Increasing Data Center Physical Infrastructure Efficiency

Five Contributors to Inefficiency

Summary Strategy and Technologies

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The Data Center Efficiency Challenge

Efficiency goal:

Provide power and cooling…

- **In the amount needed**
- **When needed**
- **Where needed**
- **But no more than what is needed**

But …

> You can't MANAGE what you can't MEASURE

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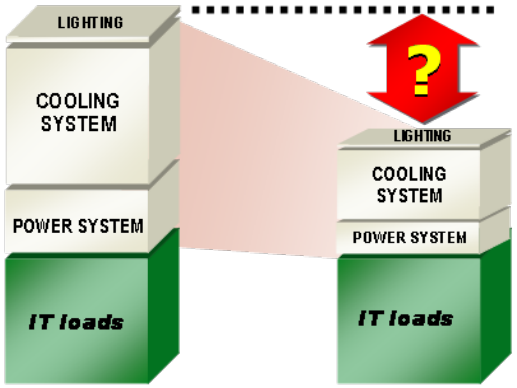
Five Contributors to Inefficiency

Where are the inefficiencies ?



1. Device inefficiencies of power equipment
2. Device inefficiencies of cooling equipment
3. Power consumption of lighting
4. Oversizing of power and cooling systems
5. Cooling inefficiencies due to configuration

These two are less well understood, but they dominate inefficiencies

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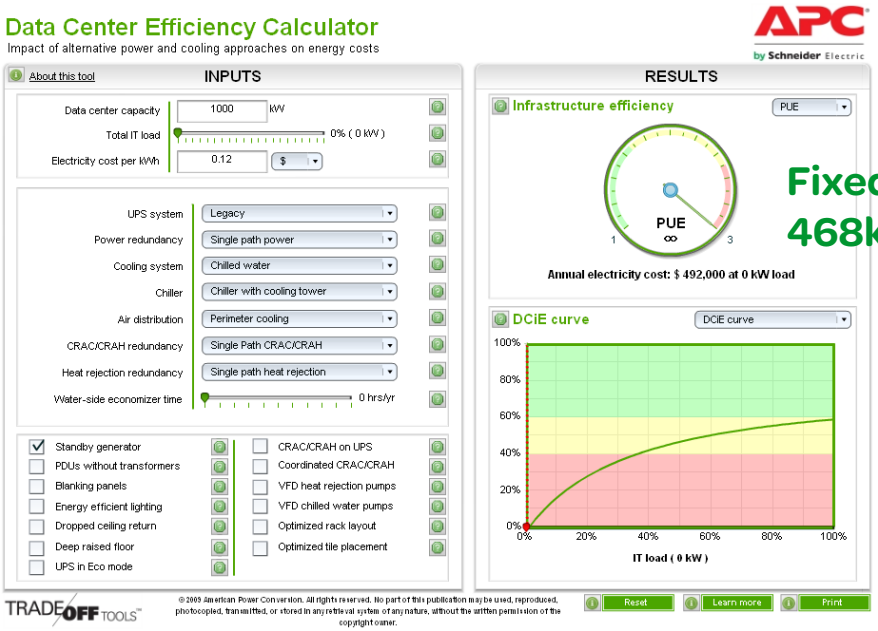
4 Oversizing of Power and Cooling

Traditional data center, over ½ of infrastructure power use is *fixed* and does not vary with load

