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White Paper

# Network Infrastructure Considerations When Deploying a Digital Building

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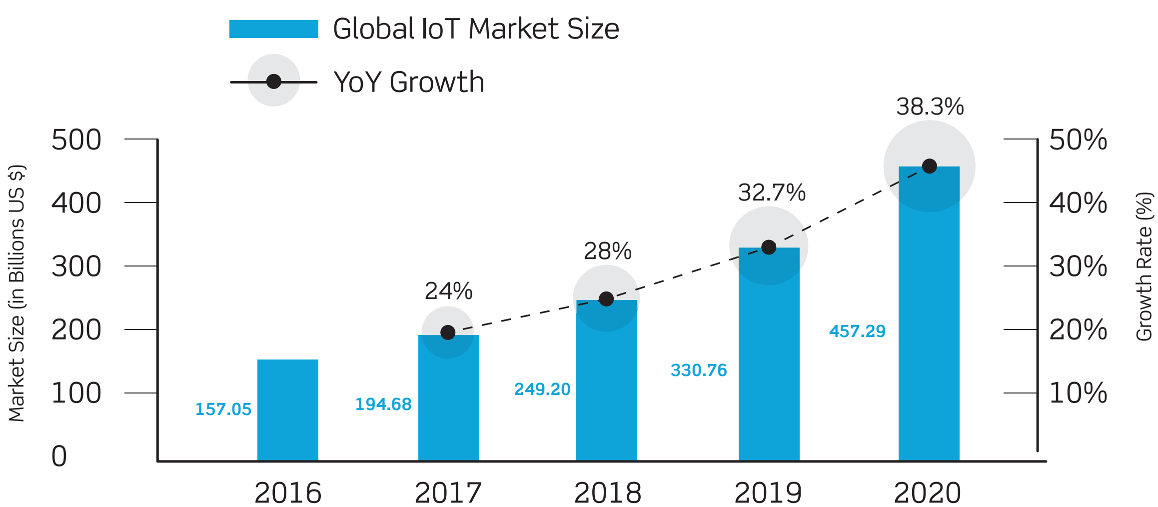
## Key Aspects of Design for Digital Buildings

The increasing interconnectivity of devices to the internet — and to each other — has given rise to a “smart” ecosystem known as the Internet of Things (IoT). This network of physical objects that communicate or interact with their external environment[1] is moving into the enterprise on a global scale in the form of digital buildings. When applied to building infrastructure, the IoT framework translates to communication and data exchange among multiple systems over a common cabling network within an individual structure or campus environment.

The growth of IoT will reshape the enterprise for years to come. According to GrowthEnabler Analysis[1], the worldwide IoT market will grow from $157 billion in 2016 to $457 billion by 2020, with a significant footprint in the smart city, industrial, healthcare, automotive, wearable technology, and utility sectors. And by 2021, there will be 27.1 billion networked devices, the majority of which will be wireless and mobile devices or building infrastructure and automation systems, with desktop computers accounting for only 25% of IP traffic[2].




1. Source: GrowthEnabler, “Market Pulse Report, Internet of Things (IoT),” 2017
2. Source: Cisco, “Cisco Visual Networking Index™ (VNI) Complete Forecast,” 2017

In order to leverage the future-focused capabilities of IoT within digital buildings, strategic planning is vital. Numerous options are available in building and system design, cabling infrastructure, port deployment, and zone cabling. However, there is no one-size-fits-all solution that will work for every system. Network designers, cabling installers, IT managers, and end-users must weigh the pros and cons of multiple network design and infrastructure options.

## Examples of Digital Building Applications





- Work Area Data Cabling
- WAPs
- Security Cameras
- Access Control
- Lighting
- HVAC
- Energy Management
- Clocks
- Digital Signage
- Time Clocks
- Paging System
- Intercom
- Elevator Control
- Infant Security
- Nurse Call

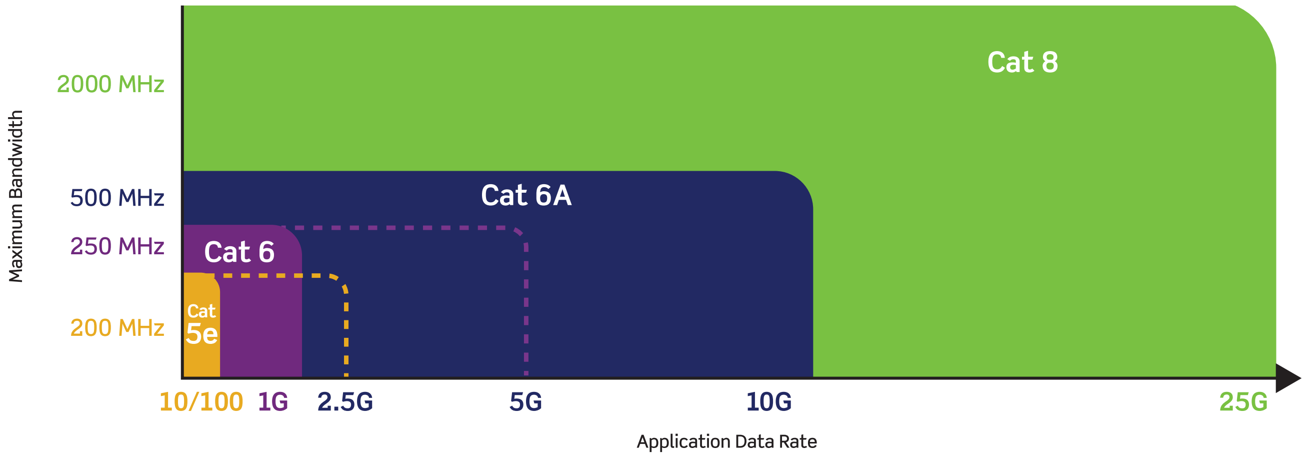
## Cabling Infrastructure Considerations

Developing the right cabling infrastructure for a digital building requires an initial determination of the category rating that will best serve the needs of the network, both in its current situation and as new demands are made on the system in years to come. This involves a careful analysis of the minimum cable requirements for the applications served by the network.

