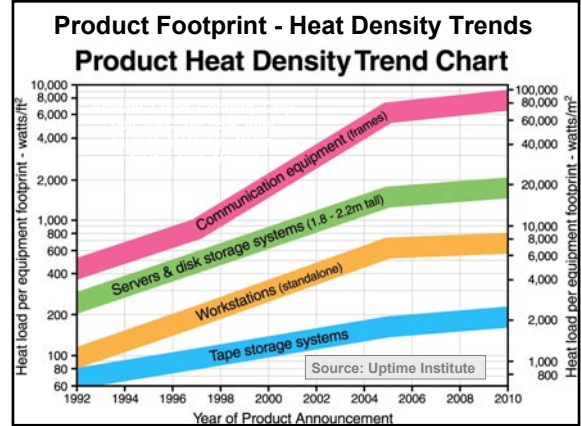


The New Data Center Cooling Paradigm – The Tiered Approach

Lennart Ståhl



Typical Server Comparisons

IBM - xSeries Bladecenter

7U High Server - Six per Enclosure [2.4 GHz Pentium Xeon, (1 or 2)]
 Fully Configured, 2.7 kW / Server = 16.2 kW = 2,370 W/sf
 Minimum Configure, 1.6 kW / Server = 9.6 kW = 1,405 W/sf

Hewlett Packard - Proliant BL 20p Blade Server

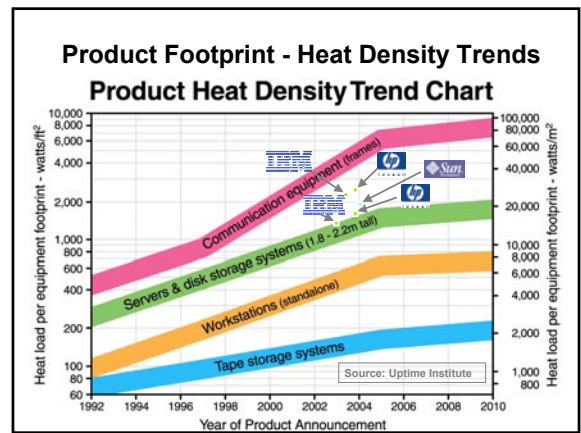
7U High Server - Six per Enclosure [1.4 GHz Pentium III, (1 or 2)]
 Fully Configured, 1.86 kW / Server = 11.16 kW = 1,633 W/sf
 Minimum Configure, 1.27 kW / Server = 7.62 kW = 1,115 W/sf

Sun Fire Blade, B1600 (Announced 2/10/03)

3U High Shelf - Fourteen per Encl [Sun Ultra Sparc Processor, (1)]
 Maximum Power / Shelf, 1.015 kW = 14.2 kW = 2,078 W/sf
 Avg Operating Power / Shelf, 0.5 kW = 7.0 kW = 1,024 W/sf

