DATA CENTER & COOLING SOLUTIONS

2012
Typical Energy Consumption of a Data Center

- Infrastructure
- Cooling units
- 19 Racks
- Fire protection
- Raised floor
- Power

- Cooling: 50%
- IT components: 35%
- Power Distribution: 15%
DRIVING FACTORS FOR THE NEED OF EFFICIENT COOLING

- Increasing energy prices
- Increasing capacity and cooling requirement of blade servers and pizza boxes
- Rising number of servers
- Increasing datacenter performance
- Regulatory requirements
- Power density is increasing 15% per year
- By 2011 average kW per rack is above 15kW (up from 1kW in year 2000)

<table>
<thead>
<tr>
<th>server consolidation spectrum</th>
<th>origin: Marktforschungsinstitut ICD</th>
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<tbody>
<tr>
<td>centralization</td>
<td>consolidation of servers to a few places</td>
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<tr>
<td>physical consolidation</td>
<td>consolidation of comparable applications on a smaller place with high performance systems</td>
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<tr>
<td>integration of datas</td>
<td>integration of different data formats to only one platform</td>
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<tr>
<td>integration of application</td>
<td>consolidation of servers with different applications to smaller systems with a higher performance</td>
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</tbody>
</table>
Cooling Requirement for some Servers!

<table>
<thead>
<tr>
<th>Model</th>
<th>Blade Servers</th>
<th>WATTS</th>
<th>BTUs</th>
<th>U</th>
<th>WATTS</th>
<th>BTUs</th>
<th>COOLING</th>
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<tr>
<td>Dell</td>
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<td>DELL PowerEdge 1855</td>
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<td>7U</td>
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<td>6U</td>
<td>22,500</td>
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<td>SUN</td>
<td>1 Server</td>
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<td></td>
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Figures are maximum ratings, actual operating power/heat load may be lower.

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CHALLENGE IN 2011

From 1kw (2000) to avg. 15kw (2011) per rack!!
Cooling Alternatives
Cooling Alternatives

*Traditional Perimeter Cooling
Thermal load per rack up 5 Kw
- Raised floor
- Chiller, Closed Control Unit

*Innovative Aisle Containment Application
Thermal load per rack up 10 kW
- Raised floor
- Isolation
- Chiller, Closed Control Unit
Cooling Alternatives

*Combination of in row liquid cooling system
Front Cooler + Cold corridor

- Eliminates Raised floor

*Side Cooler: Liquid cooling systems for thermal load up to 30 kW
- Side mountable to racks, enables high density cooling
Air flow in traditional Systems

- If the distance from CRAC increases, pressure of air decreases
- Hot and cold air mixes with each other
- Non-uniform (uneven) distribution of Cold Air, top of the rack is not sufficiently cooled

**RESULT!!**
% 75 of all server failures happens at the 1/3 top section of the racks
EFFECT OF DENSE CABLELING BELOW RAISED FLOOR
PROBLEMS OF TRADITIONAL APPROACH

- Low return temperature 22---24°C
- Small Delta T, high air flow
- CRAC
- CW temperature 7---10°C
- Loss of cold air
- Low supply temperature 14---15°C
- Hot spots 28-30°C
- Hot spots
- 16-18°C
- High Presssure&velocity
- Balancing required
- Short circuit of hot air
- Warm air > 30°C
FACTORS TO BE CONSIDERED IN EFFICIENT COOLING

- Do not move more air than required!
- Focus on hot spots
- Do not cool the whole datacenter, just cool the servers only!
- Maintain strict cold and hot air separation
- Obtain a uniform and more controllable closed cooling area
- Keep the cold air temperature between 22-26° C instead of 14-17° C
- Do not waste energy to cool the hot aisle
- Use energy efficient alternatives like free cooling
SOLUTION: COLD AISLE!

