

# CSE 265: System and Network Administration

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- Data Centers
  - Desirable features
  - Planning
- Hardware Maintenance



Facebook Oregon Data Center (2012)

# Desirable features of a data center

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# Desirable features of a data center

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- Air conditioning, humidity control
- Access to building-wide reliable (uninterruptable) power supply and raw power
- Elimination of single points of failure (e.g., network cable)
- Provision of hot standby equipment
- Hot-swappable parts
  - Hard drives, power supplies, UPS batteries
- Protection from natural disasters like fire and floods
  - Server room should be its own 'fire cell'

# Desirable features of a data center

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- Faraday cage for important computing equipment
  - Protect from electromagnetic leaks
  - Protect from electromagnetic pulses
- No carpet or linoleum that generates static electricity
- Well organized – equipment marked, tagged, and mapped
- Secure – both the facility (also inconspicuous), and individual spaces when multiple organizations use same facility
- Easy access to cabling

# Data Center Needs

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- Temperature: 64-80F
  - Ambient temperature (in room) is usually 40+ degrees lower than inside of computer
  - When chips reach ~120F, they may not work correctly; at ~160F, they break (some CPUs can operate up to ~200F)
    - Humidity: 30-55%
    - Too high – condensation, short circuits
    - Too low – static electricity, jamming of printers, etc.
- Security (theft, vandalism, disaster)
- Space for equipment, people (to work on equipment)

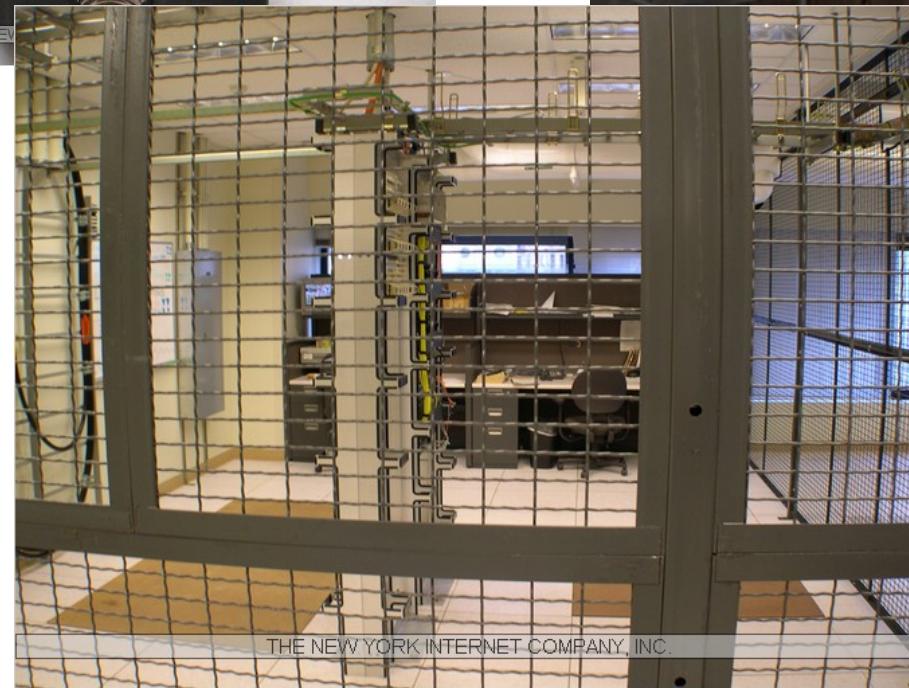
# Data Center Planning

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- What are your present and future needs?
  - We would like to exhaust all resources at the same time
- Security requirements
- Fire/other hazard protection
- How much Heating and Air Conditioning?
- How much raw power? Back-up power?
- How much space?

# Security in Data Centers

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# Fire Hazard Protection

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- Useful to have early smoke detection so that failing equipment can be turned off before a fire starts



# Earthquake Protection? - not here



# HVAC for Data Centers

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- Need to account for
  - Roof, walls, and windows (HVAC engineer)
  - Electronic gear (power consumption)
  - Light fixtures
  - Operators (people)
  - Humidity control
- Useful conversions:
  - 3.412 BTUH/watt
  - 300 BTUH/human
  - 12,000 BTUH/ton



# Example HVAC Calculation

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- 25 servers \* 450W/server \* 3.412 BTUH/watt = 38,385 BTUH
- 6 lights \* 160W/light \* 3.412 BTUH/W = 3,276 BTUH
- 4 humans \* 300 BTUH / human = 1,200 BTUH
- 20,000 BTUH for roof, walls, and windows (given by HVAC engineer)
- Total is 62,861 BTUH \* 1 ton/12,000 BTUH \* 1.5 = 7.86 tons of cooling



