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The benefits of data center temperature monitoring

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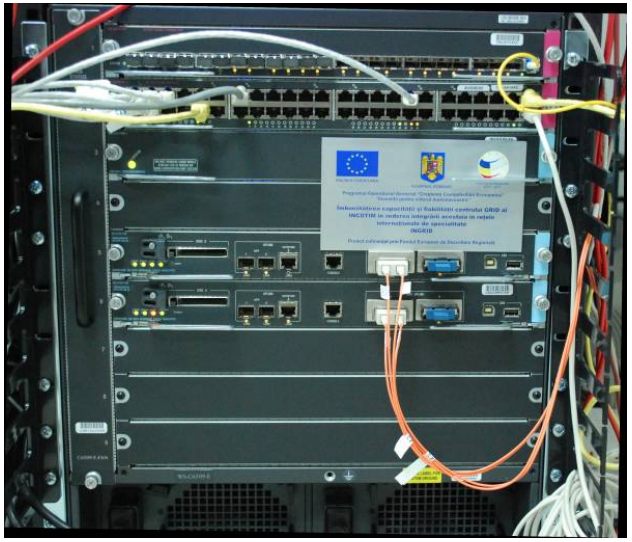
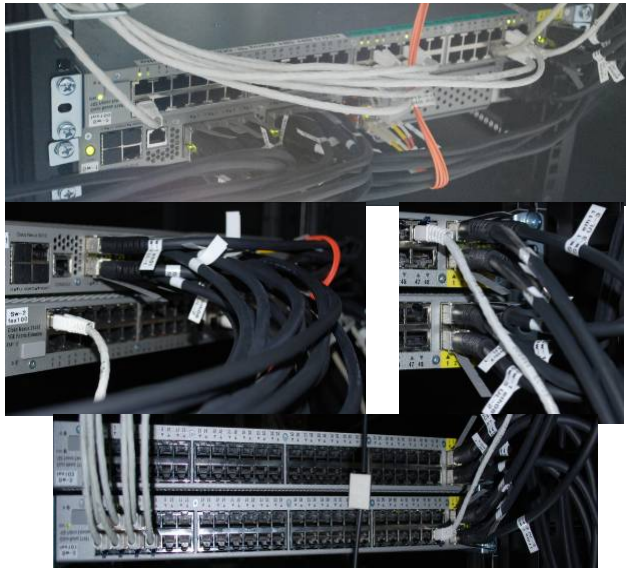
INCDTIM Datacenter

- Grid site **RO-14-ITIM**
  - **400 CPU Core, Storage 100 TB, Technology 1U servers + Blade system (IBM & HP)**
- **HPC Cluster (IBM iDataPlex unit)**
  - **512 CPU Core (16 Core, 96 GB RAM, 450 GB HDD / Computing unit), Storage 15 TB**
- **Network infrastructure of the Institute**
  - **Applications servers (e-mail, web, ftp, databases)**
  - **Cisco Core switching system**

Network capabilities

- **Layer 3 Core Switch - Cisco 6509E**
- **10 Gbps** link to RoEduNet starting from 1 Feb. 2011
- Nexus switching system
  - **40 Gbps** inside the Grid site
  - **20 Gbps** between Grid Site and Core Switch





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Why temperature monitoring?

- the temperature is an important parameter for the equipment functioning.
- the computer systems are designed to work efficiently when the ambient temperature is in the range 20 – 23°C.
- constant temperature → air conditioning systems → power consumption
- to minimize energy consumption

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Practical implementation

The followed parameters:

- voltage power supply of the cooling units;
- temperature in different points of data center;
- humidity in different points of data center;
- state of functioning of the air conditioning unit fans.