- High return temperature: 24---25°C
- High Delta T, small air flow
- CRAC
- Higher supply temperature: 22---23°C
- Low velocity & pressure
- No need for balancing!
- Warm air < 28°C
- Uniform temp.
- 22-23°C
- Cold Aisle
- 22-23°C
- Warm air < 28°C
- Uniform temp.
COLD AISLE SOLUTION

Loss Of Cold Air

Hot Air Short-Circuits

*Newest technology in data center design
Cost effective and high capacity cooling up to 10 kW per rack
Eliminates the need for raised floor balancing
Eliminates hot spots and waste of cold air
Easy to operate
Min investment, high ROI
Energy savings up to 50%
Fully scalable, from small to large deployments
COLD AISLE SOLUTION

- Optimized for energy efficiency
- Cooling capacity up to 10 kW for each cabinet
- Modular construction
- Separation of cold and warm air
- Reduction of the gradient of temperature
COLD AISLE SOLUTION

Sliding doors

Acrylic glass top cover-modular
COLD AISLE SOLUTION
IDEAL RACK FOR DATACENTER APPLICATIONS

PLATINIMUM SERIES RACKS (ALU frame)

“Unique Technology patented by European Patent office”
Advantages of Aluminum Frame

- Patented design from European Patent Office and WIP
- Load capacity up to 2,000 kg - Industry record!
- %30 weight reduction compared to conventional welded steel cabinets
- Appropriate for critical applications like seismic cabinets - Zone4 certificated
Advantages of Aluminum Frame

• Ease of assembly/disassembly with only 3 screws
• Diecast type corner joints with self-locking mechanism
• High corrosion resistance compared to steel based structures
• Natural cooling characteristics of Aluminum
19" Server Cabinets

- Aluminum frame chassis
- Compatible to all major server providers like HP, Dell, Sun, Compaq and IBM
- Perforated front&rear doors
  1. Perforation up to 80% (Free Air Ratio)
  2. Unique honeycomb ventilation pattern to increase airflow capacity
  3. Emka multipoint point swing handle locks
- Side panels with cylindrical locks and extra handles to ease assembly
- 2 pairs of heavy duty type 19 "mounting rails from galvanized steel protected against corrosion
- Top cover with 3 holes for cable entry and a fan unit fixing hole
- Support rails on the sides of the frame to increase stability and for efficient cable management
- 2 pairs of adjustable feet
Features

- Aluminum Frame
- Honeycomb ventilation pattern
  Up to %80 Free Air Ratio
- EMKA Multipoint Swinghandle lock
- Bottom cover with 3 holes for cable entry
- Single Perforated Rear Door
"19 Network Cabinets

- Aluminum frame chassis
- Glass front door
  - Tempered glass for security purposes
  - Unique serigraphic cover (tinted) on the left and right sides of glass to hide the cables from the view
  - Emka single point swinghandle locks
- Side and rear panels with cylindrical locks
- 2 pairs of 19" mounting rails from galvanized steel protected against corrosion
- Top cover with 3 holes for cable entry and a fan unit fixing hole
- Support rails on the sides of the frame to increase stability and for efficient cable management
- 2 pairs of adjustable feet
COLD AISLE CONTAINMENT IMPLEMENTATION

- *Liquid based chiller (closed control unit) cooling on raised floor*
- Free-Cooling opportunity during winter times, huge energy saving (Green IT!)- below 10C outside temperature, 100% free cooling, up to 50% energy saving is possible
- *Compact datacenter design*
FRONT COOLER

- In row technology
- No raised floor needed
- Width of 300 mm or 600 mm
- Height 2000 mm / depth 1000 mm
- 30kW or 60 kW cooling capacity
- Pressure controlled
- EC-technology
- No condensing water due to high inlet water temperature of 14 °C
- Water and DX-Version
- Extra developed for Corridor-cooling
- High efficient power management
Hot swap
COLD AISLE CONTAINMENT + Liquid Based Front Cooler) In row Cooler)

2 Options:

a) 300mm width: range 15-30 kW
b) 600mm width: range 30-60 Kw
c) Runs with 5 EC-fans
**Control SW - TEMPTRONIC**

- RJ 45 interface-optional serial interface RS 485 possible.
- Interface can communicate with following protocols:
  - OPC – Server
  - Modbus
  - LON
  - ECHELON
  - BACnet
  - Third Party Protocols
  - SNMP
  - METASYS
  - DLL

