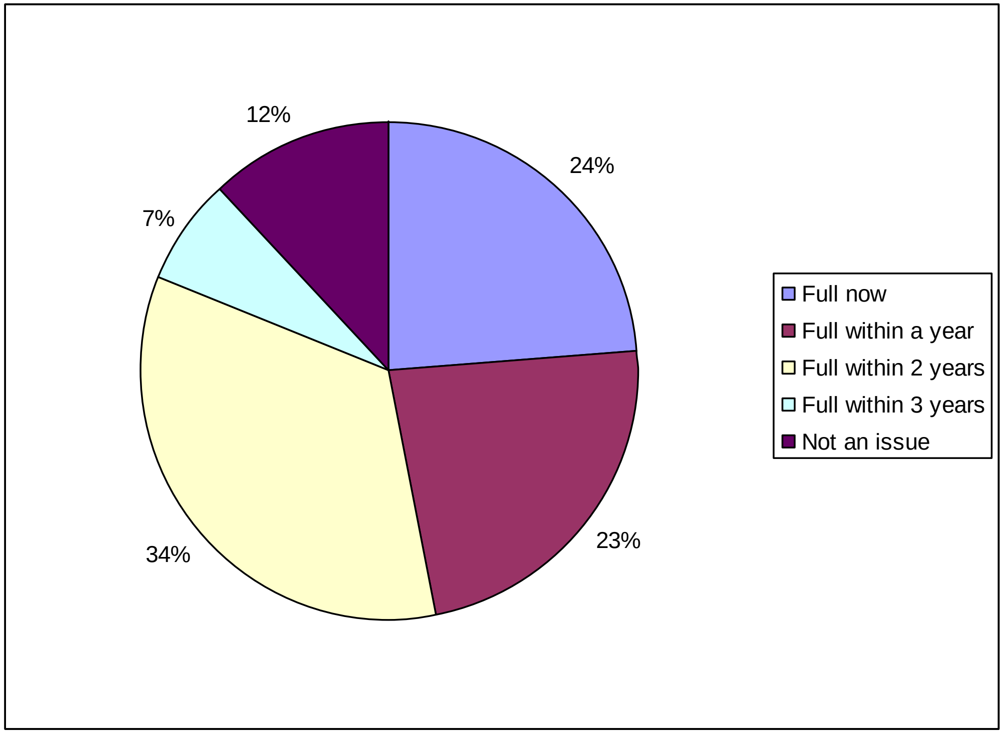
Data Centre Management

BICSI Breakfast Club

30th October 2008

Data Centres today



- A survey of data centres owned by UK banks shows
  - 24% have full data centres.
  - 23% will be full within a year
  - and another 34% within two years

The growth continues…..

- Banks are seeing 50 to 100% annual growth in Data Centre requirements
- YouTube accounts for 2 to 10% of all Internet Traffic
- BBC iplayer is seeing 30% month on month growth, 17 million hits in March 08 alone
- Storage will be an increasing issue for DC as IP Security takes off
  - an analogue pic is equivalent to 0.4 megapixel
  - digital 10 megapixel is here.

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Power is limited

- Power costs are becoming the single most important element in data centre operating costs
- Power costs are 50/60% of the entire DC running costs
- There is a move to price per KW rather than price per sq ft in the co-location/hosted environment
- In 2006, annual energy costs of an average data centre in the UK is €5.3 million per year

- **In 2011, annual energy costs of an average data centre in the UK will more than double, to €11 million**

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But consumption continues to rise

- Blade servers are becoming more common
- High density sectors such as Akamai and online gaming
- Financial services firms have realised that their in-house capability needs to be supplemented by third party Data Centre facilities

'Half the world's data centres will run out of power by the end of 2008' **Gartner, 2006**

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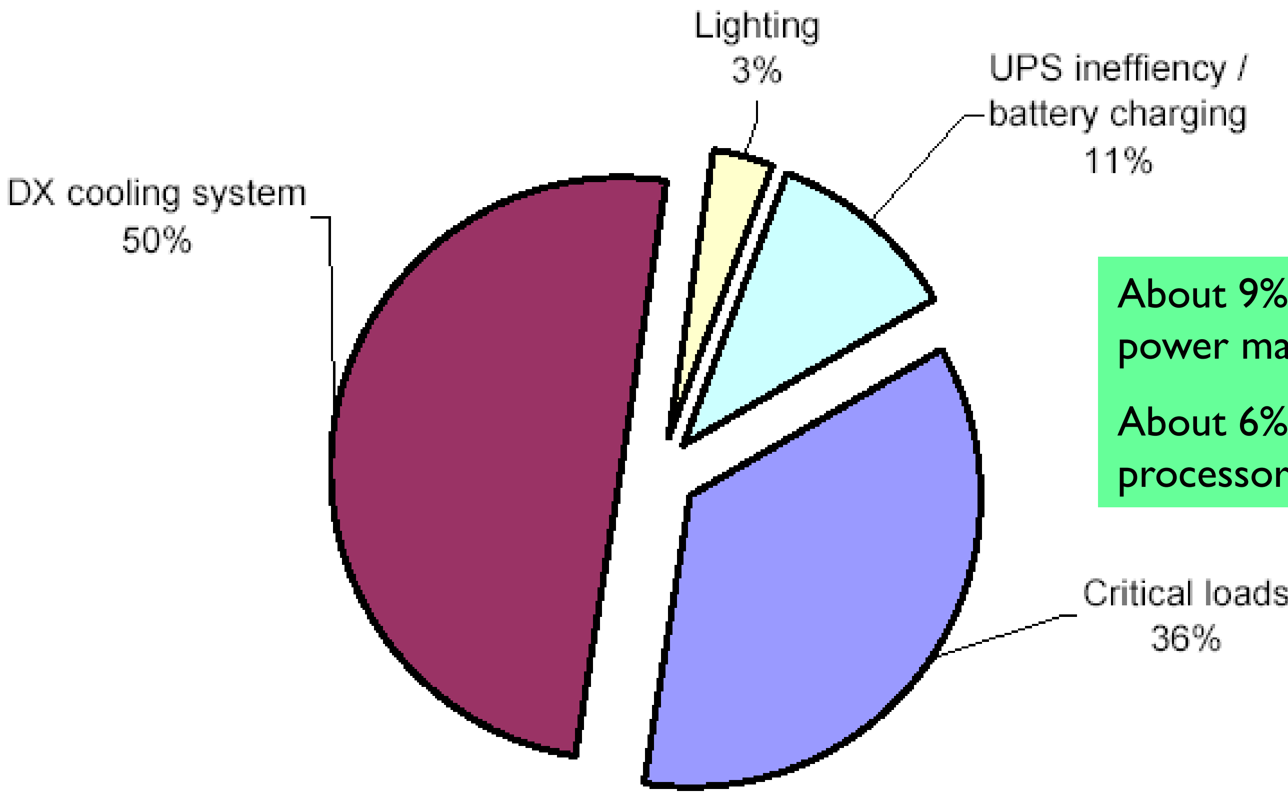
Breakdown of Typical Energy Requirements