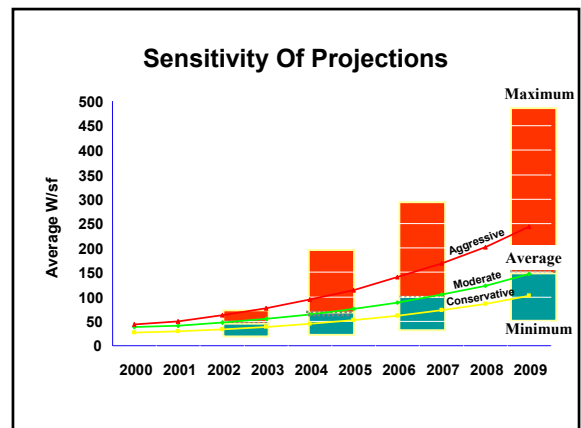
Dell PowerEdge 1650MC

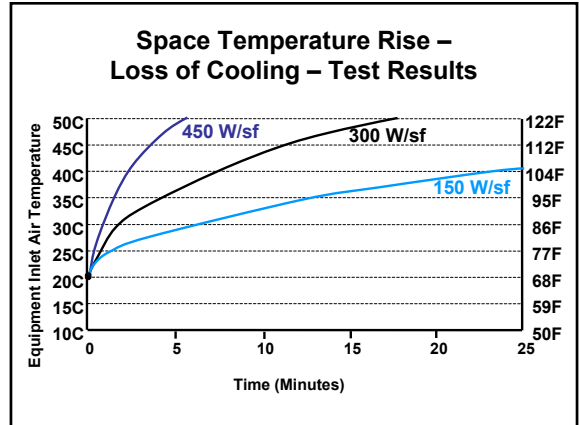
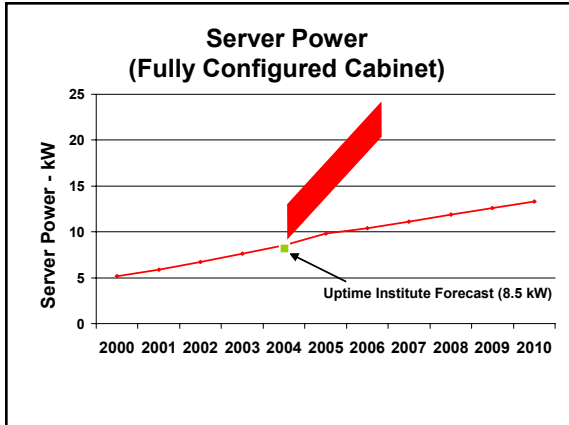
3U High Server - 14 per Enclosure [(1+1) - 1048 watt power supply]
 Fully Configured, 1.05 kW / Server = 14.7 kW = 2,100 W/sf



Sensitivity Of Projections

	Conservative	Moderate	Aggressive
Space Utilization (%)	24%	30%	36%
Product Configuration (%)	50%	60%	75%
Operating Power (%)	60%	55%	60%
Average Age (Years)	2.5	2.5	2.5
Storage (%)	15%	12%	10%
Communication (%)	5%	6%	9%
Work Station (%)	11%	10%	9%
Server + Disk (%)	69%	72%	72%