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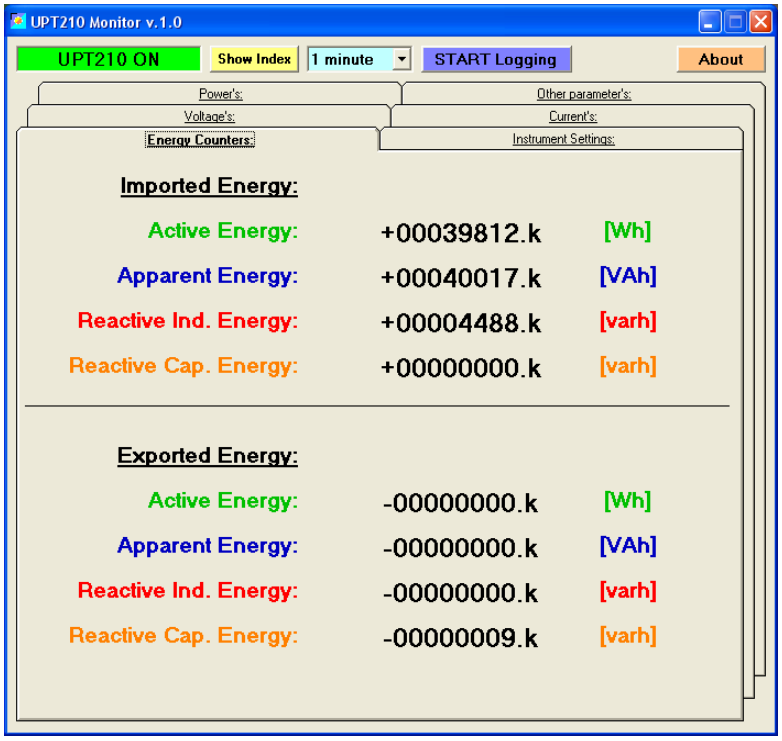
Hardware components

1. digital power meter type UPT-210 (built by *Algodue Elettronica,* Italy) that provide information about power line parameters.



Electrical values measured are:

- The system voltage and the phase voltages
- Phase currents, and current absorbed by the system
- Power factor, Frequency
- Active, Reactive and the Apparent power