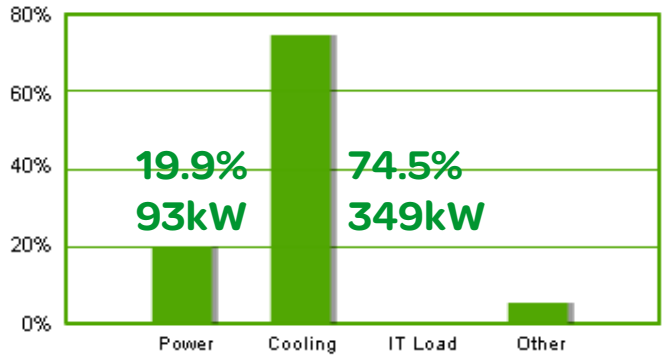
Efficiency degrades as IT load declines

Underloading is a primary contributor to inefficiency



Fixed losses
468kW

Energy allocation



Data Center Efficiency Calculator
tools.apc.com

> Low loading = low efficiency

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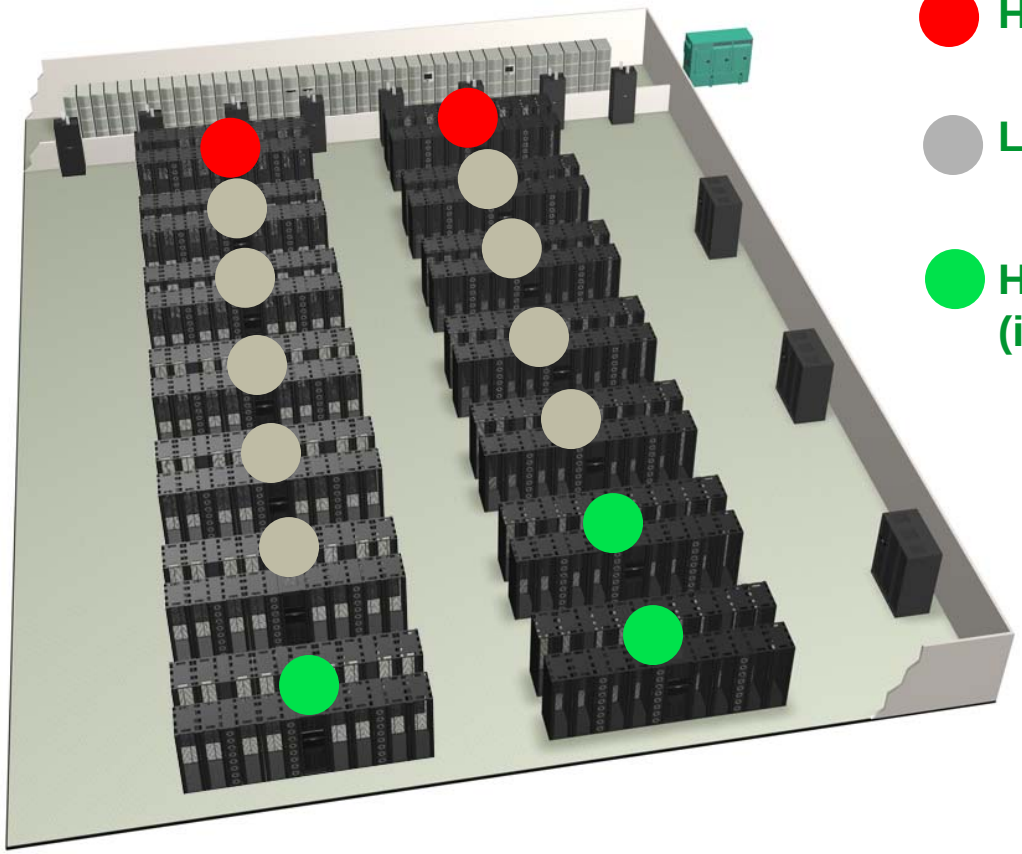
How to address it

“Hybrid” strategy

Build out in increments (“pods”) targeted on your current IT priorities

Example: 6000 sq ft data center



- High-density pods
- Low-cost pods
- High-availability pods (i.e. supported by extra redundancy)

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Cooling Inefficiencies due to Configuration

Physical configuration of the cooling system can have a dramatic effect on power consumption of the cooling system

- **Move more air than the IT equipment actually requires**
- **Generate cooler air than the IT equipment actually requires**
- **Create cooling and humidity demand fighting – typically undiagnosed and extremely inefficient**

