

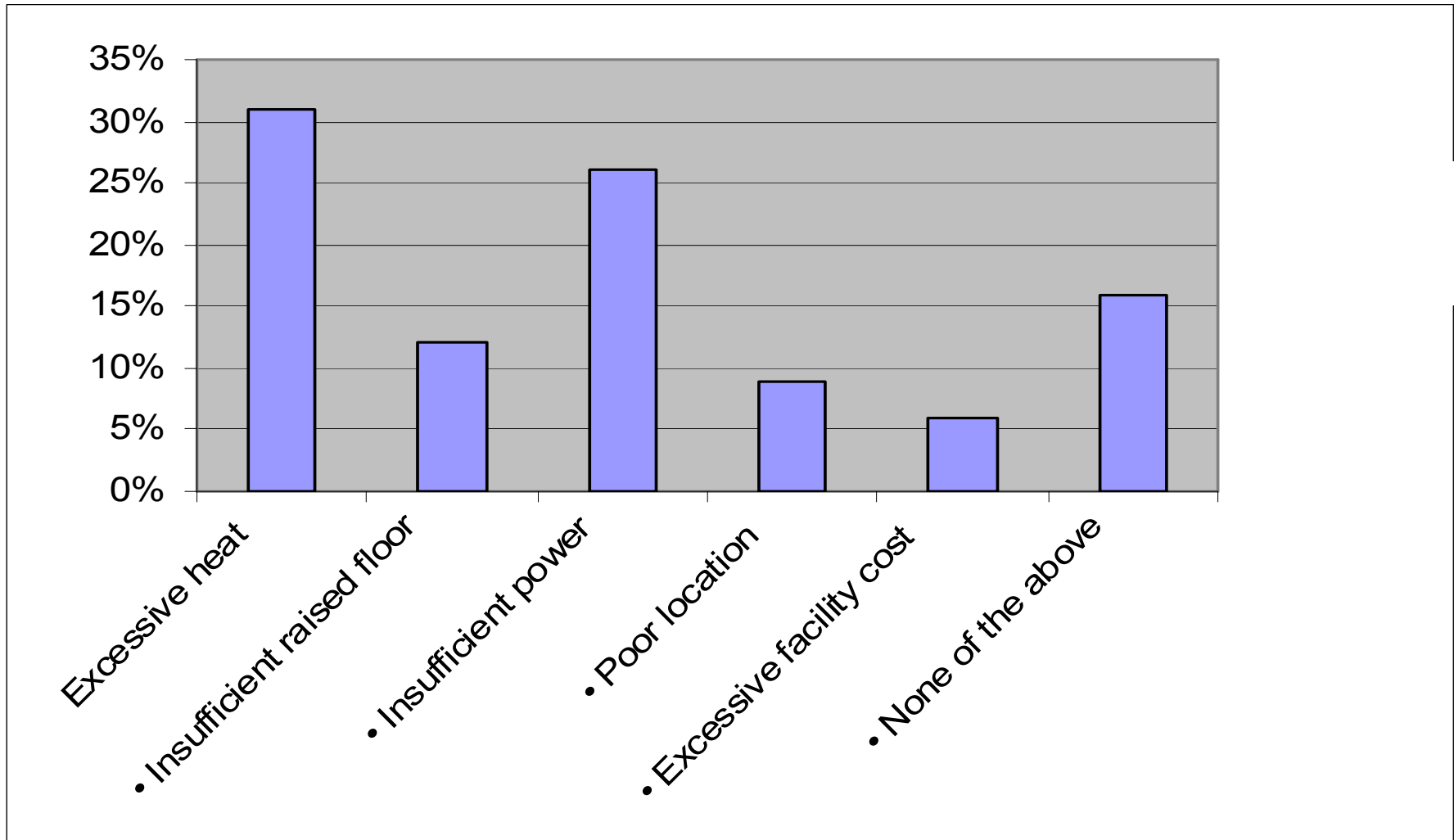
# Current Data Center Design

*James Monahan*

*Sept 19<sup>th</sup> 2006*

*IEEE San Francisco ComSoc*

# What is the biggest facility problem in your data center?



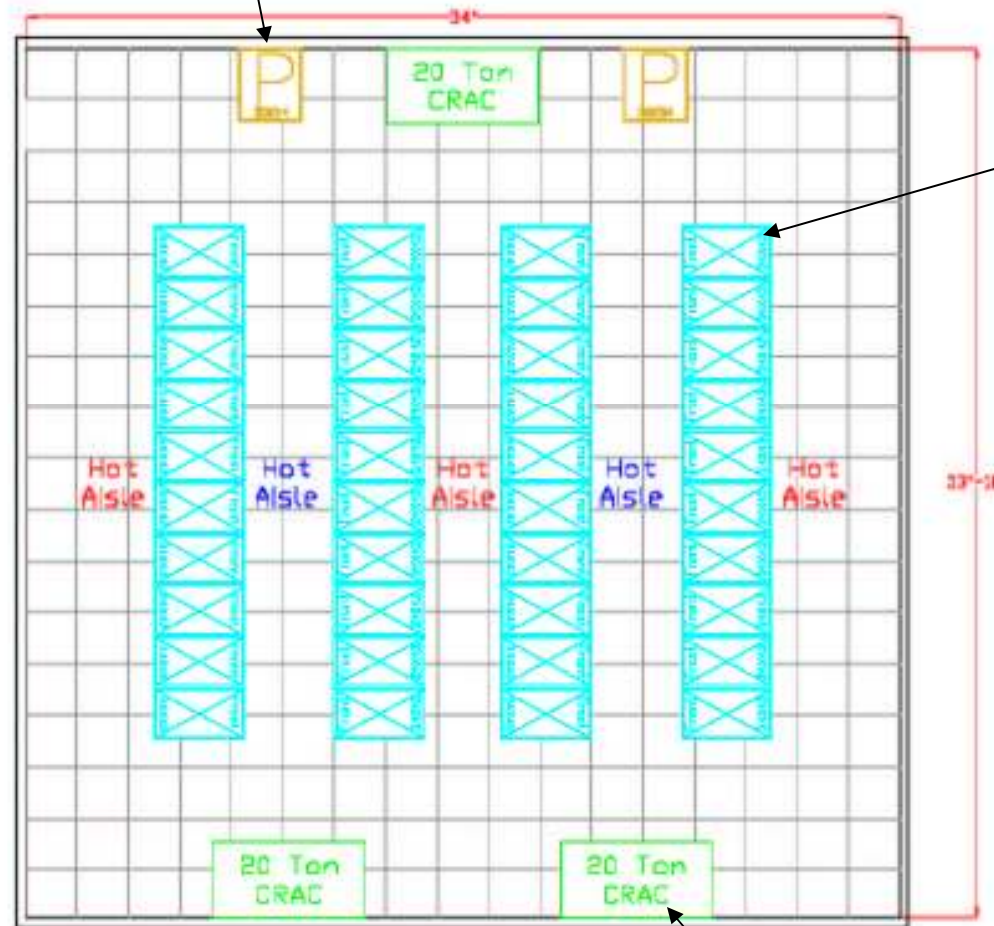
Source: Gartner 2006 Data Center Study

# Example of a Traditional Datacenter

- 34' x 34' ~ 1150 sq ft datacenter
- 120 Watts/ft<sup>2</sup>
- Total Power ~140kW
- 2 x 150kW PDUs (N+1)
- 3 x 20 Ton CRAC Downflow (N+1)
- 40 racks
- 18" Raised floor

