Innovative Data Center Efficiency Techniques

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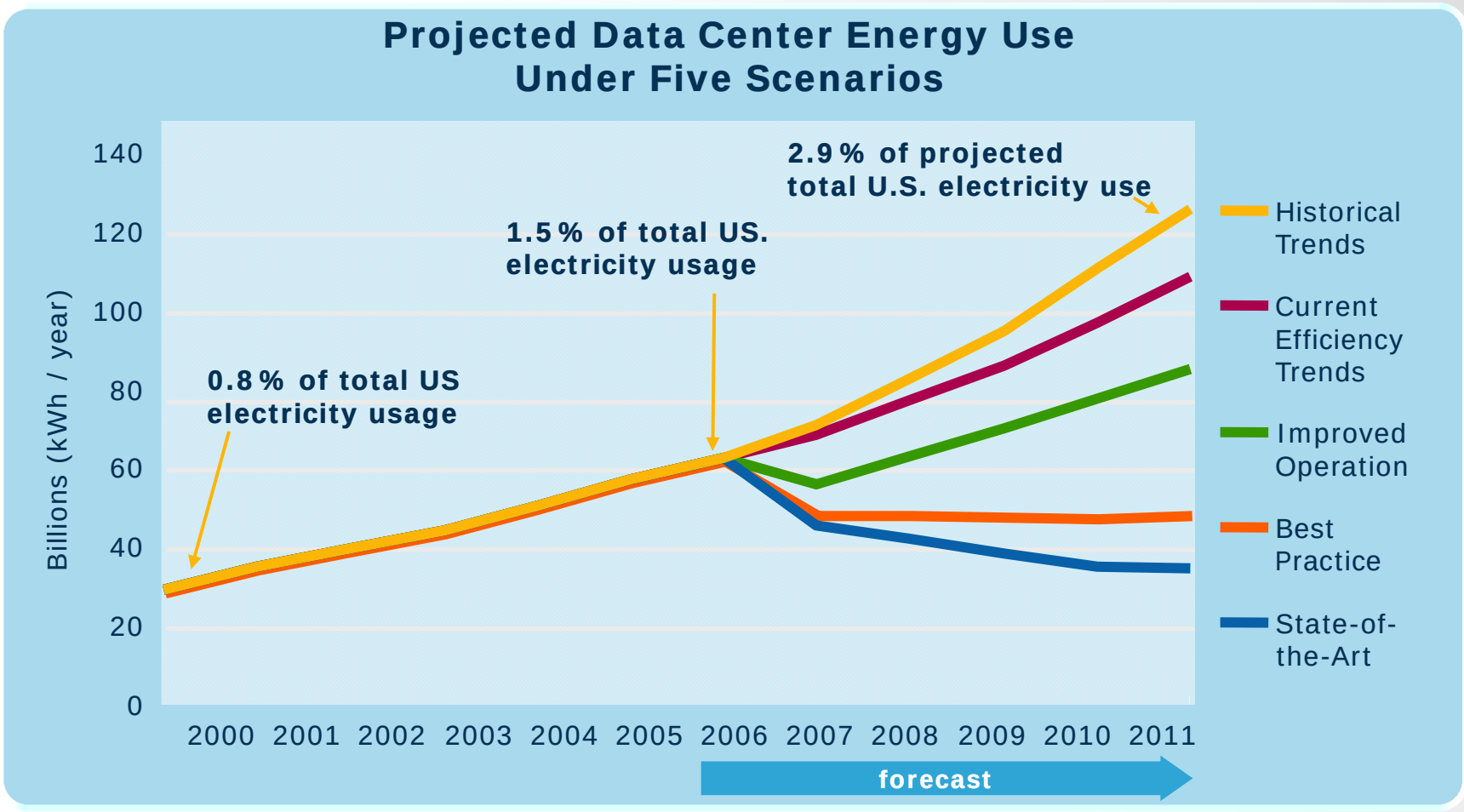
Eco-technology Program Office
Intel Corporation

Alternate titles…..

- Crisis or opportunity?
- Never build a new data center!
- Improve your PUE & your efficiency
- The hot aisle is supposed to be hot
- It's all about the denominator!

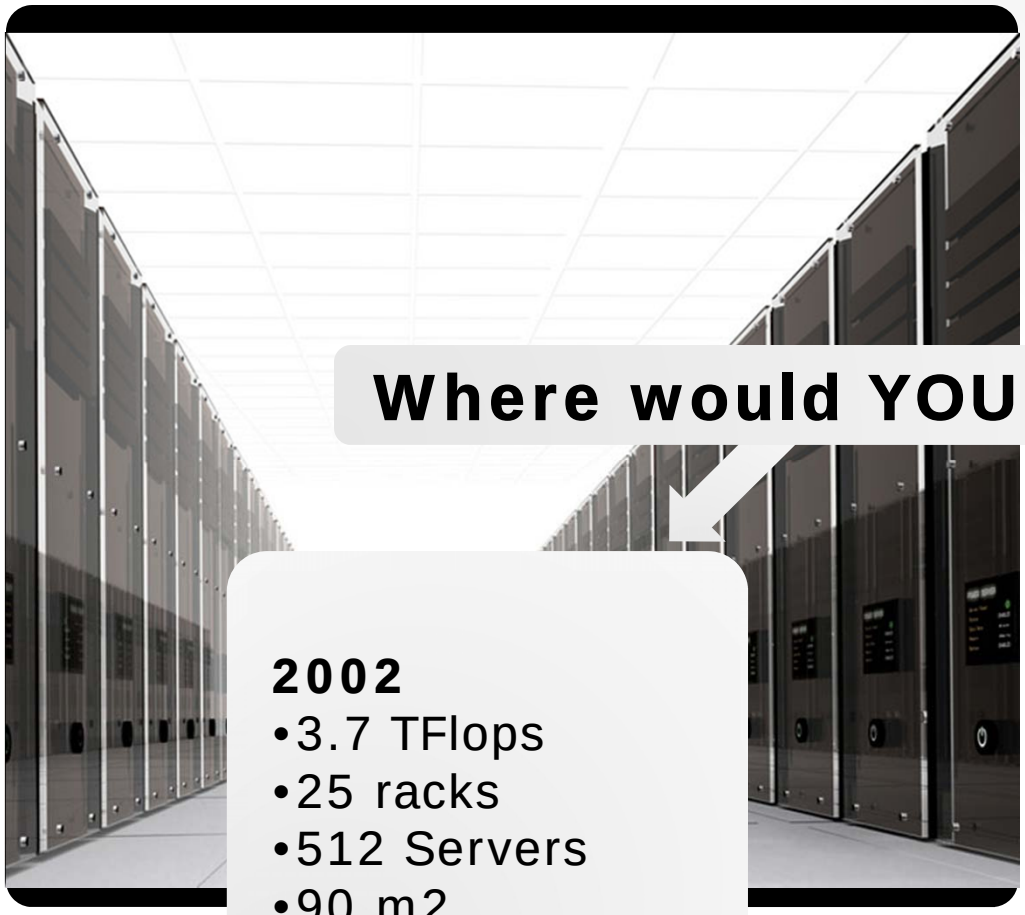
A Data Center Crisis…or Opportunity?