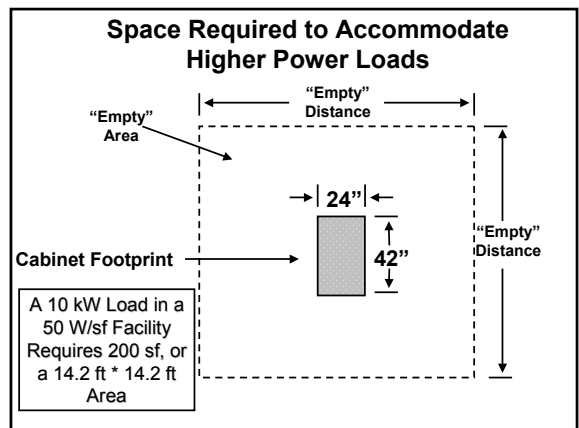
Example - Texas Site

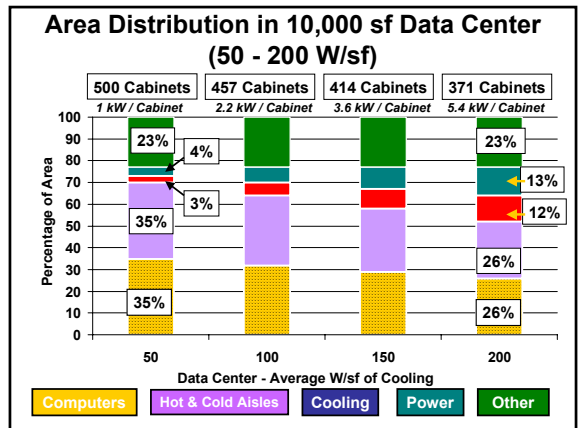
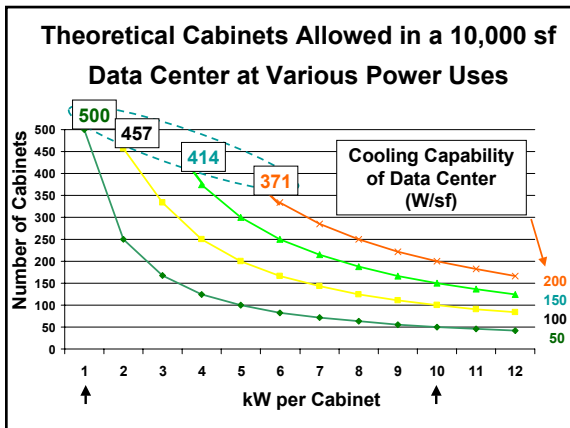
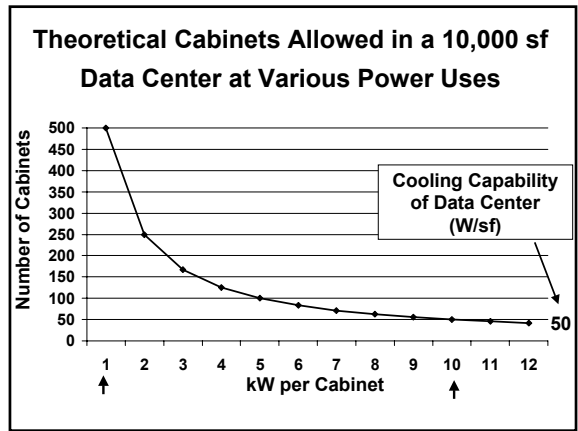
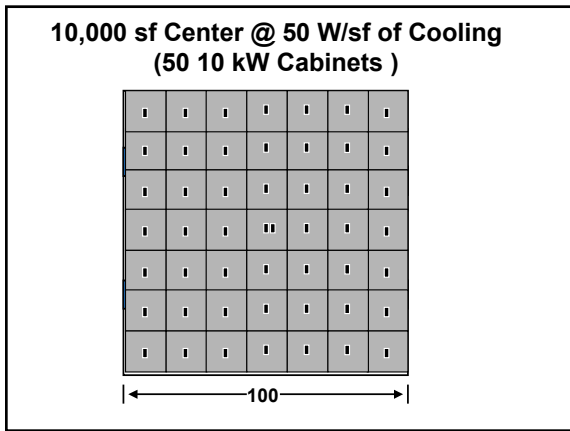
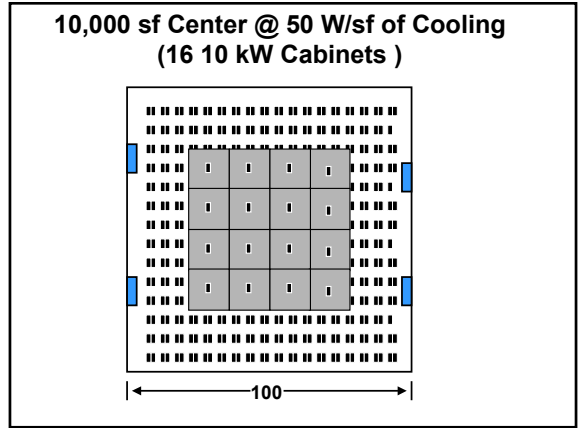
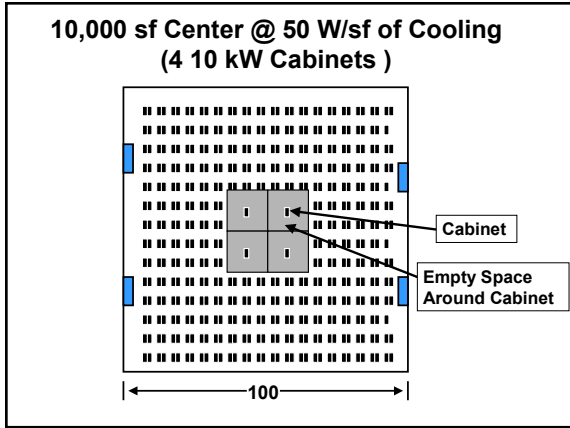
1U Server - 88 per Enclosure
 Stacked Vertically – Front & Back
 20 GHz Pentium Xeon, (1 or 2)
 Measured Power / Cabinet
 Design = 14.4 kW
 Normal = 11.0 – 11.6
 Minimum = 9.0 kW