# Example Server Room Layout

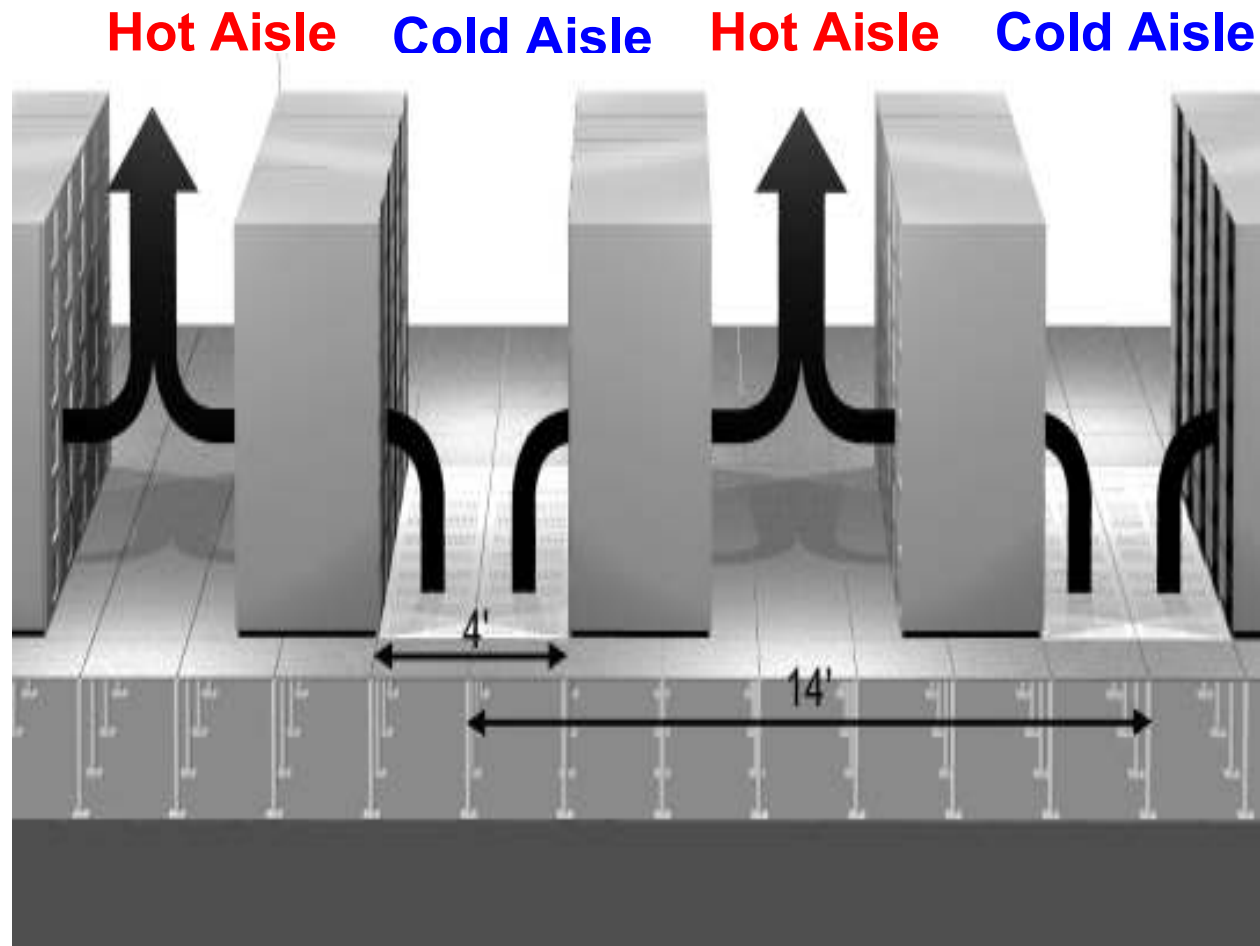
Power Distribution Unit



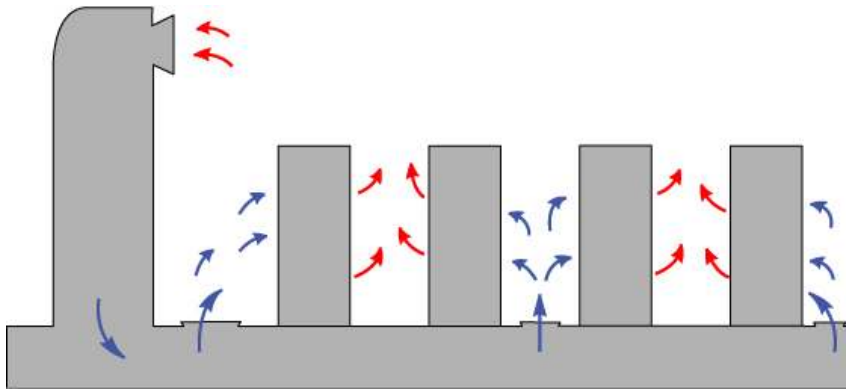
IT Equipment Racks

Computer Room Air Conditioner

# Airflow Pattern – Hot/Cold Aisle

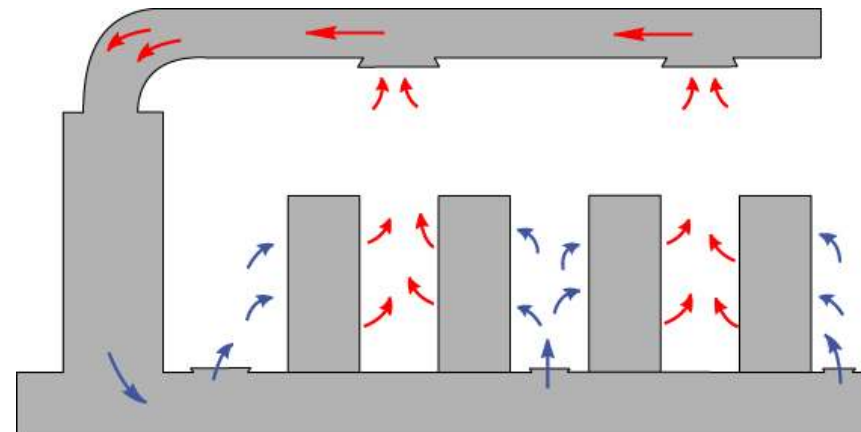


# Airflow Pattern – Raised Floor

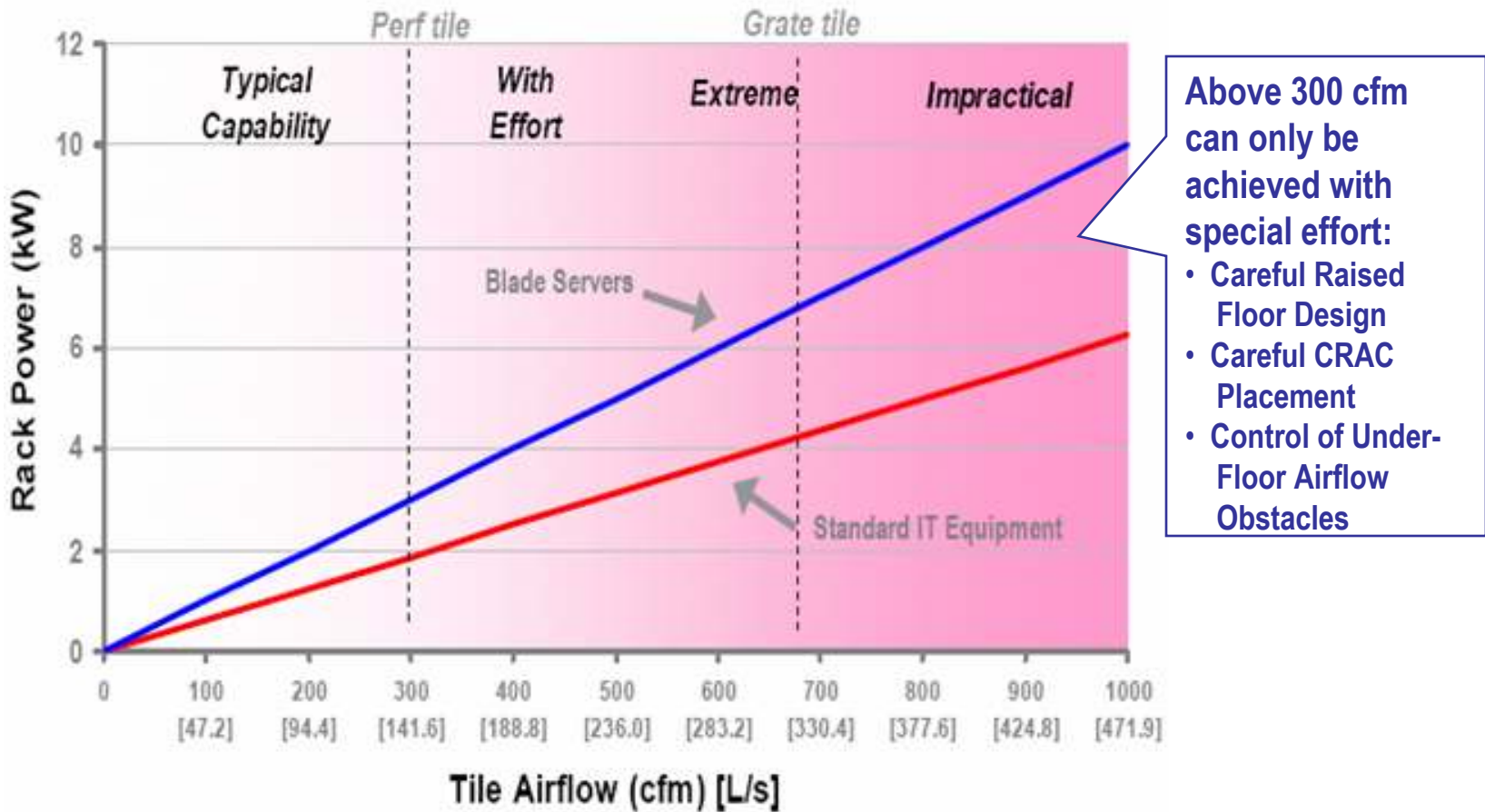