Where do you want to be?

Source: EPA Report to Congress on Server and Data Center Energy Efficiency; August 2, 2007

Moore's Law …
Alive and Well in the Data Center



Where would YOU rather be?

2002
- 3.7 TFlops
- 25 racks
- 512 Servers
- 90 m2
- 128 kW

2007
- 3.7 TFlops
- 1 rack
- 53 Servers
- 4 m2
- 21 kW

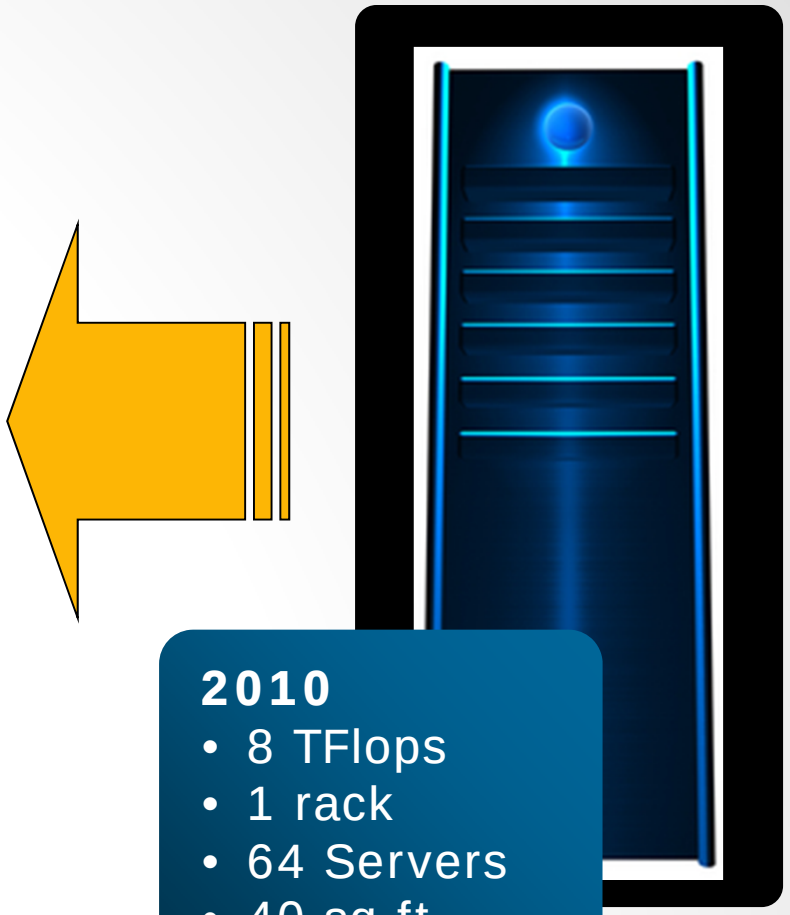
But what does this mean to our efficiency challenges?

As we have commoditized the server, we have un-commoditized the data center.

*This is NOT a "crisis", instead it's an **opportunity** to differentiate.*

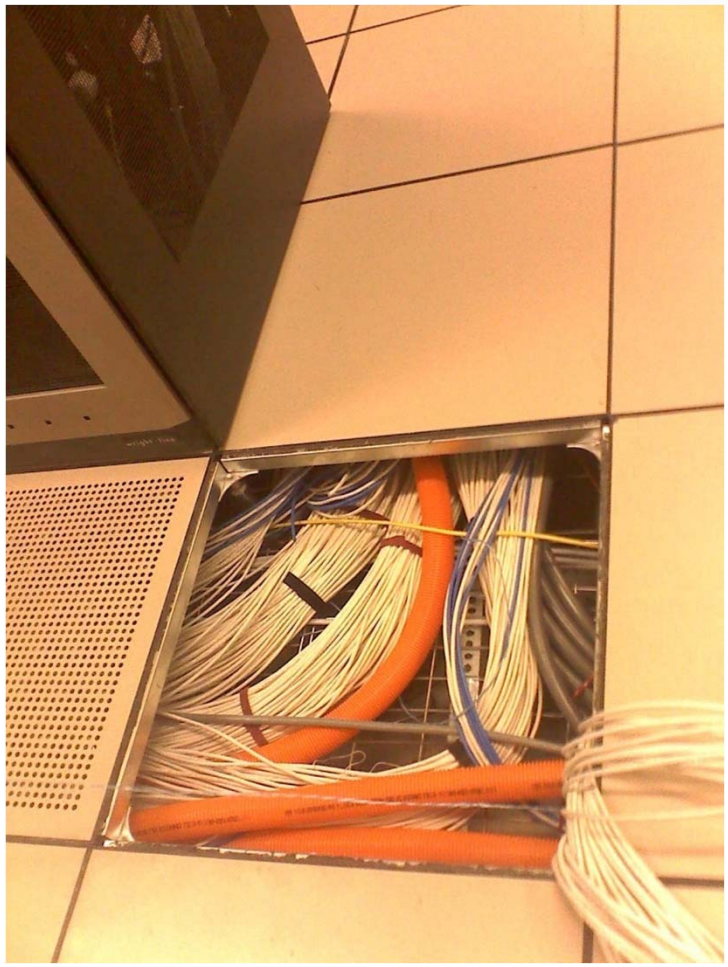
Those who apply the right planning and engineering will prosper, those who do not will suffer.

