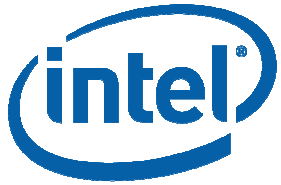

Data Center Energy Efficiency Research @ Intel Day

20 June 2007

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Milan Milenkovic
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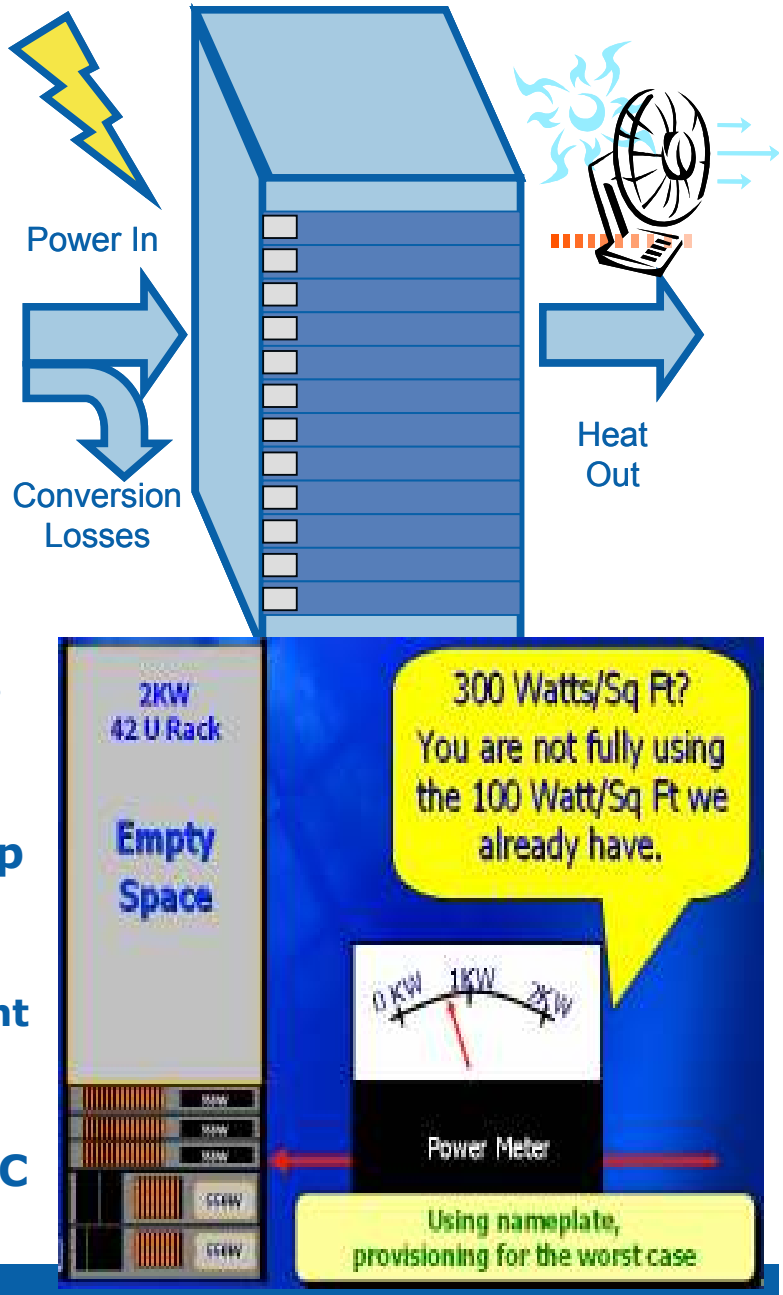
Data Center "Pain Points"

IT Needs

- **Performance Density**
  - **Performance / Watt / Sq Ft of Floor Space**
  - **Today 2W at the wall for every 1W of Compute**
  - **Which costs 2x to cool, as well**
- **Visibility into power & thermal consumption hence Racks are under-populated, DC's are over-designed**
  - **Lack of instrumentation & tools that optimize rack density & capacity within current facilities**
  - **Lack of tools need to be cross-OEM (heterogeneous systems)**
- **Power monitoring and management at group level to match how data centers are designed**
  - **Need to scale platform level power management to group level (rack, groups of racks, data center)**
- **Integration between power management, DC management systems and facilities systems**



Data Center Energy Efficiency Research

HVDC (High Voltage DC)