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How to address it

Optimize Existing Data Center

Hit the "Low Hanging Fruit" first

"Demand Fighting" for both temperature and humidity

Increase temperature setpoints

Remove cold air supply tiles from hot aisles

Remove restrictions in supply air plenum

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How to address it

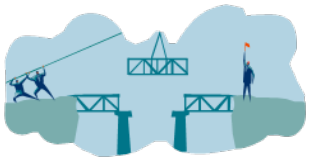
Optimize Existing Data Center

Hit the "Low Hanging Fruit" first

Balance air tile flow with CRAC air flow

Install blanking panels in unused U-space

Install solid side panels on racks



Fill in gaps in rows

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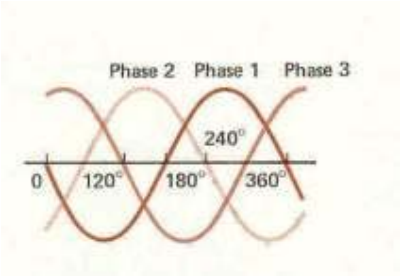
How to address it

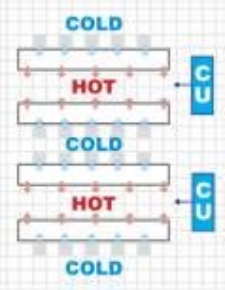
Optimize Existing Data Center

Hit the "Low Hanging Fruit" first

Clean the air filters



Balance the loads on the power system



Set up rows and aisles into hot / cold aisles

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Targeted Cooling

Hot-aisle containment ("HAC")

Sample analysis – 30 racks, 3KW/rack density

	NO air containment	WITH air containment
Heat rejection capacity *33% increase*	**11.25 kW / CRAH**	**15 kW / CRAH**
TCO **10-year life** *18% savings*	**$187,000**	**$154,000**

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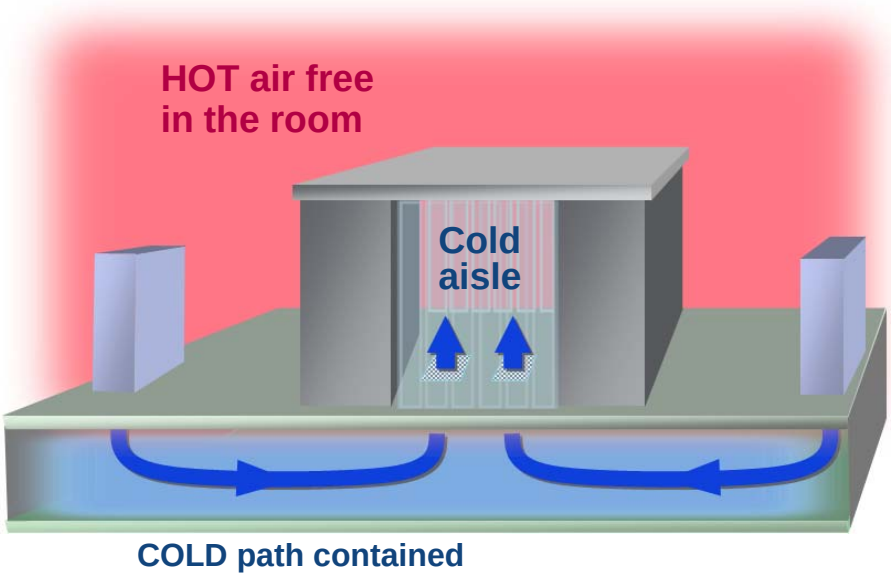
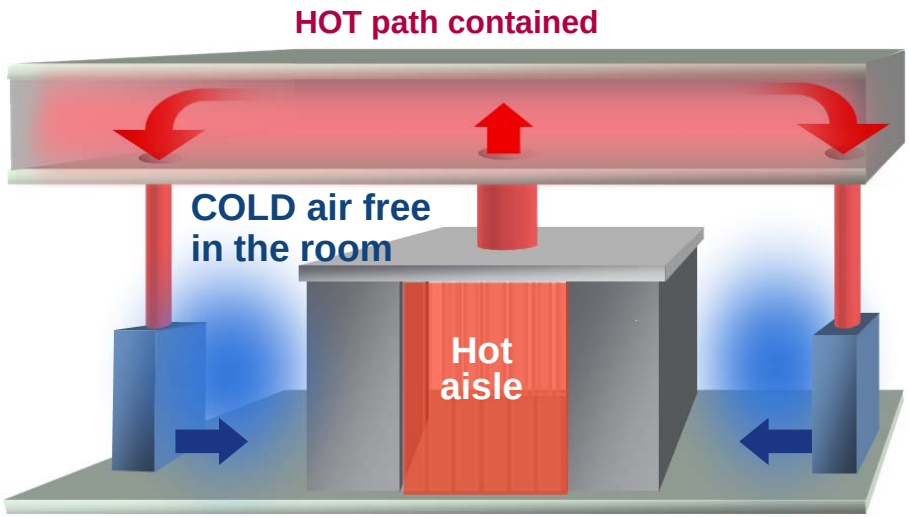
Air Containment