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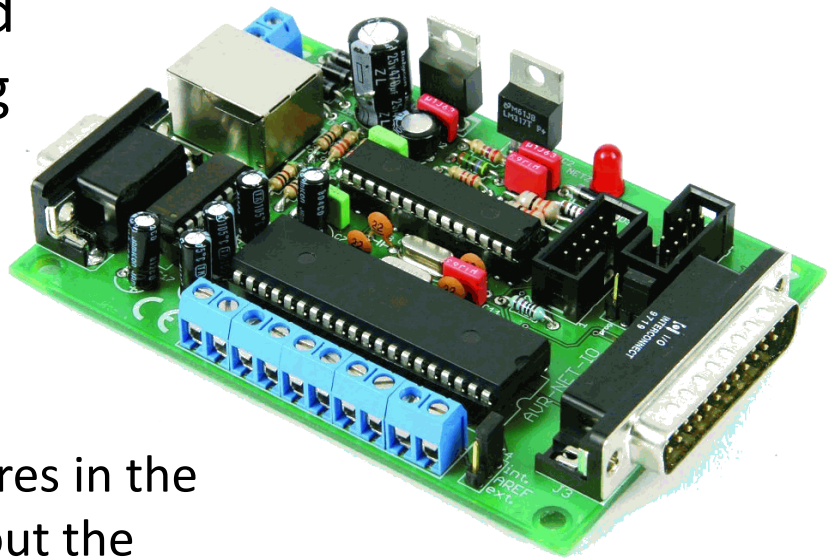
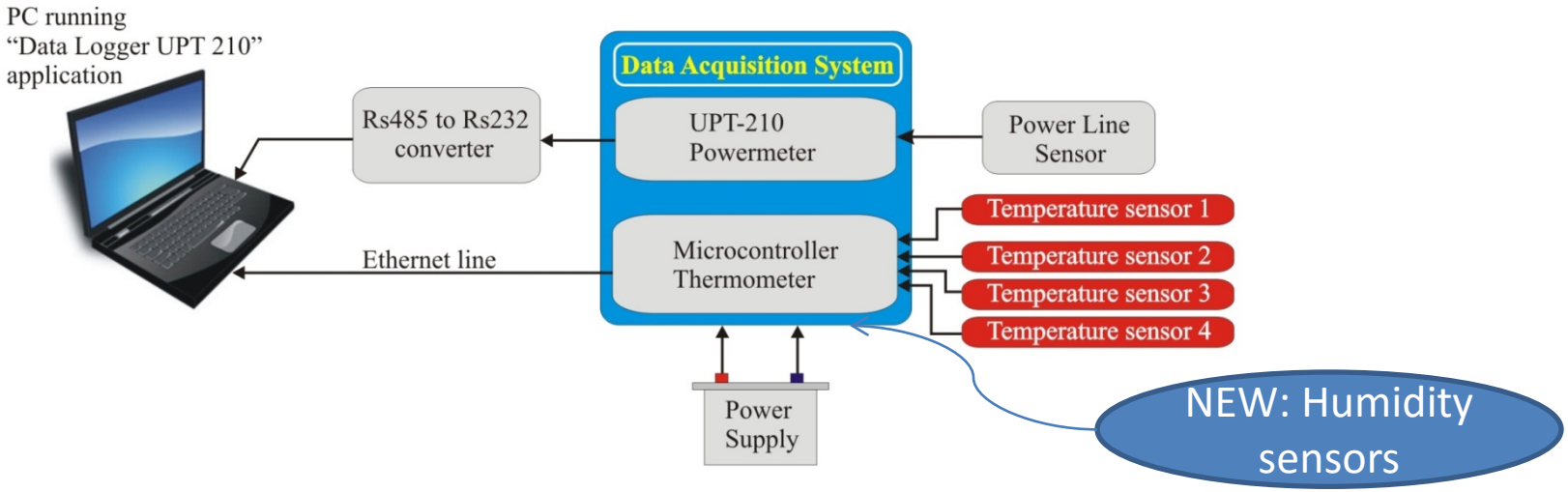
2. microcontroller-based module (designed and built in INCDTIM) that measured temperatures, humidity and monitor the state of the AC units using different type of sensors.