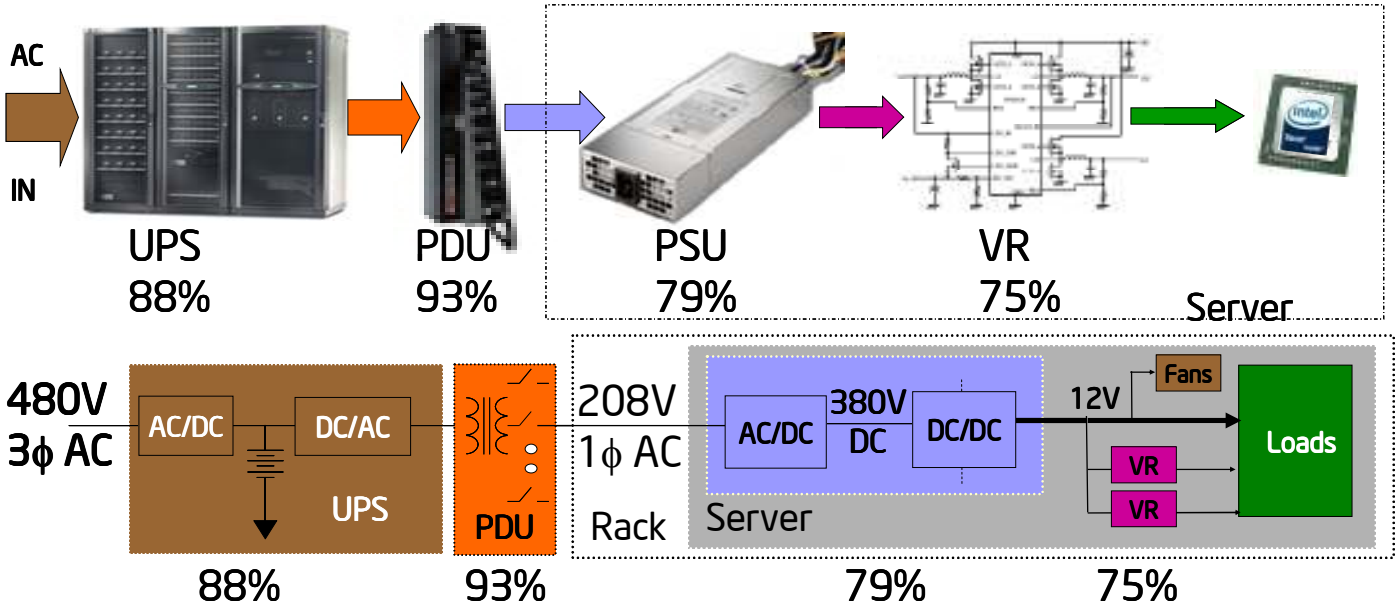
- Significant Power Savings (8-10%) by reducing the number of power conversion stages
  - Typical Medium Sized Data Center savings calculates to be $200,000 / year[1]
  - 300-400 V_{DC} so you can distribute power the same distances as AC
    - avoids the 48 V_{DC} distribution issue
- Double to Quadruple the impact
  - Every Watt saved within the system is >1 Watt less needed at the wall
    - e.g. today's systems are 50% efficient from Wall to CPU. Thus each watt saved at the CPU is 2W less needed at the wall.
  - PLUS, every input Watt saved is 1 less Watt of Air Conditioning needed

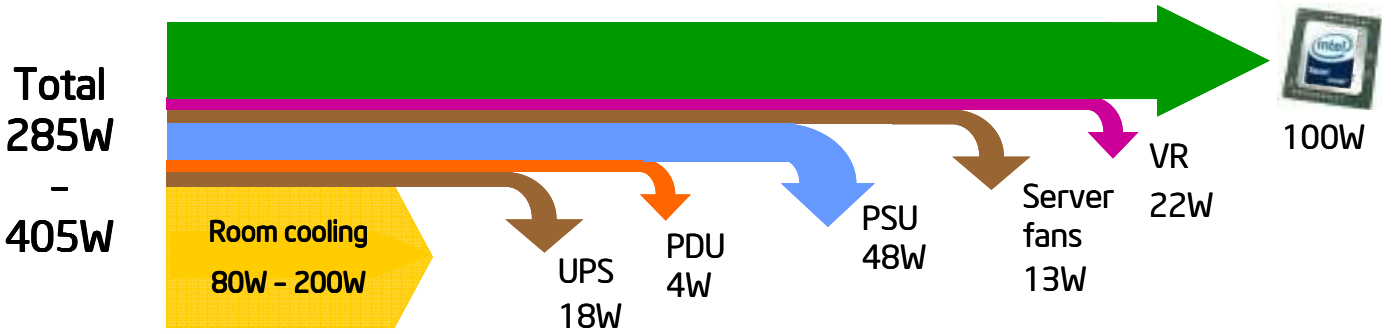
GEMS/DCPT (Group Enabled Management System / Data Center Power & Thermals)