# Air Cooling is Possible

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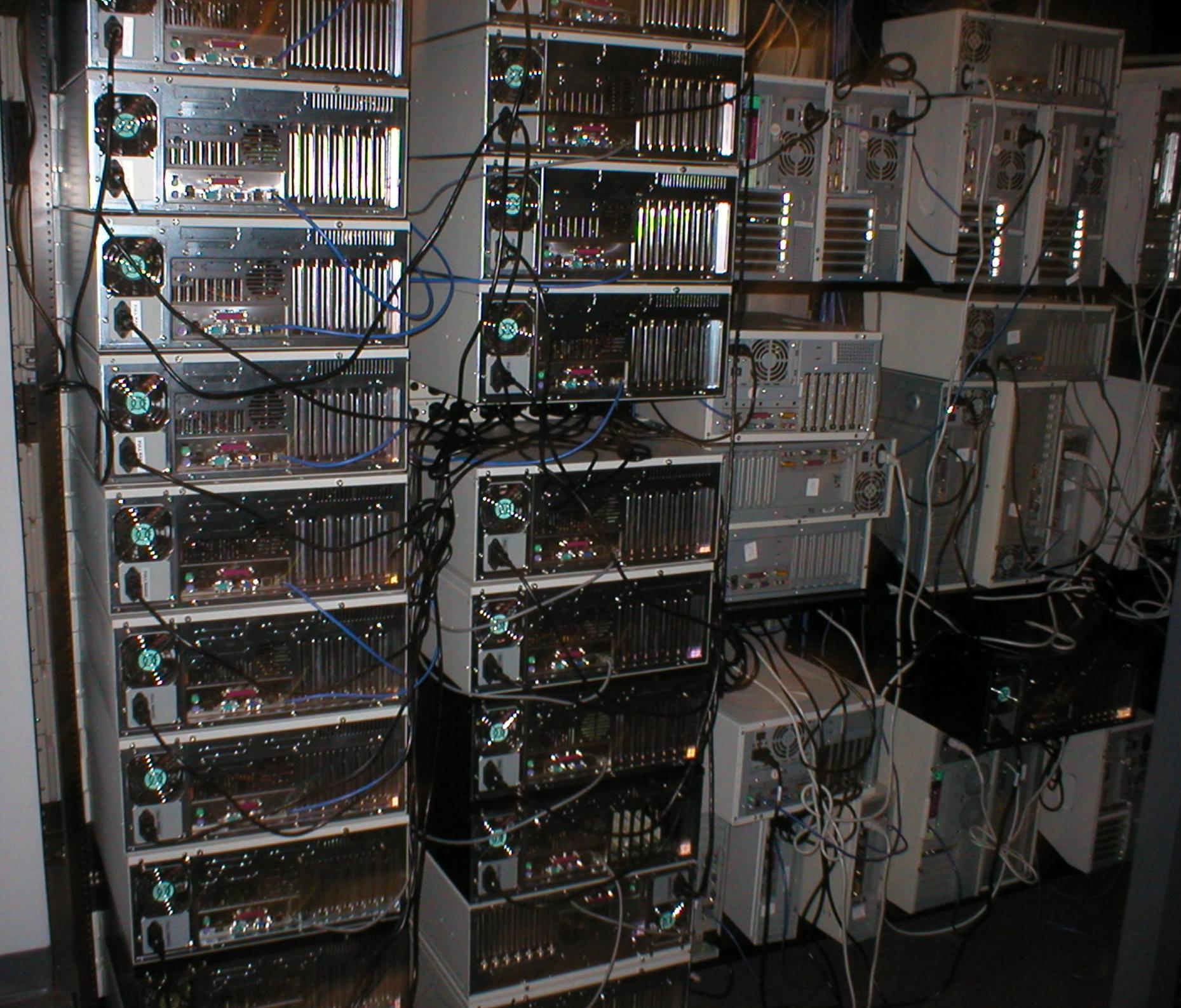
Facebook data center in Sweden.

# Power in Data Centers

It's a big deal – sometimes difficult to get enough power in a machine room, and the power to individual machines should be remotely controllable (e.g., to power cycle from afar)



APCC integrated power, cooling, management



# Data Center Space

Rarely do you get to see a data center like this (empty).  
Note the grates in the floor for cool air. The bulky refrigerator-sized units along the walls are probably air conditioners.

