How to Optimize Intelligent Building Infrastructure

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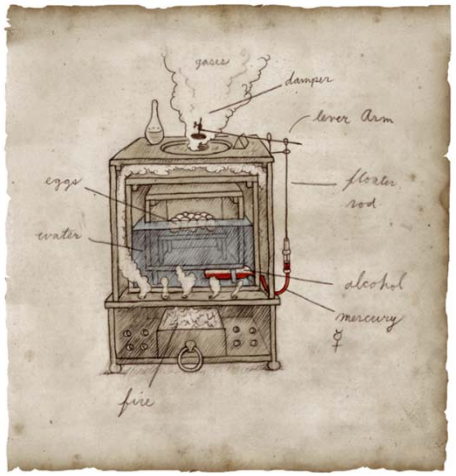
We will look at:

- The difference between Building Automation Systems and an intelligent building
- What defines a “smart building”
- Why you would want to make a building more intelligent
- A specific use case demonstrating the benefits of intelligent systems
- Where to find guidance on intelligent building network design
- Best practices for BIoT network deployment
- The future of the intelligent building network

The Beginnings of Automation



- Drebbel's Circulating Oven
  - 1620's Cornelis Drebbel
  - First self-regulating oven
  - One of the earliest examples of a "machine" taking over for human control
- First Building Automation Systems (BAS)
  - 1883 Warren Johnson
  - Invented a mechanical thermostat
  - It turned on a light telling the janitor to shovel more coal in the furnace

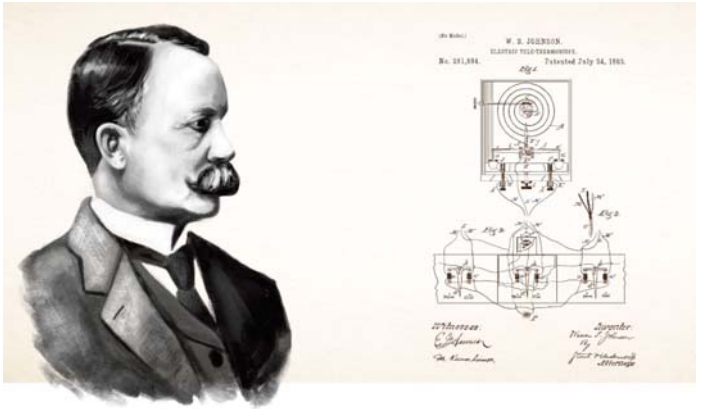
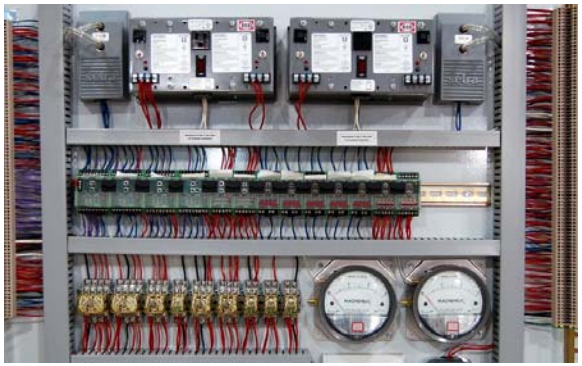


Photo Credits: http://nautil.us/issue/12/feedback/the-vulgar-mechanic-and-his-magical-oven, http://plus.usgbc.org/path-to-green/

Traditional Automation Systems

1970s



1980s

1990s

Traditional Building Automation

Building Automation Control **network** (1995):
a protocol that acts as an interpreter between different systems (HVAC, Fire Detection, Lighting, etc.)

Incorporated separate cabling for different kinds of building functions

What is an Intelligent Building?

- BAS ≠ Intelligent Building
- BAS is usually self contained – not always connected to the internet
- BAS systems primarily benefits building the owner/management.
  - Reduced energy consumption/cost
  - Reduced maintenance, etc.

Who Defines what an Intelligent Building is?

- "Green" buildings have standards and definitions
  - U.S. Green Building Council's LEED system
  - Certified, Silver, Gold, Platinum apply regardless of building's function

- "Smart" buildings don't have this type of independent evaluation system

- Definitions vary according to your perspective

What is an Intelligent Building?

Intelligent Building Institute

"One which provides a productive and cost-effective environment through optimization of four basic elements: structure, systems, services and management, and the interrelationship between them."

TIA

"Intelligent buildings now include technologies focused on enhancing systems interoperability to improve safety, security, functionality and productivity, energy efficiency, and resilience."

Bicsi

"An intelligent building, or premise, utilizes communication technology to integrate building systems, allowing for intersystem connection and coordination that provides an environment which is safer, more comfortable, productive or efficient."

What is an Intelligent Building?

Intelligent Building Institute

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Intelligent Buildings Put Simply

- Have sensors and devices that allow us to represent physical objects, systems, and spaces digitally
- Data collected by IoT devices give us the ability to optimize the function of the building's systems and spaces
- There are many benefits to making a building more intelligent

Why Create a Smart Building?

Economic

- Energy Efficiency
- Reduced Operating Cost
- Increased Productivity

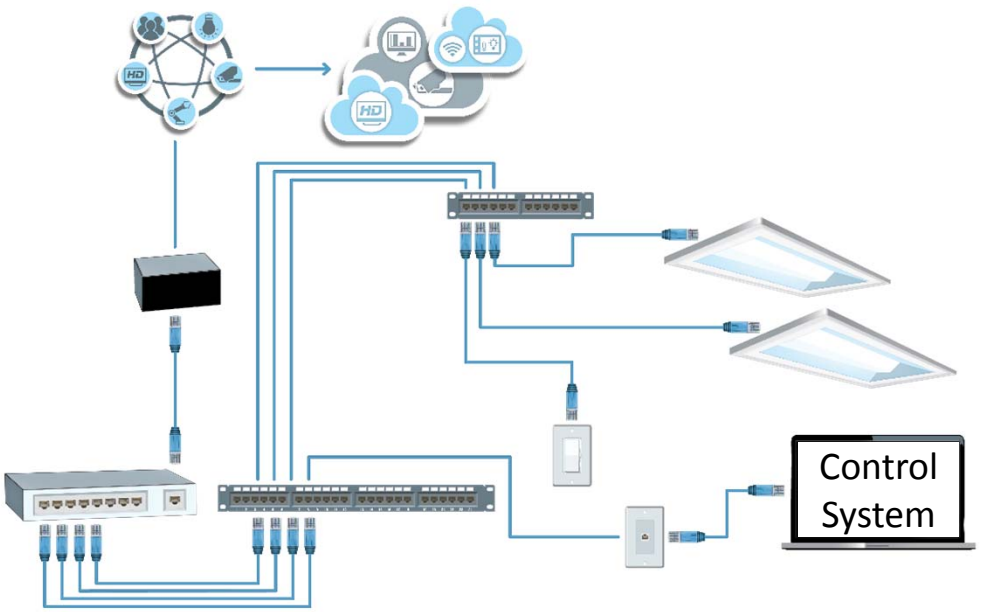
Social

- Health and Wellbeing of Occupants
- Safety and Security

Environmental

- Environmental Responsibility and Sustainability
- Resiliency

One Use Case of an Intelligent Building System



Intelligent PoE Lighting

- Devices include LED troffers, switches, dimmers, controls
- Cat 5e 22 AWG cabling to support PoE power delivery
- Sensors in each fixture
  - Occupancy
  - Ambient Light

Capex benefits of Intelligent PoE Lighting

PoE Powered Smart LED System	
Fixtures ($300x250)	$75,000
PoE Switches	$19,800
Cabling Costs	$20,625
Installation Labor - Fixtures	$ 6,250
Installation Labor – Switches & Control System	$ 2,980
Commissioning (automatic)	$ 0
Total	**$124,655**

A/C Powered LED System	
Fixtures ($210x250)	$52,500
Control System and Sensors	$32,000
Wiring Costs	$36,728
Installation Labor - Fixtures	$22,000
Installation Labor – Control Systems	$15,000
Commissioning	$ 6,750
Total	**$164,978**