How to address it

COLD containment



HOT containment



> The energy benefit of both methods comes from SEPARATION of cold supply air from hot return air

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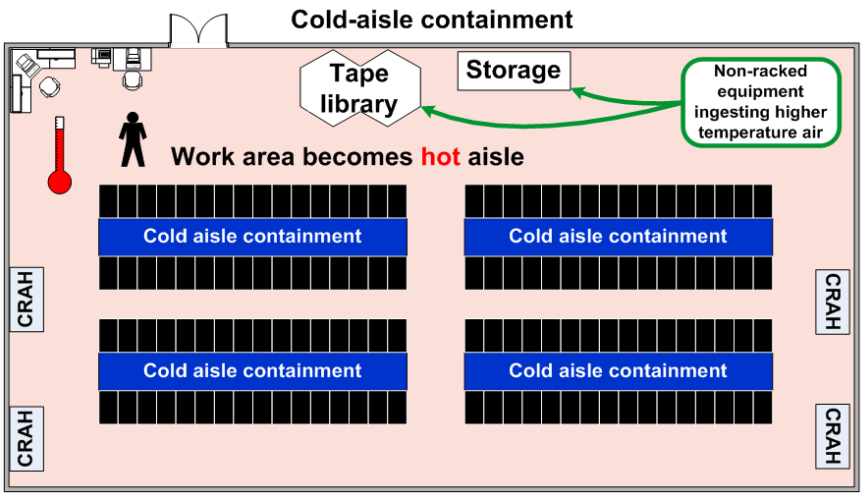
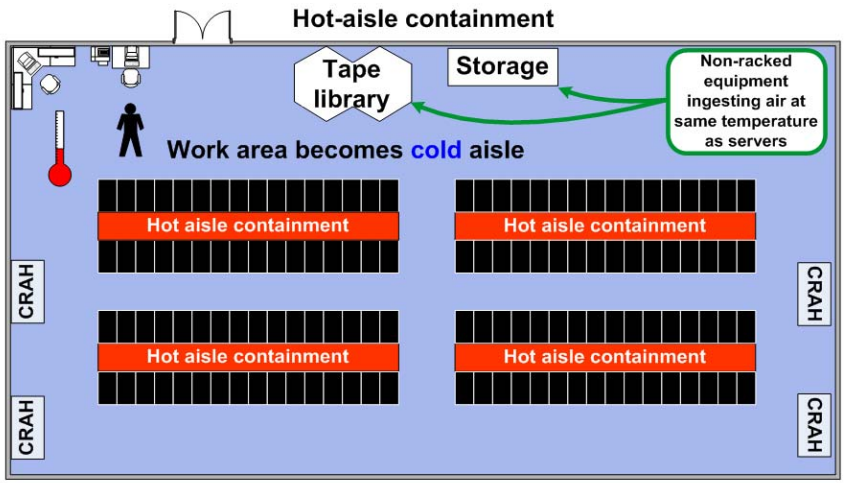
Biggest difference: ROOM temperature