About 9% of power station power makes it to the server

About 6% makes it to the processors and electronics

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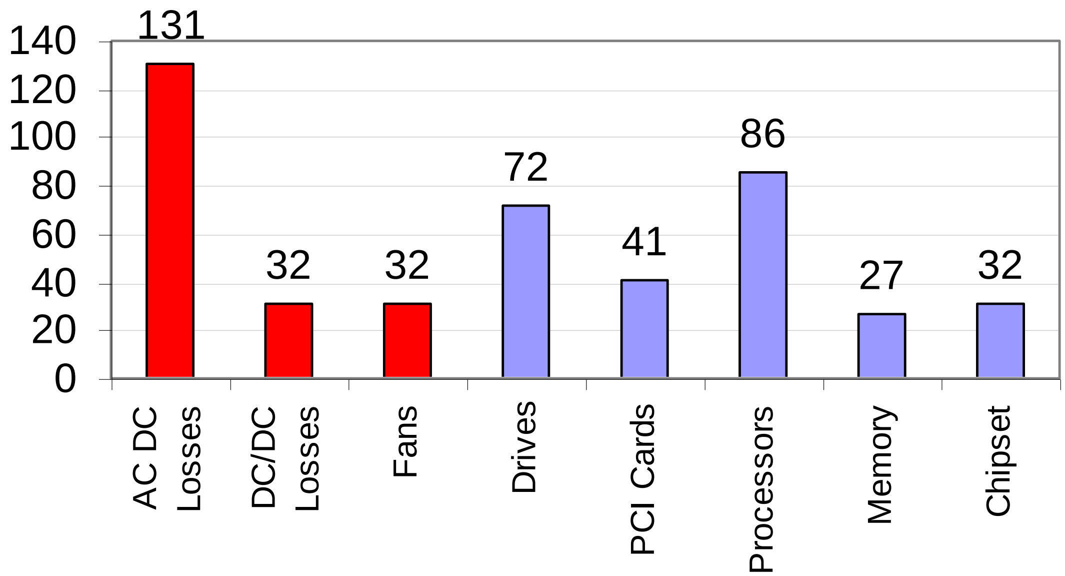
Strategies for reducing power

- 35% of the power is used by the IT load
- 50% is used to cool the IT load

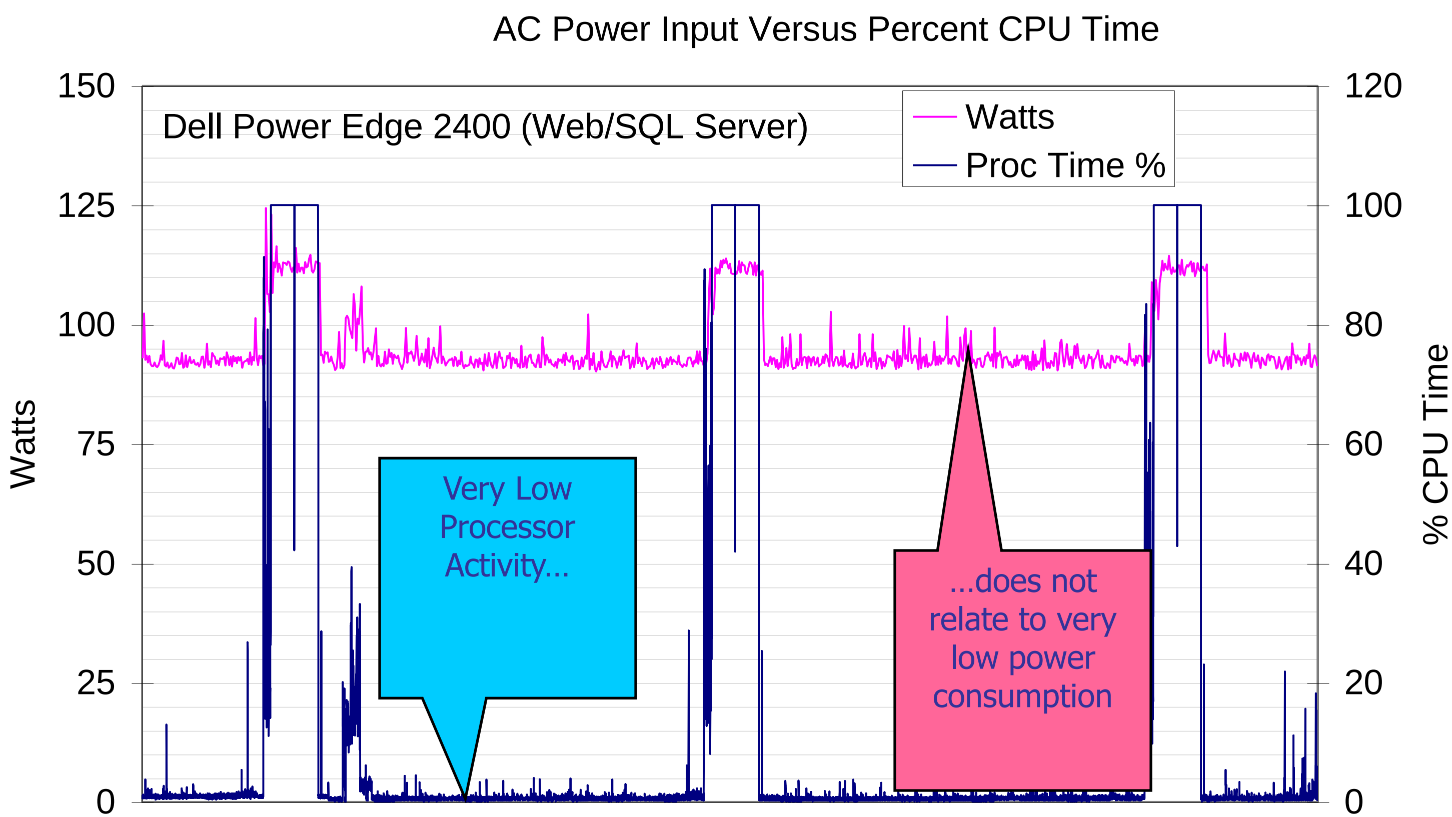
- The obvious target is to minimise the IT load whilst maintaining or increasing the data centre capability

Electricity Use in a Server



Based on a typical dual processor 450W 2U Server; Approximately 160W out of 450W (35%) is losses in the power conversion process (Source: Brian Griffith: INTEL)

Power Efficiency



Lawrence Berkely National Labs

Most of the time the GHz processor is doing activities that can be done by a MHz processor but the input power consumption is not changing much.