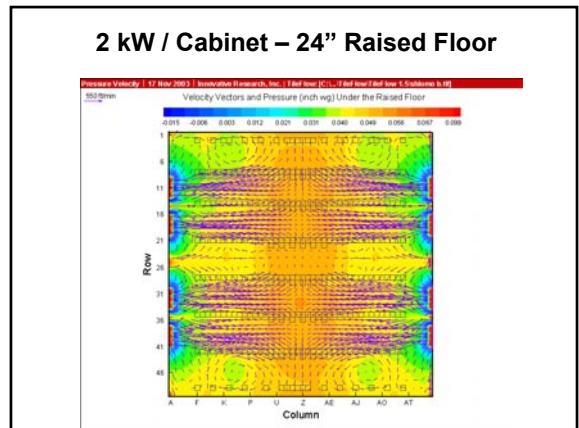
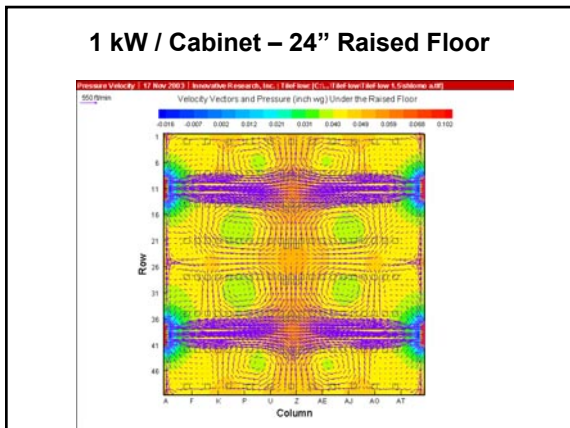
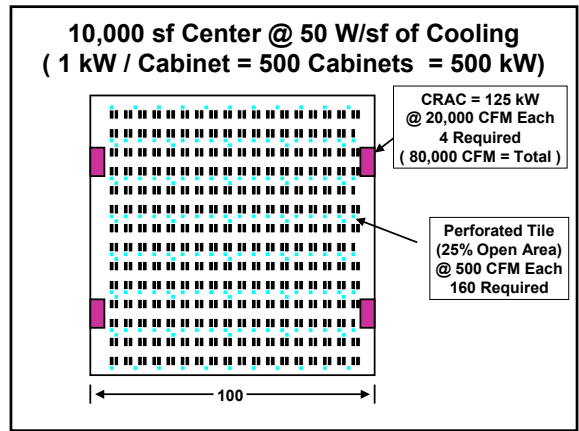
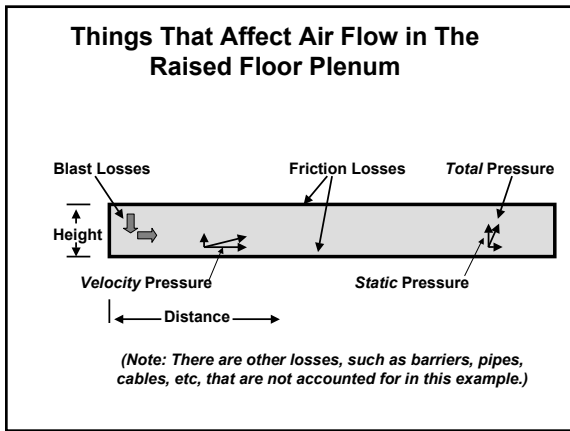
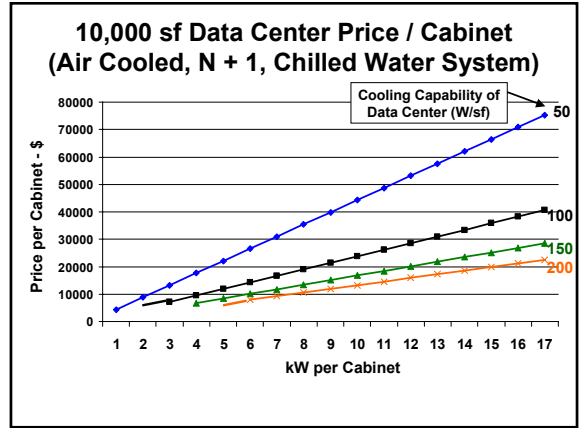
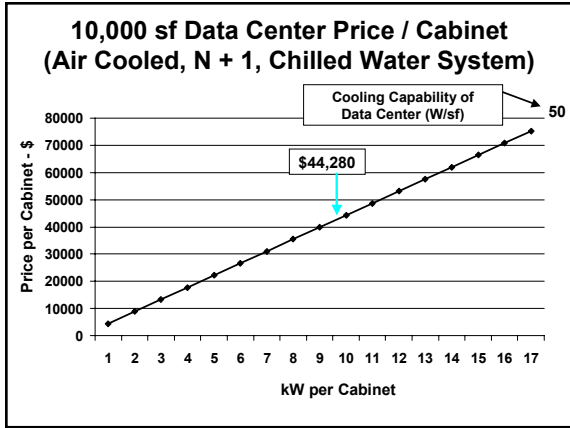
Entire Room Will Be 391 W/sf
326 Sensible Tons in a 39' x 75' Area