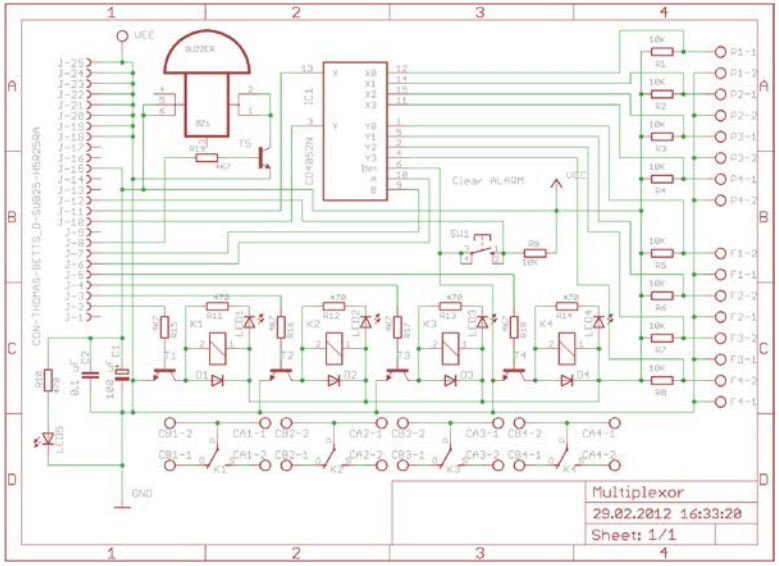


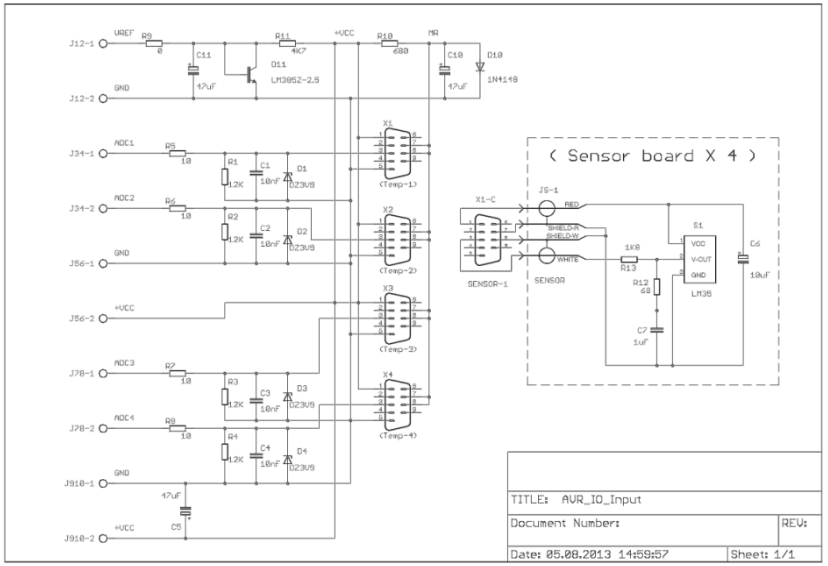
The temperature sensors, LM35 (National Semiconductor), allow to measure temperatures in the range -40 ... +150°C with 0.5°C accuracy without the need for calibration.

The humidity sensors, SYH-2R, allow determining the humidity in the range 10 ... 95% with an acceptable accuracy (3 to 5%) for usual temperatures (0-70°C)

Block diagram of the monitoring system







Electronic schema for adaptation board and sensors

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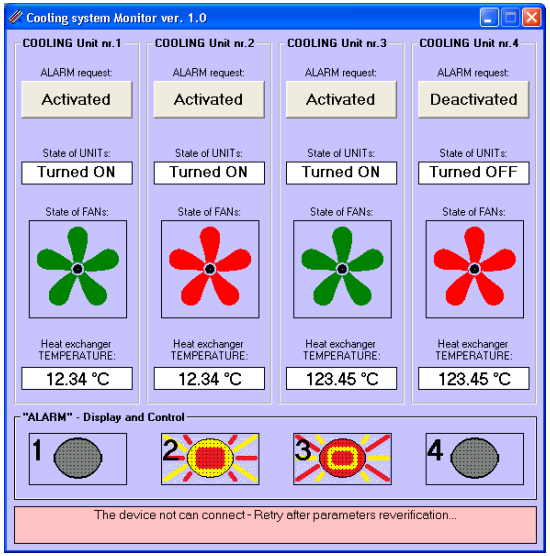
Software components



Graphic interface for cooling system, temperature and humidity monitoring

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Both software applications have a graphic interface and they are designed to:

- read the watched parameters values and display them online;
- register all the values over the time;
- generates an alarm when values are out of established range;
- implements 2 mechanisms: trigger an alarm by authorized users and send an abort command.

