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Data Center Efficiency

Presented by

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In deciding how to best implement a strategy for supporting critical data systems, Data Center *Efficiency* *is usually* ***NOT*** *the number one item on the list.*

This is usually followed by the next logical question:

"Where should it be located?"

Then of course:

"How large does it have to be?"

And the last but not least, question:

"How much will it cost?"

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Current Design Goals of Building a Data Center

1. **High Density Support**
2. **Flexibility**
3. **Expandability**
4. **Infrastructure Redundancy**
   - **Power & Cooling**
   - **Back-up Power**
5. ***Lower Operational Costs***

Most organization's data centers that were designed before 2000 were we built based on technologies did not exist or were not commonplace such as:

- >***Blade Servers*** *and 1U Low Profile*
- >*Servers w/Dual/Quad Core Processors*
- >***VM*** *- Virtual Machines*
- >***SAN & NAS*** *Storage Arrays*
- >*VOIP*

Result: Datacenters that were built only 7 years ago were not designed to support today's High-Density Hardware requirements, much less tomorrow's constantly changing standards.

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>*Blade Servers and 1U Low Profile*
>*Servers w/ Dual/Quad Core Processors*
>*VM Virtual Machines*
>*SAN & NAS Storage Arrays*
>*VOIP*

Potential Benefits

- ✓ **Higher Utilization of Computing Resources**
- ✓ **Lower Energy Usage**
- ✓ **Lower Space Requirements**
- ✓ **Better Management**

>Blade Servers and 1U Low Profile
>Servers w/ Dual/Quad Core Processors
>VM Virtual Machines
>SAN & NAS Storage Arrays
>VOIP

Potential Pitfalls

- X **Existing Power & Cooling Not Capable of Supporting new Hi-Density Equipment**
- X **Higher Energy Usage (Especially for Cooling)**
- X **In-Efficient Space Utilization**
- X **Requires Retro-fitting Power & Cooling**

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The result is that these design criterion and performance metrics have radically changed, directly affecting data center design factors such as:

Computing Capability per sq ft (i.e. MPS processing power)
Storage per sq ft (Gigabytes – Terabytes)
Power & Cooling per sq ft (Watts)
Infrastructure Scalability - Designing with the ability to scale up or down with constantly changing systems and demand while maintaining energy efficiency

Sample Power & Cooling Requirements
High Density 1 U Servers

1U Servers	Each 1 U Server		U	Rack of 40 Servers		COOLING
Model	WATTS	BTUs	1	WATTS	BTUs	TONS
Dell Power Edge 850	345	1,173	1	13,800	46,920	3.9
IBM eServer X306	350	1,190	1	14,000	47,600	4.0
HP Proliant DL360	275	935	1	11,000	37,400	3.1
Sun Fire X2100 Server	300	1,020	1	12,000	40,800	3.4
			1			
Dell Power Edge 1850	550	1,870	1	22,000	74,800	6.2
IBM eServer X336	585	1,989	1	23,400	79,560	6.6
HP Proliant DL360R4	535	1,819	1	21,400	72,760	6.1
Sun Fire X4100 Server	550	1,870	1	22,000	74,800	6.2

Challenge … *Scotti, I need More Power*

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Sample Power & Cooling Requirements

High Density Blade Servers

Blade Servers						COOLING
Model	**WATTS**	**BTUs**	**U**	**WATTS**	**BTUs**	**TONS**
Dell	**Rack of 4 Chassis**			**(40 Blades)**		
DELL PowerEdge 1855	5,000	17,000	7U	**20,000**	**68,000**	**5.7**
IBM	**Rack of 4 Chassis**			**(56 Blades)**		
IBM BladeCenter=H Class	**8,000**	**27,200**	9U	**32,000**	**108,800**	**9.1**
HP	**Rack of 5 Chassis**			**(40 Blades)**		
HP BladeSystem p-Class	4,500	15,300	6U	**22,500**	**76,500**	**6.4**
SUN	**1 Server**			**(72Proc)**		
Sun Fire E25K Server	25,000	85,000	~	**25,000**	**85,000**	**7.1**
Weber Genesis Silver Barbeque					**26,000**	**2.2**

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High Power Density

Watts per Rack ~

2KW-5KW-10KW~+30KW !!!!!