IT power trends

- From 2000 to 2006
  - IT processor power increased by a factor of 25
  - Power efficiency only increased by a factor of 8
  - Power consumed by a server spend per $1000 has increased by a factor of 4

Space is limited

- No new planning permission has been granted in London for 19 months
- Other major cities are facing the same problem

Or is it?

- US data centres are now relocating to rural sites, e.g. Washington State
- Iceland is marketing itself as a prime data centre site and fibre links are being installed
- These sites have readily available ‘green’ power available

Carbon Footprint

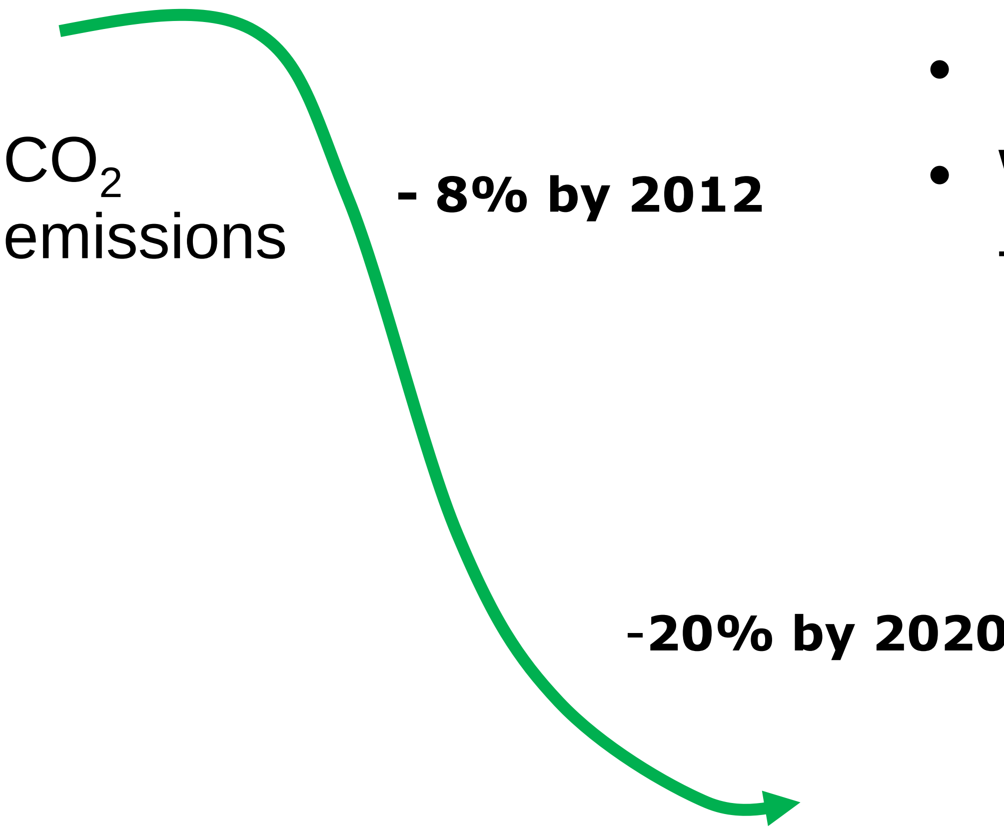
Energy Consumption

- Total worldwide power consumption in 2005 for Data Centres including cooling totalled 112.5 billion KWH

Carbon Impact

- 112.5 billion KWH = 58,837,500 tonnes Co2
  - Equivalent to a Boeing 757 flying around the world 96,542 times or 17 million cars of the road.

Environmental Regulation



- How far will it go?
- What do we know so far?
  - Kyoto accord
  - Green pressures
  - Carbon footprint
  - Financial penalties
  - Complex equation

Many factors to consider

- building & premises
  - energy efficient design, use of sustainable resources
- processes
  - access management, regular operation, value added services, recycling
- staff
  - qualification, environmental education/attitude
- technical equipment
  - power supply, cooling, external connections, air filtering, energy efficient hardware, latest technology

Some EU suggestions for compliance

- ►Energy efficient design
- ►Existence of power management tools, energy monitoring
- ►Short depreciation period (<3 years) as indicator for use of current technology
- ►Data centre energy bills paid by IT-department
- ►Proof of strategy to reduce energy consumption (e.g. a five year plan)
- ►Implementation of recycling processes (e.g. heat recycling)
- ►Energy supply coming from green

Traditional data centre

- Historically data centres were designed with large tolerances for operational and capacity changes.
- Only 15% to 20% of the grid power consumed by the data centre today actually gets to the IT systems:
  - Large amounts of redundant power
  - Inefficient cooling systems and
  - IT systems at an average utilisation of 15%
- Negligible risk to business performance from low system efficiencies.
  - Energy costs were a small proportion, or hidden, from the IT budget
  - Environmental responsibility was not considered to be the remit of the IT section.

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Environment and Energy Cost

- Energy costs have risen, and now the energy cost is as big as the IT cost.
- Increasingly difficult to expand existing DC or to site new DC because constrains on cooling, space, and electricity supply and network.
- Data Centres are becoming increasingly aware of their environmental impacts and the need to reduce waste.

Efficiency Improvement Metrics

$$\text{Datacentre Efficiency (DCE)} = \frac{\text{Total IT power}}{\text{Total input power}}$$

$$\text{Power Usage Efficiency (PUE)} = \frac{1}{\text{DCE}}$$

$$\text{Typical Efficiency 33\%} = \frac{\text{1 kW Total IT power}}{\text{3 kW Total input power}}$$

Typical PUE = 3

To measure improvement you must know the current power draw.

How do you establish your datacentre efficiency target?

