We’ll be starting in just a few minutes….

Tell us…

What topics are you interested in for future webinars?

Please send your response to the webinar organizers via the question box.
Solutions for Small- to Medium-Sized Data Centers – Air Management

June 4, 2019
3:00 – 4:00 PM EST
## Today’s Presenters

<table>
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<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Steve Greenberg</td>
<td>Lawrence Berkeley National Lab</td>
</tr>
<tr>
<td>John Sasser</td>
<td>Sabey Data Centers</td>
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Steve Greenberg
Lawrence Berkeley National Lab
The Early Days at LBNL

It was cold, but hot spots were everywhere:

Fans were used to redirect air

High-flow tiles reduced air pressure
Air Management

- Problems:
  - By-pass air
  - Re-circulation air

- Solution:
  - Air Management

- Use hot and cold aisles
- Improve isolation of hot and cold aisles
  - Reduce fan energy
  - Improve air-conditioning efficiency
  - Increase cooling capacity

- Hot aisle/cold aisle configuration decreases mixing of intake and exhaust air, promoting efficiency.
Separating Cold from Hot Airflow

- Supply cold air as close to the rack inlet as possible
- Reduce mixing with ambient air and hot rack exhaust
- Air moves from the front cold aisle to the rear hot aisle
Reduce By-Pass and Recirculation Air

Bypass Air / Short-Circuiting

- Wastes fan energy as well as cooling energy and capacity

Recirculation

- Increases inlet temperature to servers

Leakage
- Too much supply airflow
- Misplaced perforated tiles
- Leaky cable penetrations
- Too-high tile exit velocity
Recirculation Air – Common Causes

- Too little supply airflow
- Lack of blanking panels
- Gaps between racks
- Short equipment rows
Maintaining Raised-Floor Seals

Maintain seals of all potential leaks in the raised floor plenum

Unsealed cable penetration (inside rack)  Sealed cable penetration
Managing Blanking Panels

- Any opening will degrade the separation of hot and cold air
- Maintain blanking panels
  - One 12” blanking panel reduced temperature ~20°F
Reduce Airflow Restrictions & Congestion

Consider the Impact that Congestion Has on the Airflow Patterns

Congested Floor & Ceiling Cavities

Empty Floor & Ceiling Cavities
Resolve Airflow Balancing

- Balancing is required to optimize airflow
- Rebalance with new IT or HVAC equipment
- Place perforated floor tiles *only* in cold aisles
Results: Tune Floor Tiles

- Too many permeable floor tiles
- If airflow is optimized
  - under-floor pressure ↑
  - rack-top temperatures ↓
  - data center capacity increases
- Measurement and visualization assisted the tuning process
Next step: Air Distribution Return-Air Plenum
Enhanced Isolation Options

- Physical barriers enhance separate hot and cold airflow
- Barrier placement must comply with fire codes
- Curtains, doors, or lids have been used successfully
Adding Air Curtains for Hot/Cold Isolation
Air Management: Separate Cold and Hot Air

**Return Air**
- 95–105°F vs. 60–70°F (35–41°C vs. 16–21°C)
- Open Ceiling Tile

**Interstitial Ceiling Space**
- Hot Aisle
- Interstitial Ceiling Space
- Cold Aisle
- Air Barrier (Plastic Sheet)
- Hot Aisle

**CRAH**
- Supply Air
  - 70–80°F vs. 45–55°F (21–27°C vs. 7–13°C)

**Raised Floor**
- Air Barrier (Melamine Board)
LBNL’s Cold Aisle Containment study achieved fan energy savings of ~75%
Fan Energy Savings

- Isolation significantly reduces bypass air, which in turn allows reduction of supply airflow.

- Fan speed can be reduced, and fan power is proportional to nearly the cube of the flow.

- Fan energy savings of 70%–80% is possible with variable air volume (VAV) fans.
Default **recommended** range = 64.4 - 80.6°F

- Provides guidance for operating above the default upper limit

- Default **allowable** range = 59.0 – 89.6°F (Class A1)

- Six classes with allowable ranges up to 113.0°F
Better airflow management permits warmer supply temperatures!