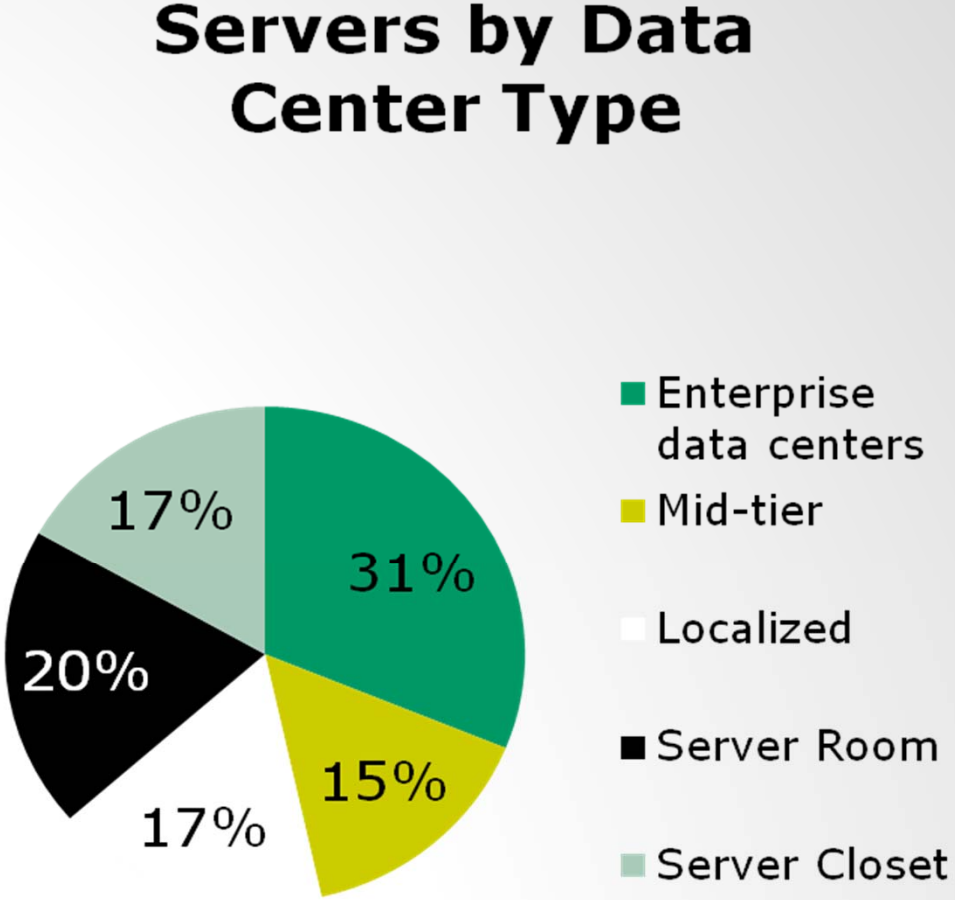
Good engineering will allow higher efficiency, lower TCO, and more computing capability.



2010
- 8 TFlops
- 1 rack
- 64 Servers
- 40 sq ft
- 30 kW

The real world……





Data from IDC Data Center of the Future Report

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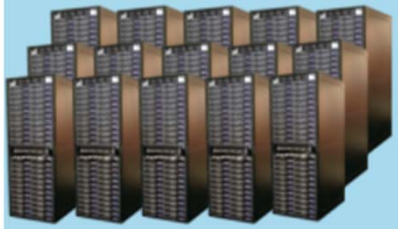
Server Refresh Example in 2010

2005



15 Racks of Single Core Servers

2010

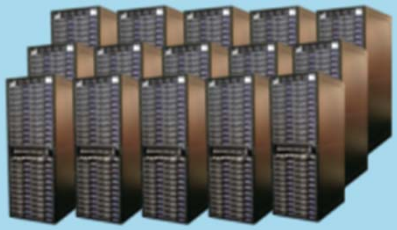
Efficiency Refresh 15:1

1 rack of new quad core Servers

More than 90% Annual Energy Cost Reduction (estimated)

– OR –

Performance Refresh 1:1



15 racks of quad core Servers

Up to 15x Performance

8% Annual Energy Costs Reduction (estimated)

Source: Intel estimates as of Jan 2010. Performance comparison using SPECjbb2005 bops (business operations per second). Results have been estimated based on internal Intel analysis and are provided for informational purposes only. Any difference in system hardware or software design or configuration may affect actual performance.

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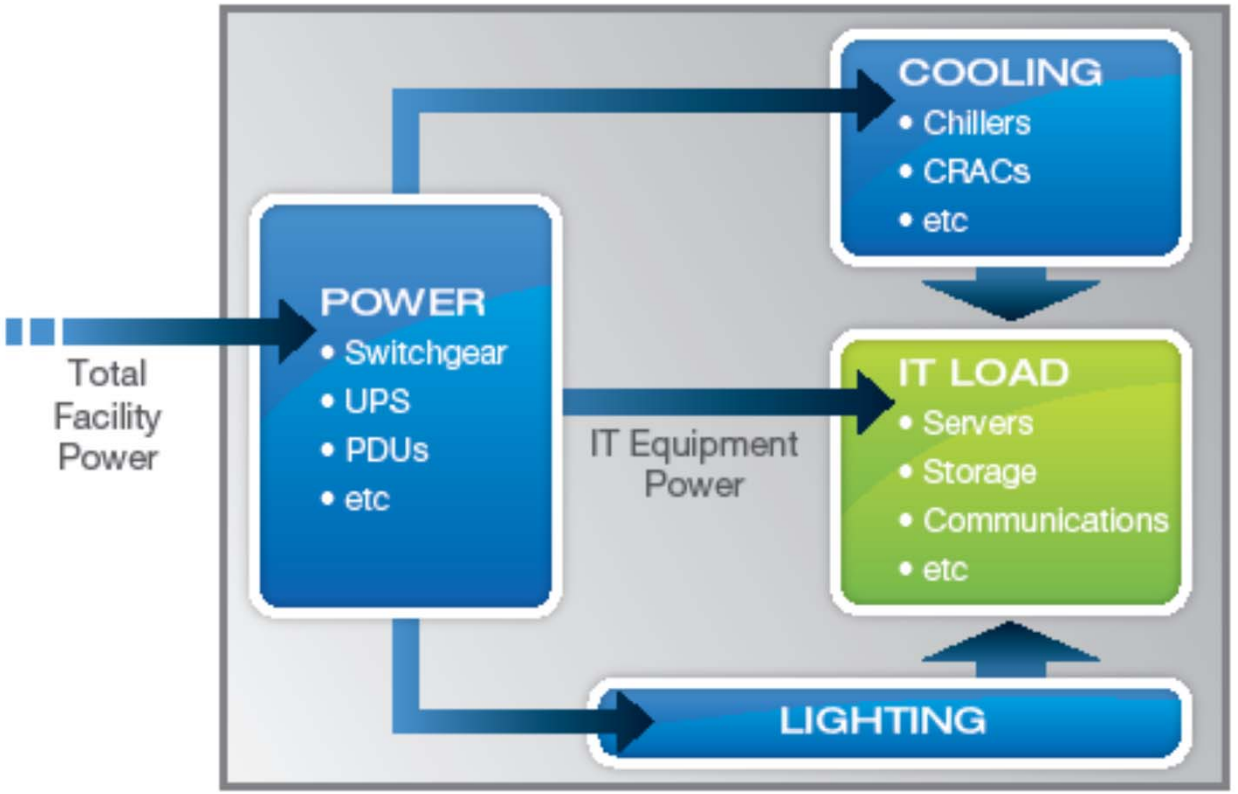
PUE: Power Usage Effectiveness