Cold Air discharge underneath raised floor with hot air stratifying to return to CRAC

Cold Air discharge underneath raised floor with ductwork to return hot air to CRAC



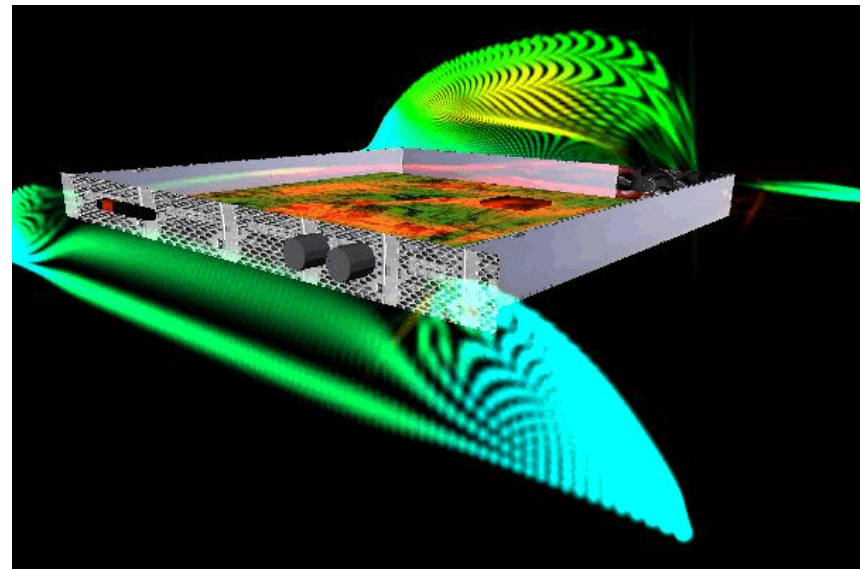
# Floor Tile Cooling - Practical Limitations



Available Rack Enclosure Cooling Capability of a Floor Tile as a Function of Per-Tile Airflow