Based on 20,000 sq. ft. installation

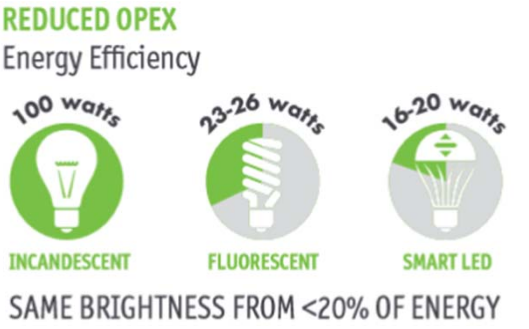
OpEx benefit of Intelligent PoE Lighting

Energy Consumption

- LED Retrofits offer energy savings of 27% to 29%*
- Intelligent PoE lighting systems have demonstrated as much as 80% savings

Sensors and Analytics

- Improvements in space utilization can deliver cost avoidance savings



Linear LED Lighting Retrofits, General Services Admin, 2016

Hidden Benefits of Smart Buildings

- $3 – $30 –$300 Rule of thumb in Real Estate
  - $3/ft^2 for Utilities
  - $30/ ft^2 for Rent
  - $300/ ft^2 for People

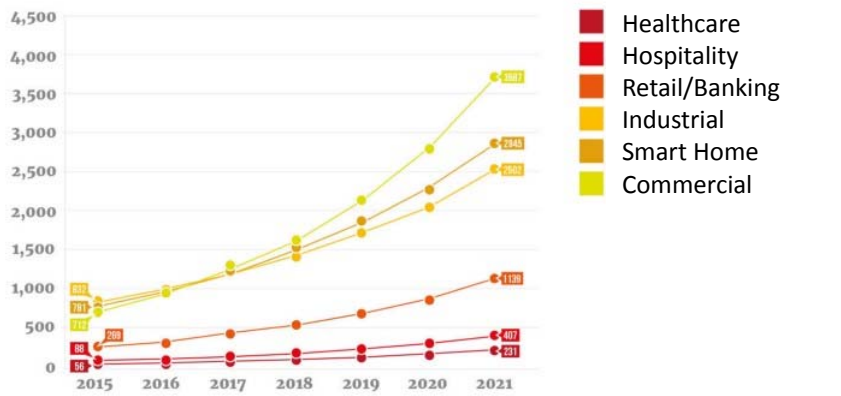
- Smart buildings have been shown to increase employee productivity
  - Smart lighting systems with built-in occupancy and ambient light sensors contribute to this
- Productivity gains account for 75% of the benefit of BIoT*
- Energy Savings account for another 14%

*McKinsey – *Unlocking the Potential of the Internet of Things*

Smart Building Device Market Growth

Fig 3.2

Growth in Smart Building Connected Devices over time (millions of devices)



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- Commercial Office connected device market to be over 4 Billion units by 2021
- CAGR is >10% in Commercial Real Estate
- Includes both wired and wireless devices

Intelligent Buildings Take Planning

- Define objectives and desired outcomes
- Must include all stakeholders
- Identify system and function “owners”

The Internet of Things in Smart Commercial Buildings

2018 - v3.0

SMART BUILDINGS

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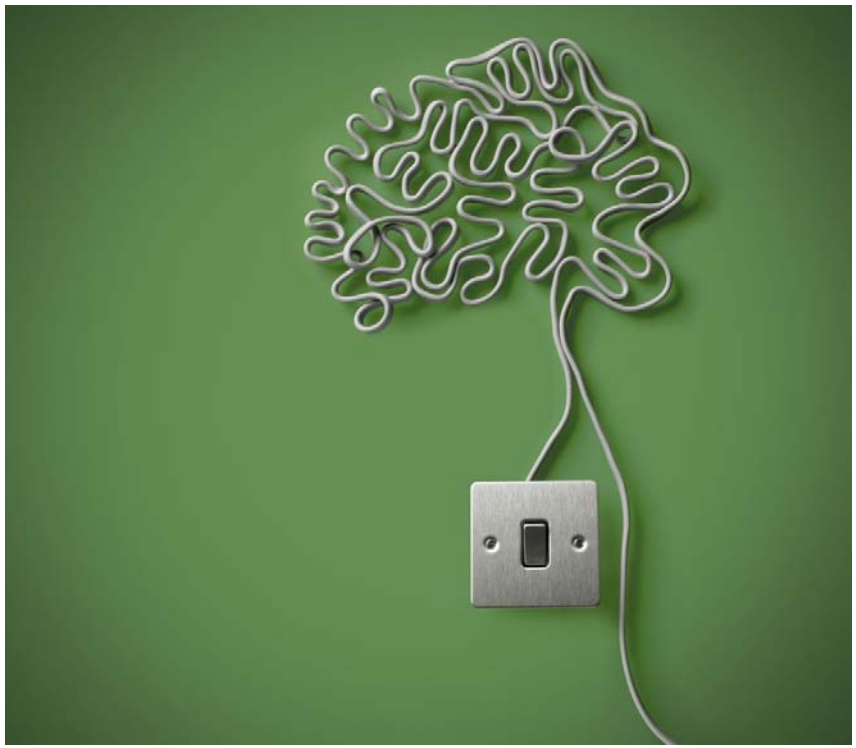
The Nervous System of the Building

- Intelligent buildings require a **network** to connect:
  - The data input devices
  - The actuators, switches, system controls
  - The intelligent system (software) that can take action based on the inputs
- Today more and more systems are being adapted to, or running on, an Ethernet network



Building Internet of Things (BIoT) Network Design

- Plan for maximum useful life of network infrastructure
  - Enterprise Network –
    - ✓ Technology upgrades every 3 – 5 years
  - Building Facilities –
    - ✓ System upgrades and replacements 10+ years
- BIoT cabling infrastructure must support devices over a longer period of time

Cabling Standards for Intelligent Buildings

ANSI/TIA-862-B-2016
Standard for Structured Cabling Infrastructure for Intelligent Building Systems

EN 50173-6:2018
Information Technology – Generic Cabling Systems – Part 6: Distributed Building Services

BICSI 007-2017
ICT Design and Implementation Practices for Intelligent Buildings and Premises

ISO/IEC 11801-6
Information Technology – Generic Cabling Systems – Part 6: Distributed Building Services

Concerns for the BIoT Network Designer

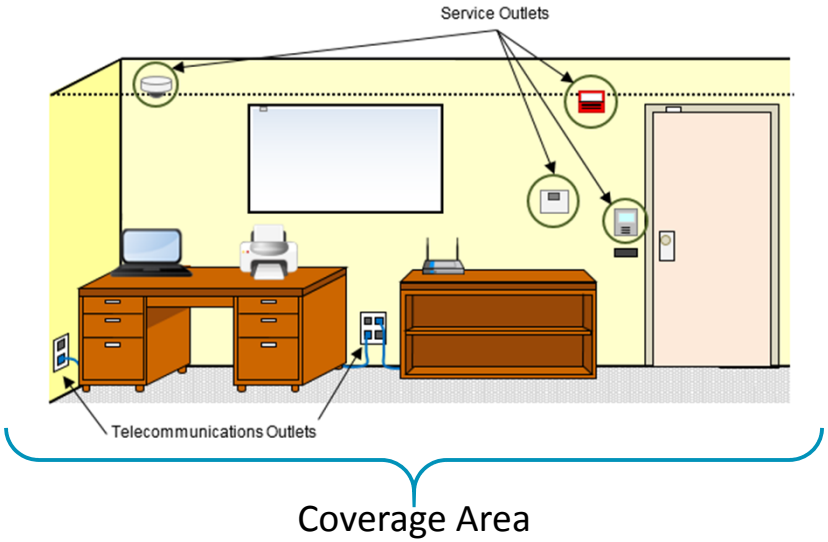
- Support for many different systems and services with various bandwidth requirements
- Support for various levels of power delivery – PoE
- Pre-planning for deployment of BIoT devices