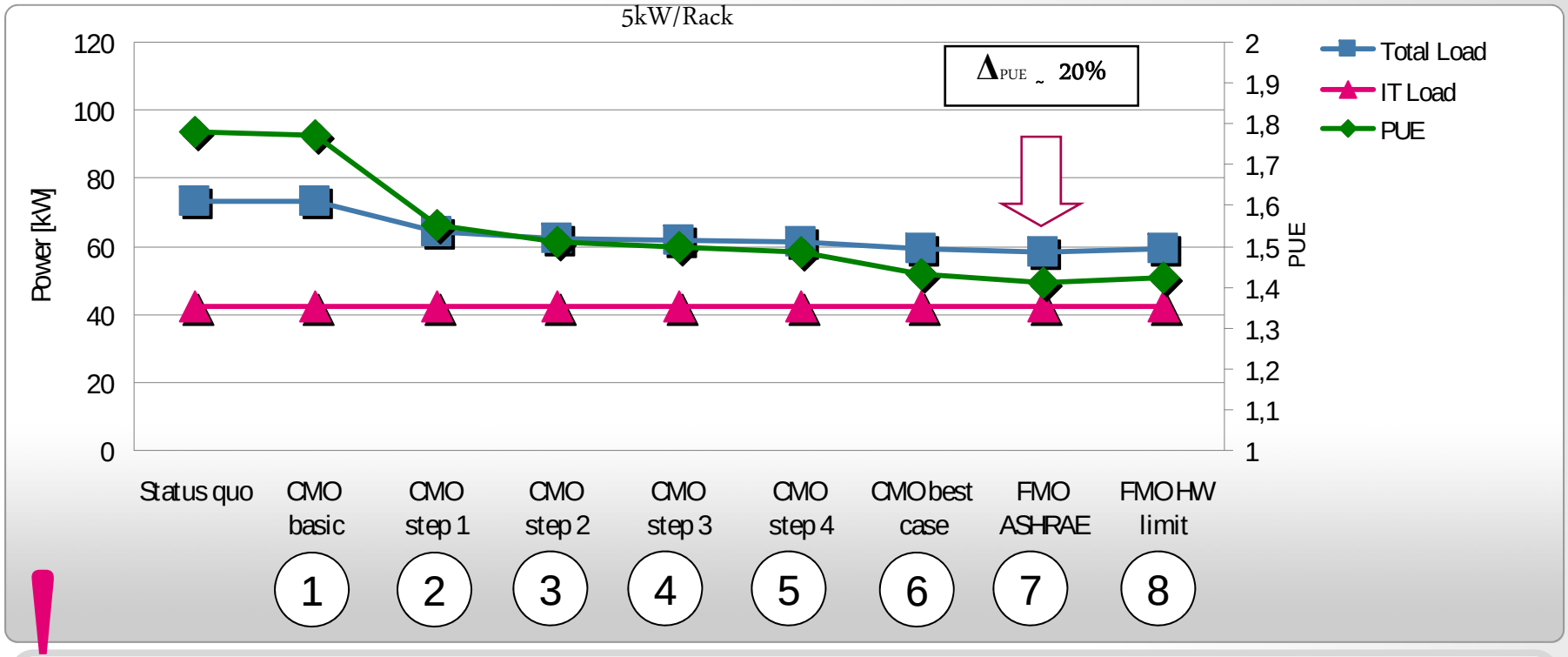


$$PUE = \frac{\text{Total Facility Power}}{\text{IT Equipment Power}}$$

$$DCiE = \frac{1}{PUE} \times 100\%$$

Source: The Green Grid

Infrastructure Optimization Effects – DC 2020 Part I.



1. Reduce Leakage
2. Optimize Fan Speed
3. Apply Doors, opt. Fan
4. Grating Tiles, optimize Fan
5. Complete enclosure, opt. Fan
6. EC Fan, Water supply 14°C
7. Water supply 24°C, Server Inlet 27°C
8. Water supply 34°C, Server Inlet 35°C

http://www.datacenter2020.com/

ERE Development

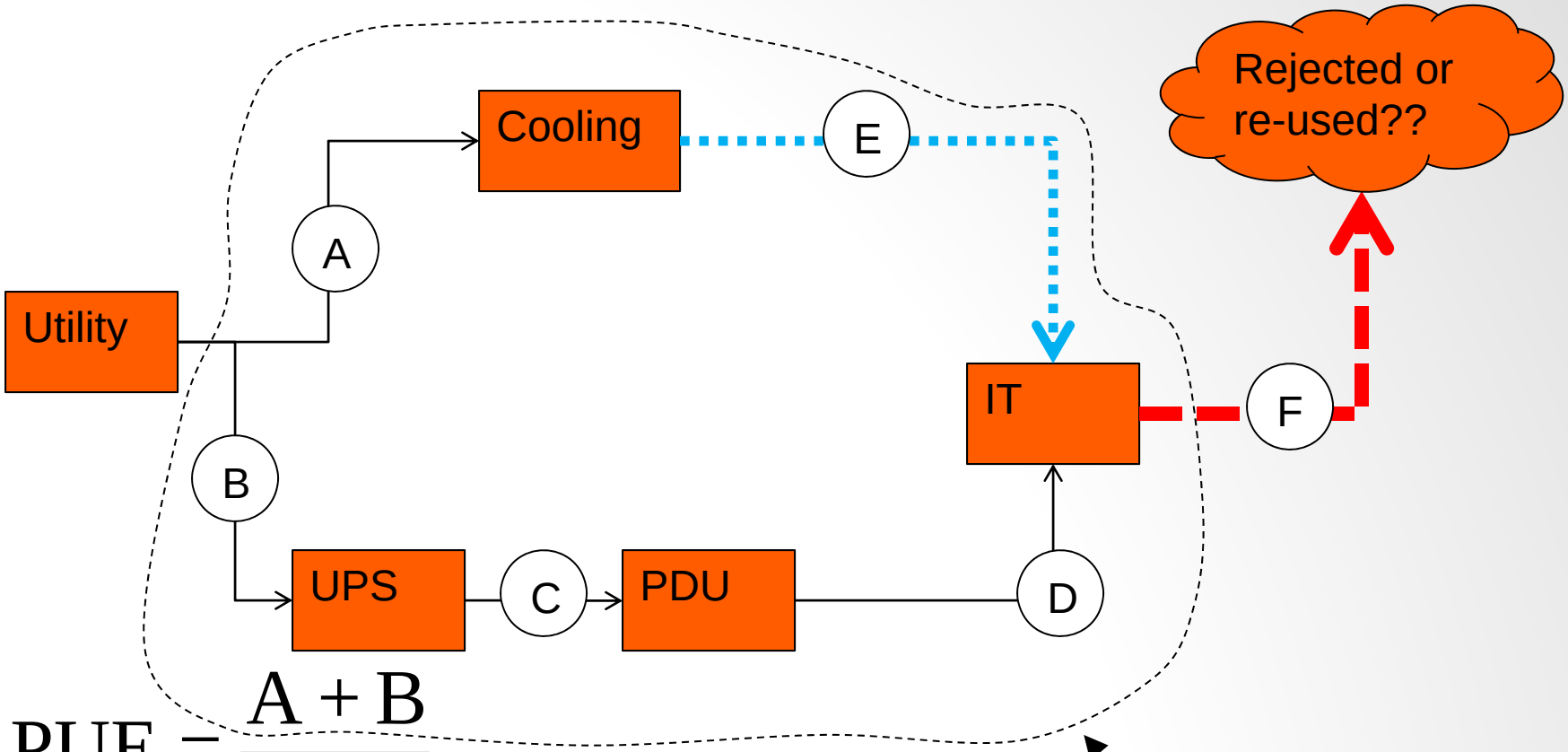
$$PUE = \frac{\text{Total Energy}}{\text{IT Energy}}$$

$$PUE = \frac{\text{Cooling} + \text{Power} + \text{Lighting} + \text{IT}}{\text{IT}}$$

$$ERE = \frac{\text{Total Energy} - \text{Reused Energy}}{\text{IT Energy}}$$

$$ERE = \frac{\text{Cooling} + \text{Power} + \text{Lighting} + \text{IT} - \text{Reused}}{\text{IT}}$$