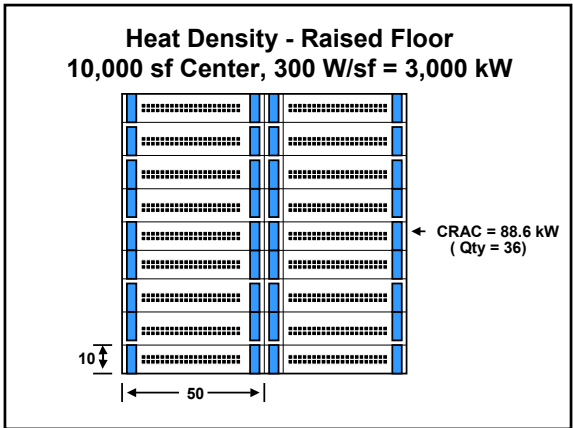
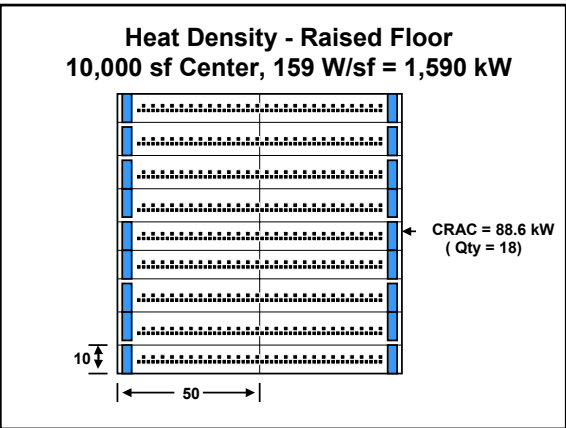
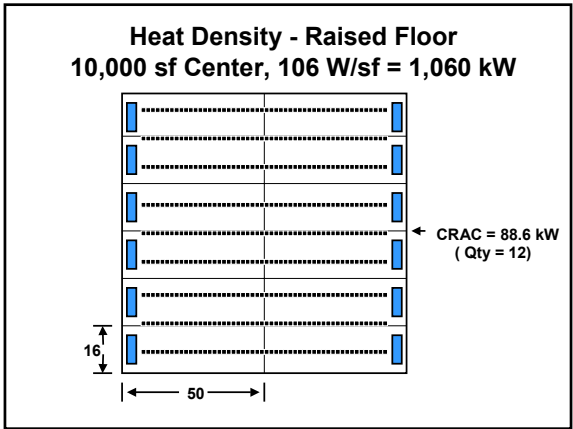
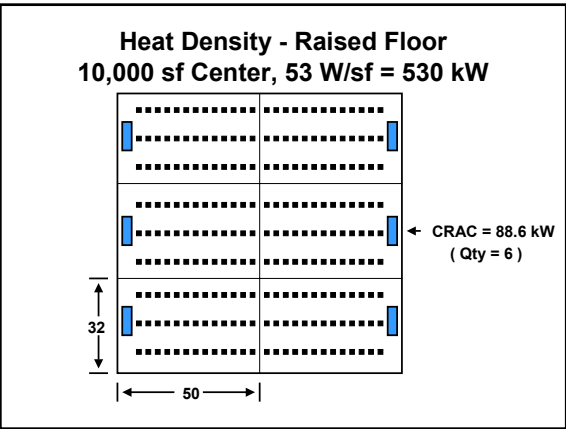
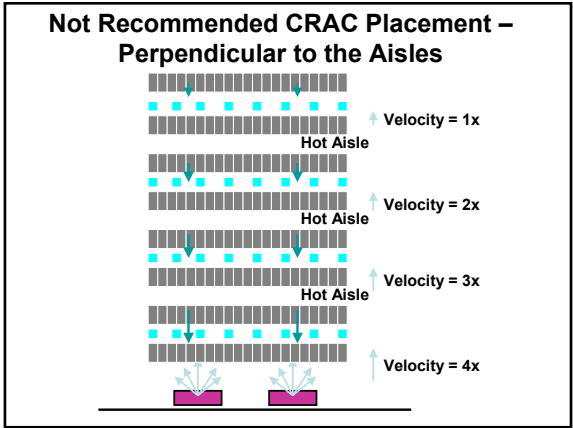
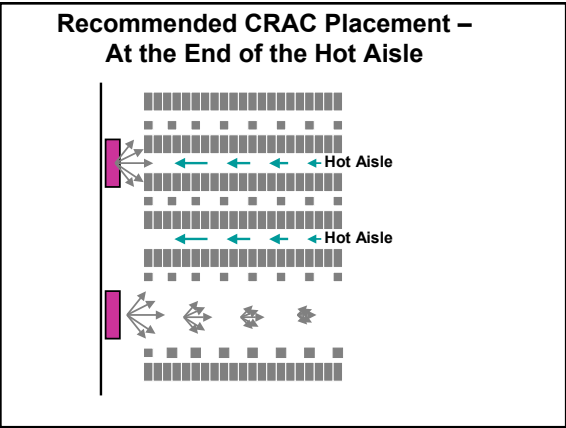
Example - Virginia Tech Installation