Digital building applications such as lighting, security cameras, energy management systems, and environmental sensors and controls will typically require less than 1 Gb/s and are adequately served by a Cat 5e cabling system. Wireless access points (WAPs), 4K video transmission, and desktop computing connections require a stable, consistent bandwidth of 1 Gb/s or more and necessitate an infrastructure built on Cat 6 cabling. In recent years, active-gear manufacturers have developed switches that support intermediate speeds of 2.5 and 5 Gb/s. While existing Cat 5e and Cat 6 cabling can support these speeds within the guidelines of TIA TSB-5021, there are some limitations, and we recommend conducting a thorough risk analysis when considering 2.5GBASE-T and 5GBASE-T.

For applications requiring an even higher bandwidth of up to 10 gigabits per second, Cat 6A is appropriate. And for highly demanding applications that need more than 10 Gb/s, Cat 8 may offer additional security against premature network obsolescence.

## Bandwidth and Minimum Cable Requirements

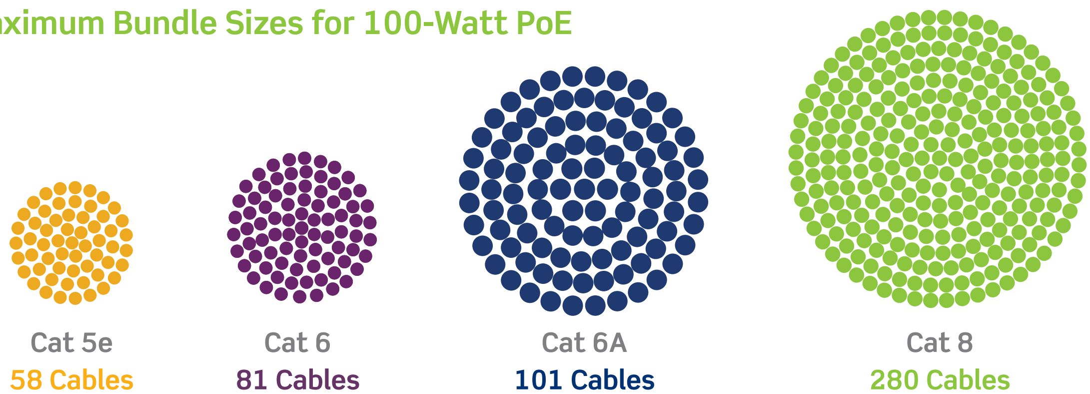



Within the domain of digital building cabling, an infrastructure offering Power over Ethernet (PoE) capability is critical. A PoE-optimized infrastructure supports the transmission of data and power over the same cabling system, improving system control and providing centralized administration for greater operational efficiency.

However, there are many factors that must be considered in order to implement a future-proof PoE system. By its nature, PoE generates significant heat as power is transmitted over copper cabling. The higher the power being transmitted, the greater the heat increase in the cabling. The types of cables and jacks — and how they are deployed — play a significant role in managing temperature rise in high-power PoE applications.

Higher category-rated cable tends to transmit power more efficiently than lower category-rated cable due to the larger sizes of the high-category conductors. The result is a lower overall temperature build-up per cable. When cables are tightly bundled or grouped together, the temperature of each cable will increase. It is important to understand how many cables can be bundled together without exceeding the temperature rise limits set by industry codes and standards, such as the maximum bundle sizes from TIA shown below.

## TIA Maximum Bundle Sizes for 100-Watt PoE




TIA-TSB-184-A: Maximum bundle size in air for 15 °C temperature rise at 20 °C ambient for 100W (1000 mA per pair)

Temperature rise in PoE can also affect jacks and, in turn, channel performance. The material used in the construction of the connector will impact how much heat the unit retains or dissipates. System longevity can be negatively impacted by arcing damage caused by intentional and inadvertent intermittent disconnects due to vibration or operational movement where plugs and connectors make contact. Deploying PoE-optimized jacks with tine geometry designed to maintain constant contact force and prevent arcing is essential.

Digital building applications vary in the level of power they need in order to function. Low power applications — such as voice over internet protocol (VoIP) phones, indoor security video cameras, energy management systems, and digital clocks — require PoE Types 1 or 2, typically delivering 30 watts of power or less. Higher power applications will require PoE Types 3 or 4 for 60 to 100 watts, supporting technology like WAPs, lighting, and outdoor security video cameras.

To support all levels of PoE effectively, Leviton recommends Cat 6A for any new construction or IT infrastructure installation. Cat 6A offers a number of benefits for PoE applications within a digital building environment, including improved heat management and the flexibility to handle higher bandwidth demand in the future.

## Planning for Port Deployment in a Digital Building

As more connected devices are incorporated into the digital building ecosystem, density requirements for the pathways and spaces that support the network will be impacted. And additional devices will require additional ports, along with larger-volume racks, more rack units, and a concurrent increase in the size of the telecommunications room (TR).