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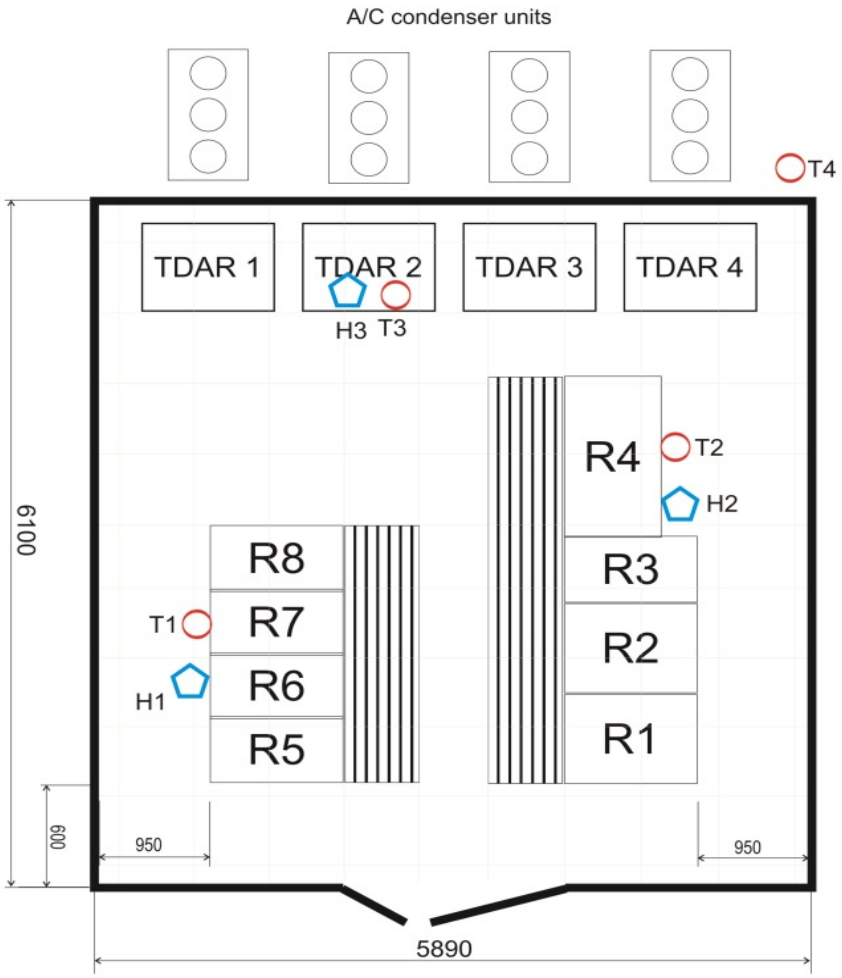
Schema of Data Center



