Cooling Small Server Rooms Can Be Inexpensive, Efficient and Easy

- Jim Magallanes

Computer Room Uptime:  www.CRuptime.com
Uptime Racks:  www.uptimeracks.com
Outline

• Server Rooms
  – Description & Heat Problem
  – Trends
  – Calculating Cooling Load
  – Cooling Strategies
  – Best Cooling Practices

• Cooling Solutions
  – Portable Air Conditioners
  – Air Conditioned Server Racks & Cabinets
  – Ceiling Mount Air Conditioners
  – Mini Split Systems

• Conclusion
## Server Room Market Size

### Estimated U.S. Data Center Electricity Consumption by Market Segment (2011)*

<table>
<thead>
<tr>
<th>Segment</th>
<th>Number of Servers (million)</th>
<th>Electricity Share</th>
<th>Total US Data Center Electricity Use (billion kWh/y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small/Medium Server Rooms</td>
<td>4.9 (40%)</td>
<td>49%</td>
<td>37.5</td>
</tr>
<tr>
<td>Enterprise/Corporate Data Centers</td>
<td>3.7 (30%)</td>
<td>27%</td>
<td>20.5</td>
</tr>
<tr>
<td>Multi-Tenant Data Centers</td>
<td>2.7 (22%)</td>
<td>19%</td>
<td>14.1</td>
</tr>
<tr>
<td>Hyper-Scale Cloud</td>
<td>1.0 (8%)</td>
<td>5%</td>
<td>3.4</td>
</tr>
<tr>
<td>High-Performance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total (rounded)</strong></td>
<td><strong>12.2</strong></td>
<td><strong>100%</strong></td>
<td><strong>76.4</strong></td>
</tr>
</tbody>
</table>

In 2013, small and medium server rooms consumed an estimated 45.5 billion kilowatt-hrs of electricity. This is the equivalent annual output of 17 large (500-megawatt) coal-fired power plants, enough electricity to power all the households in New York City.*


* Scaling Up Energy Efficiency Across the Data Center Industry: Evaluating Key Drivers and Barriers – The Natural Resources Defense Council / August 2014
Server Room Description

• Servers / Telecom / UPS / Electrical Equipment
  – Floor Space is a Premium: < 100 ft²
  – Contents: 1 – 3 Server Racks
  – Heat Load per Rack: 1.0 – 3.0 kW Avg. (3,412 – 10,236 Btu/hr)
  – Cooling: None / Building cooling during the day
  – Remote location in building (afterthought)
    • Room never designed to cool IT equipment
  – Security: Locked Door and/or Locked Cabinet

• The average server room can easily contain more than $100,000 of IT equipment
Server Room Heat Load

- Power = Heat
  - Servers
    - Smaller & More Powerful
  - VOIP Telecom Equipment
    - High powered switches & equipment
    - Requires UPS support
- Heat = Electronic Equip Problems
  - Reduced Life
  - Reduced Reliability
  - Slower Network
  - General Rule
    - Every 10°C temperature rise in nominal temperatures produces a 50% reduction in the lifetime and long-term reliability of IT hardware
      - MIL-HDBK 217 / Arrhenius Models

Product Heat Density Chart

![Datacom Equipment Power Trends](image.png)

*Figure 1. Equipment densities are rising even faster than once predicted. © 2005 ASHRAE TC 9.9 Datacom Equipment Power Trends & Cooling Applications*
Server Room Downtime

• Direct Costs
  – Equipment costs for damaged equipment
  – Employee wages for lost productivity & overtime
  – Lost revenue due to systems being down
• Indirect Costs
  – Reduced customer satisfaction
  – Customers driven to competitors while your systems down
  – Damaged brand perception / Negative public relations
• Downtime Costs*
  – Banking: $5,220.80 /hr
  – Retail: $9,774.80 /hr
  – Media: $4,789.60 /hr
  – Hospitality: $1,544.80 /hr
  – Insurance: $14,836.80 /hr

* Reference: Schneider Electric (assuming 40 employees)
Server Room Trends

• Number of server rooms increasing
  – Network applications moved to the cloud (external and internal)
  – Servers & IT hardware moved to colocations (multi-tenant DC)
  – Servers becoming more versatile
  – Large data centers decreasing

• Physical size of server room is shrinking
  – Amount of IT hardware is shrinking and need fewer cabinets
  – IT hardware becoming smaller (less rack units) and denser
  – Floor space is becoming prime real estate