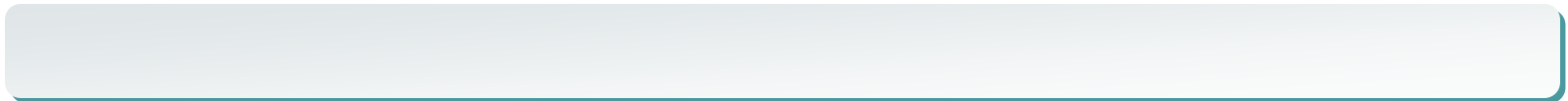
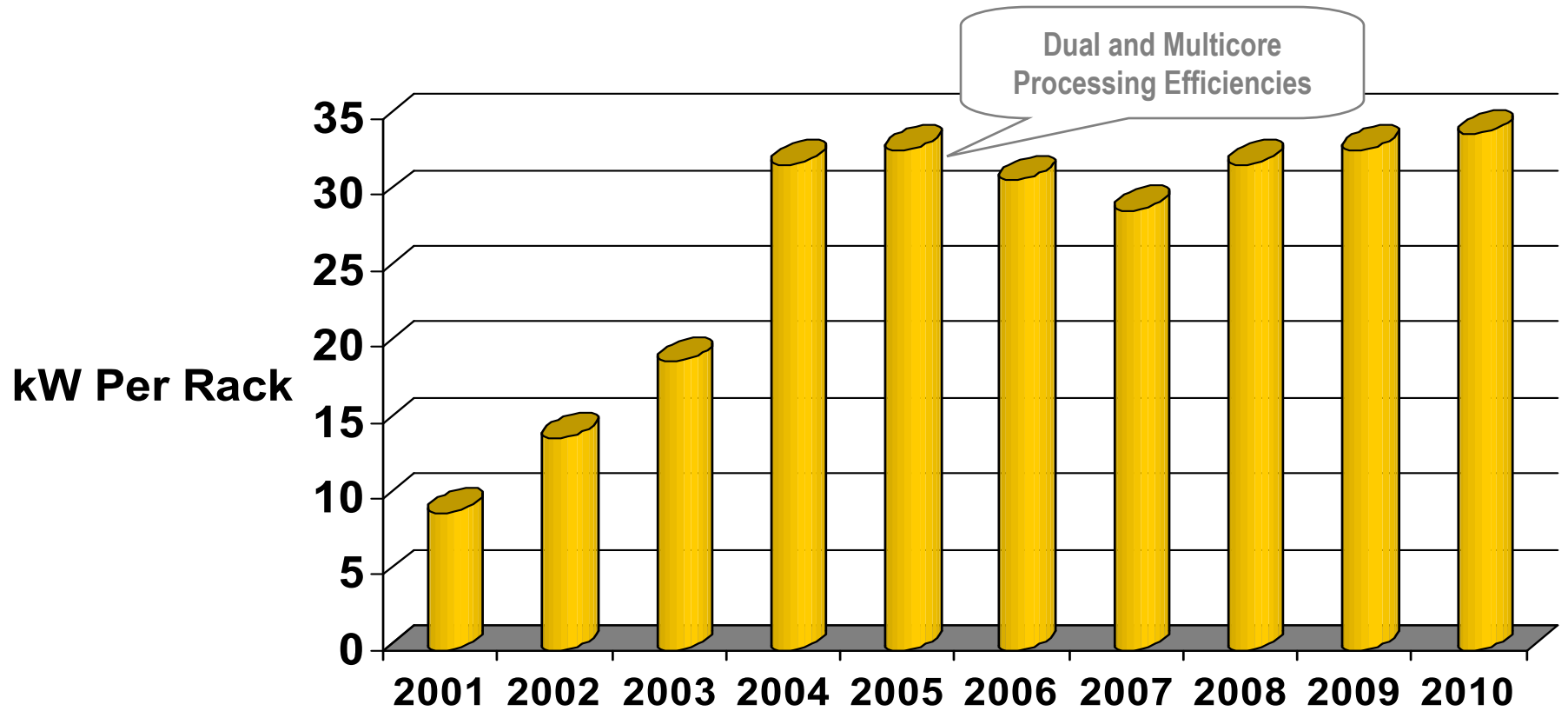
# Server Airflow Requirements

- For 20°F server delta Temperature rise the server required 160cfm of cold air per Kwatt
- From our previous slide we see the raised floor will provide 300 – 500 cfm
- Therefore average density per rack density ~ 2.5 - 3kW



# Rack Historical and Future Loads

Source: IBM 2006 Data Center Dynamics Conference



# High Density Racks -The Culprits



**Blade Servers**



**1U Rackmount Servers**

# The Culprits –High Density Servers

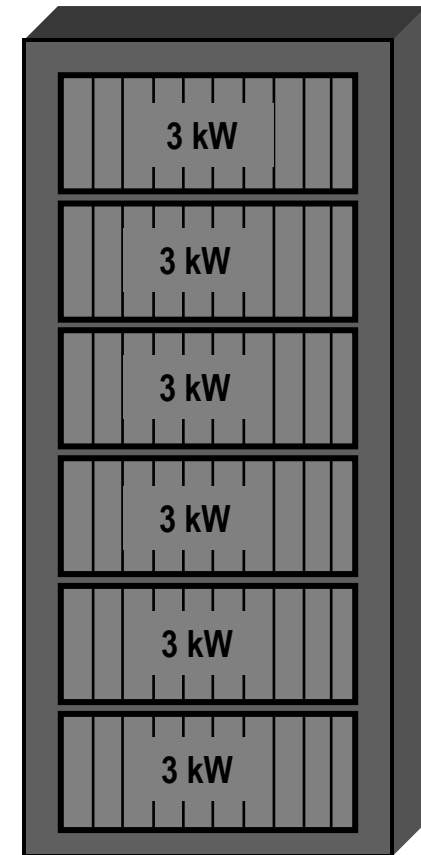
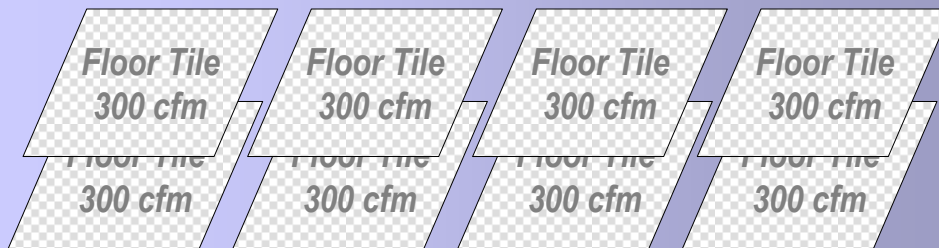
Power Requirements:

18kW per rack

Cooling Requirements:

2,500 cfm per Rack

**Would Require 8 Vented Floor Tiles per Rack**  
*(8x More than Normally Allocated)*



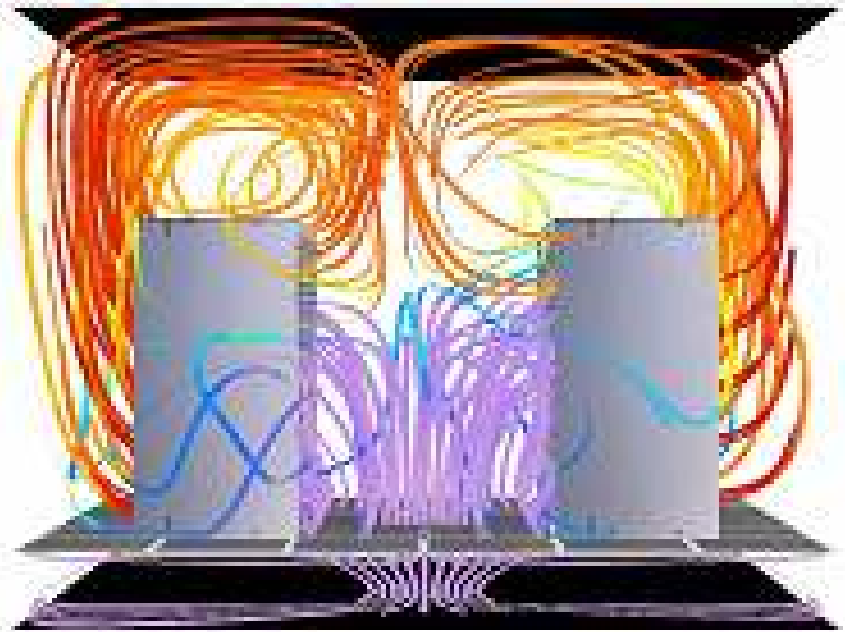
# Resultant Airflow

## Re-circulation from Hot Aisle

Top portions are pulling in warm re-circulated air from equipment exhaust – cool air never reaches top of rack

## Floor tile not supplying adequate air flow to rack

Under floor obstructions  
Incorrectly placed perforated tiles  
Missing floor tiles  
Unsealed floor openings