Cold-aisle containment

HOT room



Hot-aisle containment

COOL room

White Paper #135
Hot-Aisle vs. Cold-Aisle Containment for Data Centers

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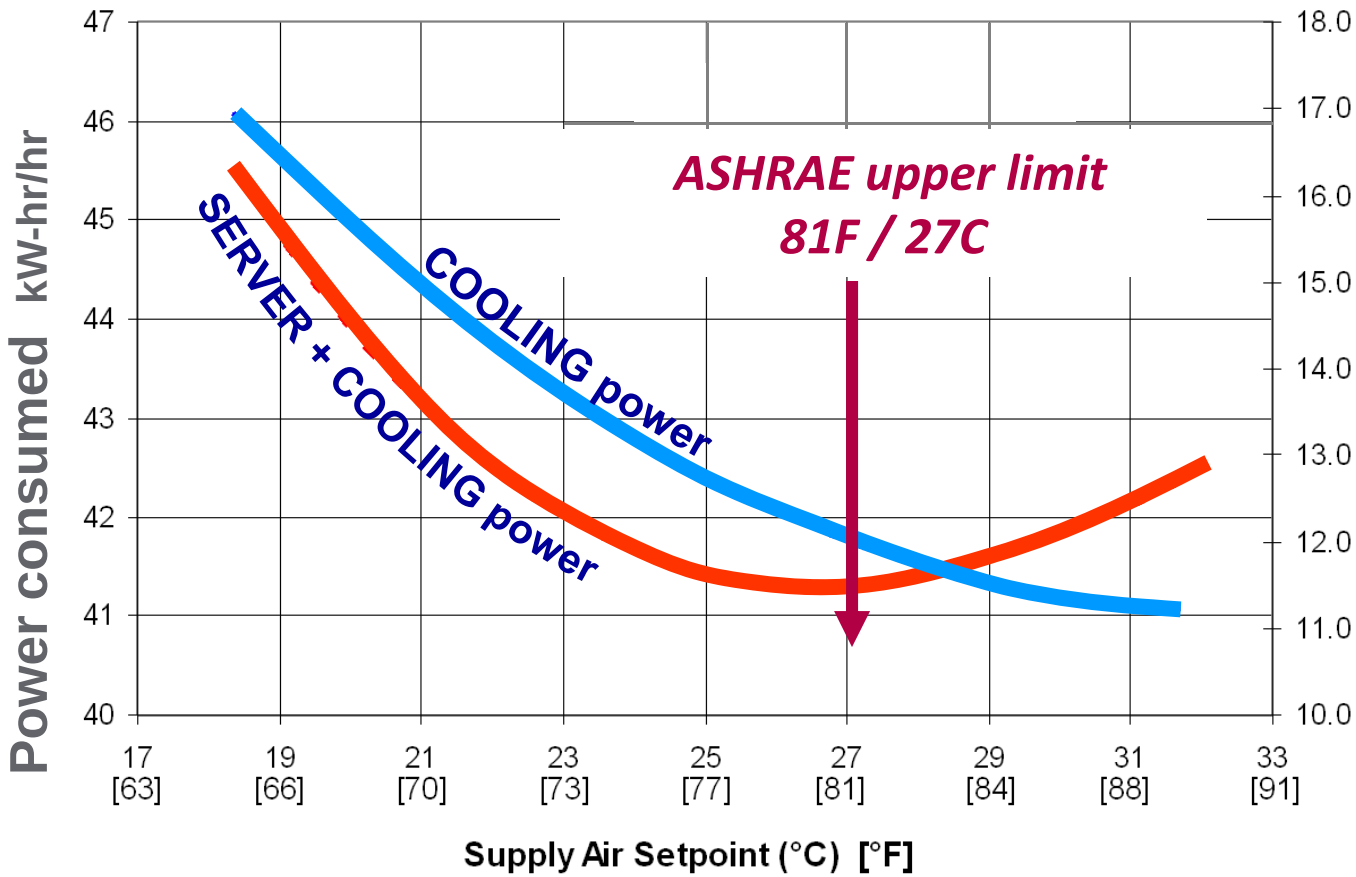
How to address it