Efficiency measures

Methods

- EER - Energy Efficiency Ratio (CoE)
- PUE - Power Usage Efficiency
- AFCOM

Measure

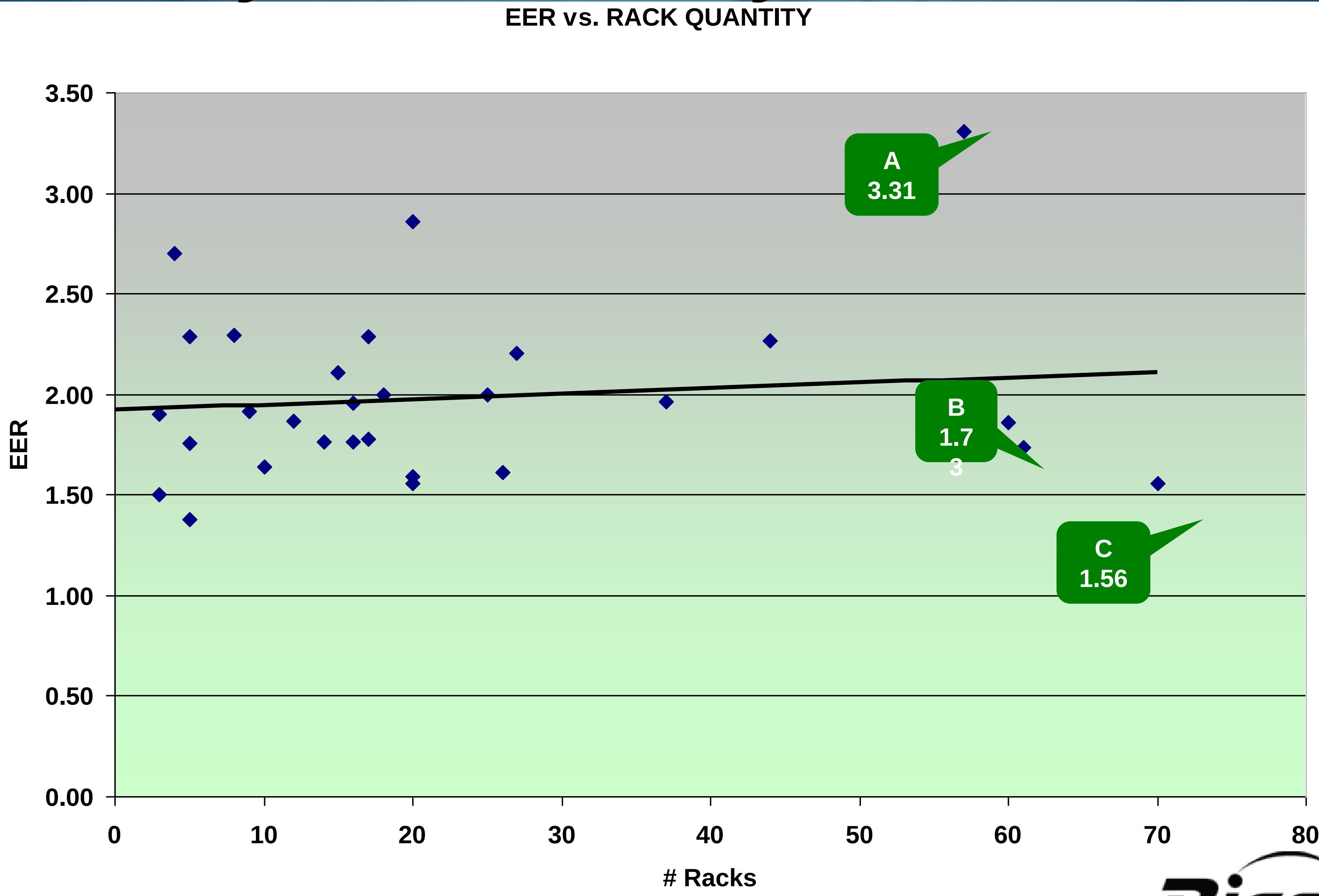
Total IT Facility Load	**Building Load**
Power delivered to the Server	**Total IT**

Benchmark

	Excellent	Very Good	Good	Fair	Poor
EER	1.5	2	2.5	3	>3
% Server	67%	50%	40%	33%	<33%

Source : HP, Uptime Institute, Green Grid

Keysource Survey Initial results



Initial findings

Benchmark

Site	EER	Score	Target
A	3.31	43	68
B	1.73	53	68
C	1.56	59	68

If Site A could achieve EER 1.56

- Could support **>2x** IT equipment
- Reduce power consumption by 122kW/Hr
- **Save £96K per year**

CO_2 Impact

Saving 36m³ CO_2 or 71kg per hour (621,960kg year)

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Two Golden Rules

- Energy required to operate the data centre as compared to the power dissipated by the computer equipment (critical power)
  - Get the computer equipment operating more efficiently
  - Increase the overall efficiency of operating the electrical and mechanical infrastructure

Cooling De-mystified

- There are different approaches to cooling data centres but we should remember that it is simply a means to an end
- IT equipment (servers, switches etc) are all carefully designed internally so that they draw in cold air to cool their electronics and expel hot air
  - EVERYTHING ELSE is' about getting sufficient cold air to the IT equipment inlet and efficiently removing the hot air from the outlet
  - Ensuring efficient airflow is the key to success
  - Bypass airflow is 'a killer'