The Smart Building Ecosystem

- Enterprise Business Network
- Voice over IP
- WiFi
- IP Surveillance Systems
- Digital Signage
- Access Control
- Lighting
- HVAC Control

Intelligent Building Design Considerations

- Horizontal Cabling Systems Planning
  - 2 - Telecommunications Outlets (TO) per work area – Enterprise LAN
  - Additional **Service Outlets** for intelligent building devices - also referred to as Equipment Outlets (EO)



Office diagram courtesy of BICSI 007 Intelligent Building standard

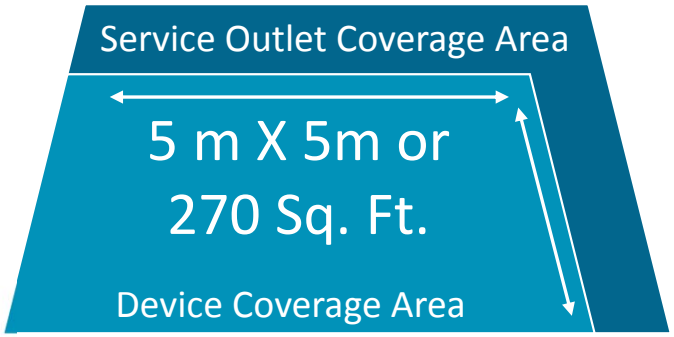
Planning the Smart Building Cabling Systems

- TIA 862-B recommends a minimum of one dedicated link per intelligent building system device be provided to each Service Outlet

- Intelligent Building network designers may not know how many devices or systems will be connected in any given area

Commercial Office Service Outlet Coverage Area

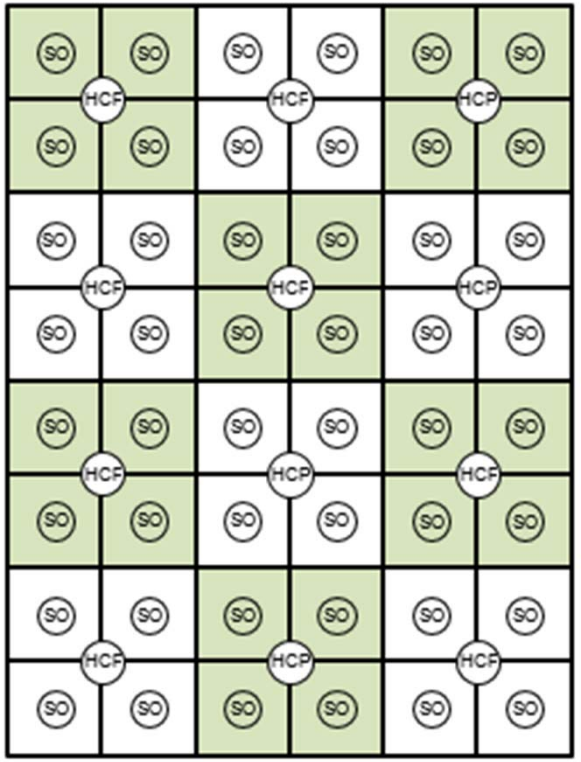
- Building device coverage area* = 270 ft^2
- Service Outlet coverage area* = 360 ft^2
  - Plan for multiple devices (services) per SO coverage area



*BICSI 007 and TIA 862-B

BIoT Cabling Best Practice – Zone Cabling

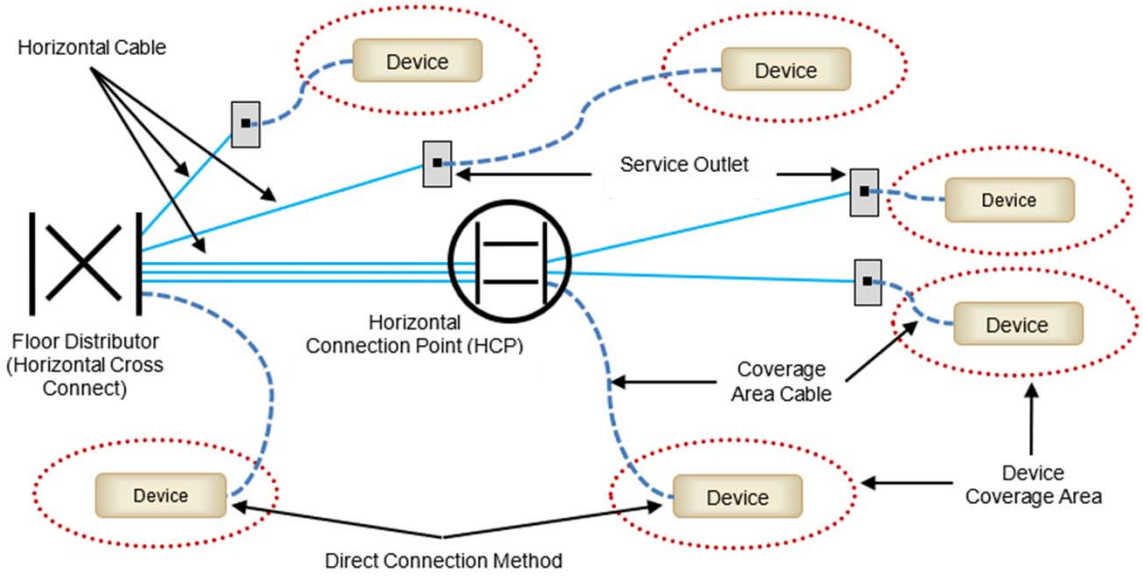
- Use **Zone Cabling** architecture where one Horizontal Connection Point (HCP) can service 4 to 5 Service Outlet coverage areas
- Estimate that each HCP supports ≈ 15,000 ft^2
  - Should have 56 ports minimum
  - Recommend 72 ports to support future growth
  - Or – estimate one BIoT device for every 208 ft^2
    - Average Cubicle size was 75 ft^2 in 2010
    - In 2017 cubicles were an average of 25 to 36 ft^2*