# Prizes – Who's done it?



# High Density Deployment Strategies

Deployment Strategy	Description	Application
Spread the Load	Split the equipment among enclosures to keep peak load down.	<ul style="list-style-type: none"> <li>Existing data centers, when high density equipment is a small fraction of the total load.</li> </ul>
Borrowed Cooling	Provide average cooling capability with rules to allow borrowing of underutilized capacity.	<ul style="list-style-type: none"> <li>Existing data centers, when high density equipment is a small fraction of the total load.</li> </ul>
Supplemental Cooling	Provide average cooling capability with provision for supplemental cooling equipment.	<ul style="list-style-type: none"> <li>New construction or renovations</li> <li>Mixed environment</li> <li>High density equipment location is not known in advance</li> </ul>
Dedicated High Density Areas	Create a special high density row or zone within the data center.	<ul style="list-style-type: none"> <li>New construction or renovations</li> <li>Density 10-25kW per rack</li> <li>When requirement exist to co-locate high density devices</li> </ul>
Whole Room Cooling	Provide high density cooling capability to every rack.	<ul style="list-style-type: none"> <li>Rare and extreme cases of large farms of high density equipment with very limited physical space</li> </ul>

# High Density Deployment Strategies

Deployment Strategy	Advantages	Disadvantages
Spread the Load	<ul style="list-style-type: none"> <li>•Works anywhere, no planning needed</li> <li>•Essentially free in many cases</li> </ul>	<ul style="list-style-type: none"> <li>•High density equipment must be spread out even more than the second approach,</li> <li>•Uses more floor space</li> <li>•Can cause data cabling issues</li> </ul>
Borrowed Cooling	<ul style="list-style-type: none"> <li>•No new equipment needed</li> <li>•Essentially free in many cases</li> </ul>	<ul style="list-style-type: none"> <li>•Limited to about 2X the design power density</li> <li>•Uses more floor space</li> <li>•Requires enforcement of complex rules</li> </ul>
Supplemental Cooling	<ul style="list-style-type: none"> <li>•High density where needed and when needed</li> <li>•Deferred capital costs, High efficiency, Good floor space utilization</li> </ul>	<ul style="list-style-type: none"> <li>•Limited to about 10kW per enclosure</li> <li>•Racks and rooms must be designed in advance to support this approach</li> </ul>
Dedicated High Density Areas	<ul style="list-style-type: none"> <li>•Maximum density</li> <li>•Optimal floor space utilization, High efficiency</li> <li>•High density equipment does not need to be spread out</li> </ul>	<ul style="list-style-type: none"> <li>•Need to plan a high density area in advance, or reserve space for it</li> <li>•Must segregate high density equipment</li> </ul>
Whole Room Cooling	<ul style="list-style-type: none"> <li>•Handles all future scenarios</li> </ul>	<ul style="list-style-type: none"> <li>•Extreme capital &amp; operating costs (up to 4X alternative methods)</li> <li>•May result in extreme underutilization of expensive infrastructure</li> </ul>

# Key Considerations

## Approaches NOT Recommended

- Reducing Air Temperature
- Replacing Tile with Grates
- Installing Top of Rack Fans
- Isolating Racks

## Approaches which are NOT Recommended

- Reducing Air Temperature
  - Reduce capacity of air conditioners
  - Dramatically increase humidifier water consumption
  - Dramatically decrease operating efficiency of DC (and significantly increase electrical bill)
- Replacing Vented Tile with Floor Grates
  - Decrease airflow in other areas
  - Unpredictable variations to occur in airflow
- Installing Top of Rack Fans
  - Doesn't address problematic hot air at front intake
  - Fans make more heat
- Isolating Racks to Area Open on All Sides
  - Allows hot exhaust air to return to server intake