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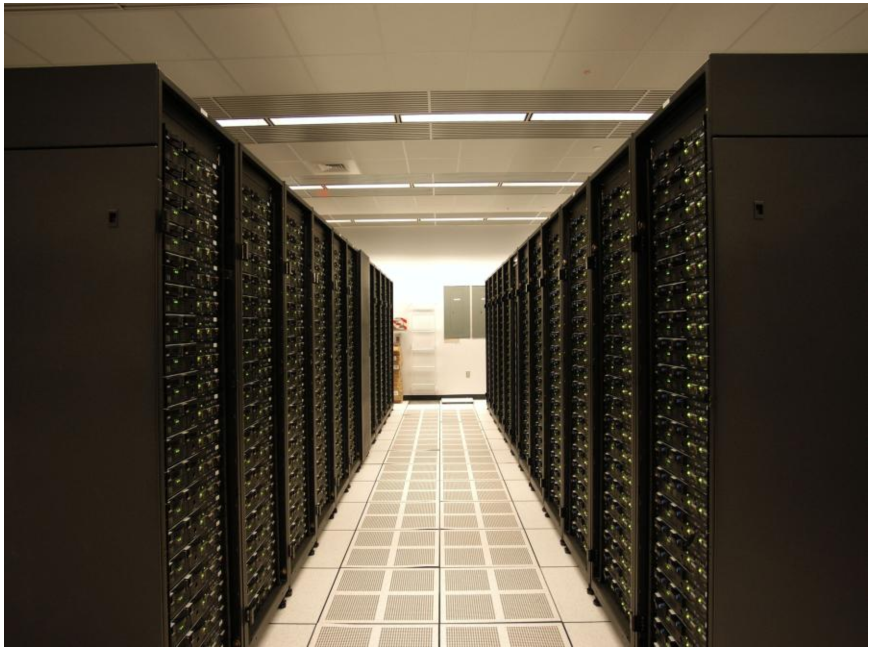
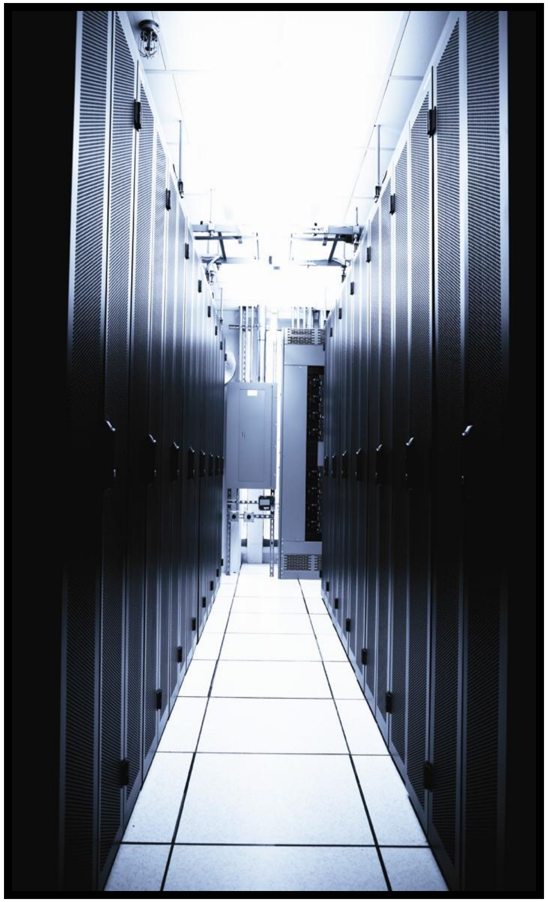
Air Distribution

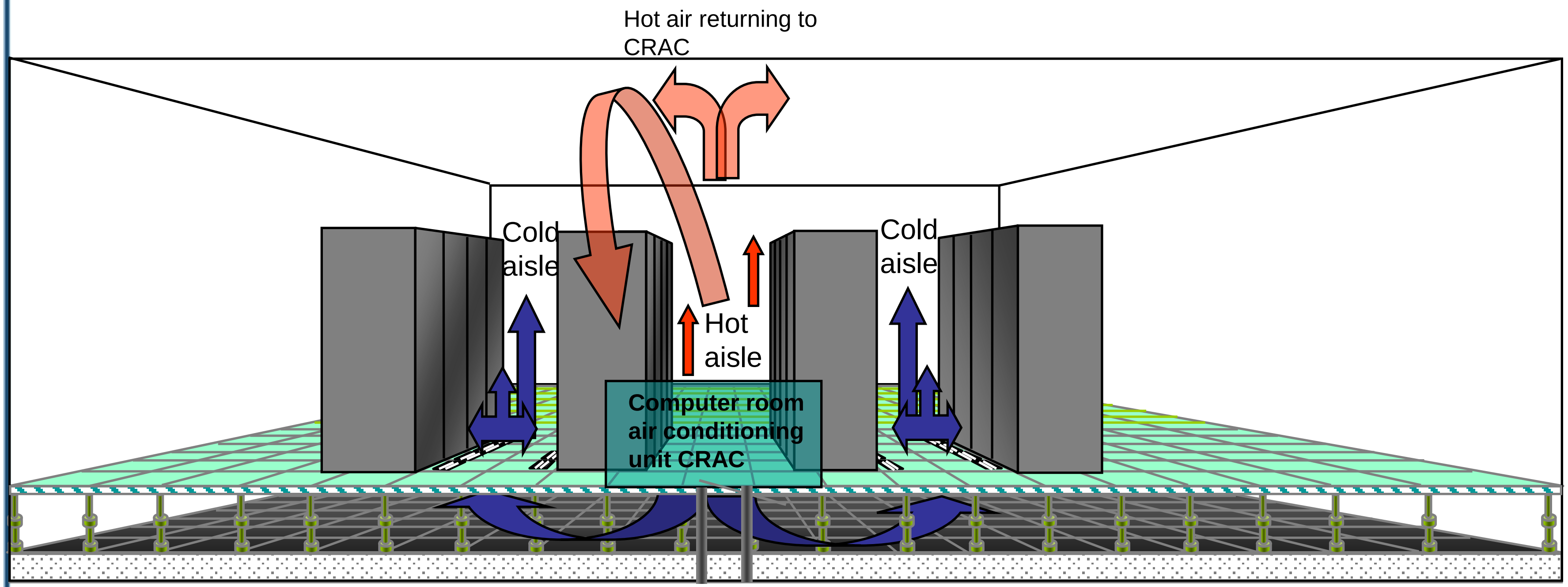


Hot aisle-Cold aisle or Cold Corridor?