• Server rooms become mission critical environments
  – Reliable infrastructure (cooling, power, etc...) found in data centers
  – Increased Efficiency
Calculate Cooling Load

- Determining the cooling load
  - Incremental load from equipment
    - Nameplate rating
      - Usually overstated
    - ASHRAE TC 9.9: Load during operating conditions
      - Not adopted by all manufacturers / Information difficult to obtain
  - UPS load
    - Load from all the equipment connected to the UPS
    - Dependent on time and day: Monitor for worst case scenario
  - Other sources of heat
    - Windows/outside wall/lights/etc...
  - Do NOT use room dimensions: Comfort Cooling
    - 400 sq. ft. = 1 Ton of A/C

- Electrical power to rejected heat conversion
  - 1 kW = 3,413 Btu/hr.
  - 12,000 Btu/hr = 1 Ton of A/C (3.5 kW)
Cooling Strategies

- **Cooling Strategies**
  - Primary cooling for IT equipment
    - Server room is not air conditioned
  - Nights & Weekends when building A/C if off
    - Shut down building A/C when people are not in the building
  - Supplemental Cooling
    - Added denser IT equipment
    - Seasonal: Summer or Winter
  - Redundancy / Emergency backup to primary cooling
    - Planned or unplanned shut downs: Inexpensive insurance plan
Best Cooling Practices

- **Server room cooling efficiency**
  - Spot Cool vs. Cooling Entire Room
    - Area directly in front of IT equipment is critical to keep cool
    - Back of the rack up to 25°F hotter than front
    - Airflow pattern is front to back
  - Close-coupled cooling
    - Locate air conditioner as close to IT equipment as possible
    - Prevents cold air from mixing with warm air
  - Cold Aisle / Hot Aisle
    - Use blanking panels for unoccupied rack space
      - Prevents warm air from recirculating to the front of the rack

- **Inlet air conditions to electronic equipment**
  - Recommend Temperatures: 64°F – 81°F
    - Data Center: Upper range temperatures acceptable – tight controls/monitoring/redundancy
    - Server rooms: 65°F – 72°F
      - Looser controls / no monitoring / no redundancy
      - Extend UPS battery life to 5 years with lower temperatures

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Temperatures</strong> (°F)</td>
<td>64.4</td>
<td>80.6</td>
</tr>
<tr>
<td><strong>Humidity Levels</strong> (%RH)</td>
<td>44 - 60</td>
<td>25 - 48</td>
</tr>
<tr>
<td><strong>Dew Point</strong> (°F)</td>
<td>41.9</td>
<td>59</td>
</tr>
</tbody>
</table>

ASHRAE – *Thermal Guidelines for Data Processing Environments*
Cooling Solutions – Portable Systems

- **Portable A/C Systems**
  - Self contained packaged air conditioner that is on wheels and easily moves from room to room
    - Voltage: 115V, 208-230V, or 460V
    - 1.5 Tons @ 115V
    - Air or Water Cooled
  - Heat Rejection: Ceiling plenum
    - Capable of long duct runs
    - Option to duct return / make-up air to condenser
  - Condensation removal
    - Tank: Empty periodically
    - Pump to drain / sink / water line
  - Plug-and-Play Installation
    - Connect accessories (15-20 minutes)
    - Non-standard applications may require contractor
  - Cooling capacity: 1 – 5 Ton units available

- **Cost Estimate:** $3,655.00
  - 12,000 Btu/hr. (3.5 kW) air conditioner
Cooling Solutions – Portable Systems

• Pros
  – Low cost
  – Relocate unit from room to room
  – Moves with tenant
  – Plug and play installation
  – No outdoor equipment
  – Cooling capacity: 1 – 5 Tons

• Cons
  – Floor space required
  – Small heat load on building’s a/c
    • Typically not a problem
  – Condensate removal
    • Tank or condensate pump
  – No humidity control
Cooling Solutions – A/C Server Racks

• **A/C Server Racks & Cabinets**
  - Self contained packaged air conditioner integrated into a server rack that easily moves from room to room
    - Voltage: 115V
    - Cabinet / Open 4 Post Rack / 2 Post Telco Rack
  - Heat Rejection: Ceiling plenum
  - Condensation removal
    - Pump to drain/sink/water line
  - Plug-and-Play Installation
    - Connect accessories (15-30 mins)
  - Cooling capacity: 13,000 Btu/hr.
  - Close-coupled cooling
    - Highly efficient
    - Cools rack only
    - Cold Aisle / Hot Aisle