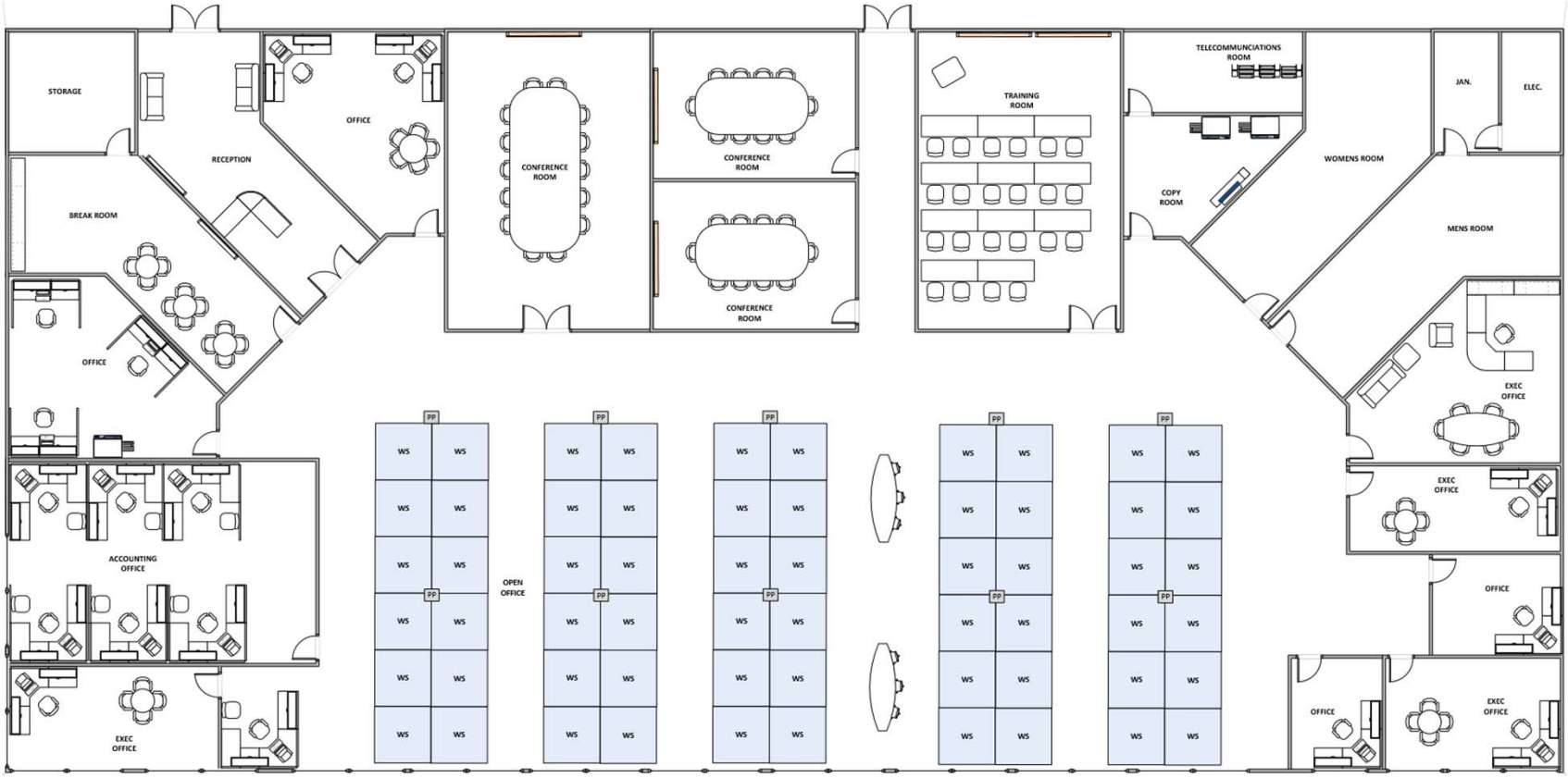
*https://bizfluent.com/info-8399850-size-office-cubicle-work-space.html

BIoT Cabling Configuration Options

- Still uses Star Wiring
- Coverage Area cable may be direct attach or through an outlet and cord
- HCP location mounted permanently in an “accessible” area