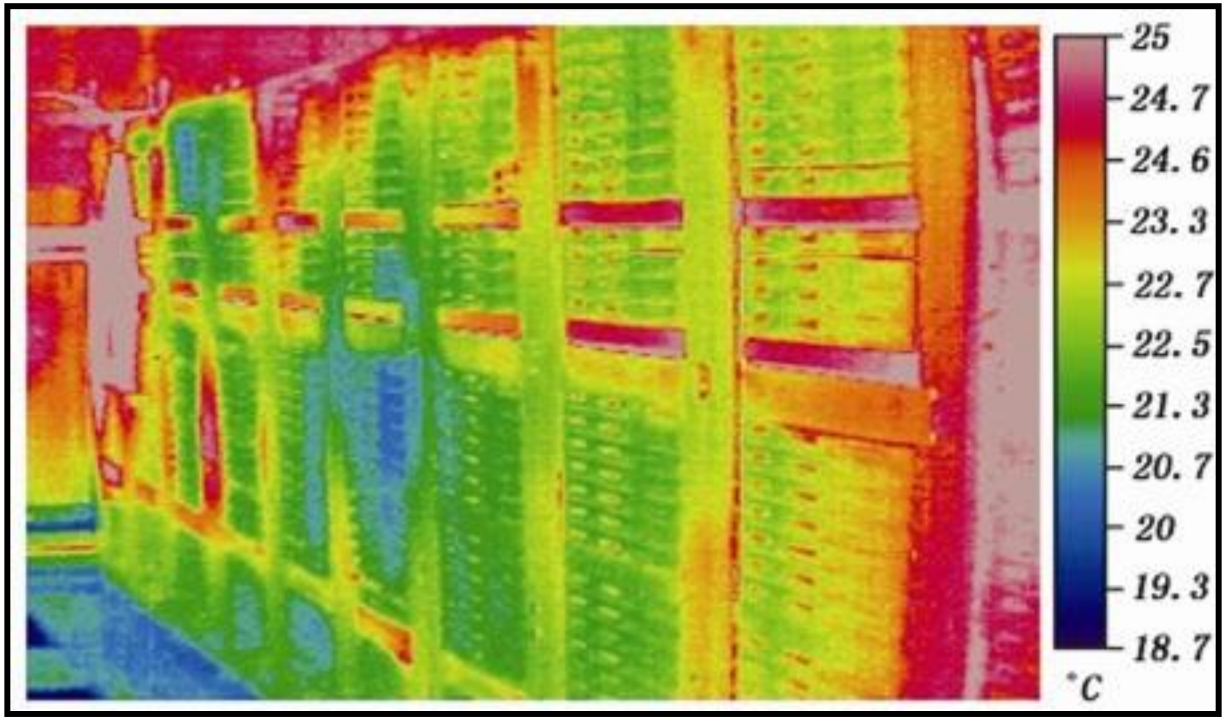


Air Distribution

Cold air pumped into plenum space beneath floor tiles and vented into cold aisles and returns to the CRAC unit



Standard Hot/Cold aisle Temp. distribution



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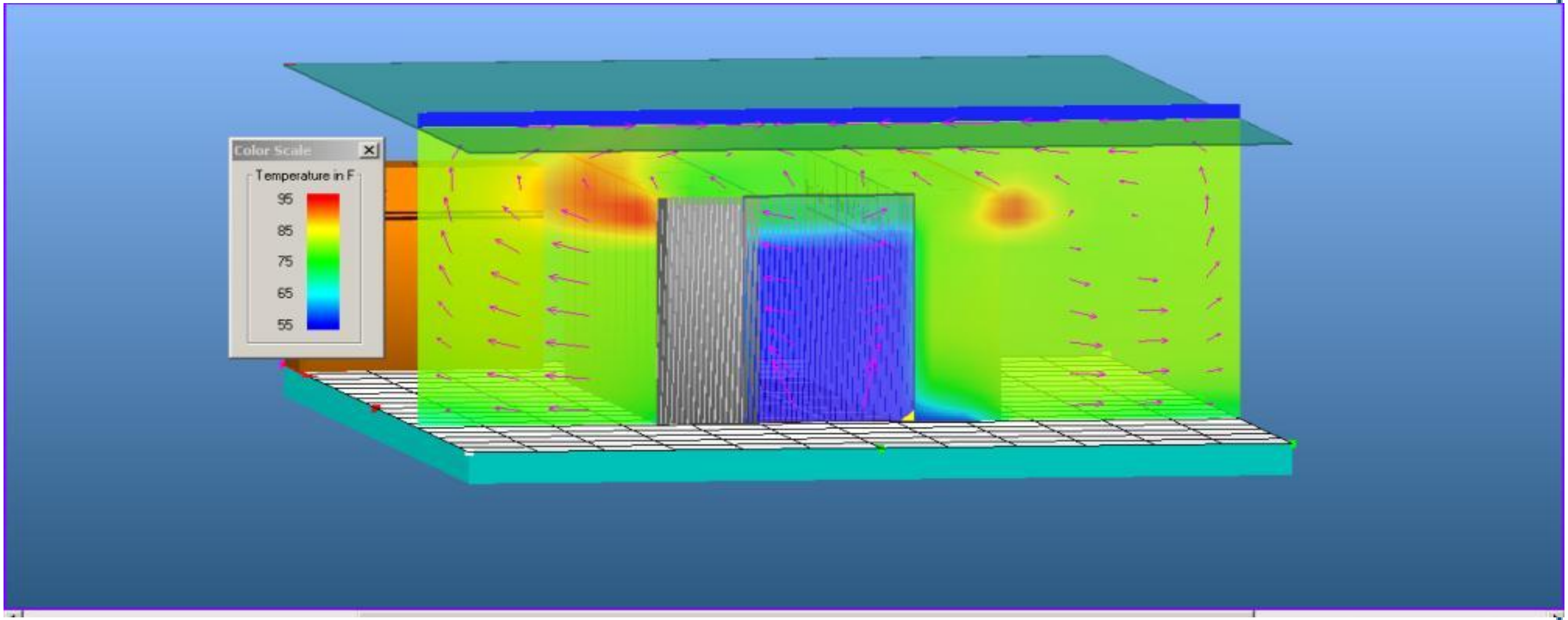
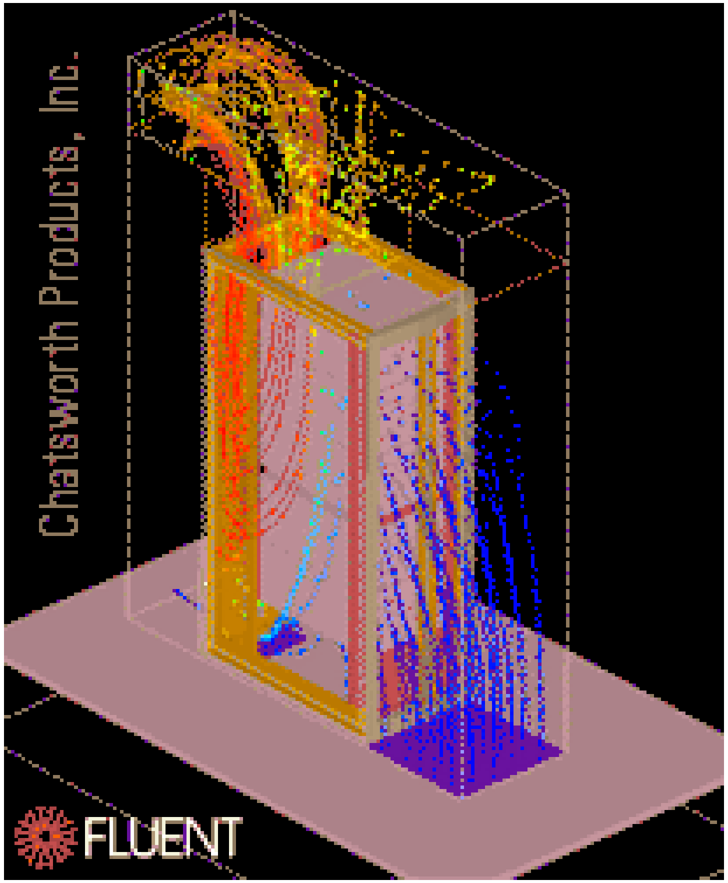
Cold corridor CFD
Temp. distribution



Ceiling Plenum



- Ducted racks vent the hot air directly into a ceiling plenum

Upsite Survey Findings

- Interesting revelations
  - At a CoE of 2.0 it takes twice the "critical power" to operate even an efficient data centre
  - When CoE gets above 2.4 most of the additional power is going into inefficient mechanical systems
  - As the CoE increases the environment in the computer room deteriorates
    - More cooling = More Hotspots???