Per ANSI/TIA-568.0-D and ISO/IEC 11801-1, one panel port per switch port per device is specified for an interconnect topology in which the switch port is patched directly into a patch panel. By contrast, two panel ports per switch port are specified when patching between two patch panels using a cross-connect topology. **(Figure 1)**.

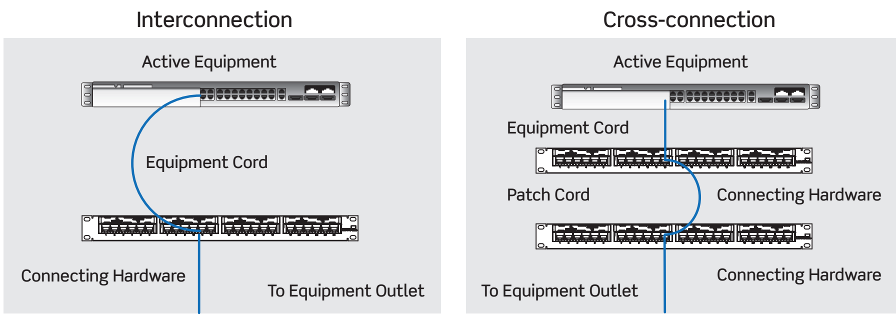



**Figure 1**

ANSI/TIA-569-D also provides minimum telecommunications room floor space guidance, based on the number of equipment outlets being served **(Figure 2)**.

**ANSI/TIA-569-D**

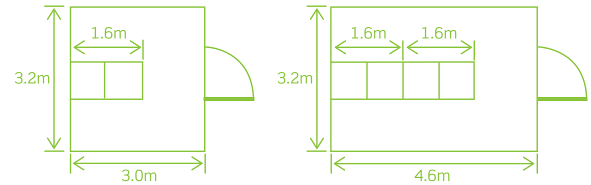
| Equipment Outlets Served | Min. Floor Space $m^2$ ($ft^2$) | Typical Dimensions m (ft) |
|---|---|---|
| Up to 100 | 9 (100) | 3 x 3 (10 x 10) |
| 101 to 200 | 13.5 (150) | 3 x 4.5 (10 x 15) |
| 201 to 800 | 36 (400) | 6 x 6 (20 x 20) |
| 801 to 1600 | 72 (800) | 6 x 12 (20 x 40) |
| 1601 to 2400 | 108 (1200) | 9 x 12 (30 x 40) |

**Figure 2**

Alternate telecommunications room size guidance is provided by ISO/IEC 14763-2: For every 500 outlets served, TR dimensions are doubled, with an assumption of two cabinets per 500 ports **(Figure 3)**.

## ISO/IEC 14763-2

| Equipment Outlets Served | Min. Floor Space m² | Typical Dimensions m |
|---|---|---|
| Up to 500 | 9.6 | 3.2 x 3.0 |
| 501 to 1000 | 14.7 | 3.2 x 4.6 |
| 1001 to 1500 | 19.8 | 3.2 x 6.2 |




- Increase length by 1.6m for every 500 outlets
- Assumes cabinet size of 800mm x 800mm
- For 1000mm x 1000mm cabinets; length increase is 2.0m

**Figure 3**

More power will also be necessary to run the IoT devices, which will increase heat generation by PoE-enabled cables transmitting power. As a result, single-phase power distribution units (PDUs) may be inadequate. Instead, three-phase PDUs may be required, and more PDUs will mean more power outlets in the telecommunication room. Mitigation strategies for dealing with heat generated by PoE switches will also be necessary. As PoE wattage transmission increases, port density drops while power usage per switch increases **(Figure 4)**.