An Example…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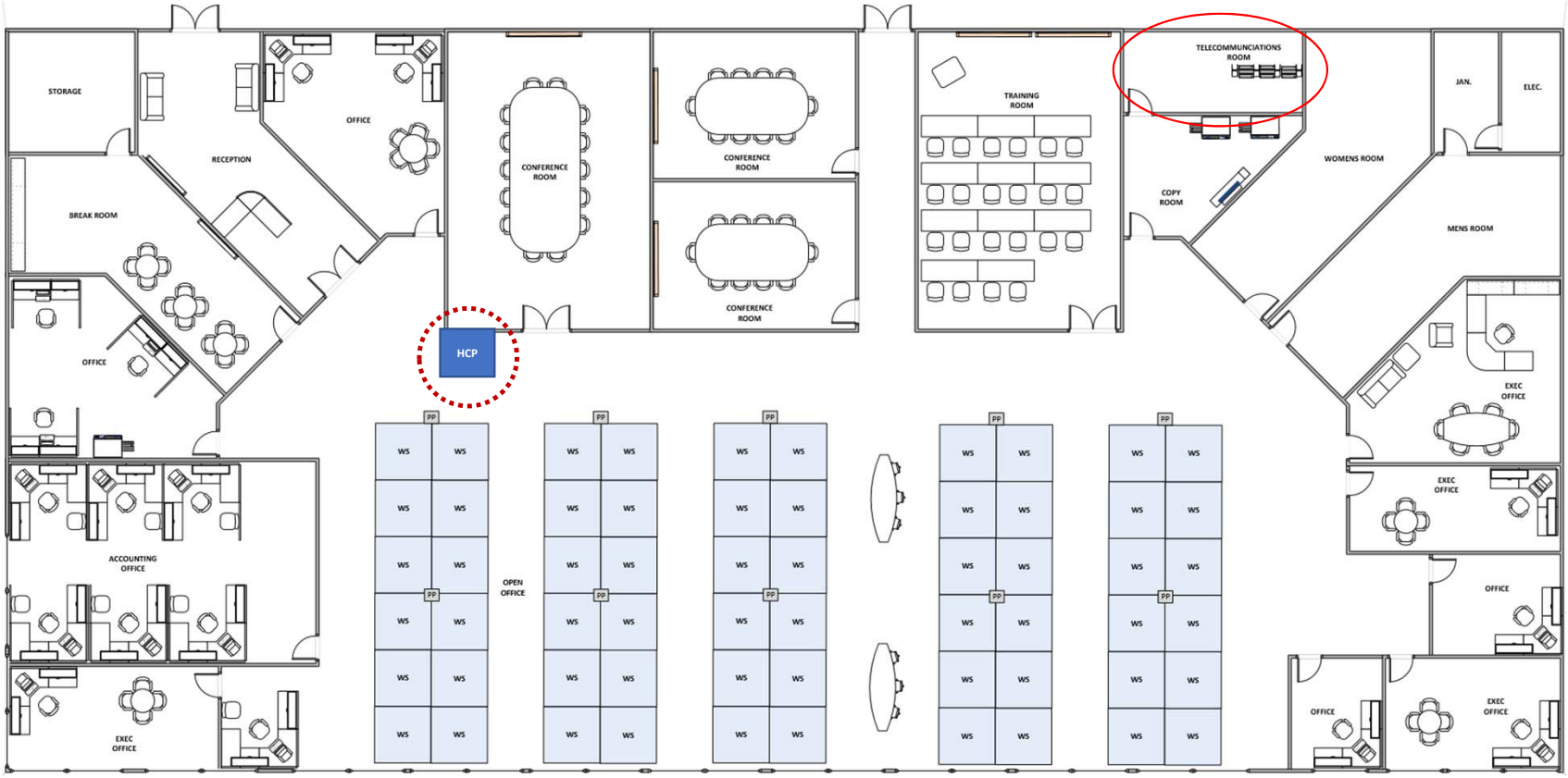
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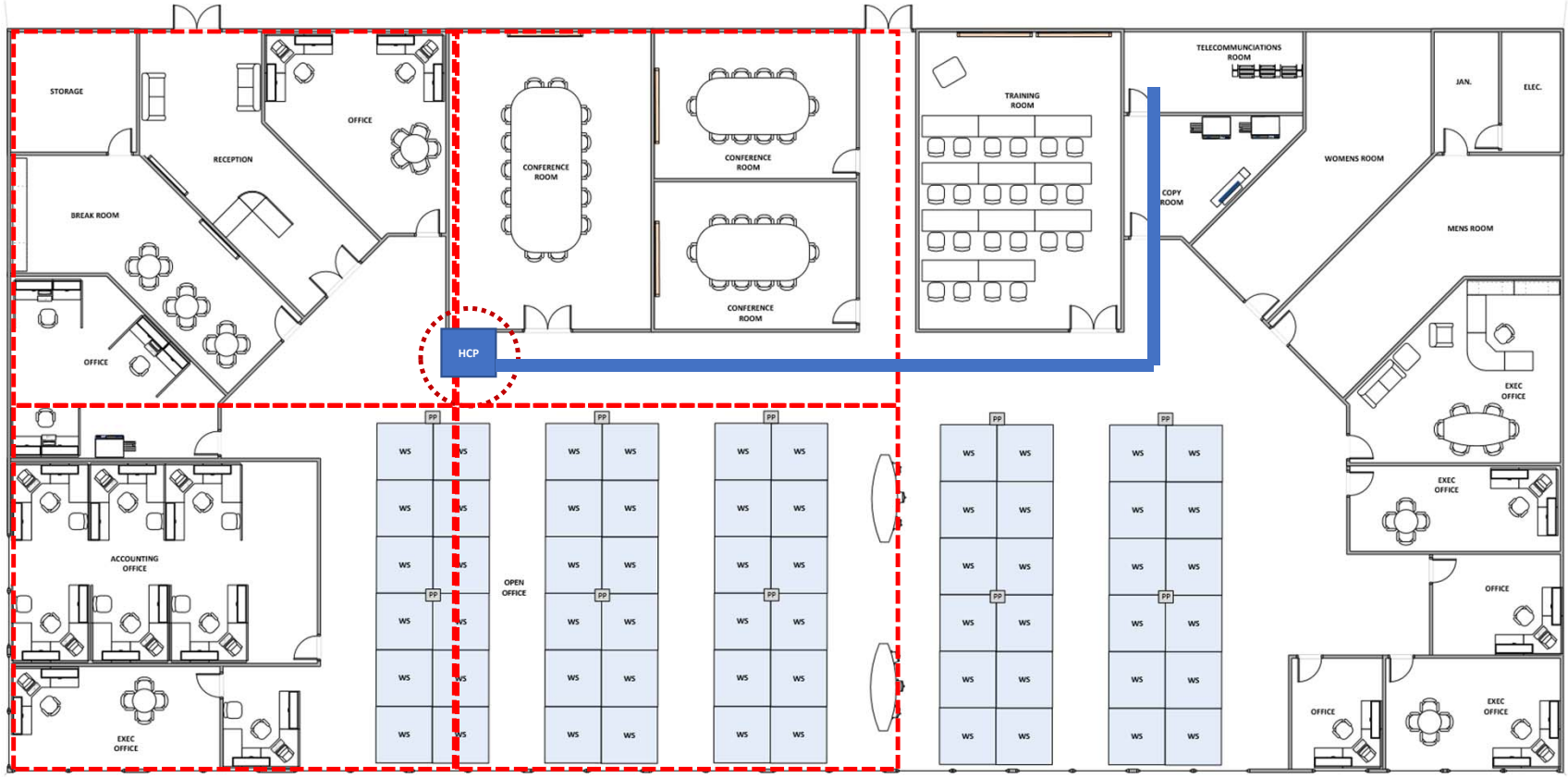
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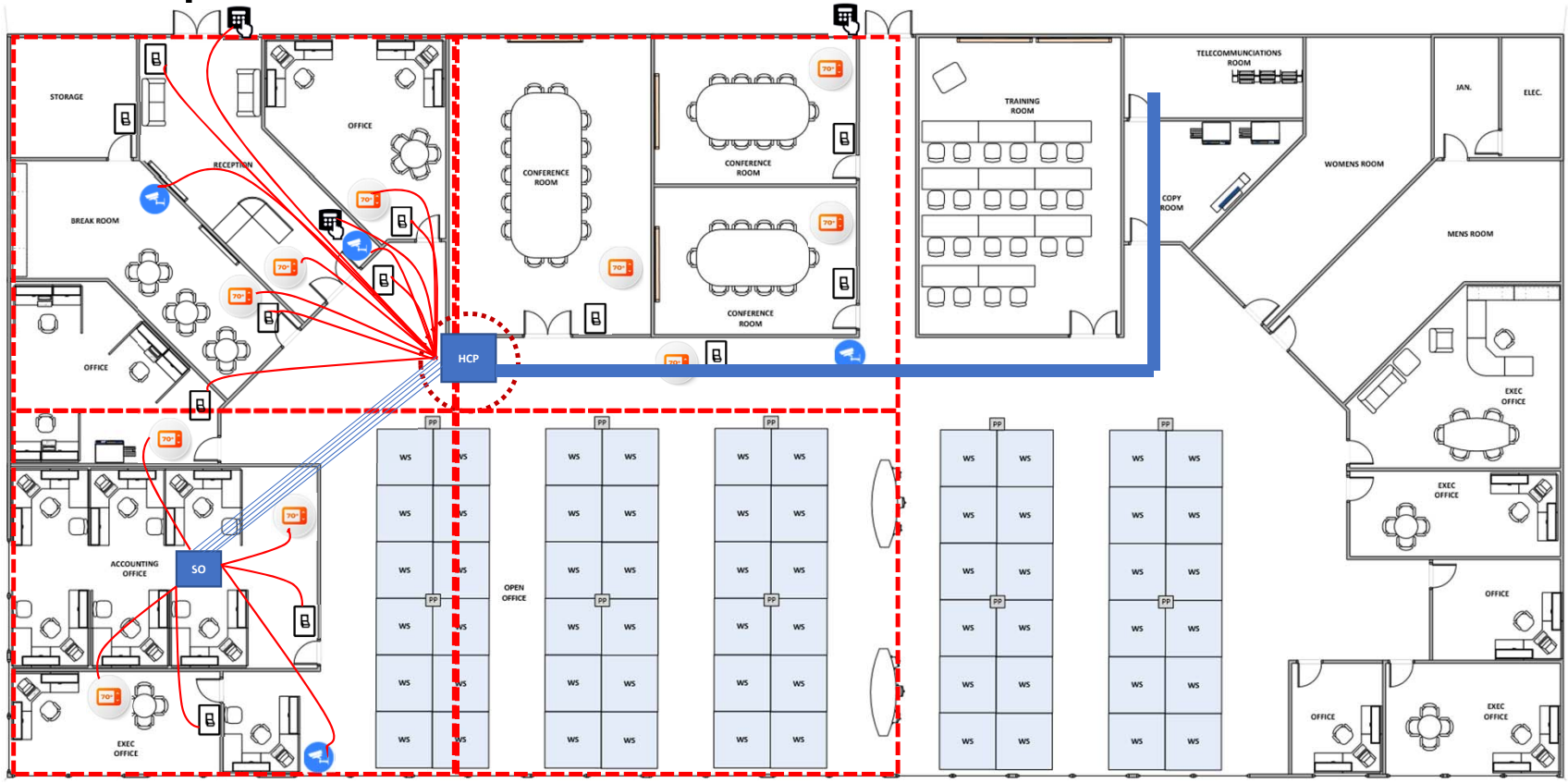
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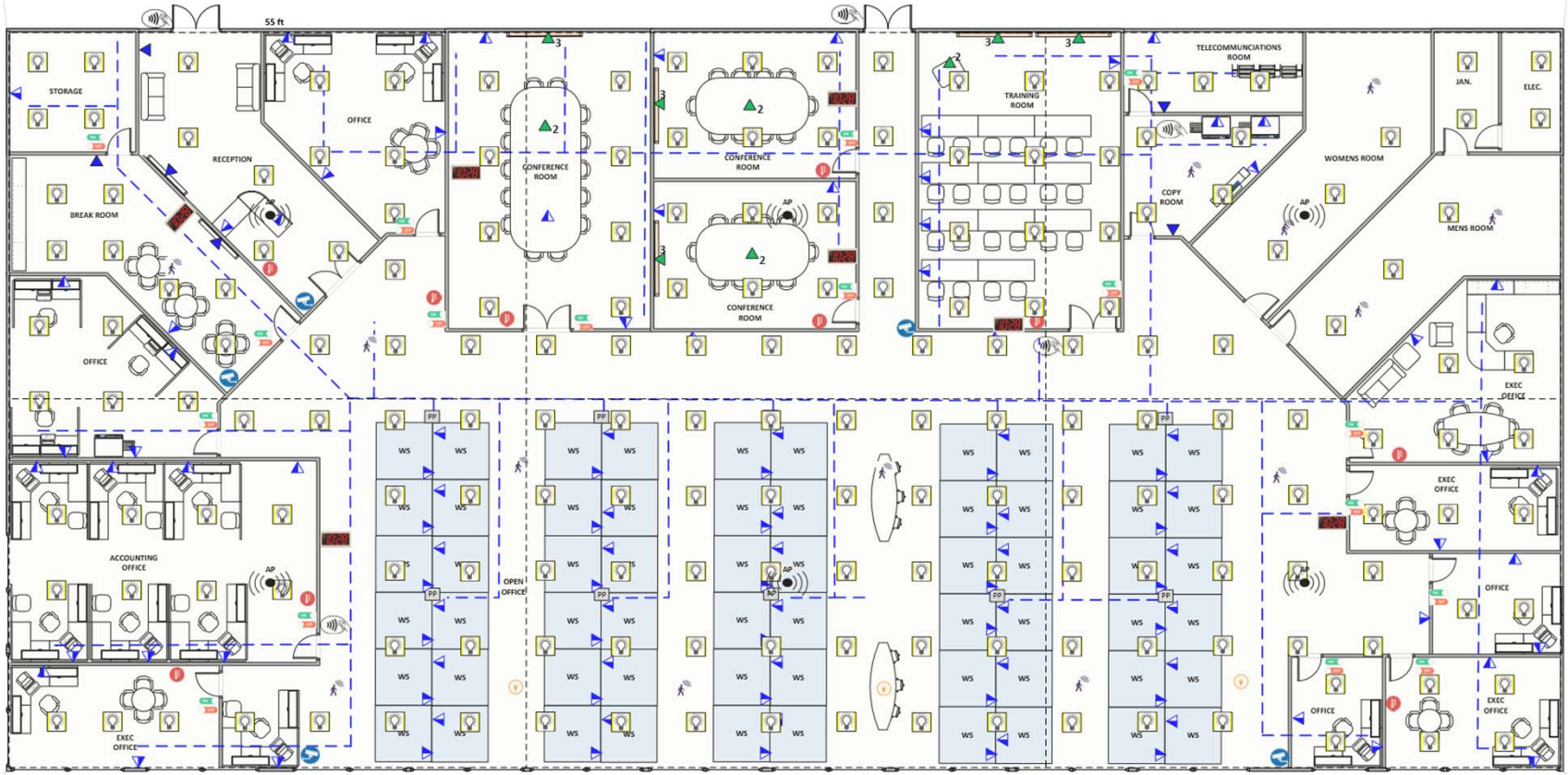
Cabling It All