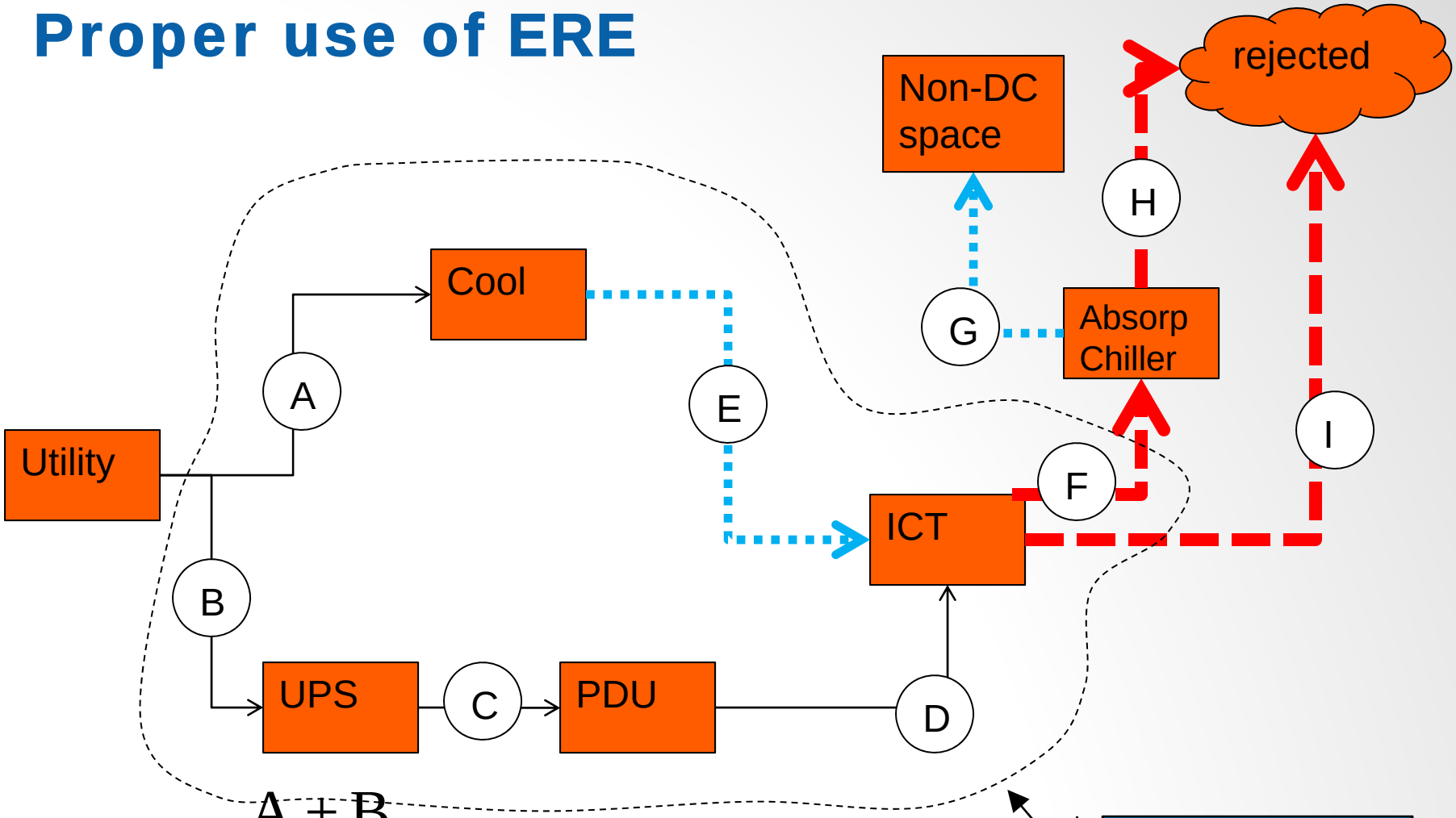
Data Center Boundary Consideration and ERF