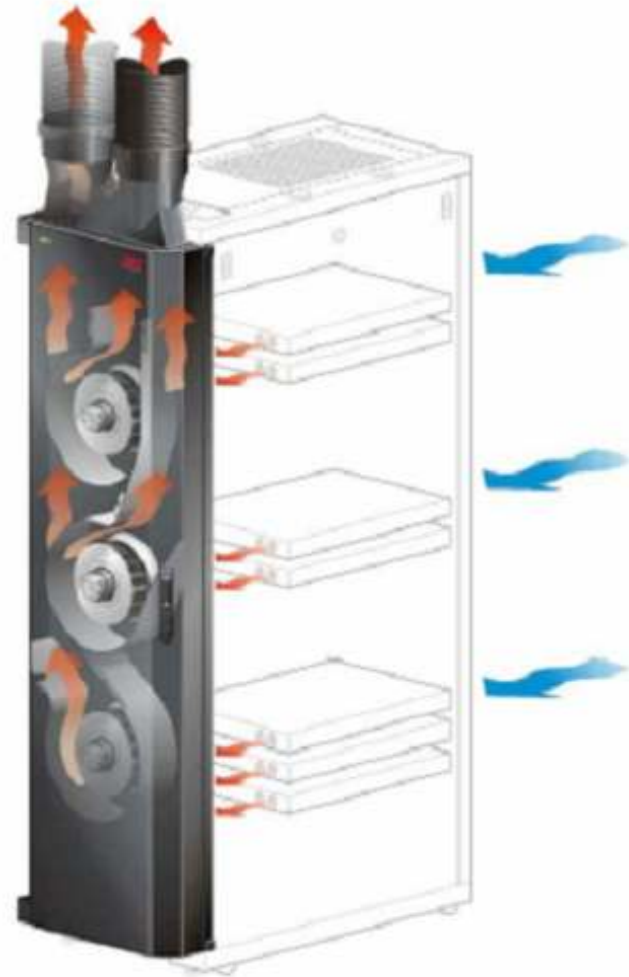


# Building High Density Zones

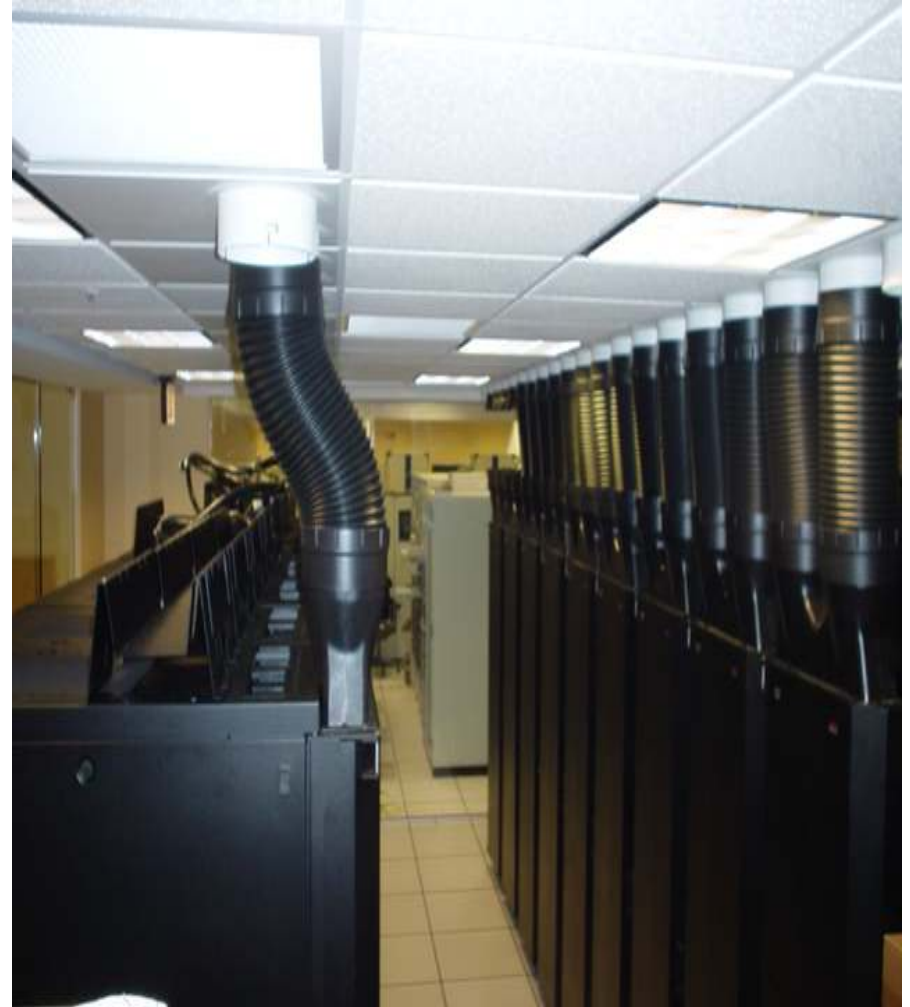
- Simple Solution
  - Coupling the heat source (servers) to the heat sink (CRACs)
  - Providing a **PREDICTABLE** supply and return air distribution method

# Rear Door - Airflow Diagram

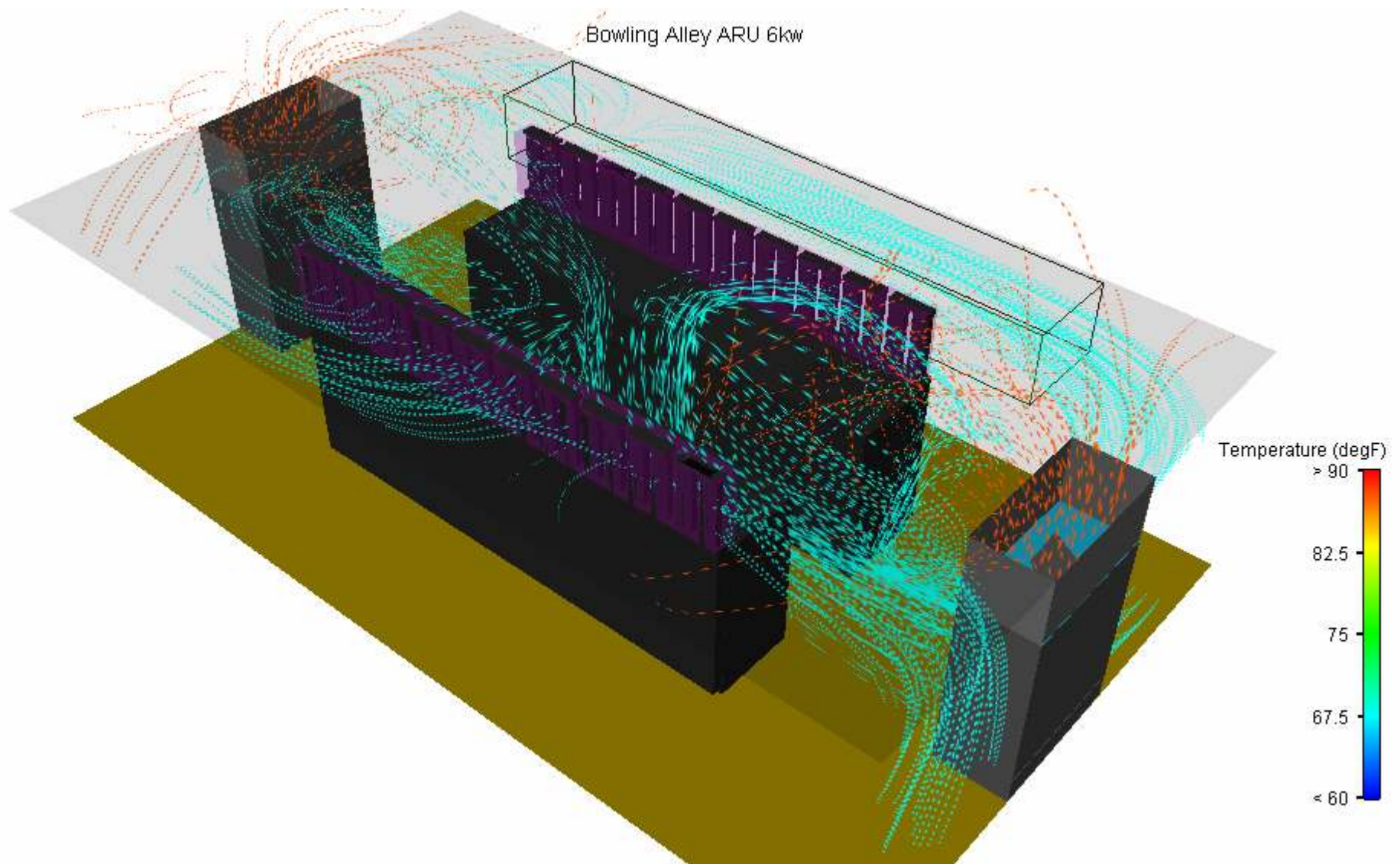
- Fans pull in rack equipment exhaust air
  - Cable impedance is overcome by high powered fans
- Ducted exhaust system (optional) delivers hot air to plenum
  - Eliminates hot air from mixing with room air
- Proper airflow through the enclosure is ensured
  - Cool inlet air moves freely to equipment in the rack