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<table>
<thead>
<tr>
<th>Anlagenkomponente</th>
<th>Schaltbefehl</th>
<th>Fühler</th>
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<th>Sammelstörung</th>
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<td>Überwachung</td>
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</table>
COLD AISLE CONTAINMENT + Liquid Based Front Cooler (Inrow Cooler)

No need for Raised Floor!!
Ambient air is extracted from the warm aisle through the perforated rear door, cooled and blown into the cold corridor.
COLD AISLE CONTAINMENT + Liquid Based Front Cooler (In row Cooler)

COLD CORRIDOR + FRONT (IN ROW COOLING)

No need for raised floor!
Hot Aisle with FrontCooler
Cold Aisle with FrontCooler
Hot Aisle with FrontCooler
DIRECT LIQUID BASED RACK COOLING
“SIDECOOLER”

*High density hot spot cooling up to 30kW
*Patented modular and ergonomic design
Functionality of the SideCooler
Direct rackcooling / key features SideCooler

- Reliable against failures
- Redundant
- No condensing water
- Saving space because of case shape
- Simple construction with only a few mechanical components
- Energy efficient fans
- High energy efficient level cause of using high water inlet temperatures
- More than 1000 installations worldwide
Advantages of SideCooler

- Automatic regulation of the cooling capacity 0-30 kW
- Cooling capacity up to 30 kW
- Space reduction because of the trademarked Slide In® design.
- Failsafe with emergency running at fail of the controlling
- Hot-plug fans
- Working with BacNet, Modbus, RS 485, RJ 45 uva.
- Variants: H= 1800, 2000, 2200 mm
  T= 800, 900, 1000, 1200 mm
- Available for all fabricates of cabinets / racks
- Integrated monitoring system
- Also working with water/glycol
All-in-one Compact Datacenter
All-in-one Compact Datacenter

- Cabinet
- Side Cooling System
- Modular UPS
- IP PDU
- 1U Fire Extinguisher System with Novee™ 1230
- Cable Partitions
- Rack Monitoring System
## Competitor Analysis

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<tr>
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<th>ACRD 502</th>
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<td>for Watertemp. 14/20</td>
<td>60kW</td>
<td>30kW</td>
<td>37kW</td>
<td>11kW</td>
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<td>30kW</td>
<td>29kW</td>
<td>25kW</td>
<td>24kW</td>
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<td><strong>Power Consumption</strong></td>
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<td>790W</td>
<td>3300W</td>
<td>1100W</td>
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<td></td>
<td>14000kW</td>
<td>915W</td>
<td>1230W</td>
<td>1800/2500W</td>
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<td><strong>Energy saving</strong></td>
<td>21%</td>
<td>21%</td>
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<td>no</td>
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<tr>
<td>due to high inlet water</td>
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<td></td>
<td></td>
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<tr>
<td>temperature compared</td>
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<td>APC</td>
<td></td>
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<td>Condenswater by nominal</td>
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<tr>
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</table>
Energy efficiency of the SideCooler

- Condensing water free cooling up to 24 kW with water temperature 14 °C
- No wasting of energy for latent Cooling
- With „warm“ water 18°C still 19 kW cooling capacity
- Maximum consumption of energy per SideCooler is <= 500 W
- FreeCooling up to 90% p.a.
Examples of placings of Side Cooler

- left / right placing
- redundant placing
- part redundant placing
- space saving placing
- space saving placing with part redundancy
Flexible Installation

- Easy installation
- No raised floor required
- No device outside the building required

Small server room with water chiller for placing indoor (movable solution)
Green-IT-Cooling /PUE

**PUE = 2,5 Standard Datacenter installed**

**PUE = 2,0 new standard datacenter with Cold Aisle Containment**

**PUE = 1,39 Cold Aisle Containment with Front Cooler or SideCooler by using FreeCooling**

**PUE = 1,17 SideCooler with Geothermic cooling**

**PUE = Power Usage Effectiveness = total energy consumption / IT-Equipment**
## Comparison PUE of different Free Cooling solutions