Increased Server Inlet Temp Example



68F 20C — *Server inlet temp* → 81F 27C

29% energy savings in chilled water plant

White Paper #138
Energy Impact of Increased Server Inlet Temperature

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Summary Strategy and Technologies

	Potential Savings	Guidance	Limitations
Right-size DCPI	**10 – 30%**	•*Using a modular, scalable power and cooling architecture* •*Savings are greater for redundant systems*	•*For new designs and some expansions*
Virtualize servers	**10– 40%**	•*Not technically a physical infrastructure solution but has radical impact* •*Involves consolidation of applications onto fewer servers, typically blade servers* •*Also frees up power and cooling capacity for expansion*	•*Requires major IT process changes* •*To achieve savings in an existing facility some power and cooling devices may need to be turned off*
More efficient air conditioner architecture	**7 – 15%**	•*Row-oriented cooling has higher efficiency for high density* •*Shorter air paths require less fan power* •*CRAC supply and return temperatures are higher, increasing efficiency, capacity, and preventing dehumidification thereby greatly reducing humidification costs*	•*For new designs* •*Benefits are limited to high density designs*
Economizer modes of air conditioners	**4 – 15%**	•*Many air conditioners offer economizer options* •*This can offer substantial energy savings, depending on geographic location* •*Some data centers have air conditioners with economizer modes, but economizer operation is disabled*	•*For new designs* •*Difficult to retrofit*

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Summary Strategy and Technologies

	Potential Savings	Guidance	Limitations
More efficient floor layout	**5 – 12%**	*•Floor layout has a large effect on the efficiency of the air conditioning system* *•Involves hot-aisle / cold-aisle arrangement with suitable air conditioner locations*	*•For new designs* *•Difficult to retrofit*
More efficient power equipment	**4 – 10%**	*•New best-in-class UPS systems have 70% less losses than legacy UPS at typical loads* *•Light load efficiency is the key parameter, NOT the full load efficiency* *•Don't forget that UPS losses must be cooled, doubling their costs*	*•For new designs or retrofits*
Coordinate air conditioners	**0 – 10%**	*•Many data centers have multiple air conditioners that actually fight each other* *•One may actually heat while another cools* *•One may dehumidify while another humidifies* *•The result is gross waste* *•May require a professional assessment to diagnose*	*•For any data center with multiple air conditioners*
Locate vented floor tiles correctly	**1 - 6%**	*•Many vented tiles are located incorrectly in the average data center or the wrong number are installed* *•Correct locations are NOT intuitively obvious* *•A professional assessment can ensure an optimal result* *•Side benefit – reduced hot spots*	*•Only for data centers using a raised floor* *•Easy, but requires expert guidance to achieve best result*

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Summary Strategy and Technologies

	Potential Savings	Guidance	Limitations
Install energy efficient lighting	**1 – 3%**	•*Turn off some or all lights based on time of day or motion* •*Use more efficient lighting technology* •*Don't forget that lighting power also must be cooled, doubling the cost* •*Benefit is larger on low density or partly filled data centers*	•*Most data centers can benefit*
Install blanking panels	**1 – 2%**	•*Decrease server inlet temperature* •*Also saves on energy by increasing the CRAC return air temperature* •*Cheap and easy*	•*For any data center, old or new*

White Paper #114
Implementing Energy Efficient Data Centers

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