R1 – R2 – network distribution racks

R3 – R8 – computing servers racks

R4 – HPC rack

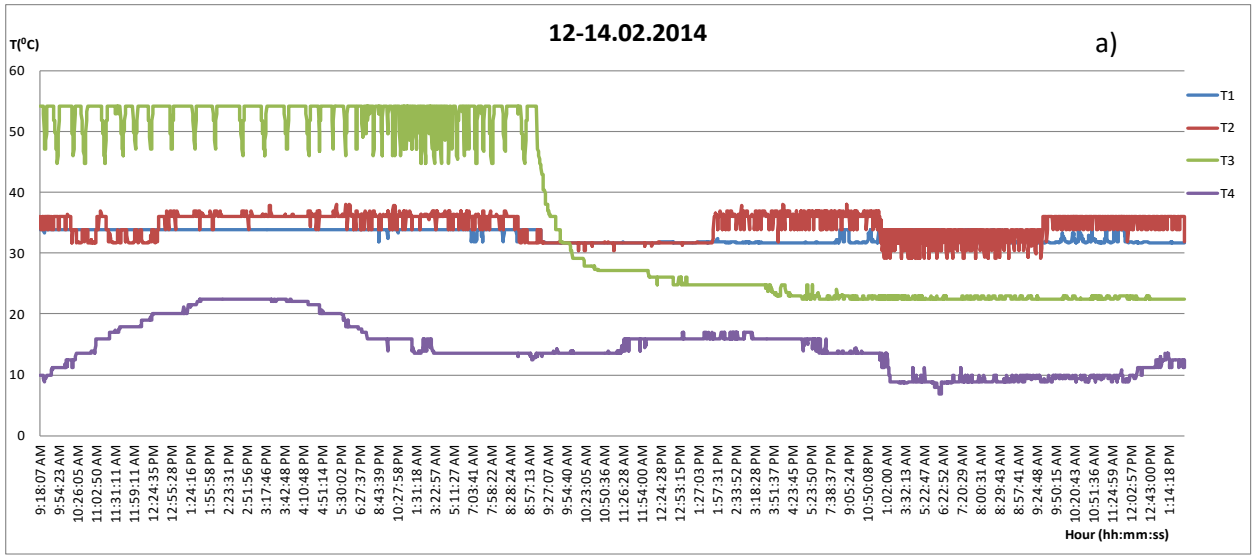
R7 – GRID rack

○ - position of the temperature sensors

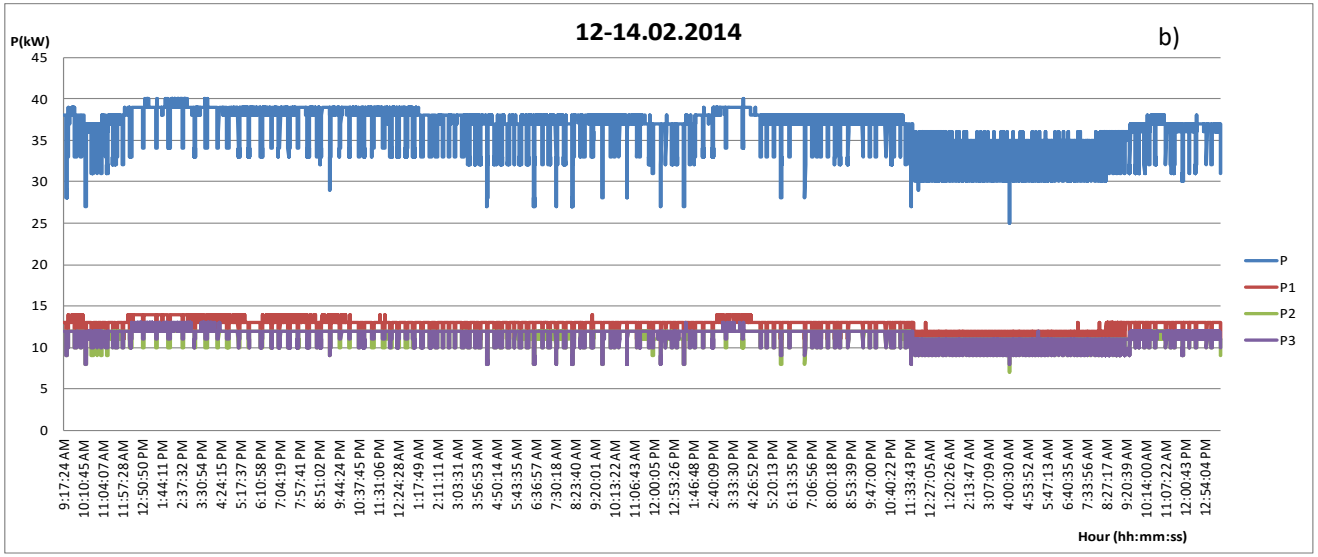
⬠ - position of the humidity sensors