Watts per Sq. Foot ~

100W-150W-200W~+300W!!!!

Challenge…

Scalable UPS Power & COOLING !!

IBM BladeCenter

H Class

9U = 14 Blades

Power=8,000VA

Heat=27,200 Btu/hr

with 4 per 42U rack

=32,000KVA Power

=105,000 Btu/hr

=9 Ton Cooling!!

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Challenge … *Scotti, It's Very Very Hot in here*

I Need More Cooling

Heat Load Per Cabinet

14 Servers@550W =7.5KW
=26,000 BTUs = 1 Weber Grill !!

28 Servers@550W =15KW
=52,000 BTUs = 2 Weber Grills !!

42 Servers@550W =22.5KW
=78,000 BTUs = 3 Weber Grills !!

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Server Power Supply Efficiency

contents

Overview

HP ProLiant DL380 Generation 5 (G5)

Power Supply Specification - AC	Part number		380622-001			
	Spare Kit		403781-001			
Operational Input Voltage Range (Vrms)	90 to 264					
Frequency Range (Nominal) (Hz)	47 to 63 (50/60)					
Nominal Input Voltage (Vrms)	**100**	**120**	**208**	**220**	**230**	**240**
Max Rated Output Wattage Rating	800	850	1000	1000	1000	1000
Nominal Input Current (A rms)	10.0	8.8	5.85	5.5	5.2	4.97
Max Rated Input Wattage Rating (Watts)	980	1035	1193	1186	1172	1169
Max. Rated VA (Volt-Amp)	1000	1056	1217	1210	1196	1193
Efficiency (%)	81.5	82	84	84	85	85.5
Power Factor	0.98	0.98	0.98	0.98	0.98	0.98
Leakage Current (mA)	0.44	0.52	0.91	0.96	1.00	1.04
Max. Inrush Current (A peak)	30	30	30	30	30	30
Max. Inrush Current duration (mS)	3	3	3	3	3	3

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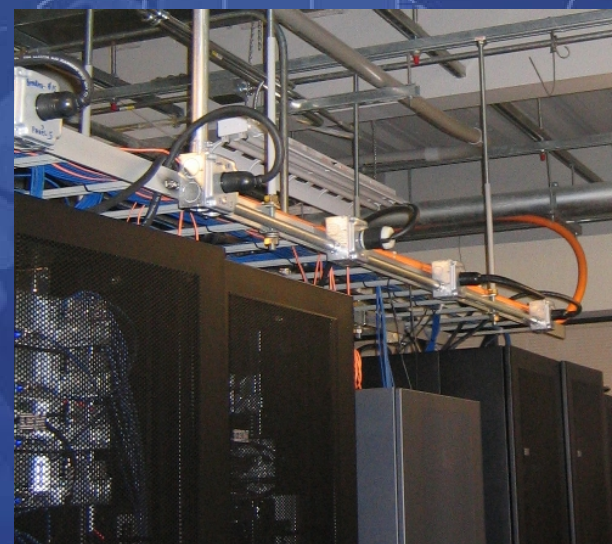
Traditional-Data Center Little/NO Flexibility