**Datacenter with 500 kW IT-load**

<table>
<thead>
<tr>
<th>FreeCooling</th>
<th>No</th>
<th>No</th>
<th>Indirect</th>
<th>Indirect</th>
<th>Indirect</th>
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<td>2° =&gt; C</td>
<td>13° =&gt; C</td>
<td>15° =&gt; C</td>
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<tr>
<td>technic</td>
<td>CRAC standard</td>
<td>CRAC new technology</td>
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<td>Cold Aisle CRAC</td>
<td>Cold Aisle FC</td>
<td>SideCooler</td>
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<tr>
<td></td>
<td>%</td>
<td>kW</td>
<td>%</td>
<td>kW</td>
<td>%</td>
<td>kW</td>
<td>%</td>
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<td>IT Equipment</td>
<td>59.9%</td>
<td>500</td>
<td>65.3%</td>
<td>500</td>
<td>66.2%</td>
<td>500</td>
<td>72.3%</td>
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<td>Cooling</td>
<td>24.0%</td>
<td>200</td>
<td>21.7%</td>
<td>166</td>
<td>20.5%</td>
<td>155</td>
<td>18.8%</td>
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<tr>
<td>Air Movement</td>
<td>9.6%</td>
<td>80</td>
<td>5.9%</td>
<td>45</td>
<td>6.0%</td>
<td>45</td>
<td>4.3%</td>
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<td>USV</td>
<td>6.0%</td>
<td>50</td>
<td>6.5%</td>
<td>50</td>
<td>6.6%</td>
<td>50</td>
<td>4.3%</td>
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<td>5</td>
<td>0.7%</td>
<td>5</td>
<td>0.7%</td>
<td>5</td>
<td>0.3%</td>
</tr>
</tbody>
</table>

### Energie costs Klima:(€)

- 120cent / kWh

| PUE: | 1.67 | 1.53 | 1.57 | 1.38 | 1.31 | 1.26 | 1.15 |

### Energie costs%

- 289% 216% 206% 165% 129% 100% 47%
FREE COOLING

Free-Cooling opportunity during winter times, huge energy saving (Green IT!!)
- Below 10C outside temperature 100% free cooling
- Up to 50% energy saving is possible
- Applications from 80kW up to 2000 kW
Free Cooling Potential Solution

Average ambient temperatures of Nürnberg region - Germany 1999 - 2009

| ambient temp. | 30° C | 29° C | 28° C | 27° C | 26° C | 25° C | 24° C | 23° C | 22° C | 21° C | 20° C | 19° C | 18° C | 17° C | 16° C | 15° C | 14° C | 13° C | 12° C | 11° C | 10° C | 9° C | 8° C | 7° C | 6° C | 5° C | 4° C | 3° C | 2° C | 1° C | 0° C | 1°C/2°C | 3°C/4°C |
|---------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| cpm | 100%  | 98%   | 92%   | 89%   | 83%   | 81%   | 77%   | 72%   | 68%   | 63%   | 60%   | 55%   | 51%   | 47%   | 43%   | 39%   | 34%   | 30%   | 25%   | 21%   | 17%   | 13%   | 10%   | 8%    | 5%    | 5%    | 5%    | 5%    | 5%    |

25% Konventionell indirect freecooling

70% Indirect Free Cooling Best Practice

95% Optimized Direct Free Cooling

90 days/year more freecooling than the competition!
SPACE COMPARISON BASED ON 60kW

Traditional Perimeter Cooling

Cold Corridor

Side Cooler-Liquid Cooling

Benefits:

• Less space required
• Less rent expense
• Less HW requirement (cable, rack, raised floor etc)
FreeCooler as retrofit solution

- Saving of energy
- To place outside the building
- Silent version
- Retrofit version
- In addition usable as redundancy