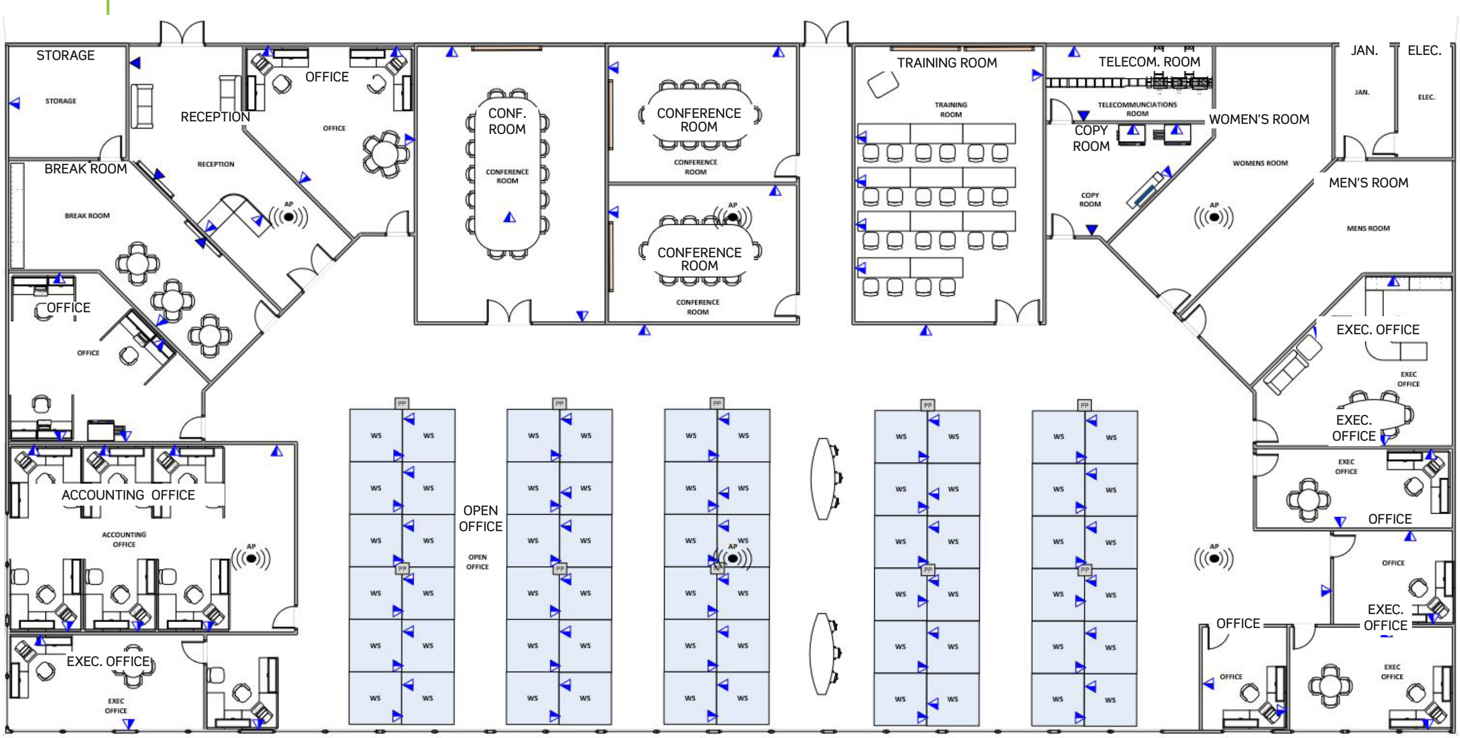
| Switch | Power | | Heat | |
|---|---|---|---|---|
| 48-port non-PoE switch[1] | 123 W | 17x per switch | 1,207 BTU/hr | 5x per switch |
| 48-port PoE+ (30W) switch[2] | 2.2 kW | | 7,586 BTU/hr | |
| 24-port UPoE (60W) switch[3] | 2.2 kw | | 7,586 BTU/hr | |

1. Cisco Catalyst WS-3850-48P at average power usage with one 350 W power supply
2. Cisco Catalyst WS-3850-48P with two 1100 W power supplies
3. Cisco Catalyst WS-3850-24U with two 1100 W power supplies

**Figure 4**

## Design Example

As devices and applications are added to the network, the total port count increases. This is readily apparent in this example of a typical small commercial building, shown below. This 13,000 square foot building accommodates 79 people. To support the traditional data application, 123 outlets are required, as shown by the blue triangles.