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# Dense Usage

- Large enough enterprises may find it useful to do mass-customization
- Note wheels on racks, no cases, pre-configured in this older Google data center





- Efficient - systems face inward
- Safe – racks secured together
- Organized – cabling tidy

# Buy a pre-built data center

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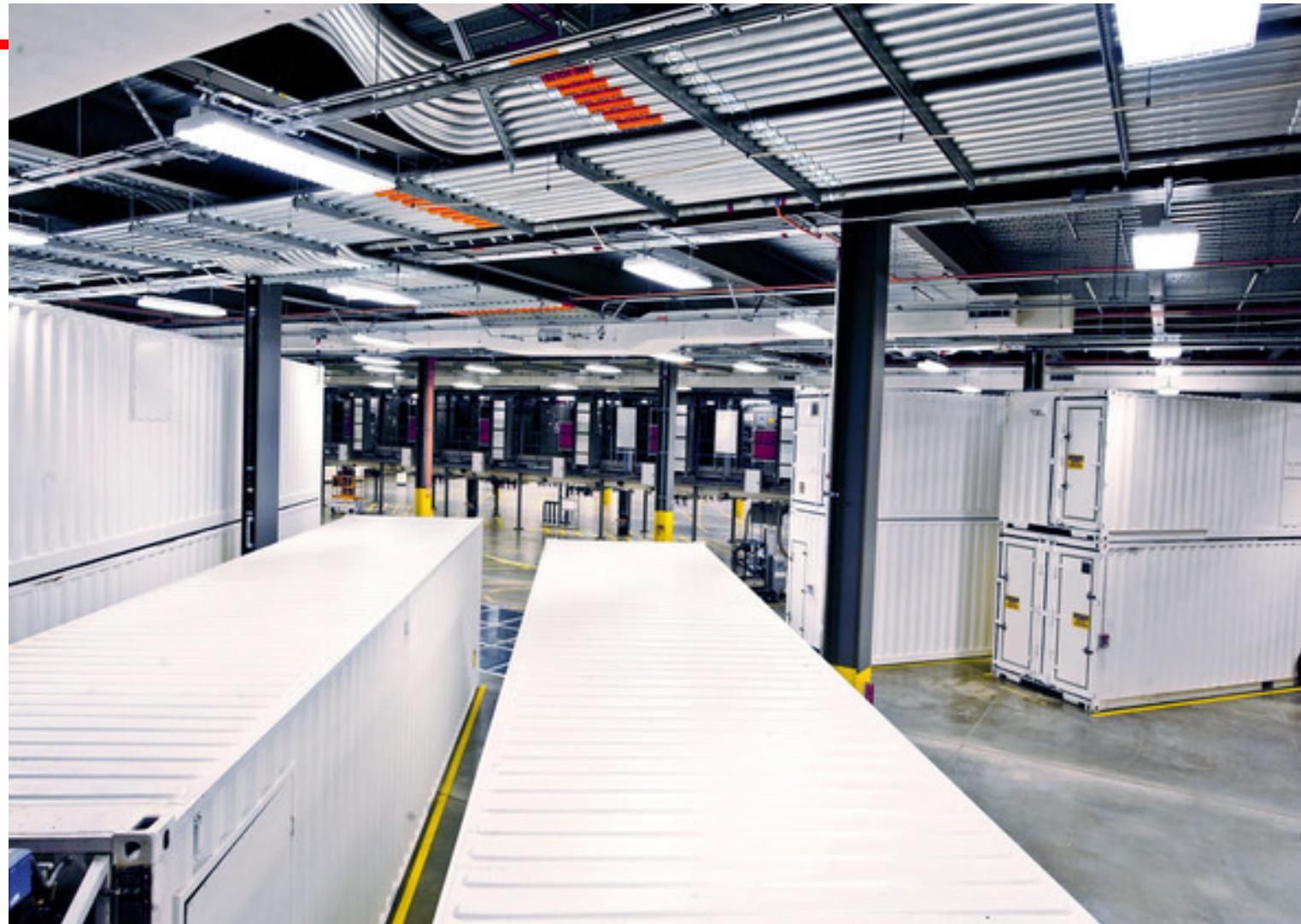
# Easy transport by truck or ship

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- [Rackable is now called SGI...]