The whole system has to check for energy savings
Coolmanager / Pumping stations

- Integration of SideCooler or FrontCoolers in an existing infrastructure of water chillers
- Save separation of primary and secondary water circuit
- Redundant pumping station
- Regulation of water inlet temperatures
- Regulation of condensing freeness
Using the geothermal cooling for the direct rack cooling

- Checking the location of the drilling based on a geothermal map + permit of the public government
- 240 -m drilling in flushing drilling method (3 x drilling each a 80 mtr. depth / diameter per drilling 140 mm)
- Piping work 3 x 80 mtr. HDPE – pipes (32)x 2,9 mm) = 3 double sondes
- Covering with clay farina cement suspension
- System stability with design with a double circulation pump N+1 (redundant)
  + UPS - buffered
Mode of operation:

The SideCooler require an inlet temperature of 14 °C, to avoid condensate during operation. In the soil (app. 90 meter deep) a constant temperature of 11 °C exists. The glycol-water returns with app. 11 °C from the underground pipe. The supply temperature to the Sidecooler of 14 °C is controlled by the three-way-valve. In the SideCooler the water-glycol will gain a temperature of app. 19 °C. The closed cycle transfers the heat of the IT equipment to the ground.
Geothermal cooling

Drilling location for cooling capacity of 68 kW

= 12 drillings with depth of 90 mtr.
Geothermal cooling

Execution the drillings
Comparison of energy costs

Supply of a cooling capacity 68 kW

A) Power consumption with usual mechanical cooling system (water chiller)

B) Power consumption with geothermal system

A) Energy consumption equates p.a.

- ca. 23,0 kW
- ca. 201.480 kW/h

EUR 30.222,00

B) Energy consumption equates p.a.

- ca. 1,5 kW
- ca. 13.140 kW/h

EUR 1.971,00

Energy savings p.a. kW/h x 0,15 € pro kW/h saving costs

+ Carbon emission

basis on energy mix = 514 gr./kWh

p.a. ca. 188.340

ca. EUR -28.251

ca. 968.067 kg.
**Comparison costs of invest**

<table>
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<tr>
<th>Description</th>
<th>Cost</th>
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<tbody>
<tr>
<td>A) Invest costs water chillers (2 pieces cause redundancy)</td>
<td>EUR -62,000</td>
</tr>
<tr>
<td>B) Invest costs geothermal systems</td>
<td>EUR -105,000</td>
</tr>
<tr>
<td>Yearly saving energy costs with geothermal system</td>
<td>EUR -28,251</td>
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</table>

**ROI (Return of Investment) 18 months!**
Direct Free Cooling

- No transfer medium like water or any agent
- Uses air temperature up to 22°C
- Environment friendly
- Freecooling potential up to 90%

Green - IT - Cooling
Direct Free Cooling

3d Drawing of Direct Free Cooling Application

Free Cooling up to 90% Capacity

Green - IT - Cooling
Solar cooling systems
Solar cooling systems

The sun collectors are equipped with vacuum tubes.

The heat is getting collected to a hot water buffertank.

The hot water is getting pumped to the absorber cooling machine where through a chemical reaction the warmness would be changed to cooling (near without mechanical power, only a pump).

The cold water can be used for air cooling systems (closed control unit or direct rack cooling systems).
Solar cooling systems
Solar cooling systems
Advantages for placing a water chiller inside:
• No need for anti freezing medium (glycol)
• Movable and flexible instead of a fixed placed water chiller outside.
OUTSIDE WATER CHILLERS

Advantages for placing a water chiller outside:
• if there is no place to put water chiller inside-space limitations
• if there is long distance between side & front cooler and the chiller unit
CLOSED CONTROL UNITS (CCU)

Pressurized liquid based cooling, for cold corridor applications
Example of Datacenter Installation
Micro Datacenter with Top-mountable AC

Benefits:
• Cooling up to 4kw with top mountable AC unit
• Eliminates external cooling unit and raised floor
• Compact datacenter with Monitoring, UPS, IP PDU, Cooling
• Ideal solution for branch offices (Banks, Police, Schools, Ministries etc)
Micro Datacenter with Door-mountable AC
Complete Solution for Data Centers