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Sources of Mechanical Inefficiencies

- Mismatched expectations
- Mismatched architectures
- No master plan
- Failure to measure and monitor
- Failure to utilise best practices
- Thermal incapacity and excessive bypass airflow

Thermal Incapacity

- Thermal incapacity is the portion of the mechanical system that is running, but not contributing to a dry bulb temperature change because of return air temperatures, system configuration problems, or other factors
- Most thermal incapacity can be inexpensively recovered by a mechanical system “tune-up”

Causes of Thermal Incapacity

- The following results are based on detailed measurements in 30 computer rooms totaling over 300,000 ft^2
  - On Average the operating cooling capacity was 2.6 times the critical load in data centre
  - 25% of the cooling units were not operating at specified capacity
  - 10% of the cooling units had failed
- **Inefficient Cooling Systems**

Causes of Thermal Incapacity

- DX system refrigerant being partially charged
- "Dueling" dehumidification/humidification
- Insufficient airflow across cooling coils
- Cooling unit sensors out of calibration
- Chilled water temperature too low
- Computer room return temperature too low (temperature set points too low)
- Bypass Airflow - Too much cold air passing through unmanaged openings

Consequences of Thermal Incapacity

- Inefficient cooling system
  - Operating cooling capacity is 2.6 times the critical load (UPS output)
  - At Coefficients of Efficiency of 2.0 – 2.4
    - 10% of the racks had “hotspots” at the intake air exceeding 77°F (25 °C)
  - At Coefficients of Efficiency > 3.0
    - Up to 25% of the racks had “hotspots”
  - Rooms with the greatest excess of cooling capacity had the worst environment
  - Excess cooling capacity
    - Poorer environment
    - Wasting capital and operating expenses

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Bypass Airflow

- Conditioned air is not getting to the air intakes of computer equipment
  - Escaping through cable cutouts and holes under cabinets
  - Escaping through misplaced perforated tiles
  - Escaping through holes in computer room perimeter walls, ceiling, or floor

Typical Hot Aisle
Bypass Airflow Condition

Open cable cutouts and perforated tiles in Hot Aisle.
Why? "Because that's where it is hot."

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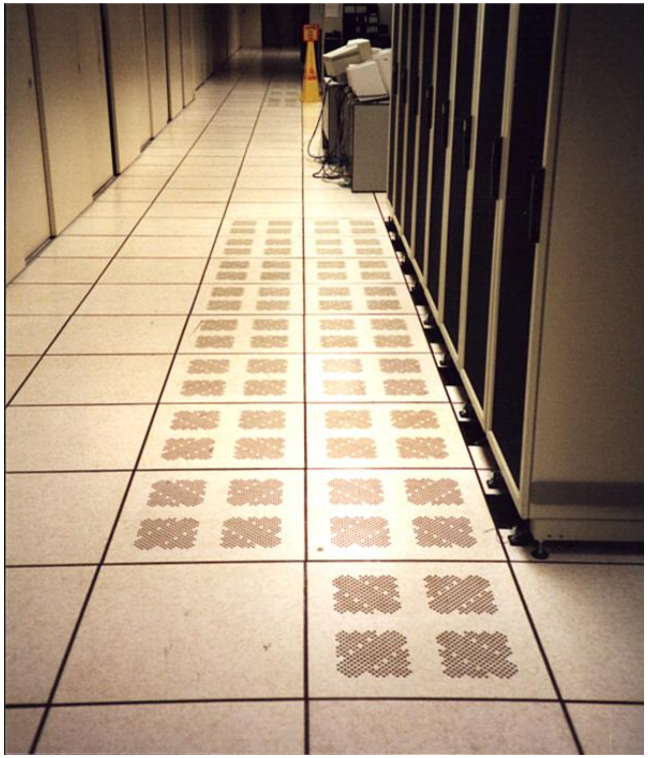
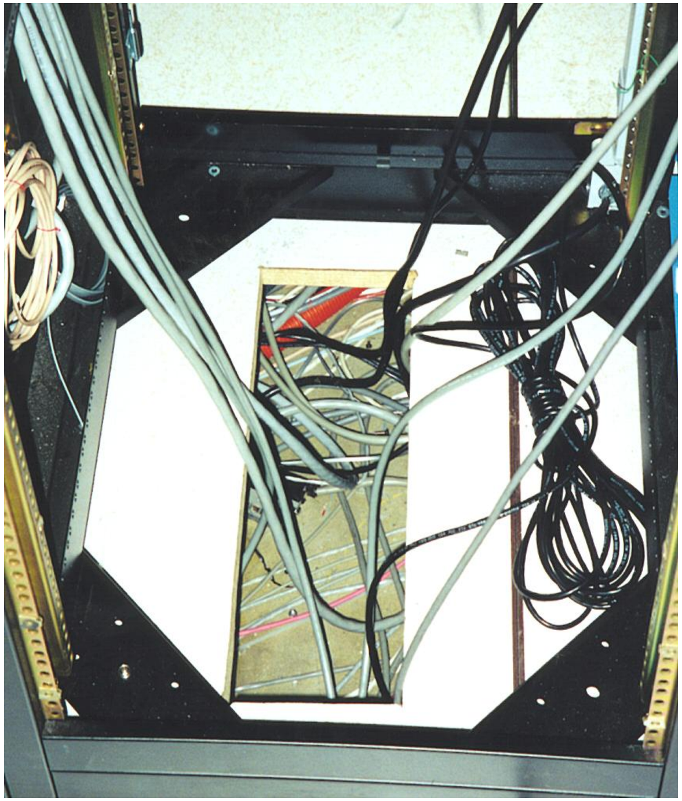
Hot Aisle
Bypass Airflow Condition

Perforated tiles "stored" in the hot aisle.