**Traditional data ports with 123 outlets**

= (2) Cat 6A Port



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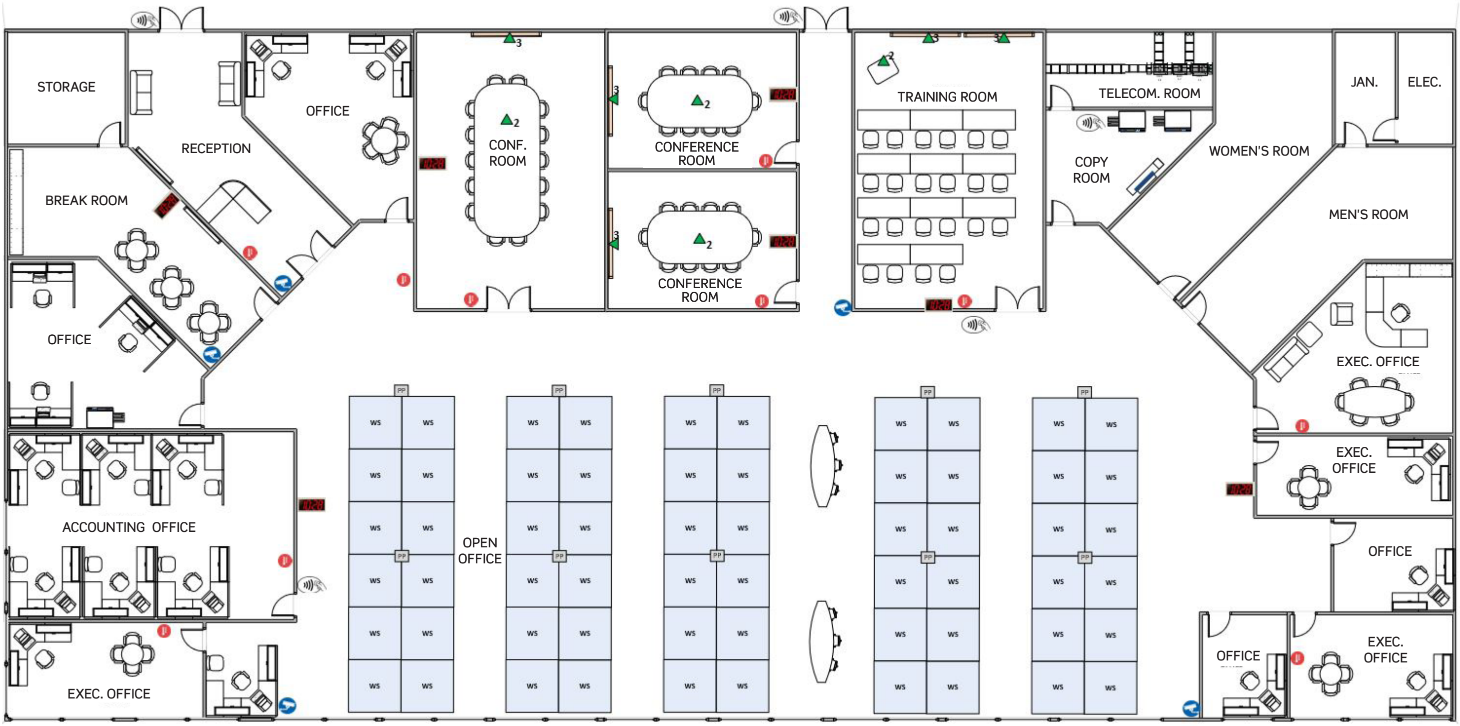
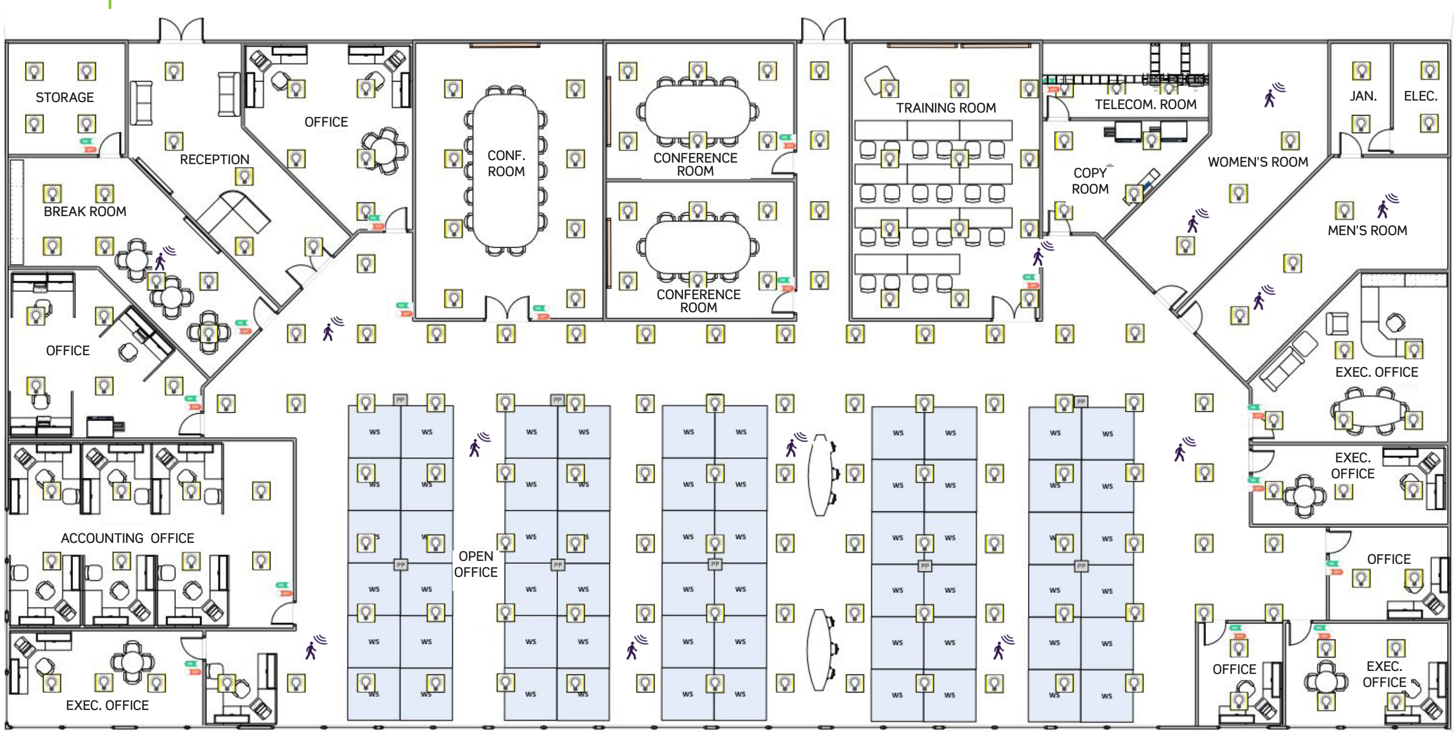
Next, we add 28 additional ports to support security, building automation systems (BAS), and IT/AV applications.




**Addition of IT/AV and security/BAS applications with 28 ports**

= Networked Clock = Cat 6A IT/AV = Security Camera = Thermostat = Card Reader

When lighting applications are added to the network, the increase in port density is more pronounced, with 223 additional ports required.




**PoE lighting system with 223 outlets**

= PoE LED Light ON OFF = Light Switch = Occupancy Sensor

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More devices on the network and more ports in the work area will impact the total number of connections in the Telecommunications Room, resulting in an increase in the overall size of the space.