"19•Racks:
• Aluminum frame based high quality server racks with carrying capacity of 2000kg and perforation of 80% Air flow ratio

• Cooling solutions:
  a. Cold corridor application based on modular aluminum frame structure - newest and latest trend in data centers
  b. Liquid cooling system up to 30KW AC units -
  c. • Security Systems: Electronic locks

• Monitoring Systems: Rack monitoring systems

• Power Systems: Rack mount and modular UPS Systems

• Power distribution Units:
  - IP controlled smart PDU’s
  - All types of modular customized PDU’s
IP PDU’s with POPS Feature

• Per Outlet Power Sensing and Control
• Integrated temperature and humidity sensors
• Wireless sensor connectivity -up to 9 sensors
• Industry leading accuracy level: 97% accuracy in measuring
• Camera connection capability
RACK MONITORING AND CONTROL SYSTEM

Designed to monitor the working environment and control access to electronic equipment in racks and data center applications.

**Technical Specifications**
TCP/IP, RS232 and RS485 connection
10/100 Base Ethernet
8 different sensor connection- wireless!!
  .Temperature
  .Humidity
  .Motion
  .Smoke
  .Non-contact access
  .Proxy card reader
Electromagnetic Lock
Optional Fan Controller
Waterless Fire Suppression Systems

FM-200 Fire Suppression Systems

• Reach extinguishing levels in 10 seconds or less
• Less damage
• Lower repair costs
• Less downtime and disruption of business.
• FM-200® is in use in over one hundred thousand applications, in more than 70 nations.
1U Inrack fire Extinguisher with Novec™ 1230

The 1U active extinguishing system is a compact, independent unit for detecting and extinguishing fires in closed cabinet systems.

- Fire extinguisher agent Novec™ 1230
- Used inside racks
- Only 1U system in the world
- Less downtime and disruption of business.
Security Lock System

- Ideal solution for Colocation centers of ISP’s
- Remote management up to 300 locks
- Numerical & smart card access
Efficient, Modular UPS
**UPS Flexibility**

**Compact - more power in less space**
- 25 kW modules occupy of standard rack space, Combine modules in building block fashion to deliver 250 kW of redundant backup power in one rack enclosure

**Scalable - easily deploy and expand**
- Flexible – numerous configurations
- The solution can grow with expanding
- IT needs offers a fully redundant architecture, as opposed to simply adding power modules to increase capacity
UPS Efficiency

**Efficiency - Reduce cooling costs**
- Unparalleled efficiency results in cooler operating conditions and less heat dissipation
- Overall air conditioning requirements reduce by more than one third
- UPS can be located close to equipment racks without creating hot spots

**Efficiency - Reduce energy costs**
- delivers an industry-leading 97% efficiency
- UPS will quickly pay for itself through energy and cooling savings alone
- On average, a user will save more than €24,000 over a five-year period, coupled with increased reliability and performance on a 60 kW N+1 configuration
Highest efficiency in modular three-phase UPS design

- industry leading >96% efficiency – even at loads below 40% of capacity.

**Mega Power+ High Efficiency UPS**

Mega Powers deliver the highest efficiency rate. At an efficiency rate of 96%, Mega Powers provides significant energy and cooling savings.

**Mega ROI (Return On Investment)**

Calculations based on USA electricity cost

*Mega Payback time = 1.5 Years*

**Mega Power+ User-Friendly Controller**

Each Mega Power+ features a unique and proprietary Controller, which is the user's main interface with the Mega Power+. The Controller features a colored, touch-sensitive screen which enables the user to navigate through the system screens by pressing various icons. Multilingual functions allow simple usage worldwide. The Controller is not a failure point and UPS operation is not interrupted if the Controller is removed. Its interface offers up-to-the-minute, intelligent monitoring of all UPS parameters including intelligent battery monitoring functionality, system voltage, temperature, etc. Each system element has its own Control and History Log. Built-in SNMP/TCP & optional GPS/SMS interface provides complete control over units operation without installing software or using dedicated computers or control hardware.
THANK YOU FOR YOUR ATTENTION QUESTIONS?