• **Cost Estimate:** $5,150
  - 13,000 Btu/hr. (3.8 kW) Air Conditioner
Cooling Solutions – A/C Server Racks

• Pros
  – No floor space required
  – Close-coupled cooling: Highly efficient
  – Relocate unit from room to room
  – Moves with tenant
  – Plug and play installation
  – Reliable – 10 year operation
  – No outdoor equipment
  – Works in most environments

• Cons
  – Small heat load on building’s a/c
    • Typically not a problem
  – Condensate removal
    • Pump to drain/sink/water line
  – No humidity control

Delivers Cold Air in Front of IT Equipment
Cooling Solutions – Ceiling Mount Systems

- Ceiling Mount A/C Systems
  - Self contained packaged air conditioner that installs above the drop ceiling over the server room
    - Voltage: 115V or 208V/230V
  - Packaged system
    - Air cooled
    - Water cooled
  - Condensation removal
    - Pump to drain / sink / water line
    - Gravity drain
  - Contractor Installation
    - Unit comes pre-charged with refrigerant
  - Cooling capacity: 1 – 5 Ton units available
- Estimated Cost: $4,400
  - 13,000 Btu/hr (3.8 kW) air conditioner: $2,900.00
  - Installation: $1,500.00
Cooling Solutions – Ceiling Mount Systems

• Pros
  – No floor space required
  – Efficient cooling: front to back airflow
  – Works in most environments
  – No outdoor equipment
  – Reliable: 10 years operation

• Cons
  – Permanent installation
  – Contractor/electrician needed for install
  – Small heat load on building’s a/c
    • Typically not a problem
  – Condensate removal
    • Condensate pump
  – No humidity control
Cooling Solutions – Mini Split Systems

• Mini Split A/C Systems
  – Consists of 2 units connected by refrigerant lines
    • Indoor Unit: Inside server room
      – Discharges cold air
    • Refrigerant lines
      – Transfers heat to the outdoor unit
    • Outdoor Unit: Outside the building
      – Discharges hot air to the environment
  – Condensation removal
    • Pump to drain / sink / water line
  – Comfort Cooling
    • Low sensible cooling: Temperature drop
    • High Latent cooling: High moisture removal
  – Contractor installation
    • Mounting/electrical/refrigerant lines/condensate line
    • Pre-charged refrigerant lines or charge at site

• Estimated Cost: $3,700
  – 18,000 Btu/hr. (5.3kW) air Conditioner: $1,700
    • Oversize because of inefficiency & comfort cooling
  – Installation: $2,000
Cooling Solutions – Mini Split Systems

• Pros
  – Low cost
  – No floor space required
  – No affect on building’s A/C system