-Fixed UPS Size
-Pre-build for Maximum Expected Loads



-Hardwire
-Electrical Power Distribution

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Flexibility

- Traditional- Fixed Hardwire Electrical Distribution

+ Modular – Flexible Power Whips and Plug-in PDUs

= Easy Reconfiguration for Changing Loads & Equipment Types

- **Power & Cooling**
- **(N+1) and/or (2 N)**

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Cooling

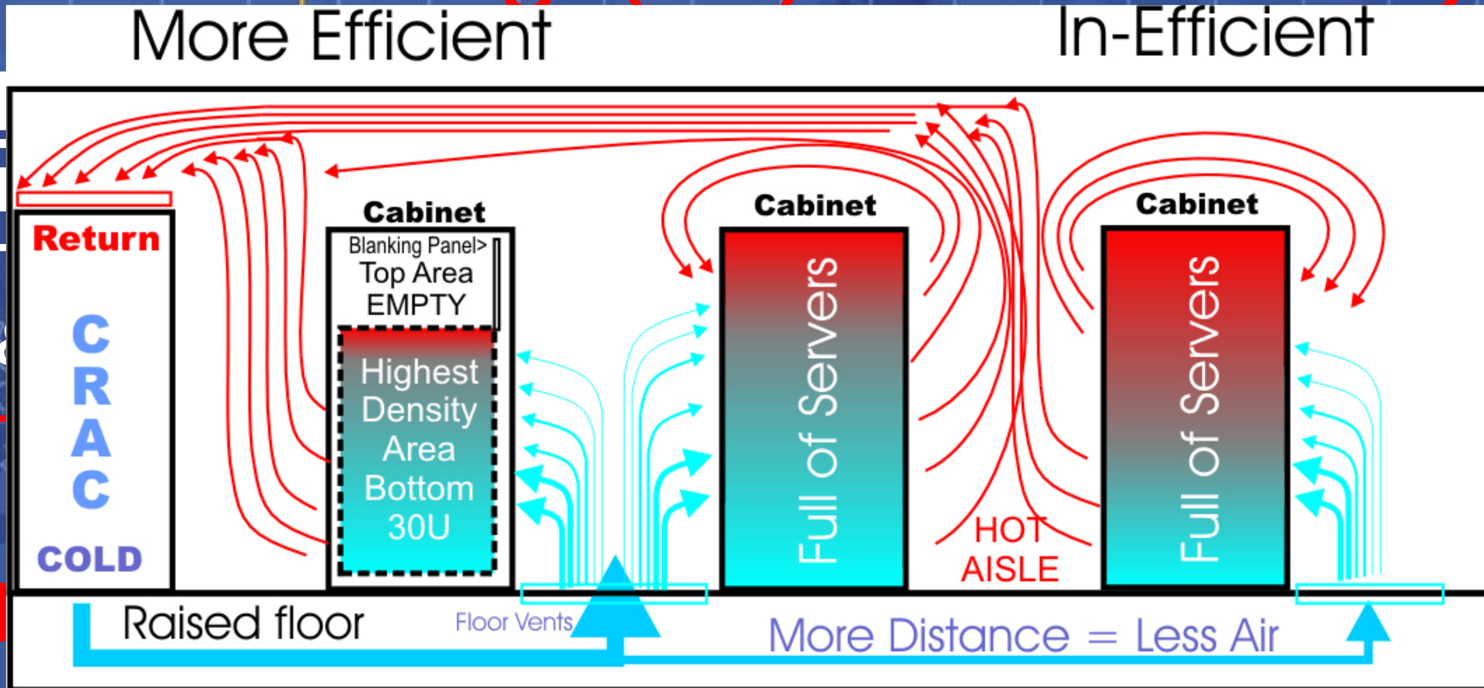
Traditional-Data Center **Little/NO Flexibility**

-Fixed A/C Unit Size
-Pre-build for Maximum Expected Loads

Designed for Lower Watts per Sq. ft.

Not Able to Cool High Density Loads

Cooling (in) Efficiency



- For every **$1.00** spent on Energy to power computing equipment from **$0.50 to $2.00 is spent on cooling.**
- Cooling systems not specifically designed for Hi-Density Cooling not only cannot properly cool the equipment, they use far more energy.