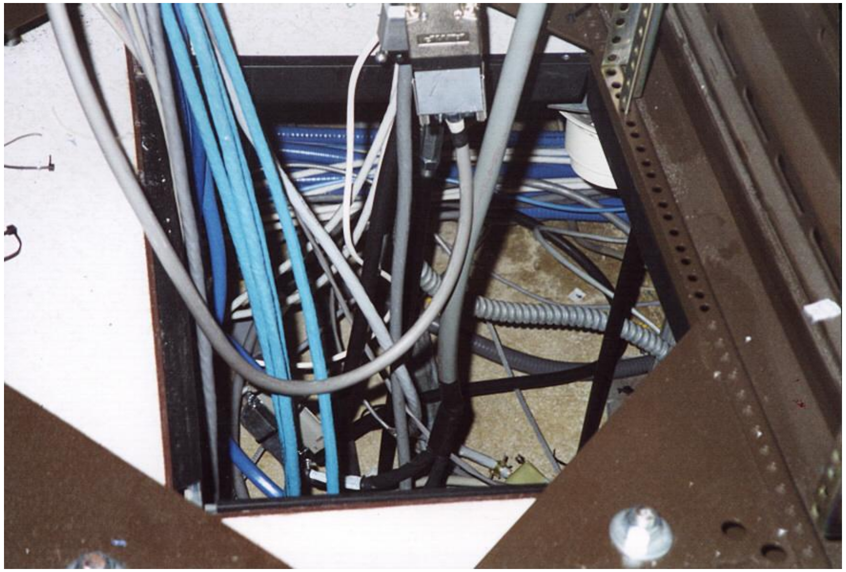
Typical Bypass Airflow Condition

This unnecessarily large raised-floor opening (hole) should be closed.



Typical Bypass Airflow Conditions

Large cable cutout under a server rack.



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How Is It Fixed?

- Seal all the holes in the computer room perimeter
- Seal all openings in the raised floor (cables, PDUs and cooling units, floor edges, cutouts for pipes, etc.)
- Seal all the holes in the computer room perimeter
  - Use permanently installed firestop materials for conduits, pipes, construction holes, etc., through walls
  - Removable fire pillows for floor or wall cable pass throughs

Perimeter Penetrations Are Sealed

Good example of fire stopping through a sidewall.

Perimeter Penetrations Are Sealed

Good use of fire pillows

Corporate Social Responsibility

- High on most corporate agendas
- Marketing
  - How to make your data centre more attractive than competition
- Investors
  - Increasing focus on who they will invest in

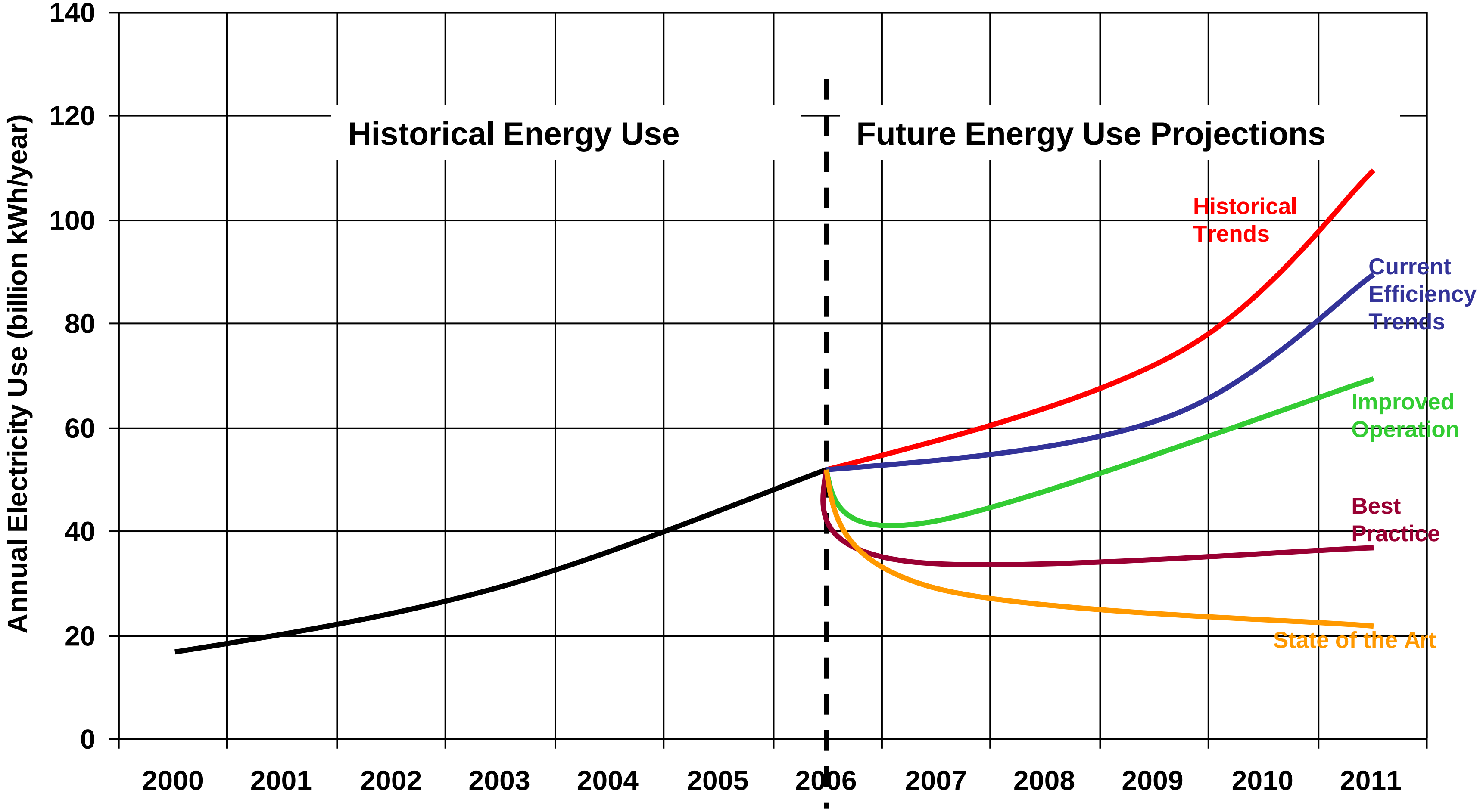
Challenging cultural mindsets

- Server hugging
- Environmental TCO (and other standards)
- Broader impact of virtualization and IT strategy
- Bringing power costs into IT budget
- Bridging the IT and FM gap

The way (ways?) ahead?

- Holistic view of IT infrastructure
- Improving power consumption management right across the board
- Rightsizing the space
- Modular and flexible designs
- Virtualisation of servers
- Whatever happens, incorporating best practices in data centre design is the key

Power Consumption Scenarios …



* EPA report to US Congress, August 2007)

Thank you for your time

Greg Sherry RCDD,NTS,WD

European Region Director

For more information:

www.bicsi.org