### Telecommunications Room Size

| Application | Switch Ports | Panel Ports (Interconnect) | Panel Ports (Cross-Connect) |
|---|---|---|---|
| Data | 123 | 123 | 246 |
| IT/AV | 8 | 8 | 16 |
| Security/BAS | 20 | 20 | 40 |
| Lighting | 223 | 223 | 446 |
| **Total** | **374** | **374** | **748** |

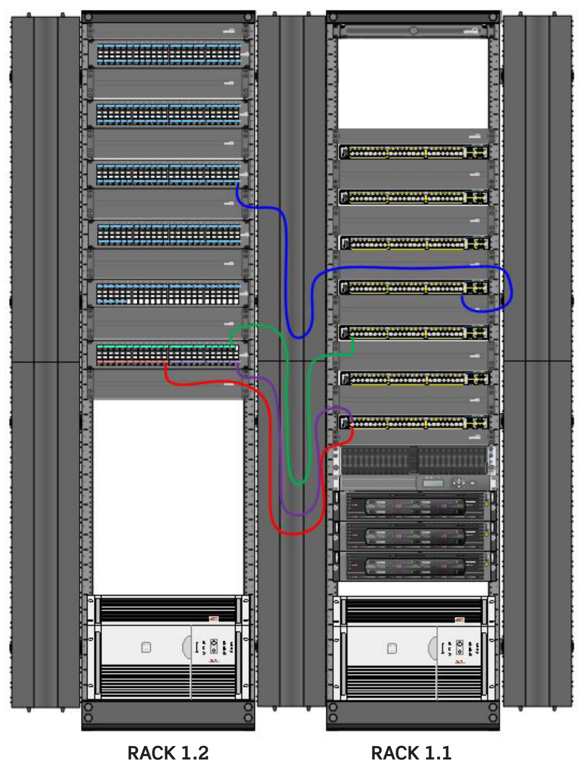
As stated previously, ANSI/TIA-568.0-D and ISO/IEC 11801-1 specify one panel port per switch port per device for an interconnect topology, while a cross-connect topology doubles the panel ports per switch ports. The result is increased RU space needed for panels, switches, and horizontal managers, a higher density of patch cords in horizontal and vertical managers, and larger pathways to accommodate more cable runs.

## Rack Space Requirements: Data, IT/AV, Security/BAS

| Application | RU Count |
|---|---|
| 2RU 48-port panel | 8 |
| 1RU 48-port PoE switch[1], 30W PoE+ | 7 |
| Horizontal Managers | 26 |
| Uninterrupted Power Supply (UPS) | 14 |
| Servers and Storage | 9 |
| **Total** | **64** |

- 151 ports of Data, IT/AV, and Security/BAS
- 64 RU for interconnect topology
- Two 42RU racks are needed
- Cross-connect would add another 8RU

1. Cisco Catalyst WS-3850-48P



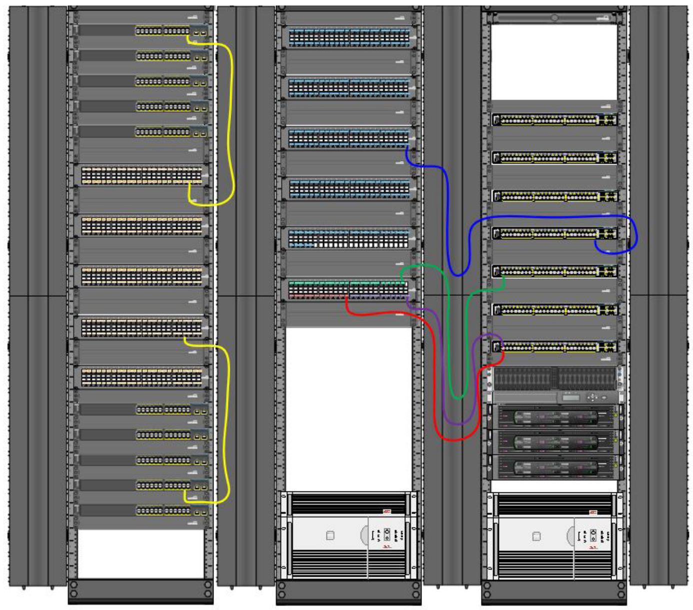
## Rack Space Requirements: With Lighting

Two racks can accommodate data, IT/AV, and security/BAS applications in a typical small commercial building layout. However, the addition of PoE lighting necessitates an additional rack to accommodate the increased port count. The third rack, in turn, will require an increase in the minimum size of the Telecommunications Room.

| Application | RU Count |
|---|---|
| 2RU 48-port panel | 20 |
| 1RU 48-port PoE switch[1], 30W PoE+ | 7 |
| 1RU 48-port PoE switch[2], 60W PoE++ | 10 |
| 2RU Cable Managers | 46 |
| Uninterrupted Power Supply (UPS) | 14 |
| Servers and Storage | 9 |
| **Total** | **106** |

- Lighting adds 223 more ports
- Total RU requirement is 106
- Third rack needed to support PoE lighting

1. Cisco Catalyst WS-3850-48P
2. Cisco Catalyst WS-3850-24U




# Zone Cabling Options

A zone cabling architecture can serve as a formidable alternative to traditional homerun cabling in a digital building. Instead of running cabling from the telecommunications room to the work area or device outlet, zone cabling provides a horizontal cable run from the floor distributor in the telecommunications room to a consolidation point enclosure, then to the work area or device outlet.

Passive zone design deploys copper cabling from the telecommunications room, where the switches are located, to a passive patching configuration located in a zone enclosure. All active equipment is housed in the telecommunications room, along with centralized power capabilities.

An active zone design reduces the size requirement for the telecommunications room by running optical fiber from the telecommunications room to zone enclosures, and copper cabling from the enclosures to the device outlets. This means a decrease in total cabling required, but an increase in active equipment that will require active switches located in each zone enclosure, with lower switch port utilization.