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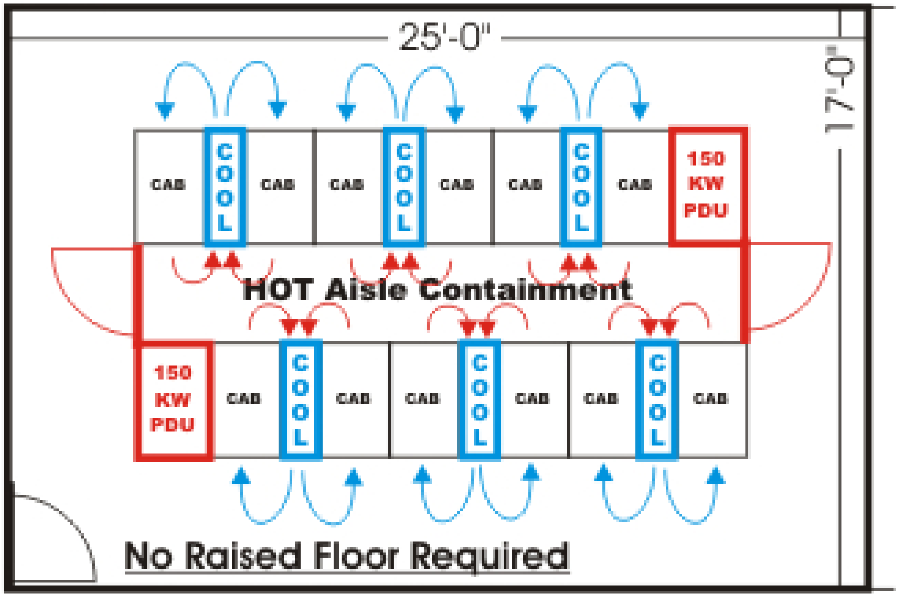
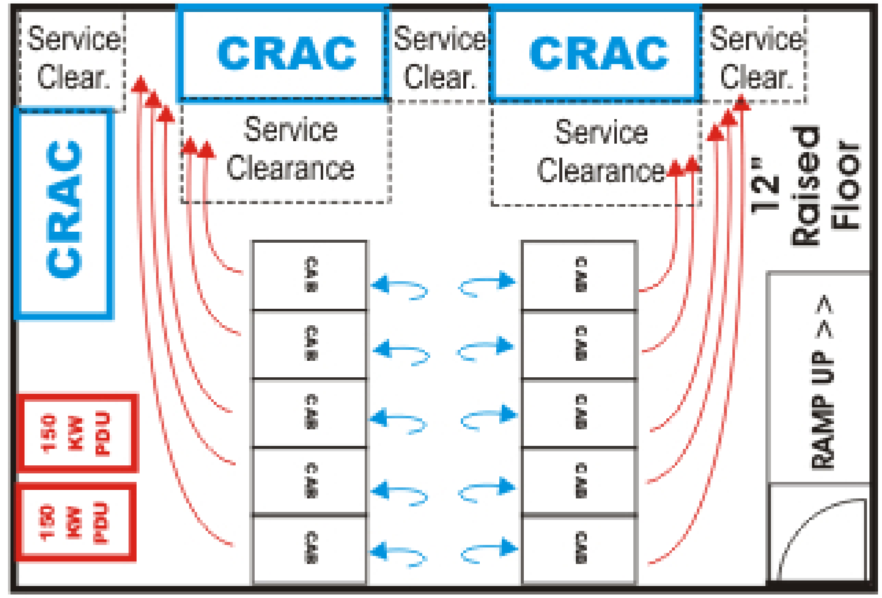
IN-ROW Cooling Technology VS Traditional Cooling Technology

High Density Hot-Aisle Containment



Power=150KW 100% Redundant (2N)
Cooling=150KW (N+1) 6 x 30KW
Payload Space=12 Cabinets=504U
Power & Cooling per Cab=12.5KW
Floorspace=17' x 25"=425 Sq. Ft.
No Raised Floor Required

Cool Air From Perforated Floor Tiles



Power=150KW 100% Redundant (2N)
Cooling=80KW (N+1) 3 x 40KW
Payload Space=10 Cabinets=420U
Power per Cab=15.0KW
Cooling per Cabinet Limited to 5KW*
Floorspace=17' x 25"=425 Sq. Ft.