$$PUE = \frac{A + B}{D}$$

$$ERE = \frac{A + B - F}{D}$$

Proper use of ERE

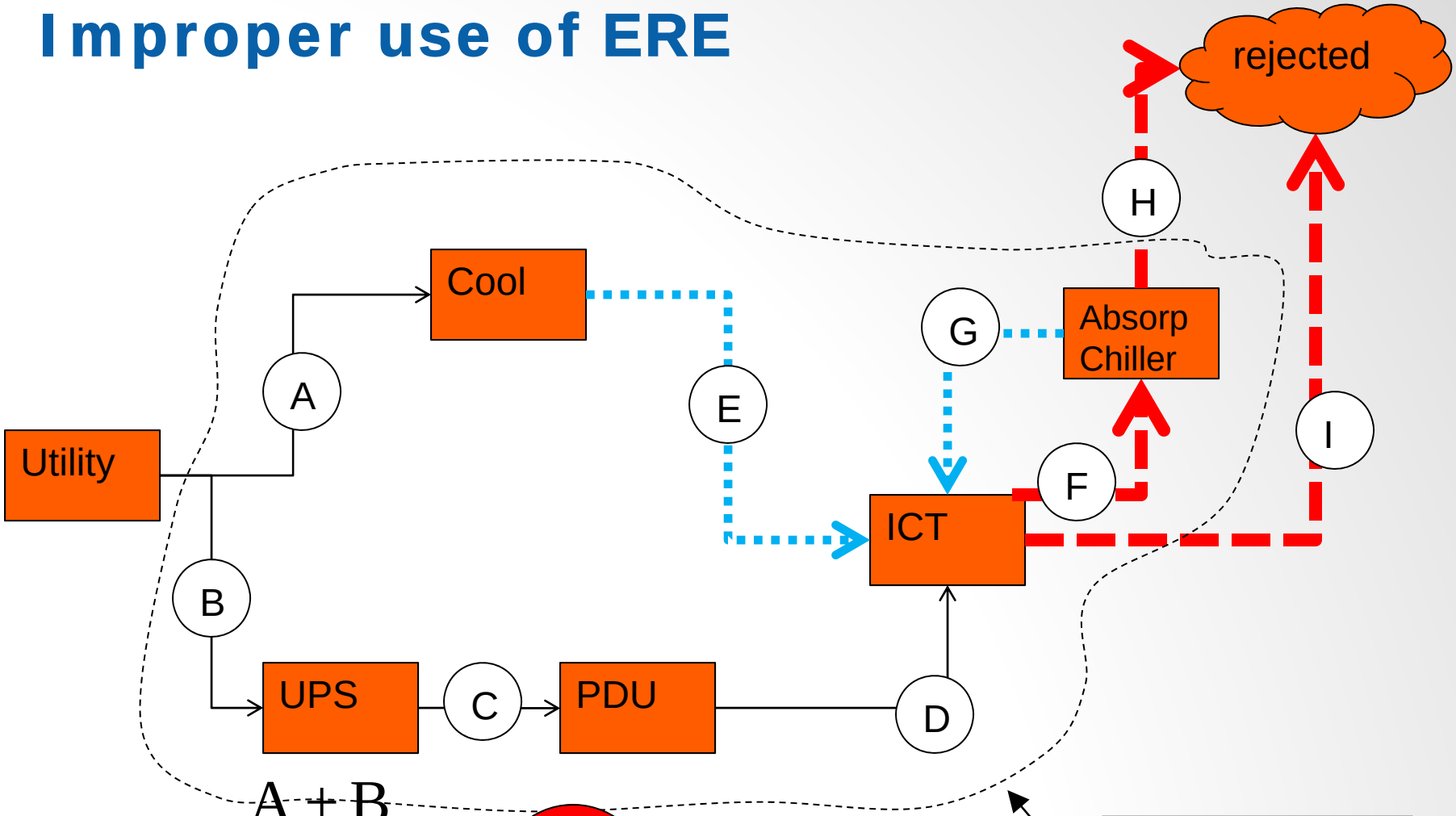


$$PUE = \frac{A + B}{D}$$

$$ERE = \frac{A + B - F}{D}$$

Both PUE & ERF valid metrics

Improper use of ERE



$$PUE = \frac{A + B}{D}$$

$$ERE = \frac{A + B - F}{D}$$

PUE is the right metric, ERE is not

PUE, ERE, and ERF Ranges

$$1 \le PUE \le \infty \qquad PUE = \frac{\text{Cooling} + \text{Power} + \text{Lighting} + \text{IT}}{\text{IT}}$$

$$0 \le ERE \le \infty \qquad ERE = \frac{\text{Cool} + \text{Pwr} + \text{Light} + \text{IT} - \text{Reused}}{\text{IT}}$$

$$0 \le ERF \le 1 \qquad ERF = \frac{\text{Reuse Energy}}{\text{Total Energy}}$$

$$ERE = (1 - ERF) \times PUE$$

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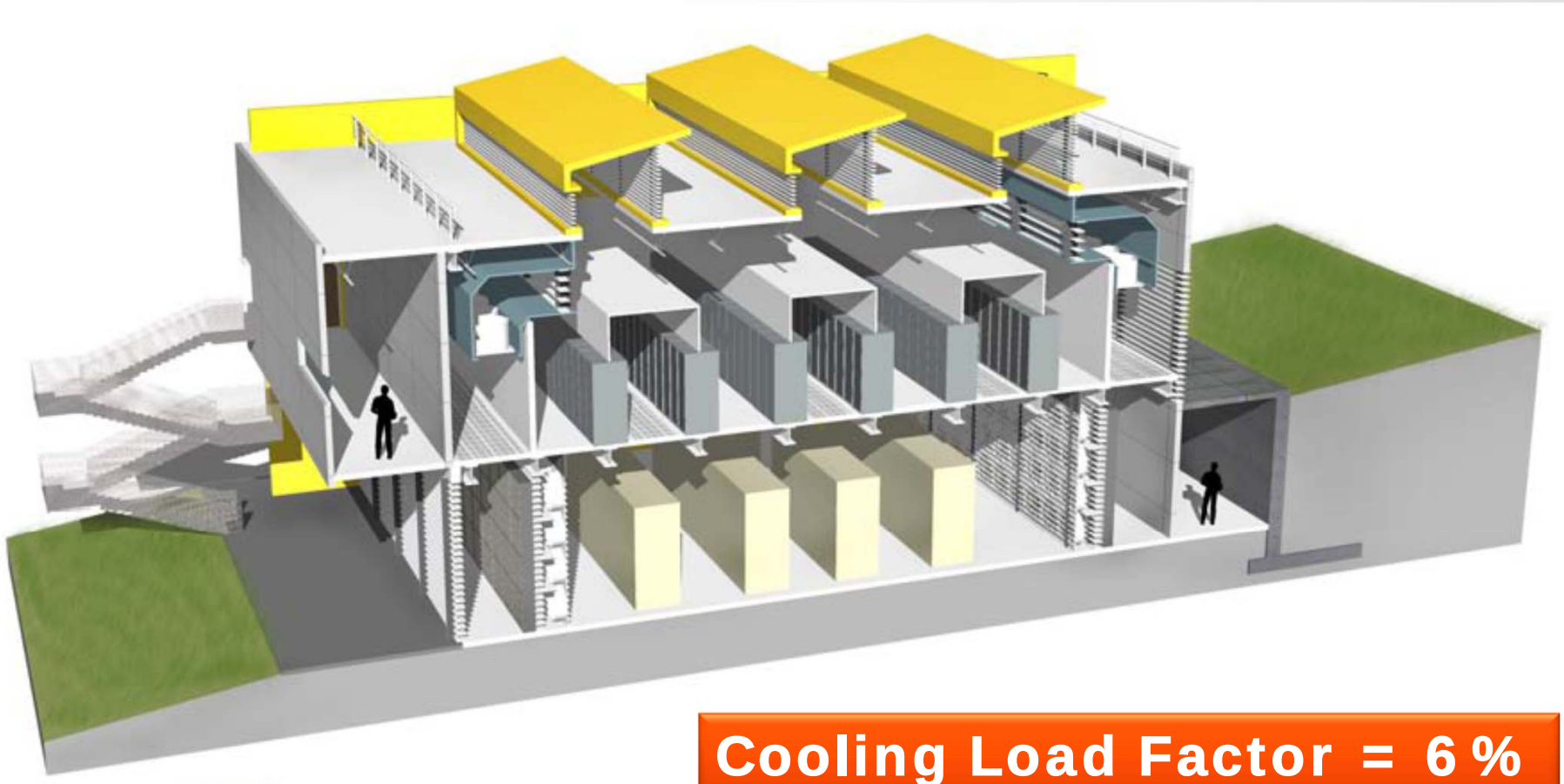
Scientific Research Computing Facility
Stanford University



