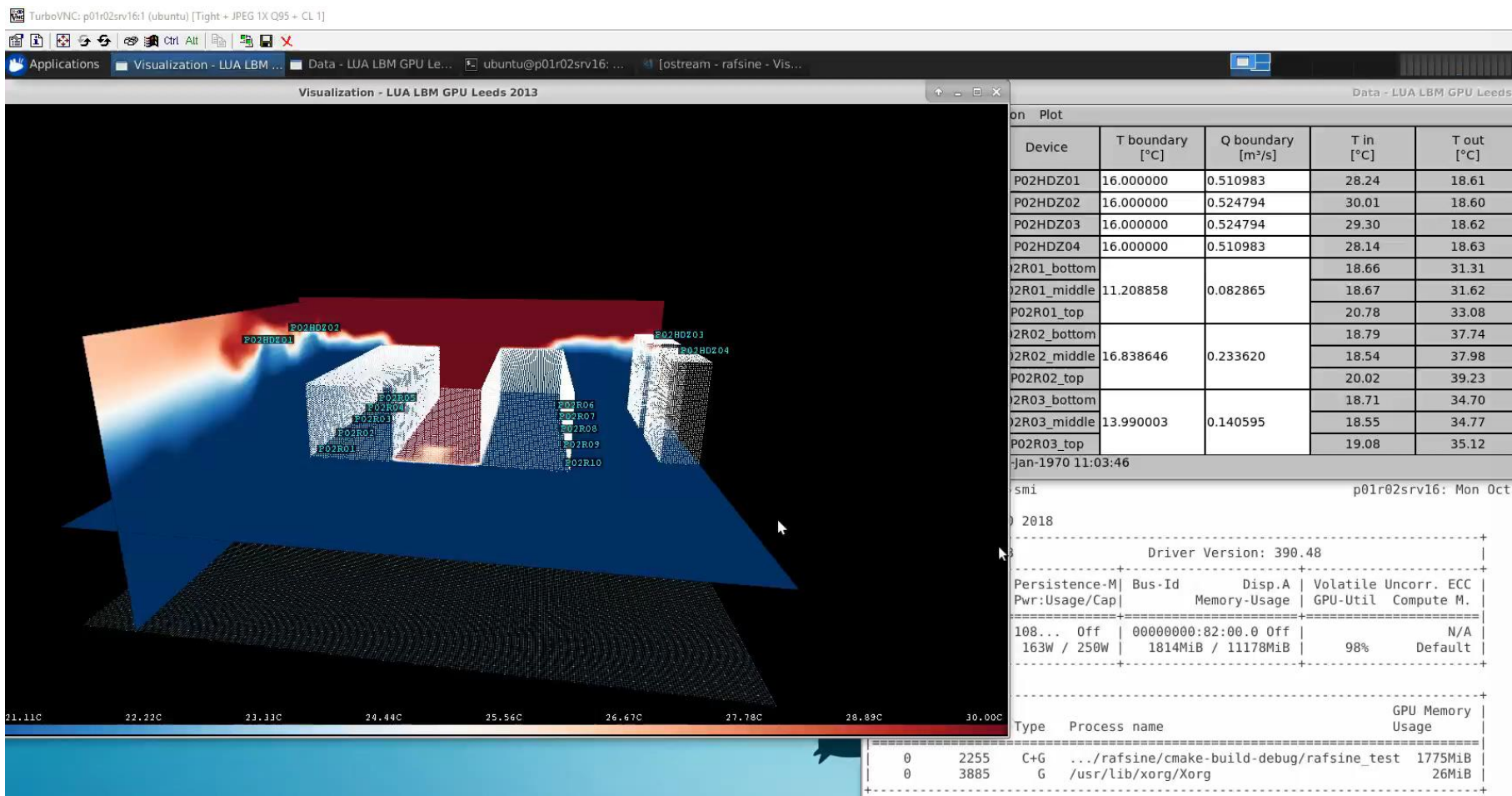
Creating a digital twin.