- Third Fastest Supercomputer in the World (10.28 TeraFlops)
- 1,100 PC, 2 Ghz CPU
- 3,000 sf Section of a 9,000 sf Data Center
- Initial Load = 190 W/sf – Tower Model
- Ultimate Load ~ 400 W/sf – 1U Model
- 18 Inch Raised Floor
- Website: <http://don.cc.vt.edu/>









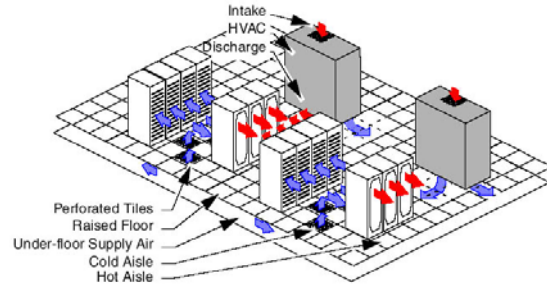
New ASHRAE Document

- “Thermal Guidelines for Data Processing Environments”
 - Equipment Environment Specifications
 - Facility Temperature & Humidity Measurement
 - Equipment and Facility Layout
 - Equipment Manufacturers Heat & Airflow Reporting

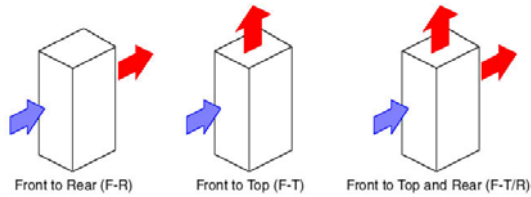
Contributors: Computer Manufacturers, Support Equipment Manufacturers, Consulting Engineers, Academic and Research Institutions, Data Center Design Software Companies

Available @ www.ashrae.org, Item Number 90431, or D90431

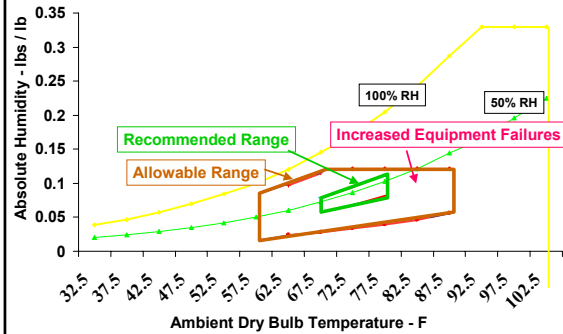
ASHRAE – Example of Hot and Cold Aisles with Under-floor Cooling



ASHRAE – Recommended Airflow Protocol for Computer Equipment



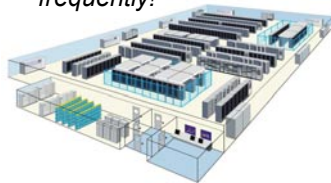
ASHRAE Class 1 Operating Conditions



Tiered Cooling Approach

- Room
 - Entire area
 - Base level of cooling
- Zone
 - Hot zones
- Spot
 - High density racks

Each Data Center Is Unique – and it changes frequently!