- Managing Power and Thermals across all the servers in a Rack
- Dynamic monitoring of workload Power & Thermal impacts
  - Avoids over-sizing the power delivery from just summing the nameplate ratings
  - Constantly monitors the actual power usage to make operating decisions
- Distributed and self-organizing
  - GEMS nodes dynamically self-organize, using web services and XML technologies
  - machine-understandable description of nodes' power-management capabilities, instrumentation, and controls

[1] 10,000 Servers @ $0.10 / kWh

Current Data Centers are < 50% Energy Efficient at the CPU





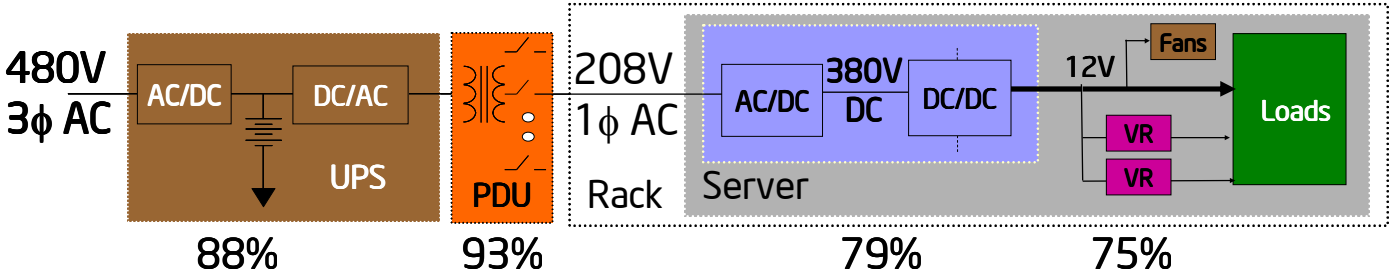
Impacts :

- Low server density
- High energy costs (TCO)
- Cooling / Thermal constraints
- Difficult to meet energy standards

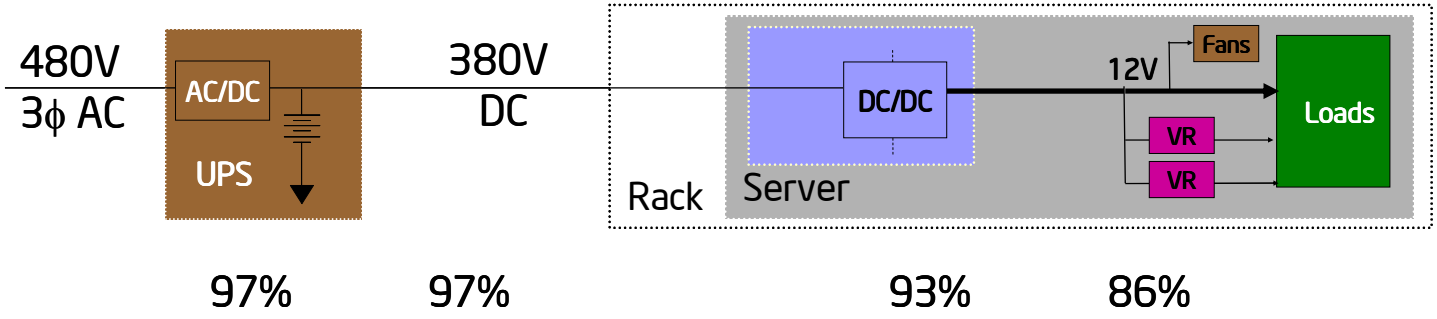
Power delivery efficiency in data centers ~ 50%