Geometry for RISE Module 2



Visual output from CFD simulations

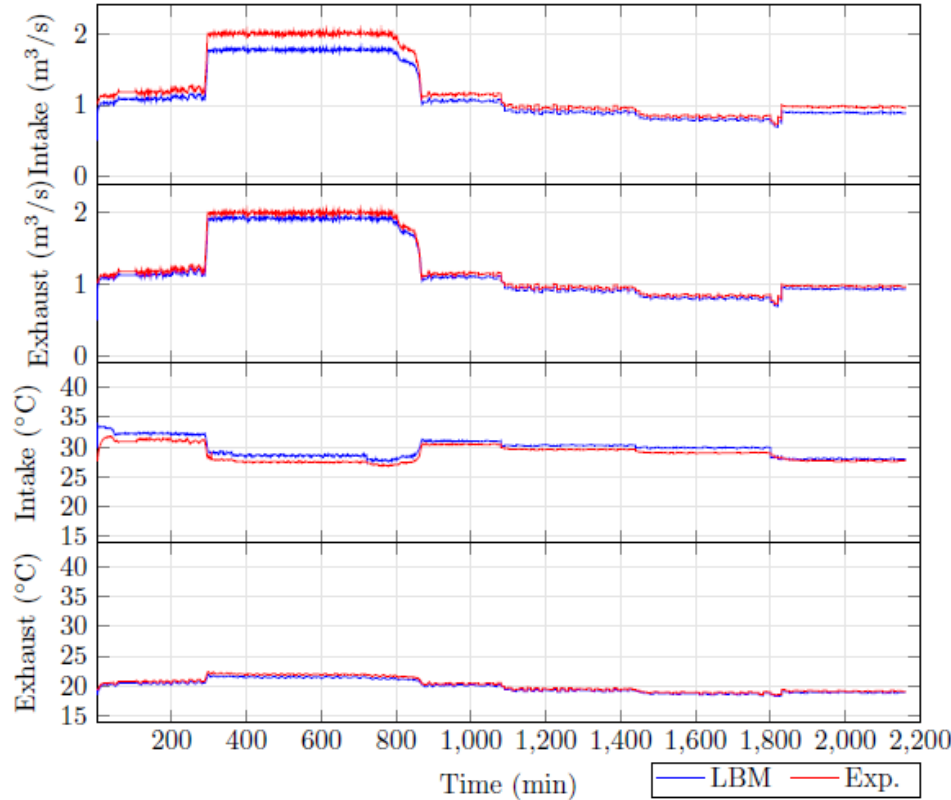




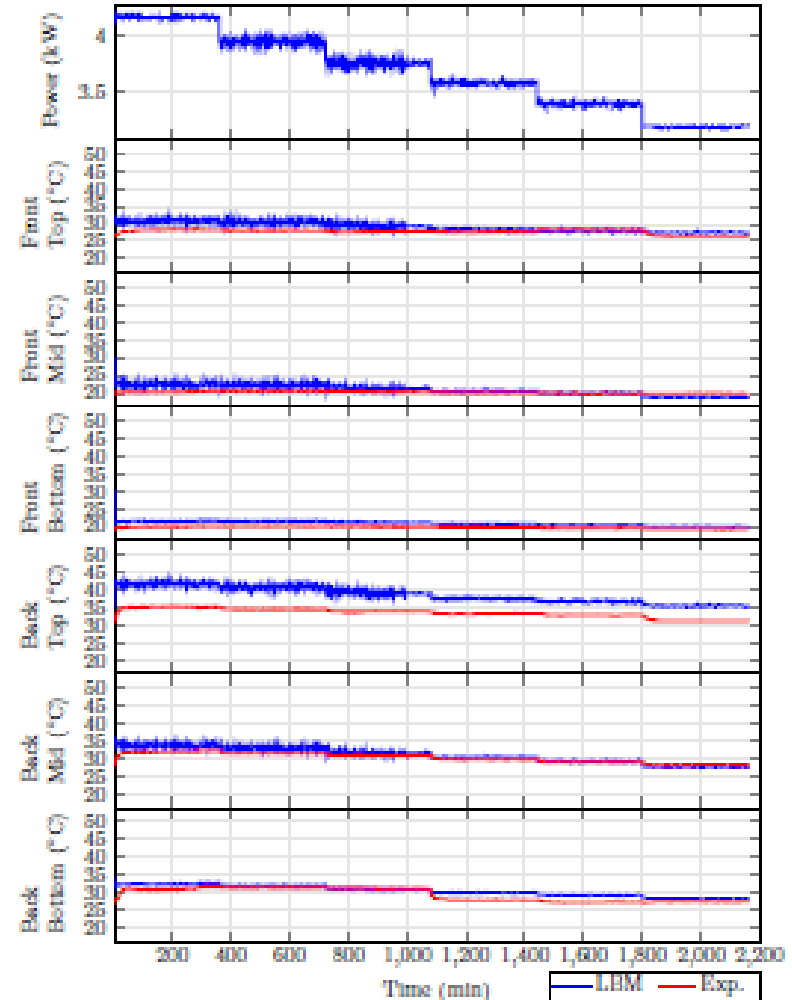
LIVE DEMO – time and Internet connection permitting.