High Heat Density Solutions on the Market

- Raised Floor
- Overhead Ducts
- Closed Loop Air Systems
- Fans in Racks
- Distributed Cooling Modules

Factors to Consider

- Protection of IT Systems
- Lifetime Costs
 - Initial Costs
 - Continuing Costs
 - Disposal/Salvage Costs
- Flexibility/Scalability

Room - Traditional Units

- Provide base level of cooling everywhere in the room
- Effective control of humidity & air cleanliness

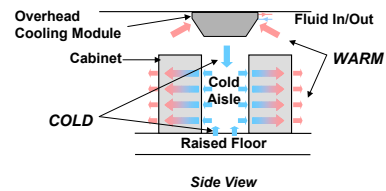


Zone – Overhead & Over Cabinets

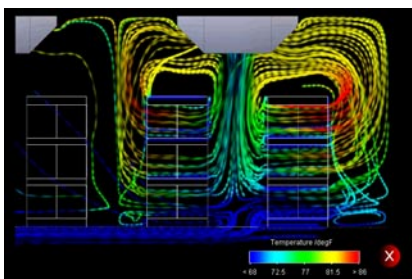
- Added capacity for high density areas
- Hot / cold aisles



Zone – Overhead & Over Cabinets



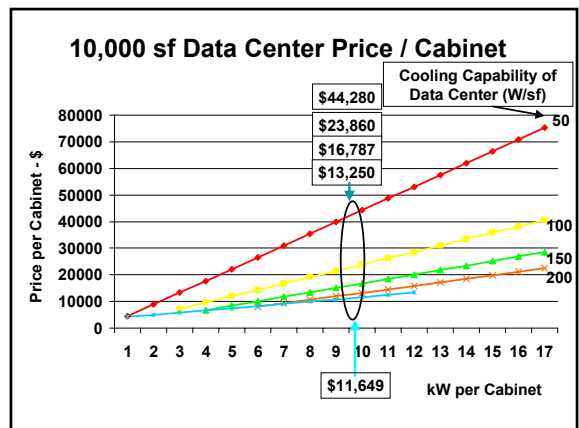
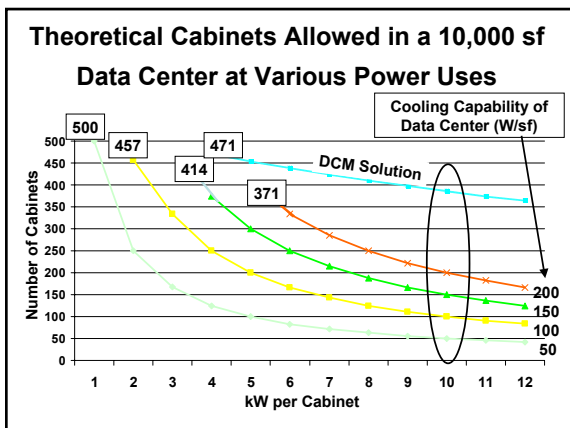