HVDC Demo – Efficiency from Eliminating Power Conversion Stages

AC Data Center Power Conversion Stages

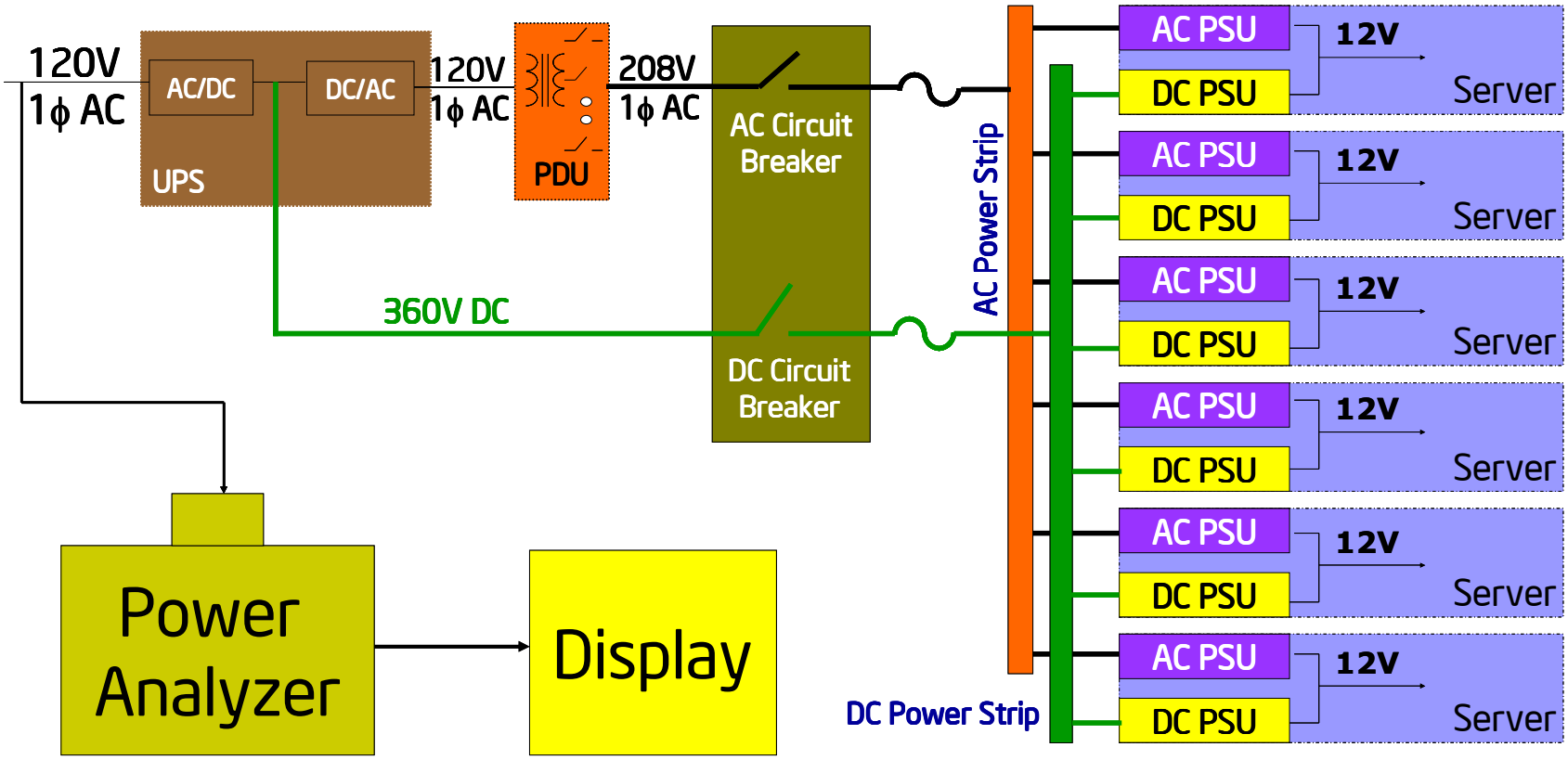


HVDC Data Center Power Conversion Stages



- Eliminate multiple conversion stages
  1 DC / AC conversion stage in the UPS; 1 AC / DC conversion stage in PSU; Eliminate the PDU
- 380V DC from Uninterruptible Power Supplies (UPS)

6 Server HVDC Demonstration Setup



HVDC Power in the Datacenter

Total Rack Power

1490 W

DC Power

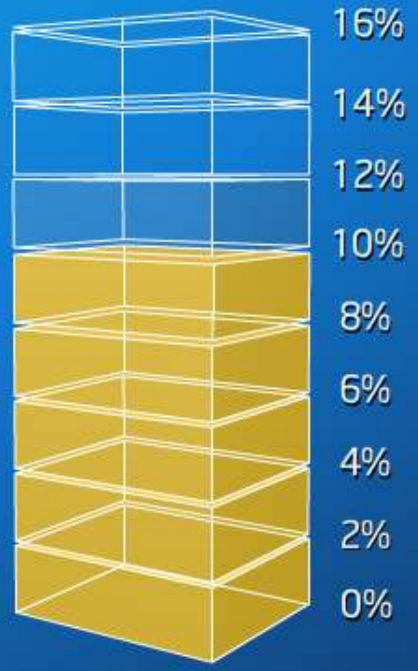
1651 W

AC Power

Annual Savings

$235,530

(10k servers)