UPS is External for both examples

**Cooling Limited by Airflow*

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Cooling Efficiency

COOLING System Types

- **Chilled Water**
- **Condenser Water**
- **Direct Expansion**

Geographic Location

- **Climate: Colder = Better**
- **Economizer Coils**

Cooling (in) Efficiency

COOLING

Humidity Control

- **De-Humidification**
- **Re- Humidification**
- **Re-Heat**

- Beside Cooling a function of a CRAC is Humidity Control.
- The Humidification & Reheat Process is important for maintaining proper levels of humidity **(i.e 50%).** However they do consume additional energy.
- **Broadening the set points i.e. 30% -70% will lower costs**

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Sample Power Costs Computing Load

KW Hour	Day	Month	Year	5 Years
1	24	720	8,760	43,800
Cost Per KWH	Day	Month	Year	5 Years
$ 0.10	$ 2.40	$ 72.00	$ 876.00	$ 4,380.00
Cost Per 100 KWH	Day	Month	Year	5 Years
$ 10.00	$ 240.00	$ 7,200.00	$ 87,600.00	$ 438,000.00
Save 5%	$ 12.00	$ 360.00	$ 4,380.00	$ 21,900.00
Save 10%	$ 24.00	$ 720.00	$ 8,760.00	$ 43,800.00

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Sample Data Center Cooling Power Costs

Cost Per 100 KWH	Day	Month	Year	5 Years
$ 10.00	$ 240.00	$ 7,200.00	$ 87,600.00	$ 438,000.00

Power Cost for Cooling / percent of Electrical Load=100KW				
% of Load	KW	Month	Year	5 Years
50%	50	$ 3,600.00	$ 43,800.00	$ 219,000.00
75%	75	$ 5,400.00	$ 65,700.00	$ 328,500.00
100%	100	$ 7,200.00	$ 87,600.00	$ 438,000.00
150%	150	$ 10,800.00	$ 131,400.00	$ 657,000.00
200%	200	$ 14,400.00	$ 175,200.00	$ 876,000.00

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Sample Energy Costs

Energy Information Administration
Official Energy Statistics from the U.S. Government

Home > Basic Electricity Statistics > State Electricity Price
Date Last Updated/Reviewed: November 2006
Next Update/Review: January 2007
Date Last Updated/Reviewed: November 2006
Next Update/Review: January 2007

State Electricity Price, 2005
(cents per kilowatthour)

All Sectors			Residential			Commercial			Industrial		
Rank	State	Price	Rank	State	Price	Rank	State	Price	Rank	State	Price
1	HI	18.33	1	HI	20.70	1	HI	19.04	1	HI	15.79
2	NY	13.95	2	NY	15.72	2	NY	14.36	2	DC	14.13
3	NH	12.53	3	CT	13.64	3	MA	12.42	3	NH	11.48
4	MA	12.18	4	NH	13.51	4	NH	12.06	4	RI	10.01
5	CT	12.06	5	MA	13.44	5	CA	11.92	5	NJ	9.76
6	RI	11.97	6	AK	13.30	6	RI	11.71	6	CA	9.55
7	AK	11.72	7	ME	13.23	7	AK	11.56	7	CT	9.40
8	CA	11.63	8	RI	13.04	8	CT	11.53	8	AK	9.29
9	VT	10.95	9	VT	12.96	9	VT	11.33	9	MA	9.22
10	NJ	10.89	10	CA	12.51	10	ME	10.63	10	NY	8.23


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