▥ - ventilation grids

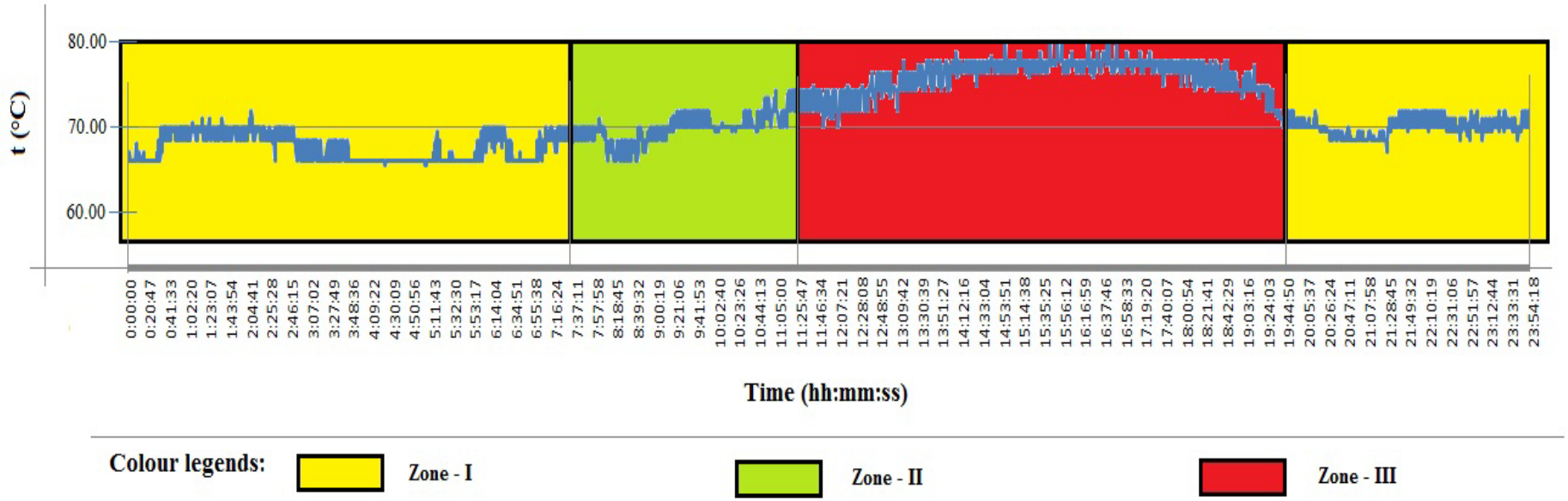
Variation of different parameters



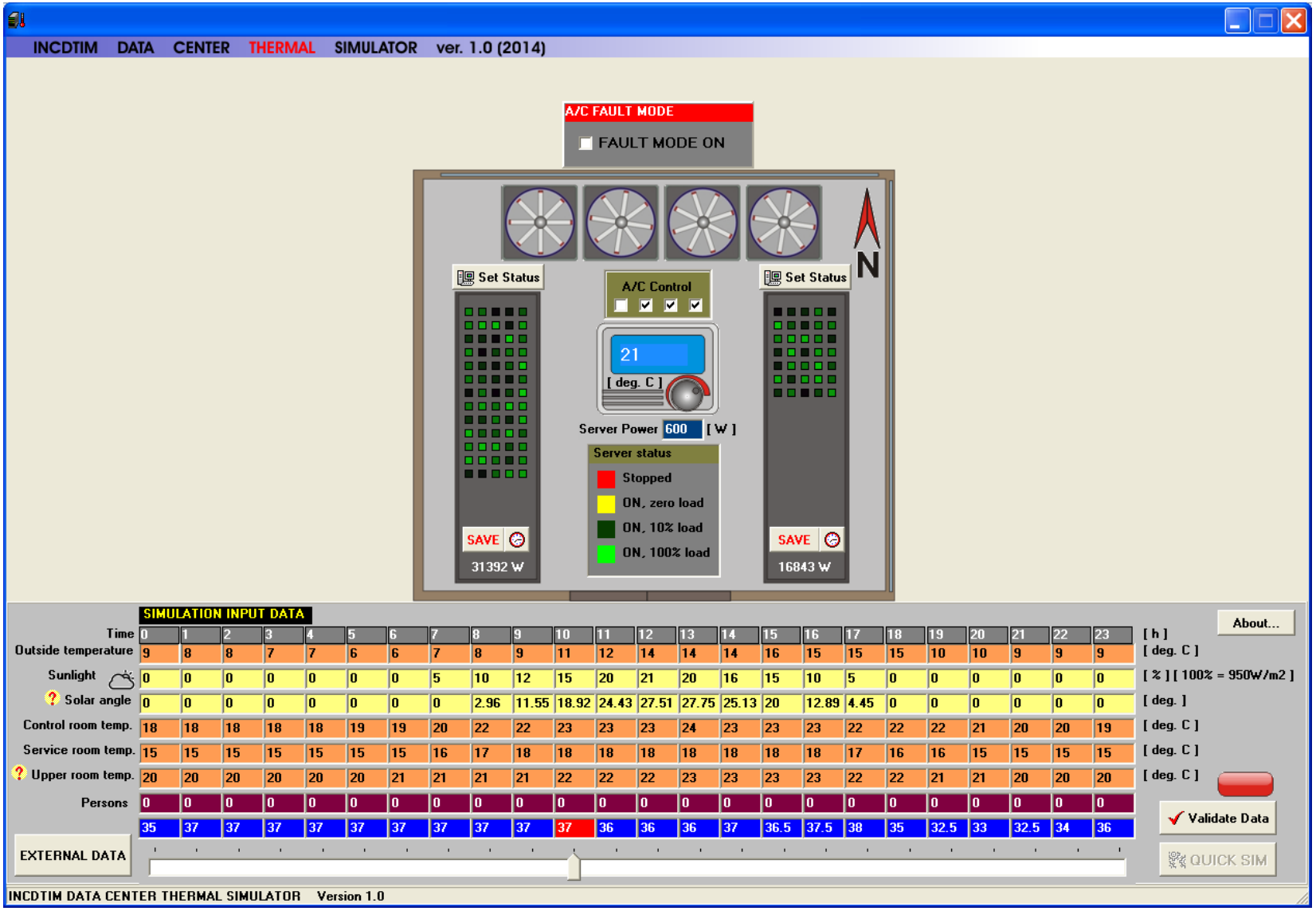
T1 - rack site GRID
T2 - HPC cluster rack
T3 - temperature of the heat agent of AC unit
T4 - outside ambient temperature