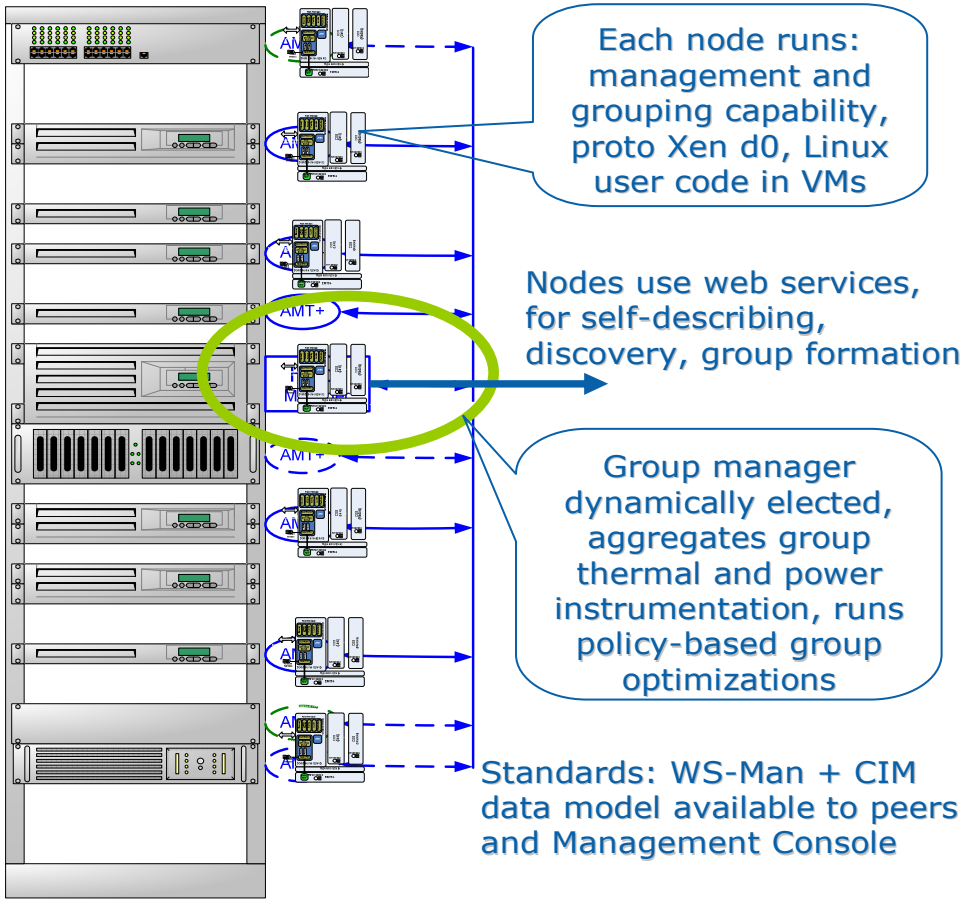
Percent Power Savings

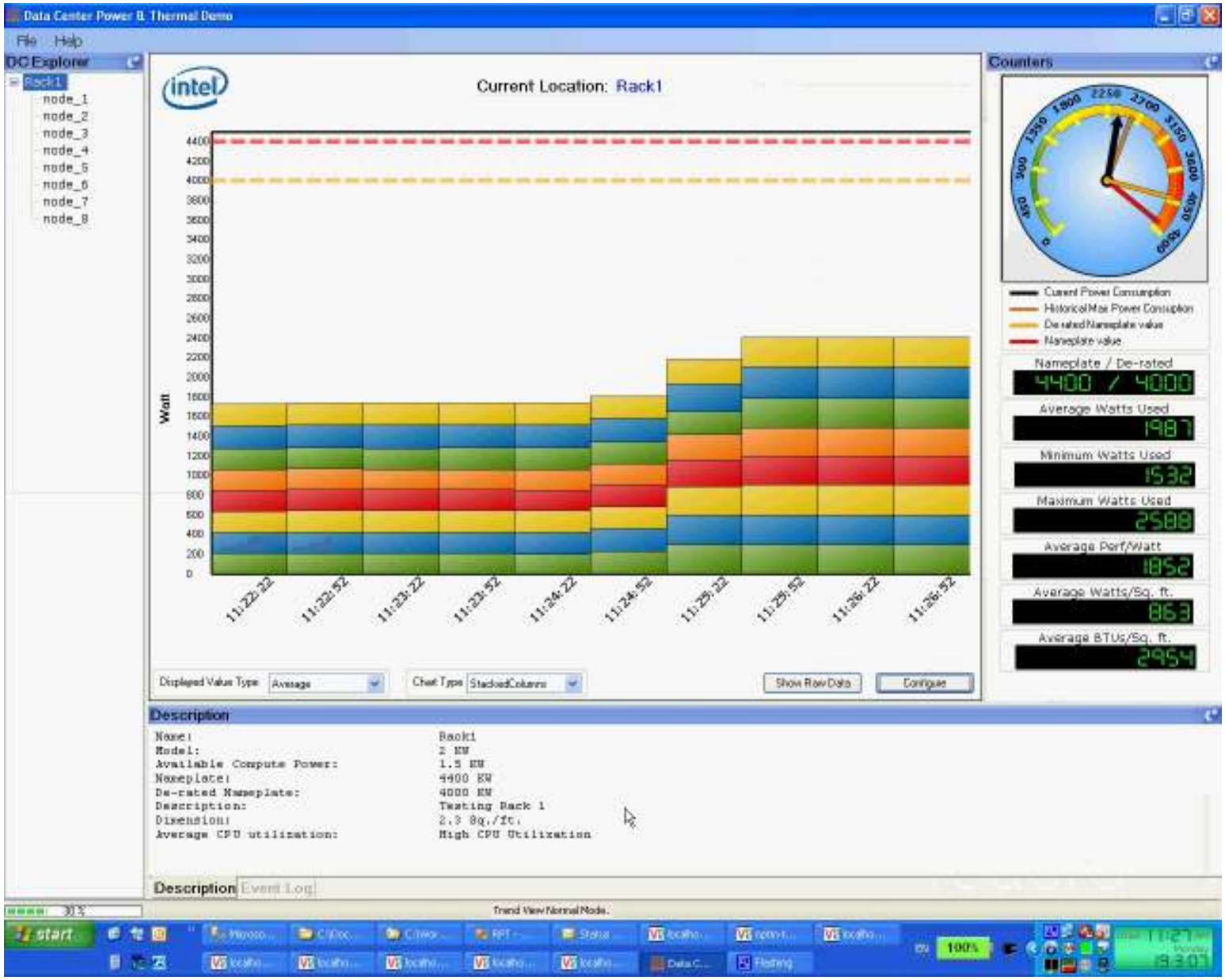
GEMS: Group-Enabled Management, applied to Power/Thermals

What is GEMS?

- GEMS: architecture, protocols, well-defined interfaces and policies that enable (1) formation of groups, (2) group-level power and thermal management
- Two separable capabilities, work great together
  - Group formation
    - self-organizing, discovery, description
  - Group-enabled management
    - group-level operations, group policies, and cross-platform P&T optimizations
- Application: group-level power/thermal optimization
  - Measured 40% power savings across nodes
- Status: working prototype
  - new JPF POC with DEG – integrated NPTM, GEMS
  - new SAP POC with EPI – GEMS integrated with virtualization manager for power and thermally aware VM placement and migration
- Where it lives: implemented as added functions in firmware/software on Intel Platform Manageability Container
- Product intercepts: Romley platform, DCPT 2.0 eco-system enablement

How GEMS works?




Data Center Power & Thermal Demo
File Help
DC Explorer
Rack1
node_1
node_2
node_3
node_4
node_5
node_6
node_7
node_8
Current Location: Rack1
Watt
Counters
Current Power Consumption
Historical Max Power Consumption
De-rated Nameplate value
Nameplate value
Nameplate / De-rated
4400 / 4000
Average Watts Used
1987
Minimum Watts Used
1532
Maximum Watts Used
2588
Average Perf/Watt
1852
Average Watts/Sq. ft.
863
Average BTUs/Sq. ft.
2954
Displayed Value Type
Average
Chart Type
StackedColumns
Show Raw Data
Configure
Description
Name:
Rack1
Model:
2 KW
Available Compute Power:
1.5 KW
Nameplate:
4400 KW
De-rated Nameplate:
4000 KW
Description:
Testing Rack 1
Dimension:
2.3 Sq./ft.
Average CPU utilization:
High CPU Utilization
Description
Event Log
Trend View Normal Mode.
start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