# Installation Pictures

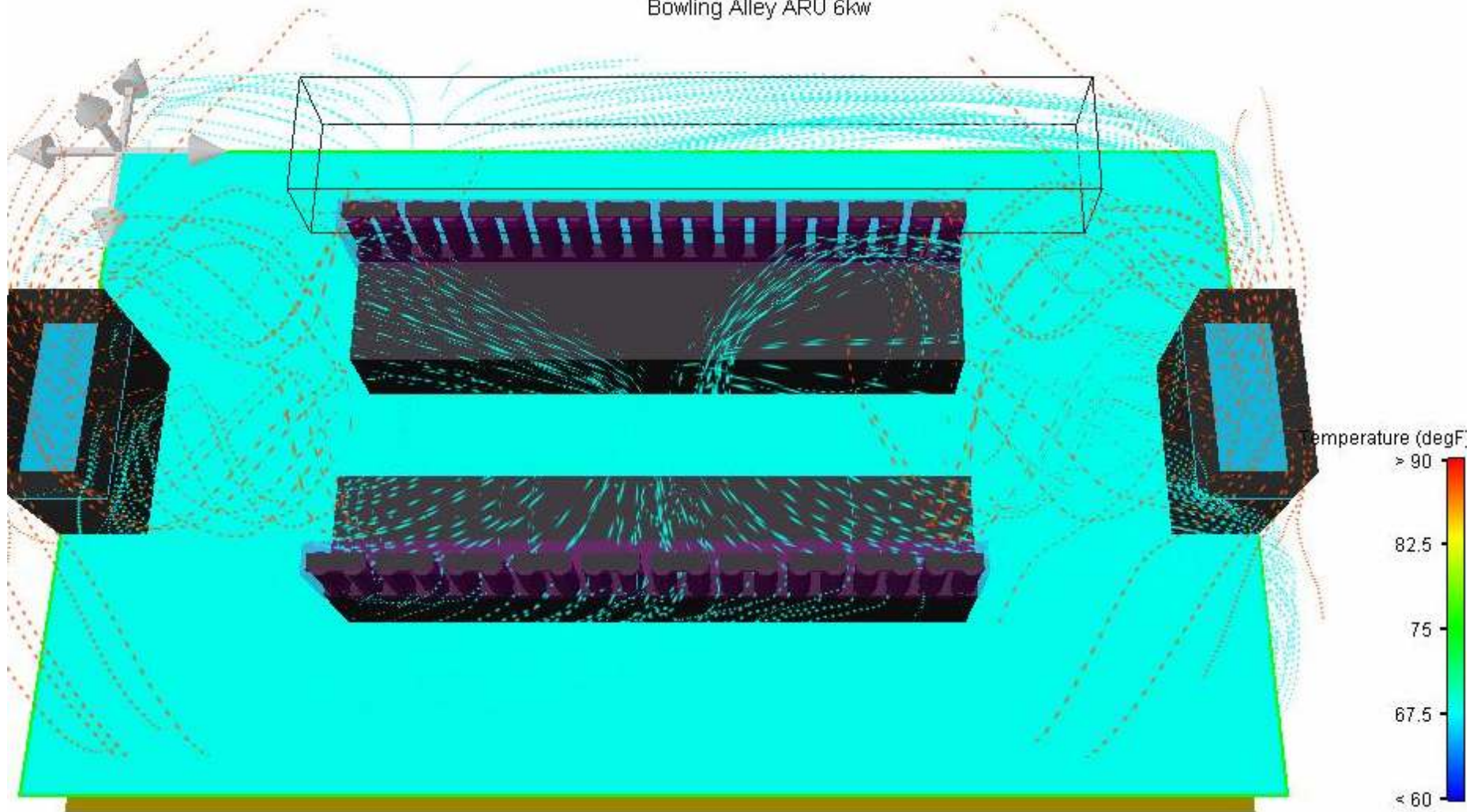


# Bowling Alley with ARU – 6kW/Rack

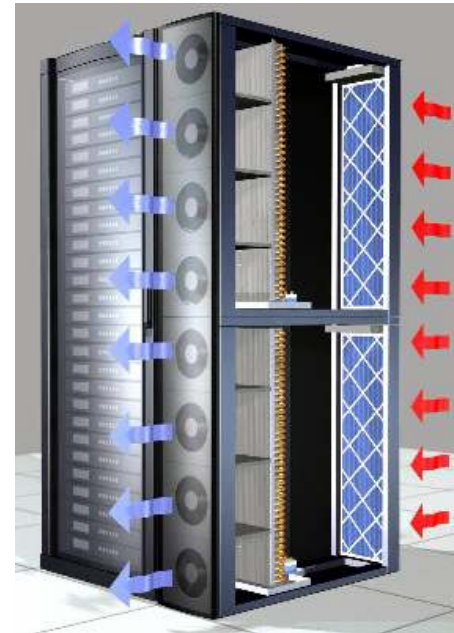


# Bowling Alley ARU – 6kW/Rack

Bowling Alley ARU 6kw



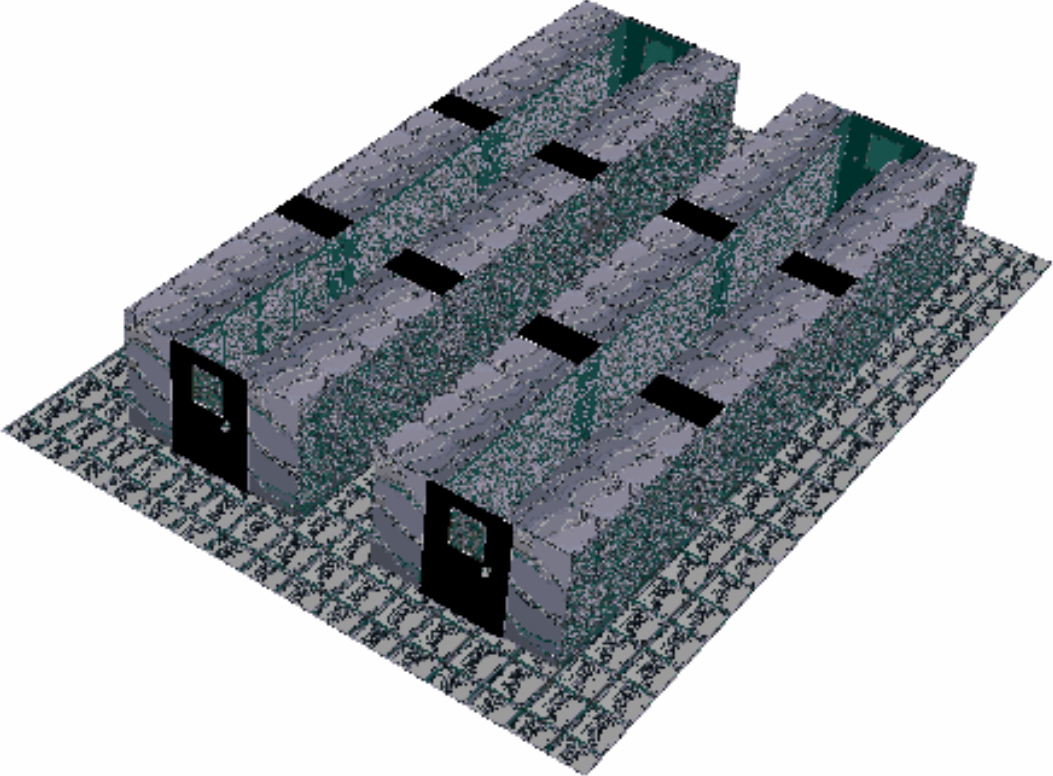
# HD Solutions - InRow Cooling



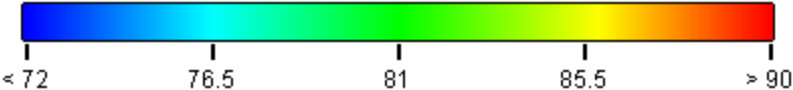
