Underfloor v. Overhead Cabling

A comprehensive understanding of the comparative advantages and disadvantages of underfloor cabling versus overhead cabling will give the viewer helpful information to consider when faced with which methodology to use.
Examples of Cable Accumulation Under a Conventional Floor, which is why the Industry is Looking for Alternatives
An Obvious Solution—Take the Cables Out of the Floor

But taking them out of the floor doesn’t solve all the problems associated with using the floor as an air distribution plenum

And you’ll still get all the problems associated with overhead cabling
One might think that having an uncluttered floor like this will solve a Data Center’s air distribution problems...

...it won’t
There are many other problems to address when using a floor for air distribution besides removing cables.

- **Air Leakage (Leaky Floors):**
  - Cable Cutout Openings;
  - Floor Joints;
  - Floor Panels Removed for Access;
  - Air Conditioner Supply Openings.

- **Increasing Floor Height:**
  - Poor Surface to Volume Ratio;
  - Low Static Pressure.

- **CRAC Fan Limitations**
- **Venturi Effect-8’ Rule**
- **Underside of Floor Panel**
- **Sharp Edge Orifice Effect**
Leaky Floors

Cable Cutouts

“...25% of the air flow in the raised floor passes through cable cutouts, cracks between the [access floor] panels and other leakage areas.*

Technician Access

A nominal 30 Ton AHU generates about 12,400 CFM of air, and requires 16.9 sf of airflow panel free area for distribution of that air.

Removing 4 floor panels (16sf) creates a leak equivalent to the air produced by a single AHU...

Floor Joints

And, there’s lost productivity when working in a cold, drafty, dirty space.

Leaky Floors
A/C Supply Openings

Piping 3.88 sf
Air Discharge 8.68 sf
Electrical .416 sf

Total: 12.98 sf of Air Leakage when Unit is Off
Increasing Floor Height:

- An inefficient attempt to accommodate cables and air;
- Virtually impossible to achieve effective pressurization;
- Very expensive to build because higher buildings mean more construction cost.

Increasing the floor height with or without cables **doesn’t** solve air distribution problems—in fact it makes them worse—because of poor surface to volume ratio.
CRAC Fan Limitations—Negative Effects on Underfloor Air Distribution and Redundancy

Turbulence (Reduces Area Coverage)

15 Ton Unit = 1,306 sf (29.28 W/sf)

30 Ton Unit = 1,242 sf (65.42 W/sf)
Conventional Floors Have a Very Low Underfloor Static Pressure

Finished Floor Height 36”

Maximum Pressure 0.130” H₂O

Mean Static Pressure .0372” H₂O

Underfloor CFD Plot at mid-height 17”
Venturi Effect--Negative Pressure at 1st 8’ with Single Level Floor

(air can be sucked back into the supply plenum)

Maximum 60’

Min. 8’ from Discharge Opening to 1st Airflow Panel

Min. 8’ from Discharge Opening to 1st Airflow Panel

GREATEST AREA OF UNIFORMITY IS MIDWAY BETWEEN CRAC UNITS

LES S UNIFORMITY

LES S UNIFORMITY

FASTER SLOWER

VELOCITY

FLOW RATE AND PRESSURE IS FURTHER IMPEDED BY HIGHER FLOORS
FLOOR LEAKS AND REQUIRED UNDEFLOOR RESTRICTIONS

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The Dimpled Underside of Floor Panels Creates Friction Loss

A typical steel floor panel—designed this way for structural and manufacturing reasons

Therefore, additional energy is required to overcome such losses
Effect of Sharp Edge Orifice on an Airflow Panel

When air is moving through a raised floor, under pressure it will resist entering a "sharp edged" orifice.

Airflow panel with sharp edged orifices

The air flow encounters resistance and repels from the opening, causing a low pressure on the under side of the airflow panel.

Airflow panel with chamfered or radius orifices

The low pressure creates a negative pressure and causes air from an adjacent opening to flow from the conditioned space back into the (underfloor).

"Vortex"--A mass of whirling gas or liquid especially when sucked spiraling toward a central axis, a whirlwind or whirlpool.
Proper Air Flow 46’ from Nearest AHU when Using an Electro Mechanical Distribution System

**Upsite™ Hood Test**

To use the Upsite™ hood, place the card in a perforated floor tile near your equipment. If the card floats, it indicates good airflow. If the card is sucked down against the floor tile, it indicates a lack of airflow, which requires action.

If the card floats, it indicates good airflow. If the card is sucked down against the floor tile, it indicates a lack of airflow, which requires action.

It is likely that network equipment will be inside this area from upper cabinets and racks. To cool this equipment, it is best to use a network rack enclosure. If your equipment cooling is inadequate, a network rack enclosure may be the best choice. It is best to configure your equipment to use the network rack enclosure, rather than use a network rack and have it become a problem to cool the network rack enclosure.

To request your Upsite™ hood test, please contact us.

The troubleshooter card floating above the raised floor indicates an ideal airflow condition.

The card being sucked down against the floor tile indicates an air velocity problem.
Summary: Issues Attributed to Conventional Raised Floor Shortfalls

% Breakdown of Conventional Floor Inefficiency Issues

- Cable Accumulation: 25.0%
- Static Pressure: 10.0%
- CRAC Fan Limitations: 10.0%
- Air Conditioner Cutouts: 10.0%
- Surface to Volume Ratio: 7.5%
- Cable Cutout Openings: 8.0%
- Floor Panels Removed: 7.5%
- Venturi Effect: 5.0%
- Underside of Floor Panel: 5.0%
- Sharp Edge Orifice Effect: 5.0%
- Floor Joints: 2.0%

With only 25% attributed to cable accumulation it’s clear conventional floors have other associated problems.
Overhead Cabling is Also Problematic...