a) registered temperatures in the fixed points;
b) power consumption in the same period



Test periods for reducing energy consumption



Simulation of data center operating using experimental data registered

Hour	07.02.2015			12.02.2015			14.02.2015		
	t_{DC}(°C)	t_{ext} (°C)	no. of AC units	t_{DC}(°C)	t_{ext} (°C)	no. of AC units	t_{DC}(°C)	t_{ext} (°C)	no. of AC units
1 - 4	21,35	9	3	21,37	8	3	20,31	9	1
5	21,24	7	3	21,22	7	3	20,42	9	1
6	21,21	6	3	21,20	7	3	20,45	9	1
7	21,18	6	3	21,17	7	3	20,47	8	1
8	21,17	7	3	21,15	8	3	20,42	9	1
9	21,15	8	3	21,14	9	3	20,53	9	1
10	21,13	9	3	21,15	10	3	20,57	9,5	1
11	21,37	11	3	21,13	11	3	20,61	9,5	1
12	21,09	12	3	21,11	15	3	20,64	9,5	2
13	21,08	14	3	21,02	20	3	20,64	10	2
14	21,07	14	3	21,17	21	3	20,65	12	2
15-18	21,07	14	3	21,12	23	3	20,68	13	2
19	20,98	15	2	21,02	16	3	20,69	9	2
20-21	20,91	10	2	20,99	15	2	20,71	9	2
22-23	20,89	9	2	21,00	12	3	20,73	9	2

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Conclusions

- The device allows to register some parameters in different points of Datacenter and monitoring of these parameters can be achieved in real-time.
- The variation of the parameters values can be followed by data interpretation on different period of time and season.
- Advantages of the temperature monitoring:
  - simulation of the Datacenter operation based on recorded data for long periods of time;
  - setting a schedule for operation of the air conditioning system;
  - maintaining Datacenter environmental conditions in the range in which computer systems work efficiently;
  - reducing energy consumption;
- It can be determined and implemented a system of functioning of the entire system, in order to improve resource utilization.

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Thank you for your attention !