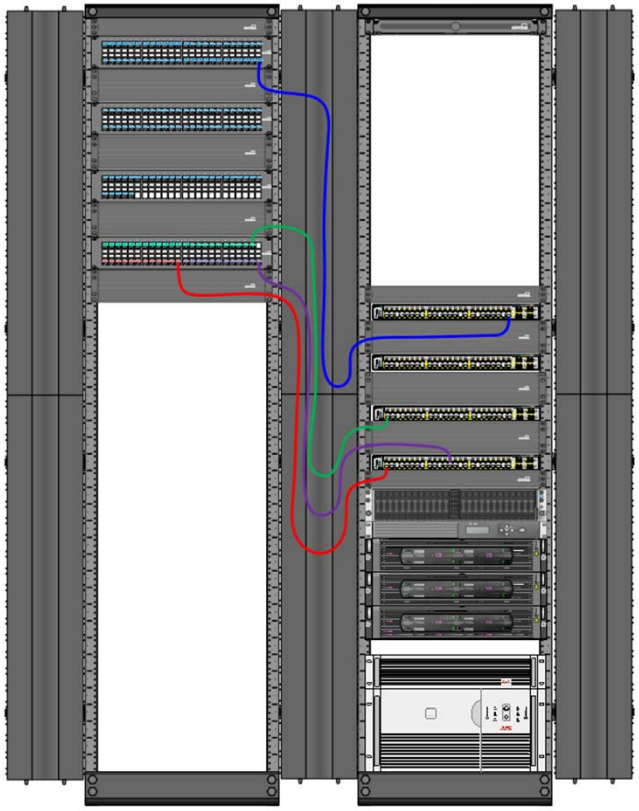


Rack Space Requirements

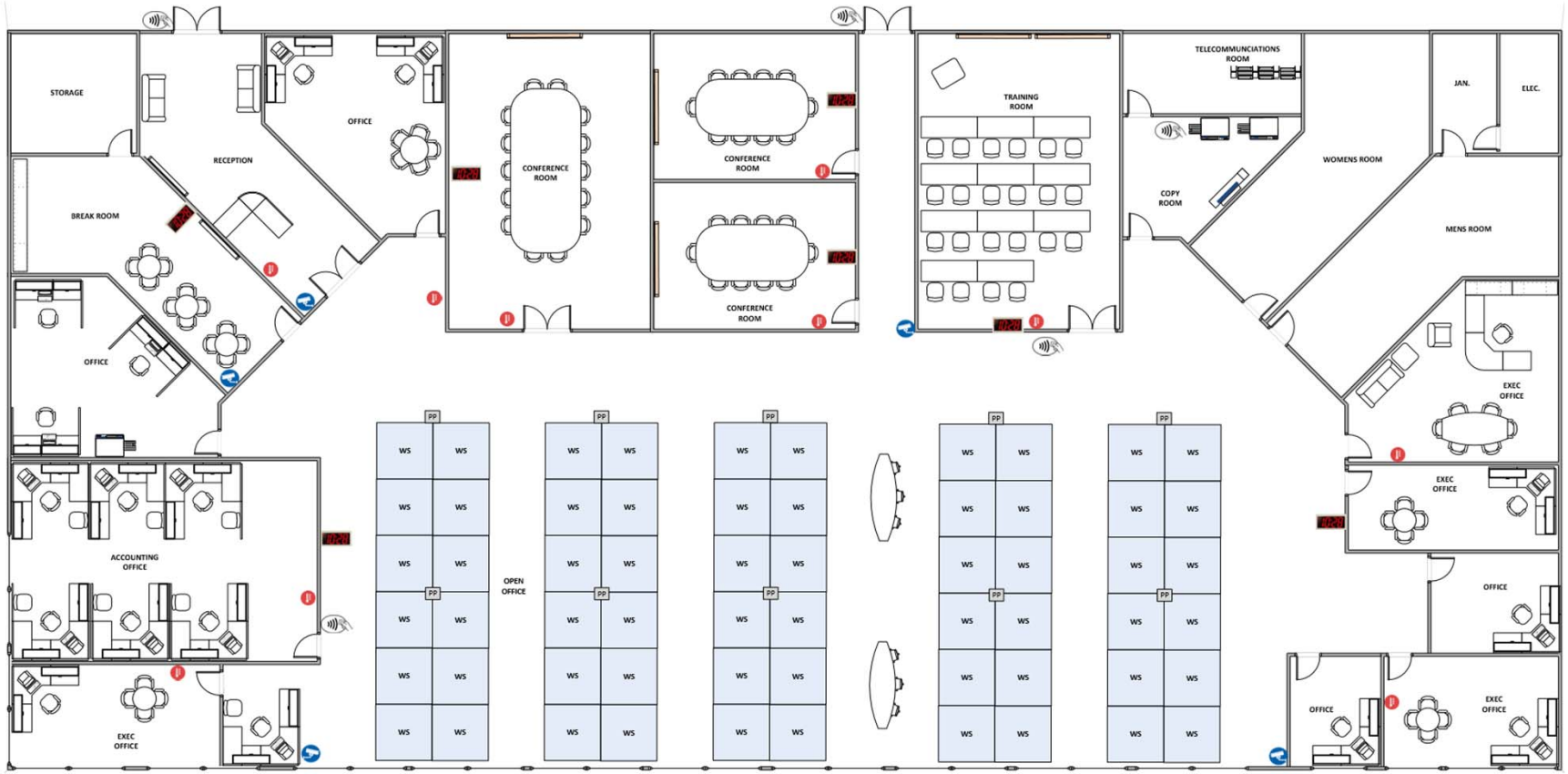
Data | A/V | WAP

Application	RU Count
(4) – 2U - 48-port panel	8
(4) – 1U - 48-port PoE switch, 30W PoE+	4
(10) –- Horizontal Cable Managers	20
(1) Uninterrupted Power Supply (UPS)	7
Servers & Storage	9
Total	**48**