Cooling Load Factor = 6 %

Graphic courtesy of Stanford University

CERN cold aisle containment

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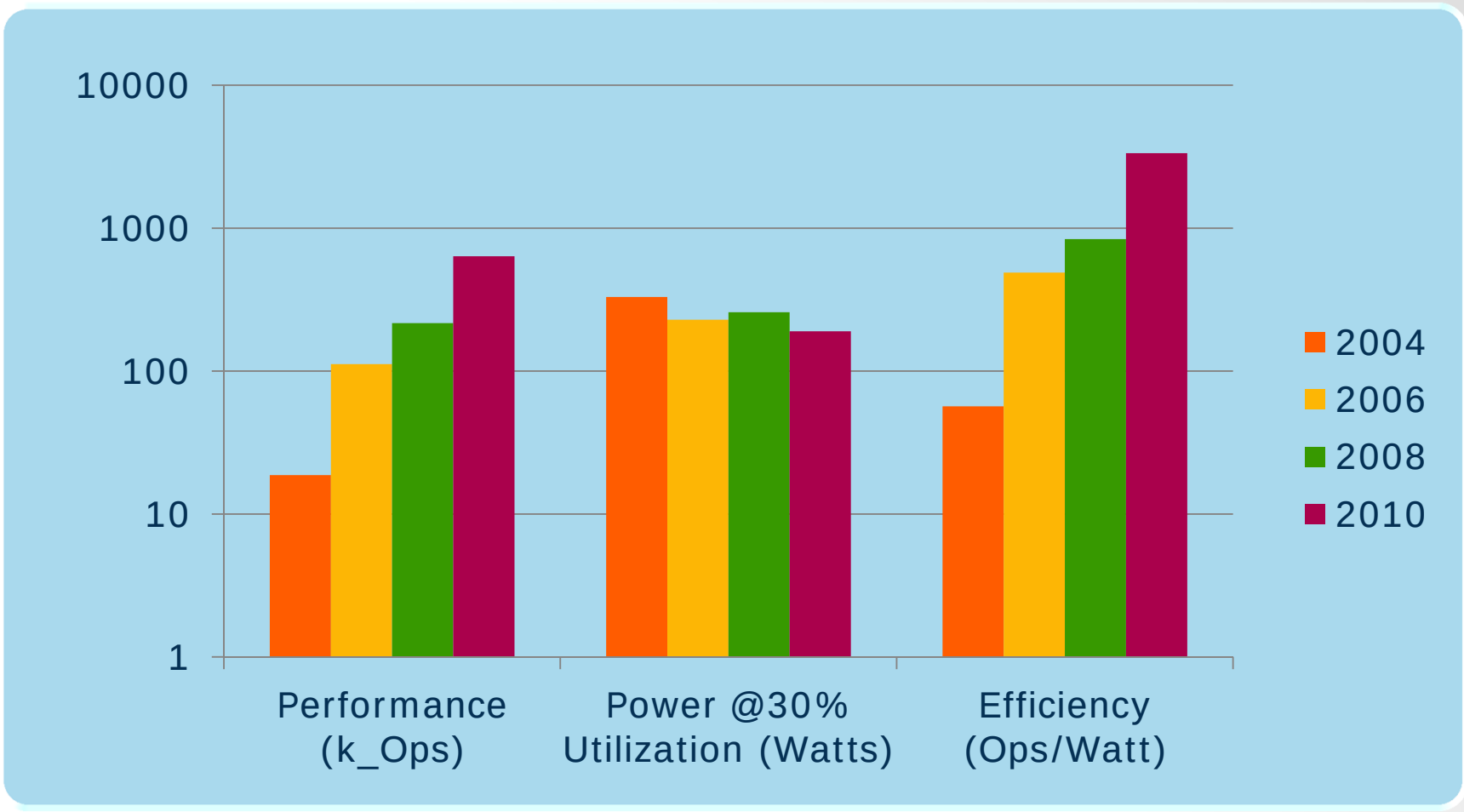
PUEs: Reported and Calculated

	PUE
EPA Energy Star Average	1.91
Intel	1.41
T-Systems & Intel DC2020 Test Lab	1.24
Google	1.16
National Center for Atmospheric Research (NCAR)	1.10
Yahoo	1.08
National Renewable Energy Laboratory (NREL)	1.06

$$\text{PUE} = \frac{\text{Total Facility Energy}}{\text{IT Energy}} = \frac{\text{Cooling} + \text{Power} + \text{Misc} + \text{IT}}{\text{IT}}$$

Xeon Platform Efficiency Trends



Higher Performance AT LOWER POWER

Performance and power consumption results are based on certain tests measured on specific computer systems. Any difference in system hardware, software or configuration will affect actual performance. Configurations: Two-socket Systems, Test Results for SPECpower_ssj2008, Testing by Hewlett-Packard. For more information go to http://www.intel.com/performance