# Or buy many...



From Microsoft's Chicago data center

# Large scale

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- Most Google's data centers are composed of standard 1AAA shipping containers packed with 1,160 servers each, with many containers in each data center. [cnet, 2009]



# Maintenance of Systems

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- Keep a log book of failures and replacements
- Shop around for good warranties
- Keep spare replacement systems
- Consider maintenance contracts
  - For equipment too expensive for holding spares
  - 4-48 hour response times; often function like an extended warranty

# Preventive Maintenance

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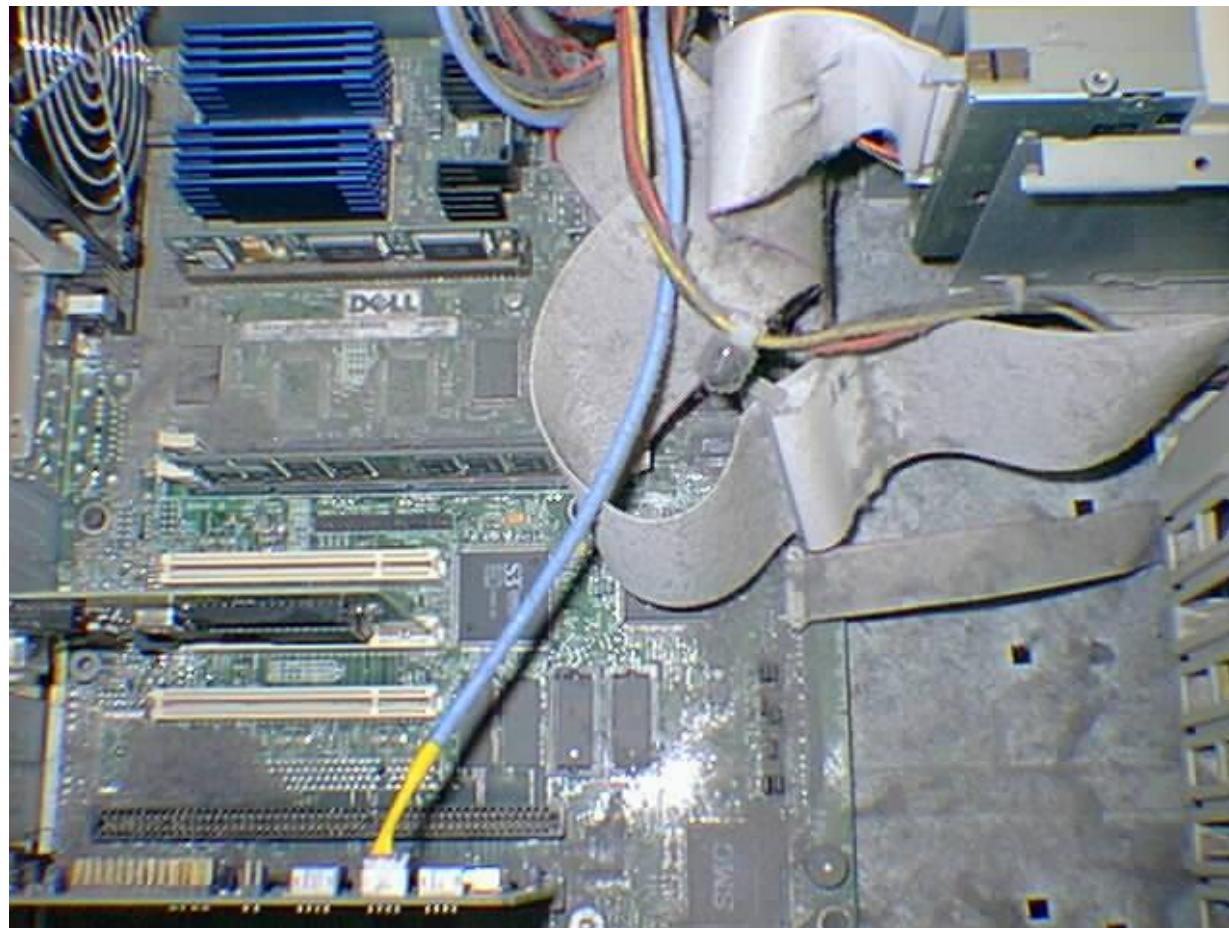
- Vacuum insides of computers in bad locations (lots of dust, carpets)



# Preventive Maintenance

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- Clean filters/vents regularly



# Preventive Maintenance

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- Avoid static electricity
  - Be grounded when handling electronics
- Periodically check servers for failed fan and power supplies
- Add temperature monitors (internal and external) and water sensors under raised floors
- Attach additional fans if noise is not an issue