Although the cabling for an Active Zone design is less expensive, the total installed cost can be higher. Active zone designs require more active equipment, which can have lower switch port utilization, and power is required at each zone location.

While zone cabling requires the installation of more cables to more locations than a home run design, there are numerous advantages to implementing this versatile architecture. Zone cabling can provide a digital building with a highly flexible cabling infrastructure that offers simple maintenance and the ability to carry out moves, adds, and changes (MACs) quickly and efficiently. It also has a lower cost after installation ("day two cost"). There are, however, several disadvantages to using zone cabling. These include a higher initial cost, fewer measurable benefits to fixed workspaces where MACs are rare, and increased generation of noise and heat by active equipment in consolidation point enclosures.

## Design Comparisons

### Home Run

- Copper cabling from TR directly to end device
- All active equipment in TR

**Cabling Cost: Base Price**

### Passive Zone

- Copper cabling from TR to passive patching in zone enclosure
- Copper cabling from zone enclosure to end device
- All active equipment in TR

**Cabling Cost: +11%**

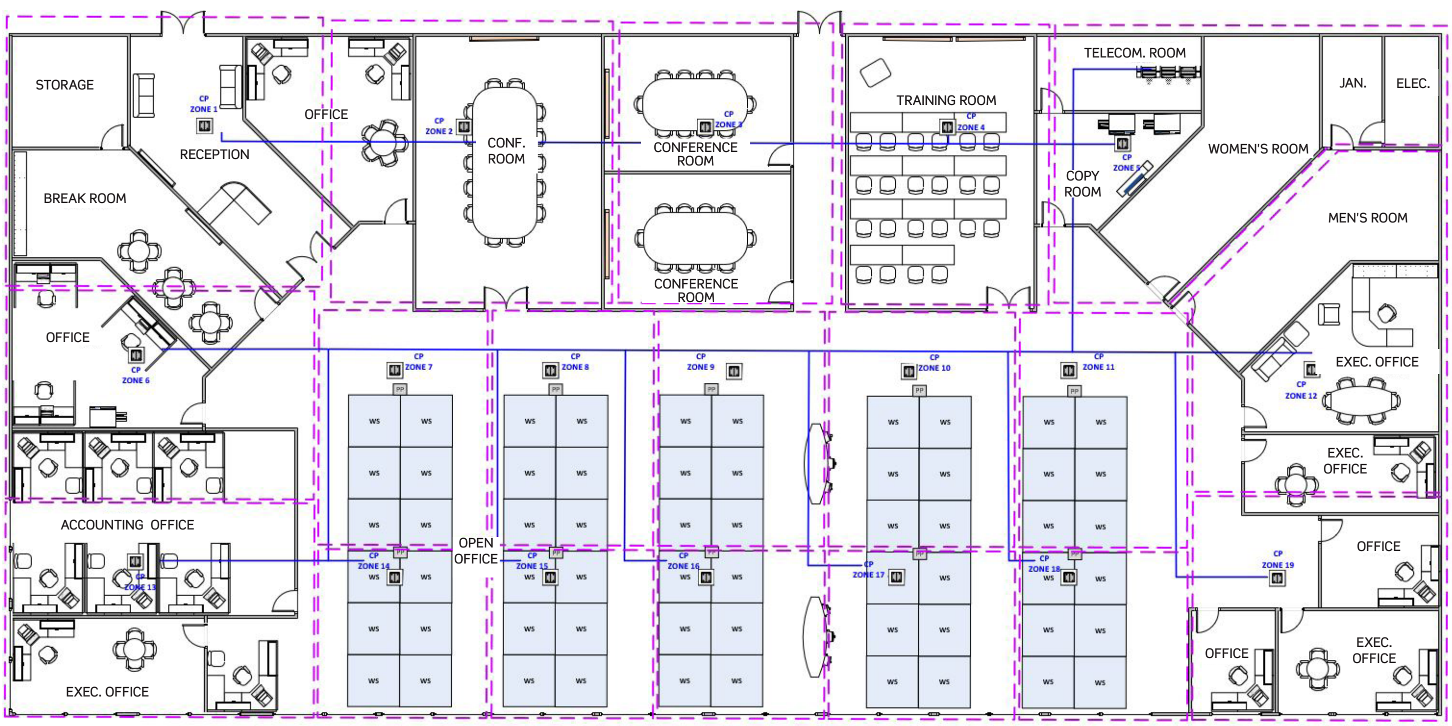
### Active Zone

- Optical fiber cabling from TR to zone enclosure
- Copper cabling from zone enclosure to end device
- All active equipment in TR

**Cabling Cost: -10%**

Ultimately, the choice of an active zone or passive zone design will depend on the needs and constraints of the specific building space and network.