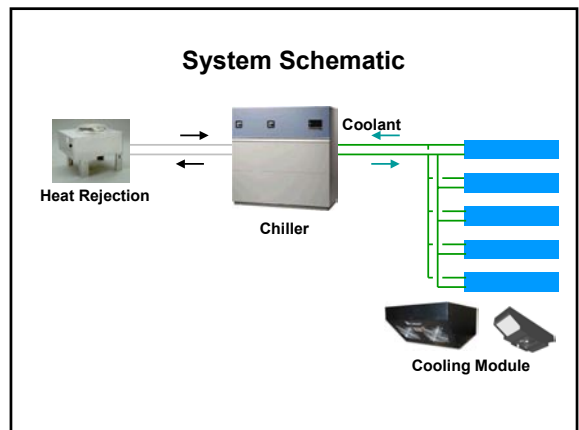
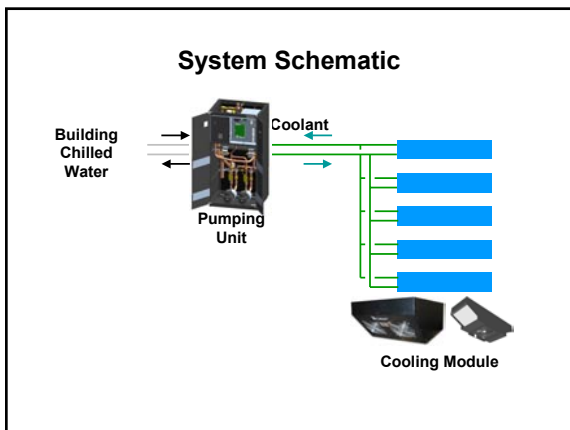
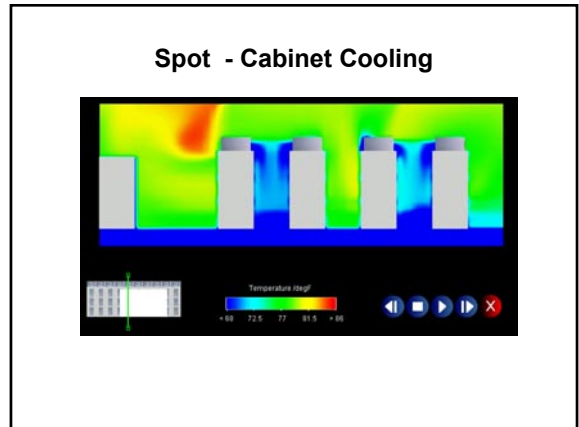
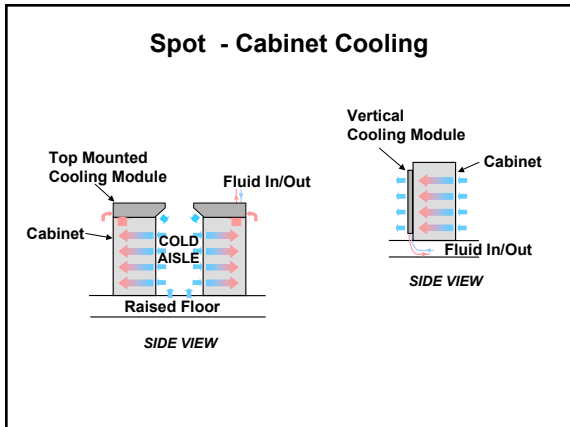
Zone – Overhead & Over Cabinets



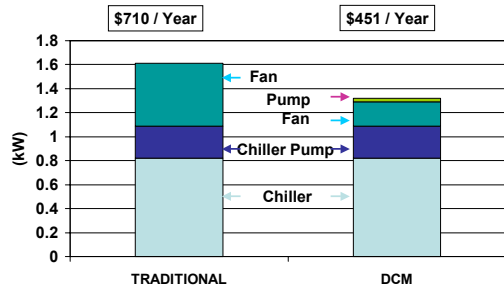
Spot - Cabinet Cooling

- Removes heat closest to source
- Targeted high capacity





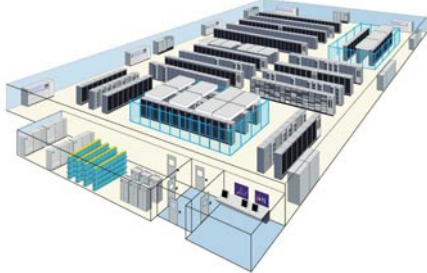
Power Required per 8 kW of Heat Load



Conclusion

- Heat loads consistently increasing. Projected to *double or triple* in the next five years
- Data Centers are transitioning from "Hot Spots" to "Hot Zones" to "Hot Rooms"
- Tiered cooling strategy
 - Spot
 - Zone
 - Room
- Multiple solutions required

***Each Data Center Is Unique –
And It Changes Frequently!***



Thank You!