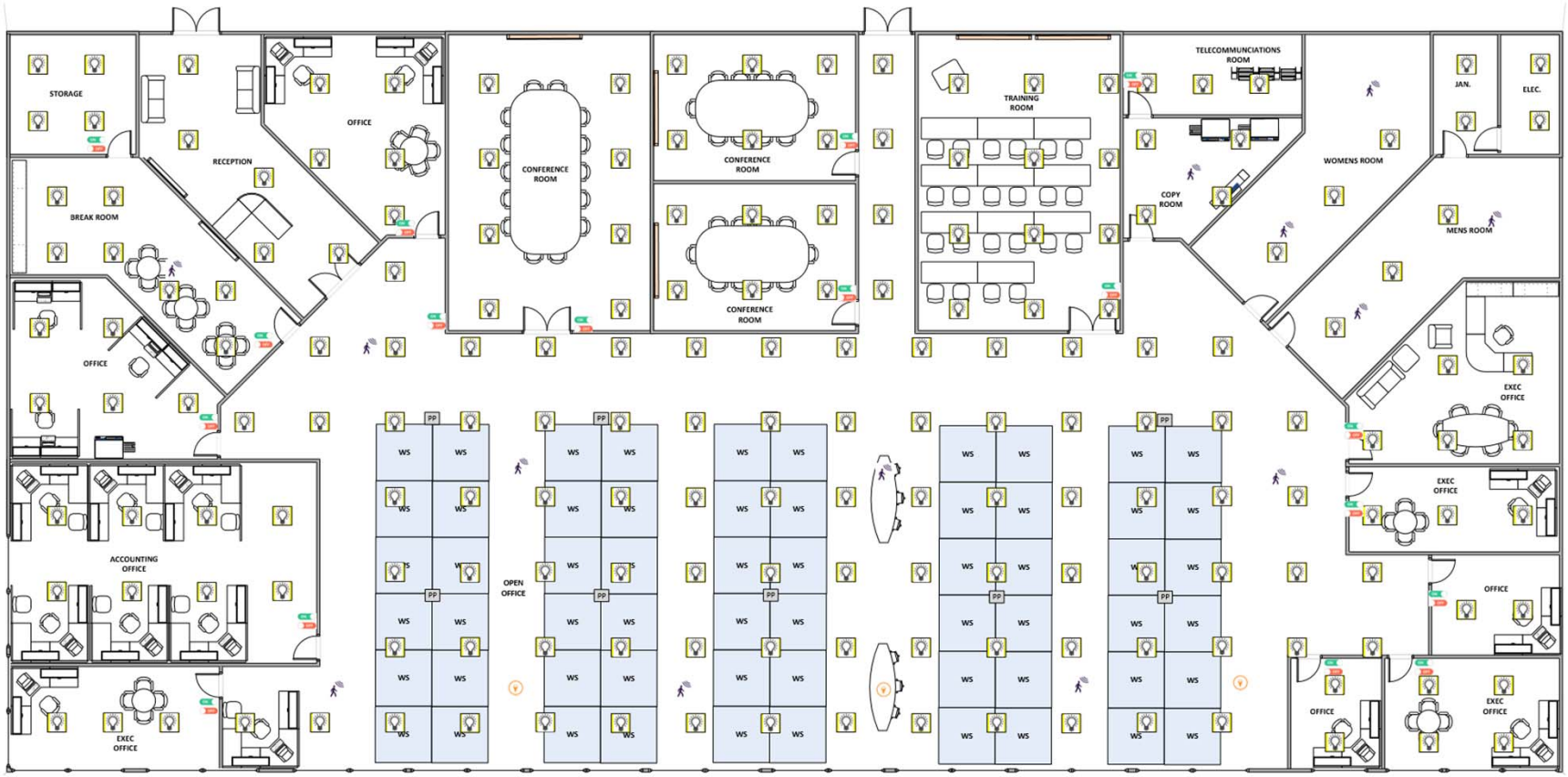
- 192 ports for Data, A/V, WAPs
- Total of 48 RU for interconnect topology
- Two racks are needed



Add Security & Access Control Applications



Add PoE Lighting

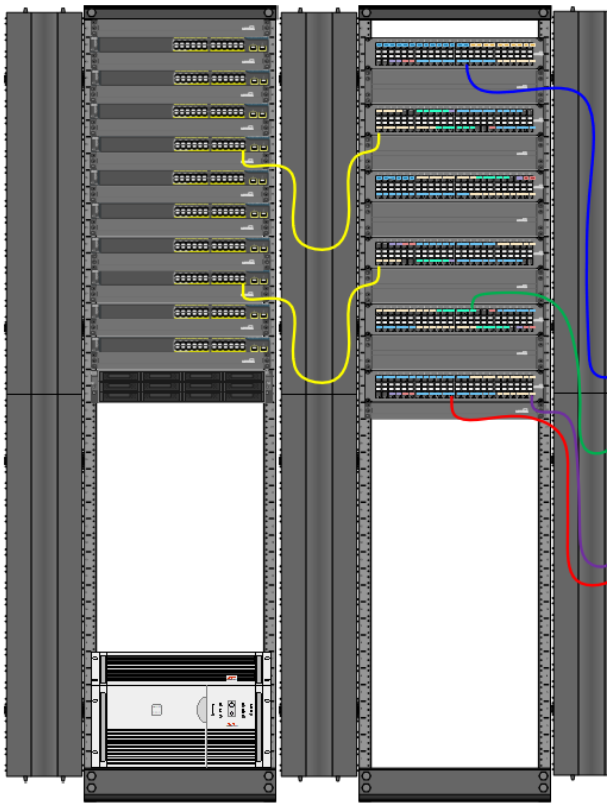


Rack Space Requirements

Intelligent Building Systems

Application	RU Count
(6) 48-port panel	12
(10) 24-port PoE switch, 60W PoE++	10
(16) Cable Managers	32
Uninterrupted Power Supply (UPS)	7
Servers	4
Total	**63**

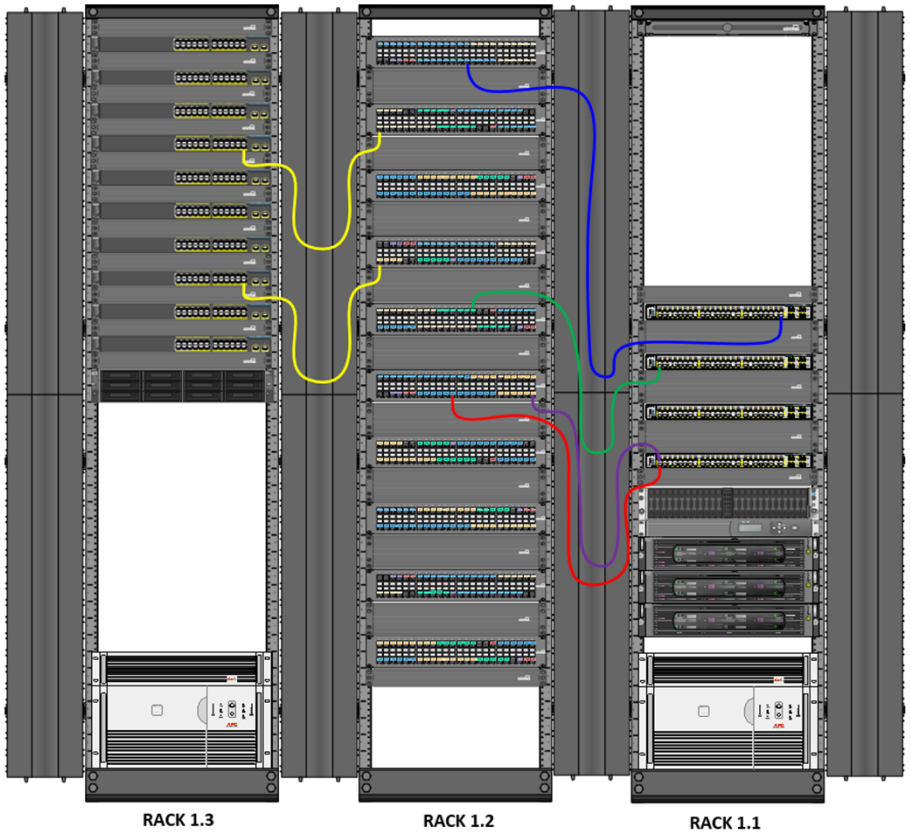
- Lighting adds 223 ports
- Security, Access Control adds 24 ports
- Additional 63 RU space needed