## Design Example with Zone Cabling




**19 Zones**

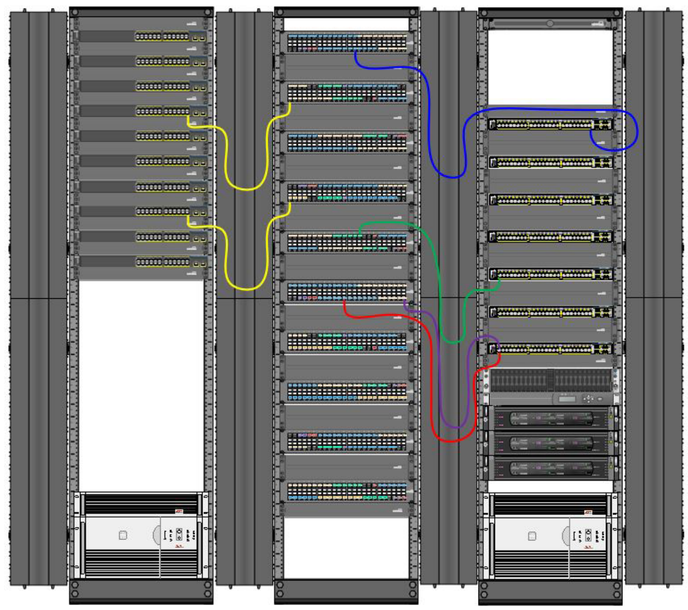
- - - = Consolidation Point Zone Boundary

In a zone cabling design for a typical small commercial building, cabling for all applications runs from the Telecommunications Room to the zone enclosures. This results in an alteration of the rack layout in the Telecommunications Room. However, three racks are still required to accommodate the port density.

## Rack Space Requirements: Zone Cabling

- All zone cabling terminates to same panel, regardless of application
- Panels placed in center rack, patching to either side for active equipment
- Use color coding (icons or jacks) in TR, zone enclosure to identify applications

**Color-coded jacks or icons**




## Solutions for Digital Buildings

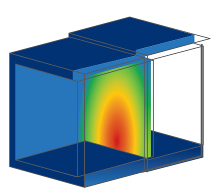
Digital building technology can provide significant energy savings, but it's important to select cabling that will provide optimal performance for the bandwidth and power requirements of the system's applications. In turn, high-quality connectivity must meet the PoE performance requirements for digital building applications.

Leviton Atlas-X1™ components are designed to meet or exceed industry standards for performance, ensure system longevity, and prepare networks for future upgrades and growth.

Atlas-X1 jacks are the only UTP jacks on the market with a solid metal body. Testing for compliance with the IEC 60512-5-2 and 60512-99-001 Connectors for Electronic Equipment standards revealed that the metal body of Atlas-X1 jacks provided a 53% improvement in heat dissipation over the more common ABS plastic body of other jacks on the market.

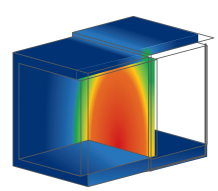
### Heat Dissipation

**Atlas-X1 UTP Jack with Metal Body**



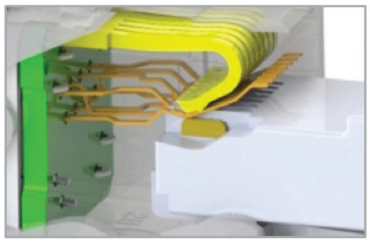
**53% improvement**
**over plastic jacks**

**Typical Plastic Jack**

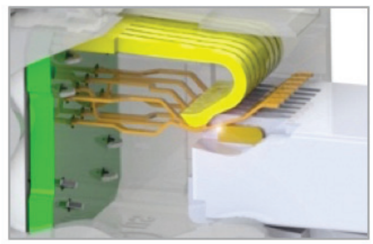


**Plastic runs hotter**

Atlas-X1 jacks are designed with PoE-optimized tine geometry that prevents tine damage that can be caused by higher current PoE applications. Leviton's patented Retention Force Technology™ (RFT) maintains constant contact force at the jack and plug interface, preventing inadvertent intermittent disconnects caused by vibration or operational movement of the plug in the critical jack and plug mating region. This increases system longevity and prevents costly repairs. The tine geometry ensures that any arcing damage caused by powered disconnects does not occur at the critical location where data transmission occurs.

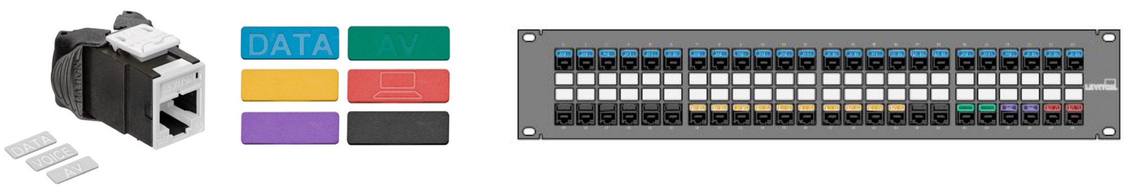


**Plug fully engaged in jack**



**Plug at point of disconnect**

Atlas-X1 jacks also feature color-coded icons for enhanced network administration and easy identification. The ability to use a single jack throughout the network increases system consistency and assures interoperability.




Prevent unauthorized or accidental network moves, adds or changes with the Leviton Copper Secure RJ system.The Secure RJ system adds physical security for critical network ports with cable assemblies and port blockers that lock into industry standard ports and can only be removed with a keyed extraction tool.


For more information about PoE and digital building optimized solutions, including secure RJ solutions, visit **Leviton.com/PoE**.



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Today's networks must be fast and reliable, with the flexibility to handle ever-increasing data demands. Leviton can help expand your network possibilities and prepare you for the future. Our end-to-end cabling systems feature robust construction that reduces downtime, and performance that exceeds standards. We offer quick-ship make-to-order solutions from our US and UK factories. We even invent new products for customers when the product they need is not available. All of this adds up to the **highest return** on **infrastructure investment**.


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