# HD Solutions - InRow Cooling



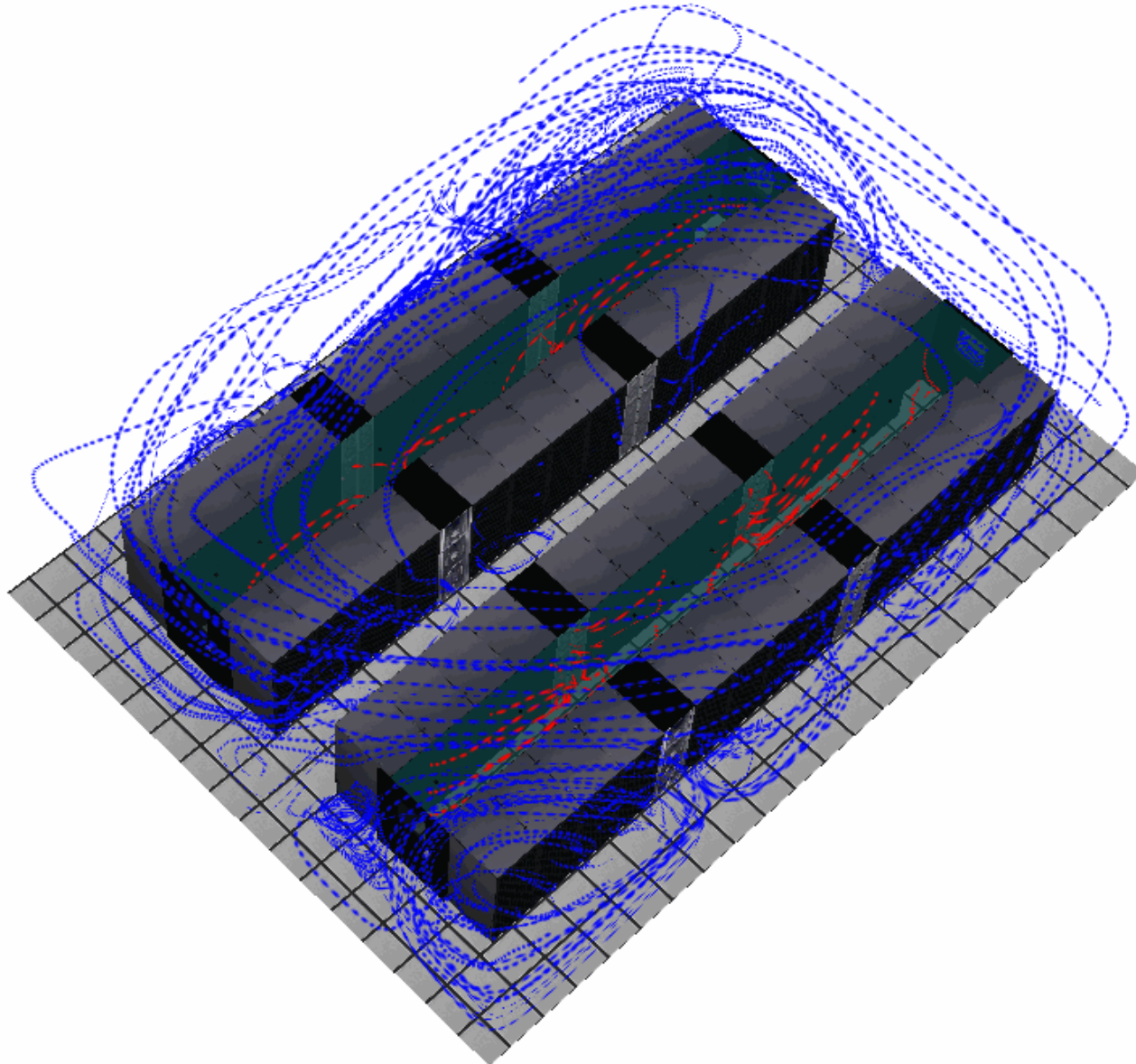
# HD Solutions - InRow Cooling Temps



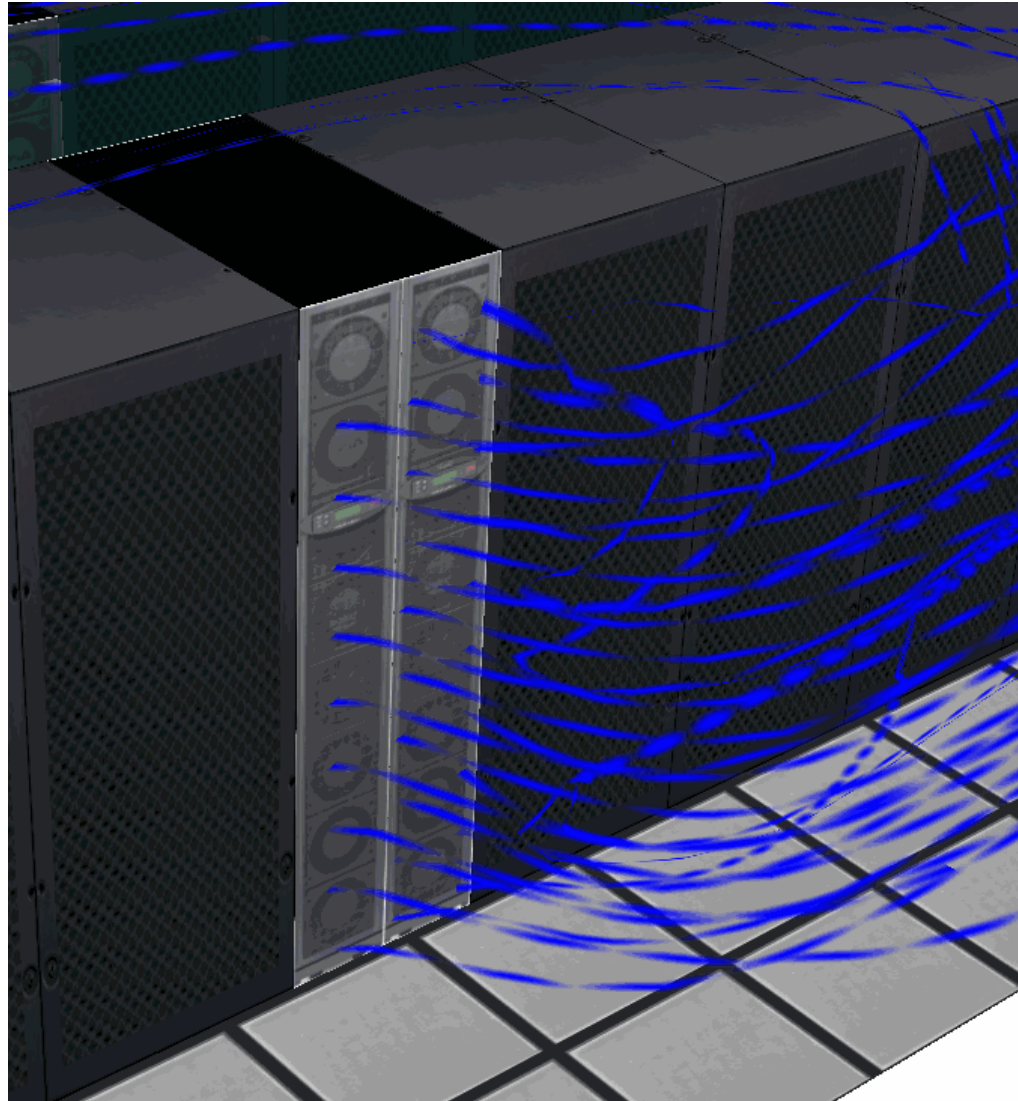
Temperature (degF)



# HD Solutions - InRow Cooling Airflow



# HD Solutions - IR Cooling Close Up



**The End!!!**

**Questions?**