**MAC for Overhead Distribution:**
- Cables must be accessed from ladders;
- Multiple workers (at least two) required for cable installation;
- Suspension supports for cable trays impedes cable installation;
- Installation of cables and wires are limited to tray locations.

**Worker or Equipment Damage:**
- Workers falling off ladders.
- Workers dropping tools on or in equipment;

**Airflow and High Temperatures:**
- Temperatures could easily exceed 104°F;
- Return air disturbance if not planned properly.

**More Wire Required Depending on Height of Trays**

**Dirt Accumulation in Trays and on Wires**

**Overall, Aesthetics**
MAC for Overhead Distribution

Cables Must be Accessed Using Ladders

And, in some states because of high hot aisle temperatures, workers must be tethered, in order to work on cabling in hot aisles.
MAC for Overhead Distribution

Multiple workers (at least two) required for cable installation

Two workers on a ladder is an unacceptable practice
MAC for Overhead Distribution

Suspension supports for cable trays impedes cable installation
MAC for Overhead Distribution

Installation of cables and wires are limited to tray locations
Ladders can be dangerous. According to OSHA 50% of all slips and falls occur as a result of being on a ladder. Furthermore, most of all ladder related accidents require medical attention.
Airflow and High Temperatures

Temperatures Can Easily Exceed 104°F

<table>
<thead>
<tr>
<th>Temperature</th>
<th>De-rate Ampacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>104°F 40°C</td>
<td>0.88</td>
</tr>
<tr>
<td>113°F 45°C</td>
<td>0.82</td>
</tr>
<tr>
<td>122°F 50°C</td>
<td>0.75</td>
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</tbody>
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Higher supply air temperatures being recommended results in higher return temperatures. For Example:

If the inlet air of a rack is raised to 80°F, the exhaust air will easily be 100°F to 105°F. Hot aisle temperatures at the ceiling are even higher. And, the effect is worse on bundled cable.

Cable manufacturers will provide different numbers based on the insulation used, therefore it’s important to consult with your engineer regarding the cables being used, the de-rating, and to factor in the premium cost.

This issue is discussed in the Mission Critical Webinar Feb. 25, 2010, “Emerging Trends in Cooling Solutions for High Density Data Centers.”
Depending on Floor to Ceiling Height a Ceiling Return Plenum May be Required

- **Return Duct**
  - Return Air Grill
  - CRAC
- **Hot Aisle**
- **Cold Aisle**
- **Rack**
  - Cable Tray #1
  - Cable Tray #2
  - Cable Tray #3
- **Ceiling Mount**
  - Cable Tray #1
  - Cable Tray #2
  - Cable Tray #3
- **Inadequate Return Air Space**
- **Rack Mount**
- **Airflow Panels**

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Cable Tray

Depending on the tray distance from the top of the Rack, more cable is required for overhead distribution than underfloor.
Dirt Accumulation in Trays and on Wires

Because of the position of the cable trays above the racks (either ceiling suspended, or rack mounted) and inadequate ceiling heights, they interfere with secondary air circulation and are a cause of and susceptible to an excessive accumulation of gaseous and particulate matter.

Due to the dry hot environment, excessive electrical space charge is always present.

For a comprehensive explanation of the space charge phenomenon consult a white paper on the subject titled, “Space Charge Control of Secondary Air Contamination Problems”
If underfloor cabling were managed as well as these cables and removed from the air stream then overhead cabling wouldn’t be necessary.
Overall, Aesthetics

Should, a Data Center Look Like This

Or, like this
A Multi-Level Electro Mechanical Distribution System...

...Solving the Performance Problems Associated With Data Center Wiring and Air Conditioning Distribution.

A Logical, Simple, Profitable Solution
An electro-mechanical distribution system is a multi-level floor that isolates wires in the upper tier from supply air in the unobstructed and virtually leak-free lower plenum.

Among other benefits, this makes it possible to distribute air uniformly throughout the space regardless of a room’s dimensions or heat load.
Underfloor Distribution

Plenum

Mean Static Pressure
0.3379” H₂O
(Almost 10 X’s a Single Level Floor)
Data Center Operational Facts

- Servers do not really require 50°F to 55°F supply air, but Data Centers must be “sub-cooled” to compensate for infrastructure shortfalls;

- Data Centers install and use 25-50% more cooling than is required to meet the IT Load, and this excess cooling provides no true redundancy;

- Despite the excess cooling, Data Centers remain plagued with hot spots and other air distribution problems.

Data Centers can be built using far less cooling tonnage and air volume-saving equipment, energy, and operational expenses.
• Cables and wires are housed in the upper tier, completely isolated from the air stream.

• An unlimited number of floor panels can be removed for fast, safe, wire installation without disturbing airflow or compromising the floor’s structural stability.

• There are no stringers connecting the pedestals, which normally impedes the laying of cables.
An unlimited number of floor panels can be removed from the floor without compromising the integrity of the airflow, or effecting the structural integrity of the floor system (11 panels removed)
Wires, Cables and Hoses Are Simply Laid in the Floor’s Upper Tier
Generous Cable Access
16” X 16”

Brush Type Cable Openings Are Limited In Size
8.25” X 4”
Overall Aesthetics

Housing Cabling in an Electro-Mechanical Distribution System will make for a Clean, Green Data Center
Anyone skilled in the art of designing, building, owning, or managing a new data center and who wants a life-long, trouble free, energy efficient facility cannot overlook the simplicity and profitability of an Electro-Mechanical Distribution System.