• Cons
  – Location restriction
    • Maximum height difference: 25 Ft.
    • Maximum piping length: 50 Ft.
  – Landlord approval
    • Leasehold improvement
    • A/C stays with building when lease is over
  – Low reliability
    • Not designed to operate 24/7/365
    • Does not operate when outside temps drop below 32°F
  – Comfort Cooling
    • High latent cooling (remove moisture): Poor for IT equipment
  – Condensate removal
    • Condensate pump
  – No humidity control
<table>
<thead>
<tr>
<th></th>
<th>Cost (25%)</th>
<th>Efficient (30%)</th>
<th>Install/Versatile/Reliable (45%)</th>
<th>Overall Rating (25% + 30% + 45% = 100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Portable A/C</strong></td>
<td>![Green Circle] $3,655 – 12,000 Btu/hr</td>
<td>![Yellow Triangle] Ability to spot cool</td>
<td>![Green Circle] Plug-and-Play Install</td>
<td>![Green Circle] Low cost / reliable cooling solution</td>
</tr>
<tr>
<td></td>
<td>[Includes only AC]</td>
<td>[Cold &amp; warm air can mix]</td>
<td>[Moves from room to room]</td>
<td>[Versatile AC for any environment]</td>
</tr>
<tr>
<td></td>
<td>[No contractor for installation]</td>
<td>[Room dictates AC location]</td>
<td>[Requires floor space]</td>
<td>[1 – 5 Tons available]</td>
</tr>
<tr>
<td></td>
<td>[No electrician needed: 115V]</td>
<td>[AC is not close to IT equipment]</td>
<td>[Store in closet for backup A/C]</td>
<td>[Better for larger rooms – Requires floor space]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[Can focus cooling to front of IT equip]</td>
<td>[Works in almost any environment]</td>
<td>[Moves from room to room – End of lease]</td>
</tr>
<tr>
<td><strong>A/C Server Rack</strong></td>
<td>![Yellow Triangle] $5,150 – 13,000 Btu/hr</td>
<td>![Green Circle] Cold air to front of rack</td>
<td>![Green Circle] Requires no floor space</td>
<td>![Green Circle] Efficient: Close-coupled cooling</td>
</tr>
<tr>
<td></td>
<td>[Includes AC + 36U Rack]</td>
<td>[Close-coupled cooling]</td>
<td>[Plug-and-Play Install]</td>
<td>[Versatile AC for any environment]</td>
</tr>
<tr>
<td></td>
<td>[No contractor for installation]</td>
<td>[Airflow: Front to Back]</td>
<td>[Moves from room to room]</td>
<td>[Data center in cabinet]</td>
</tr>
<tr>
<td></td>
<td>[No electrician needed: 115V]</td>
<td>[Cools only the space in front of rack]</td>
<td>[Reliable – 10 yrs continuous]</td>
<td>[Requires no floor space – Small or big rooms]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[Cold &amp; warm air do not mix]</td>
<td>[Works in almost any environment]</td>
<td>[Moves from room to room – End of lease]</td>
</tr>
<tr>
<td><strong>Ceiling Mount A/C</strong></td>
<td>![Yellow Triangle] $4,400 – 13,000 Btu/hr</td>
<td>![Green Circle] Cold air to front of rack</td>
<td>![Green Circle] Requires no floor space</td>
<td>![Green Circle] Efficient: Front to Back Airflow</td>
</tr>
<tr>
<td></td>
<td>[Includes AC + Installation]</td>
<td>[Return air in back of rack]</td>
<td>[Leasehold improvement]</td>
<td>[Versatile AC for any environment]</td>
</tr>
<tr>
<td></td>
<td>[Need contractor for installation]</td>
<td>[Airflow: Front to Back]</td>
<td>[Permanent installation]</td>
<td>[Permanent installation]</td>
</tr>
<tr>
<td></td>
<td>[Electrician needed]</td>
<td>[Cools only the space in front of rack]</td>
<td>[Reliable – 10 yrs continuous]</td>
<td>[Requires no floor space – Small or big rooms]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[Need barrier to prevent air mixing]</td>
<td>[Works in almost any environment]</td>
<td>[Moves from room to room – End of lease]</td>
</tr>
<tr>
<td><strong>Mini Split A/C</strong></td>
<td>![Green Circle] $3,700 – 18,000 Btu/hr</td>
<td>![Yellow Triangle] Inefficient – cools room</td>
<td>![Green Circle] Requires no floor space</td>
<td>![Green Circle] Low cost AC – no floor space req.</td>
</tr>
<tr>
<td></td>
<td>[Includes AC + Installation]</td>
<td>[Building dictates AC locale]</td>
<td>[Permanent installation]</td>
<td>[Inefficient cooling strategy]</td>
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<tr>
<td></td>
<td>[Need contractor for installation]</td>
<td>[Oversize AC for inefficiency]</td>
<td>[Cold weather restrictions]</td>
<td>[Installation restrictions / limitations]</td>
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<tr>
<td></td>
<td>[Electrician needed]</td>
<td>[Comfort cooling – Lower temp drop]</td>
<td>[Not reliable – comfort cooling]</td>
<td>[Comfort cooling – Not for server room]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[Higher moisture removal]</td>
<td>[Installation restrictions]</td>
<td>[Need contractor/electrician for installation]</td>
</tr>
</tbody>
</table>
Server Room Cooling - Conclusion

- Dedicated air conditioner system
  - Electronic equipment benefits
    - Increased life/reliability/server speed
    - Improved security with locked door
  - Selecting a cooling solution
    - Budget
      - Important but not sole deciding factor
      - Over $100,000 worth of IT equipment inside room
    - Efficiency
      - Smaller A/C cools more IT equipment
      - Lowers energy costs
    - Versatile
      - A/C systems works for specific building structures
      - Portability vs. Permanent Installation: Moves with tenant
      - Ease of installation
    - Reliability
      - Mission critical networks
      - Designed for server room cooling
      - Network downtime expensive direct and indirect costs
Server Room Cooling

• Questions

- Portable Air Conditioner
- Ceiling Mount Air Conditioner
- Air Conditioned Server Racks & Cabinets
- Mini Split Air Conditioner