ASHRAE Recommended Range

Ranges during demonstration
Hot and Cold Aisle Containment

Subzero Cold Aisle Containment

Ceilume Heat Shrink Tiles

APC Hot Aisle Containment (with in-row cooling)
Isolating Hot and Cold Aisles Summary

- Energy intensive IT equipment needs good isolation of “cold” intake and “hot” exhaust.
- Supply airflow can be reduced if no bypass occurs (assuming VFD fans).
- Supply temperature can be raised if air is delivered without mixing.
- CRACs, chillers and economizers are more efficient with warmer return air temperatures.
- Cooling and raised-floor capacity increase with air management.
Localized air cooling systems with hot and cold isolation can supplement or replace under-floor systems

Examples
- Row-based cooling units
- Rack-mounted heat exchangers

Both options “pre-engineer” hot and cold isolation
Example – Local In-Row Based Cooling
Rack-Mounted Heat Exchangers ("Rear Doors")
Air Management Review

Air management techniques:

- Seal air leaks in floor (e.g., cable penetrations)
- Prevent recirculation with blanking panels in racks and between racks
- Manage floor tiles (e.g., no perforated tiles in hot aisle)
- Improve isolation of hot and cold air (e.g., return air plenum, curtains, or complete isolation)

Impact of good isolation:

- Supply airflow reduced
  - Fan savings up to 75%+
- Supply air temperature can be raised
  - Chiller efficiency improves
  - Greater opportunity for economizer operation ("free" cooling)
- Cooling and raised-floor capacity increases.
Coming Attraction: Air Management Packages

- Develop prescriptive air management “packages” through computer modeling, targeting small data centers
- Estimate energy savings
- Look-up tables with existing and potential AM strategies
- Availability December 2019 on datacenters.lbl.gov
Contact Information

Steve Greenberg, P.E.
SEGreenberg@lbl.gov
(510) 486-6971

Lawrence Berkeley National Laboratory
MS 90-3111
University of California
Berkeley, CA 94720

https://datacenters.lbl.gov/
John Sasser
Sabey Data Centers
Air Management Solutions – Sabey’s Experience

Better Buildings Webinar
Tuesday, June 4th, 2019
Sabey Data Centers – Who We Are

Intergate.Seattle
1.2 Million SF

Intergate.Columbia
408,000 SF

Intergate.Quincy
438,000 SF

Intergate.Ashburn
900,000 SF

Intergate.Manhattan
1.1 Million SF
Solution 1: Migrate to Colocation

Modern colocation providers

• May operate with high efficiency (and reliability)
  - Not all Colos are the same
  - Dig in with questions on specific operational approach (e.g. containment requirements) and actual efficiencies achieved

• Provide remote hands services
  - Racking-and-stacking equipment,
  - Cable management,
  - Blanking plate installation,
  - Containment
Efficiency Comparisons

- Latest Uptime Institute Survey – Average industry PUE = 1.67

- Sabey:
  - Most efficient data center average annual = 1.13
  - Portfolio weighted average annual = 1.32

- Sabey practices
  - Hot aisle containment required
  - Some form of economizer
  - Variable speed fans; fan speed controlled based on differential pressure
  - On slab (no raised floor)
  - High efficiency UPS
Indirect Economizer Cooling
Solution 2: Improve Existing Data Center

- Hot aisle / cold aisle
- Blanking plates
- Network switches – supplemental ducting
- Cable management
- Containment
- System controls
- CRAH/CRAC/AHU ducting
- Controls
Switch Airflow Management

- Vertiv Geist Switchair – example of a commercially available solution for managing airflow
- Even better – order switches with correct front to back airflow
Cable Management

Poorly dressed cables may partially block airflow from server fans, reducing their effectiveness.
Hot Aisle vs Cold Aisle Containment
Controls

- Return temperature control
  - Formerly default mode of CRAH/CRAC units
  - Old/discredited

- Precision temperature control

- **Differential pressure control**

- Better airflow management enables more efficient control strategies
  - Lowering fan energy use
  - Increasing use of economizer
  - Increasing efficiency of chiller plant (if applicable)
This webinar will identify strategies for obtaining tenant consent to share their utility data; it will also explore ways to engage multifamily residents about the benefits of energy efficiency upgrades.
REGISTER NOW

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Additional Questions? Please Contact Us

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<td>LBNL</td>
<td><a href="mailto:segreenberg@lbl.gov">segreenberg@lbl.gov</a></td>
</tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Ryan Livingston</td>
<td>Allegheny Science &amp; Technology</td>
<td><a href="mailto:Ryan.Livingston@ee.doe.gov">Ryan.Livingston@ee.doe.gov</a></td>
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<tr>
<td>Kendall Sanderson</td>
<td>RE Tech Advisors</td>
<td><a href="mailto:ksanderson@retechadvisors.com">ksanderson@retechadvisors.com</a></td>
</tr>
<tr>
<td>Megan Krest</td>
<td>RE Tech Advisors</td>
<td><a href="mailto:mkrest@retechadvisors.com">mkrest@retechadvisors.com</a></td>
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