ENERGY SAVINGS FROM ENERGY STAR-QUALIFIED SERVERS

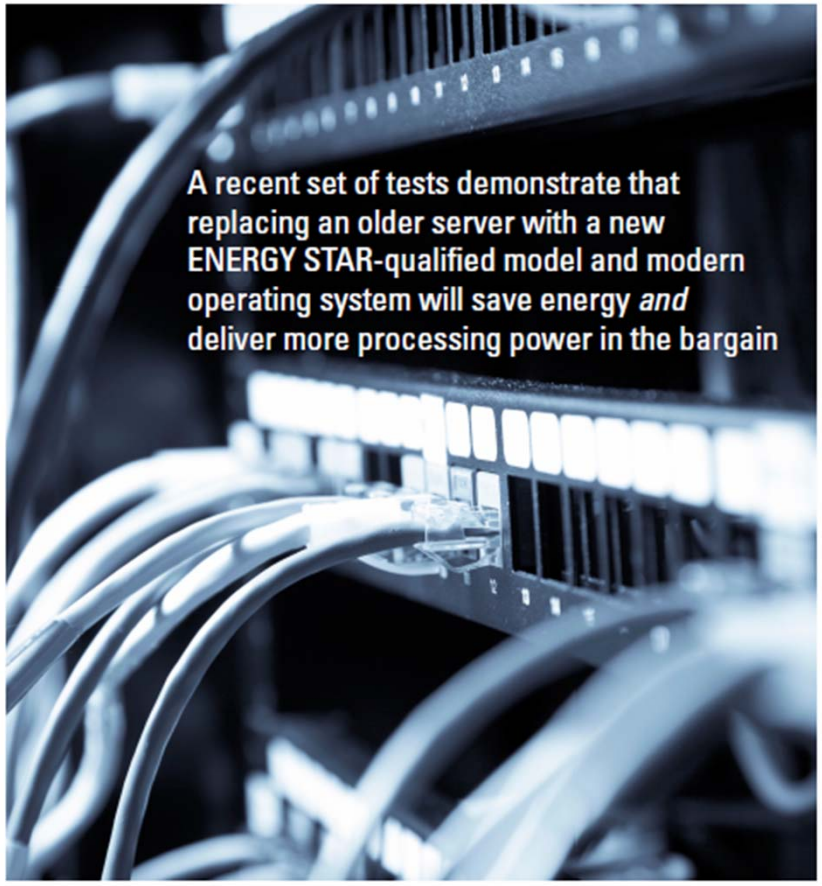


FIGURE 6: BASELINE WORKLOAD -- POWER EFFICIENCY COMPARISON AT LOAD LEVEL

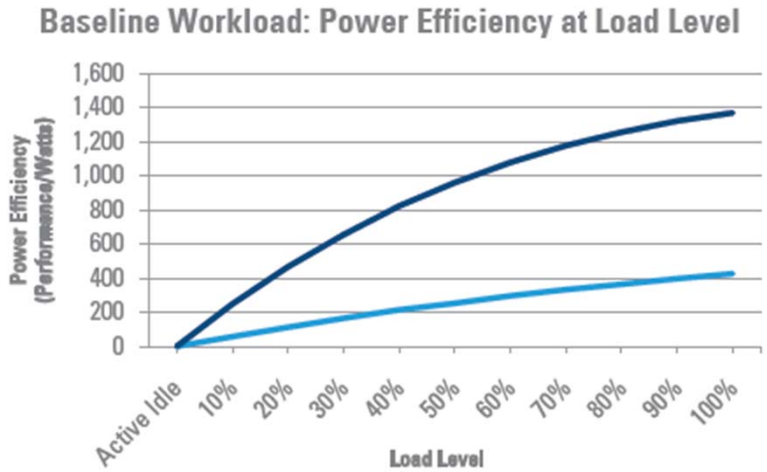
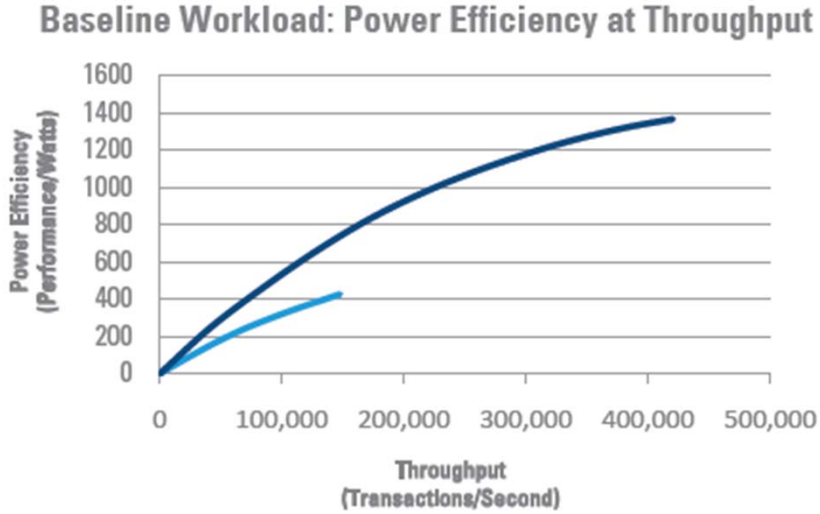
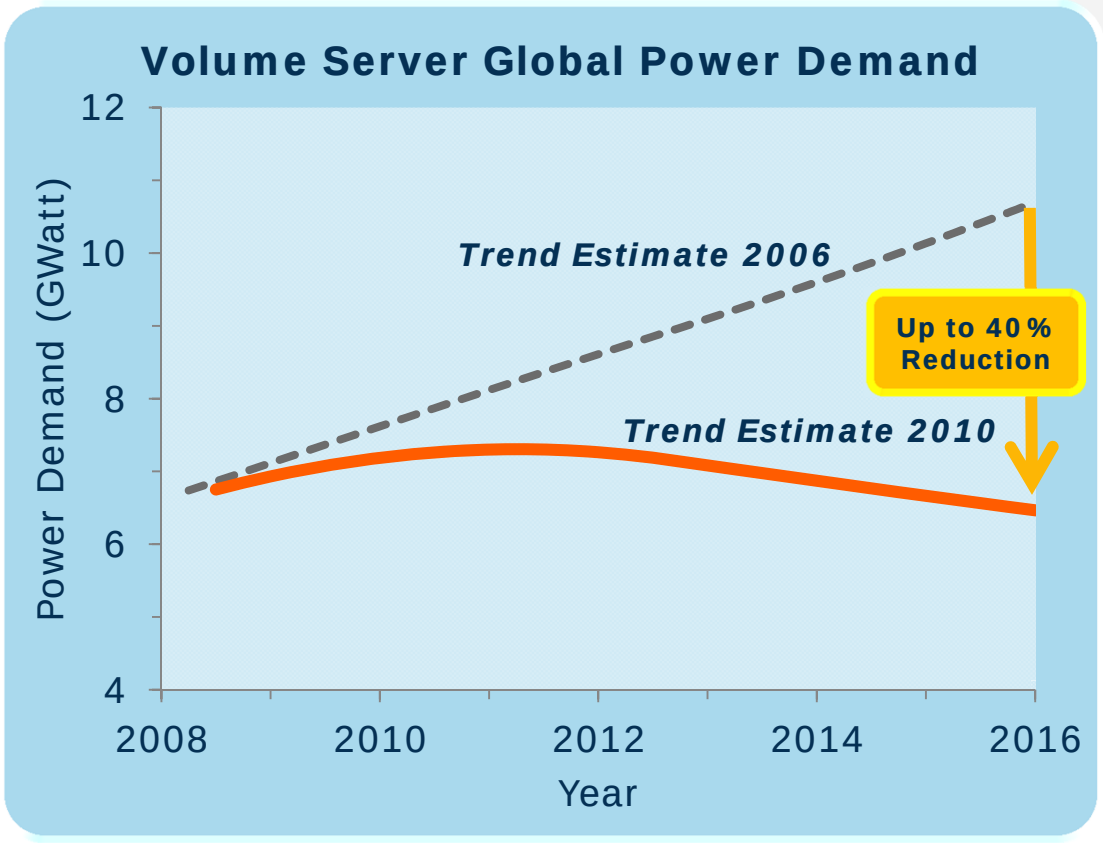


FIGURE 7: BASELINE WORKLOAD -- POWER EFFICIENCY COMPARISON AT THROUGHPUT LEVEL



Server Efficiency Focus – Global Impact



By 2016…

- Number of Servers Increases 1.5X
- Compute Capacity Grows 9X
- Total Server Energy Consumption **Stays Constant**

The Tide is Turning on Data Center Energy Consumption

Source: Intel Estimates May 2010
Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Buyers should consult other sources of information to evaluate the performance of systems or components they are considering purchasing. For more information on performance tests and on the performance of Intel products, Go to:
http://www.intel.com/performance/resources/benchmark_limitations.htm

Moore's Law is the solution to Green Data Centers, not the problem……

Thank You!

Questions?