Validation of CFD versus experimental monitored results

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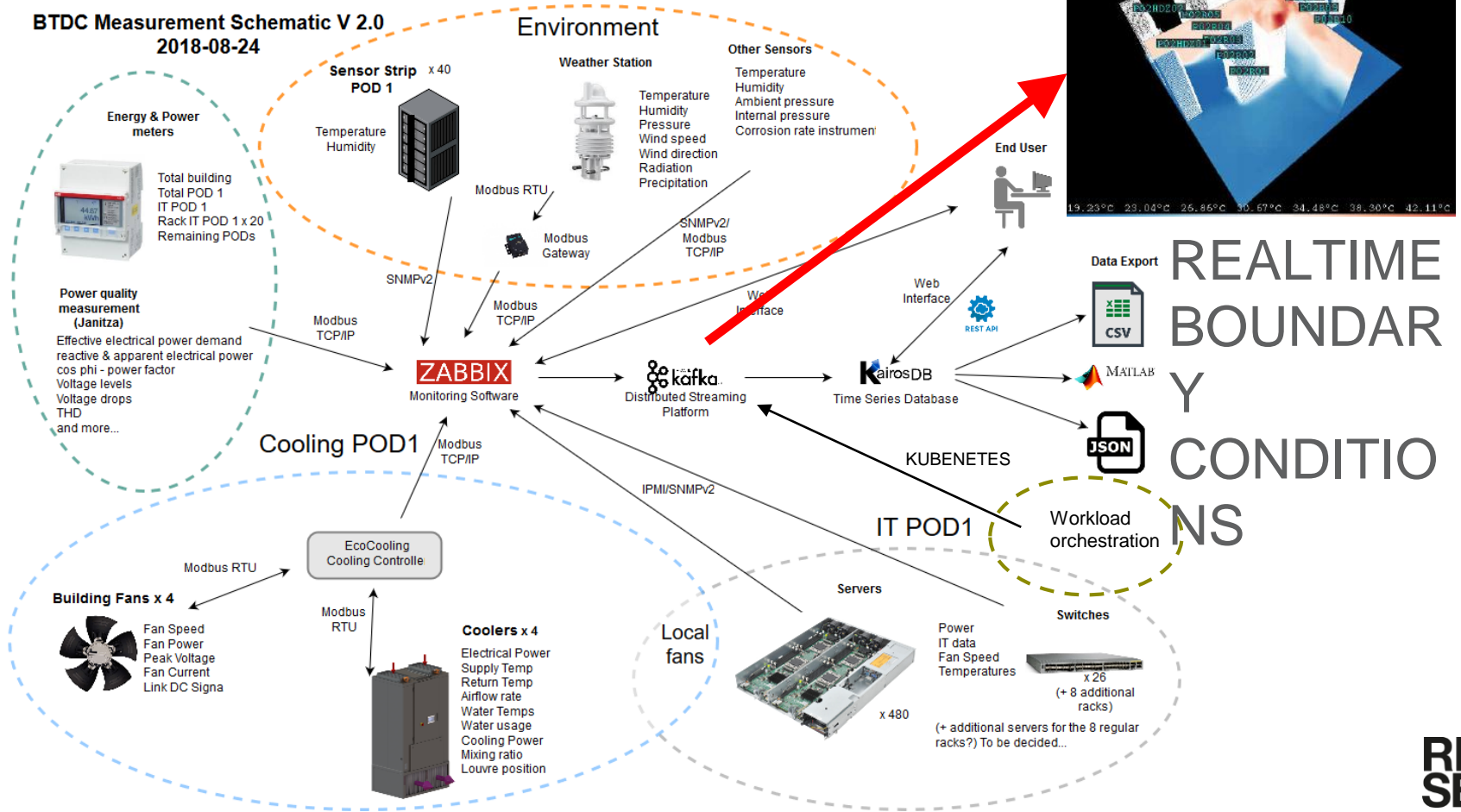


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The FUTURE for the monitoring.

BTDC Measurement Schematic V 2.0
2018-08-24



SUMMARY

- Operate and monitor experimental test data centers.
- Deployed open source software to monitor data center facilities, IT utilisation and laboratory experiments.
- Created a 150kW IT footprint using legacy OCP Windmill servers, with power and network.
- Prototype data center being built in Boden and cooled by direct air with an ambitious linking of facility and server fans.
- RISE can characterized thermal and power of servers using a uniquely developed server wind tunnel.
- The EU funded project has developed a strategy for deploying synthetic and near to real Industrial IOT workloads.
- Demonstrated a direct use of monitored systems using a digital twin.

Visit <https://bodentypeDC.eu>

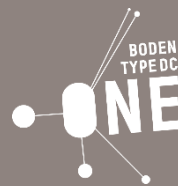
- Thanks to colleagues:

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Daniel Olsson
Jeffrey Sarkinen
Mattias Vesterlund
Johannes Sjölund

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