Total Rack Space Requirements

Application	RU Count
(10) 48-port panels	20
(10) 24-port PoE switch, 60W PoE++	10
(4) – 1U - 48-port PoE switch, 30W PoE+	4
(26) Cable Managers	52
(2) Uninterrupted Power Supplies (UPS)	14
Servers and Storage	11
Total	**111**

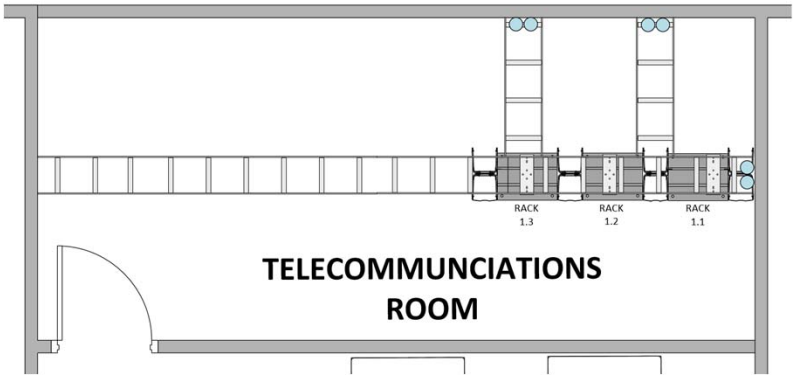
- All Cabling terminated in center rack
- Color Coding of ports and patch cords by application/service
- PoE Switches for lighting housed in their own rack with dedicated UPS



Telecommunications Room Size Requirements

Application	Switch Ports	Panel Ports (Interconnect)
Data/WAP	127	127
A/V	12	12
Security/BAS	31	31
Lighting	223	223
Total	**393**	**393**

Standard	Port Range	Room Size m (ft)
ANSI/TIA-569-D	200-800	6m x 6m (20ft x 20ft)
ISO/IEC 14763-2	Up to 500	3.2m x 3.4m (10.5ft x 11.1ft)



Choosing the Right Cabling

Bandwidth and Power Needs

Digital Building Applications

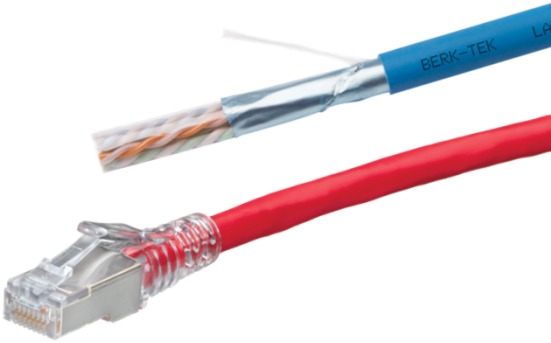
- WAPs
- Digital Signage

- Lighting
- Security Cameras

- Building Automation
- Access Control
- Clocks
- Sensors

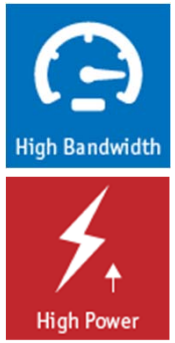
High Bandwidth, High Power

Recommendation: Category 6A System

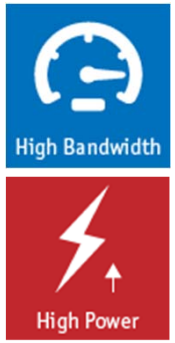


High Power, High Bandwidth Cat 6A Cable Advantages

- Lower costs by supporting higher power per cable, avoiding additional bundles and trays
- 23 AWG conductors generate less heat than 24 AWG
  - 23 AWG is larger in diameter than 24 AWG
- Discontinuous Metallic Shield
  - Dissipates heat more effectively than UTP designs
  - Cooler temp maintains cable integrity and lifespan
  - Reduced OPEX, less facility cooling required



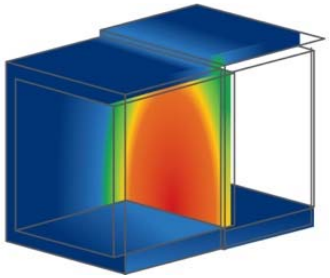
High Power, High Bandwidth Cat 6A Connectivity Advantages



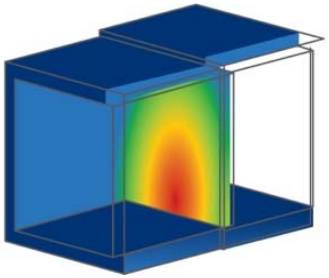
- Shielded and solid metal bodied UTP Cat 6A connectors dissipate heat better than plastic alternatives

Thermal simulation of connector bodies using plastic and metal

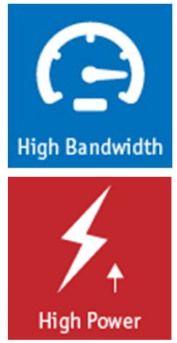
Plastic



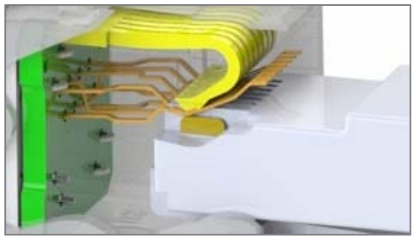
Metal



PoE Arcing Damage Protection
Retention Force Technology® (RFT)

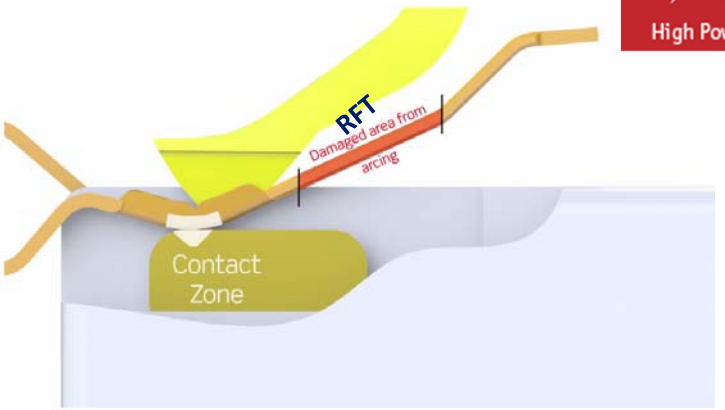


- PoE Optimized Tine Geometry
  - Specifically engineered tine shape and plug interface
  - Prevents arcing damage in contact zone between the plug and connector



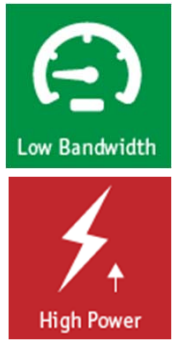
Plug fully engaged in connector

Plug at point of disconnect

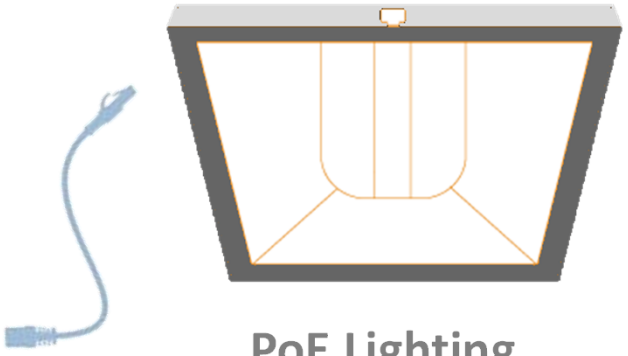


Arcing occurs away from contact zone

High Power, Low Bandwidth

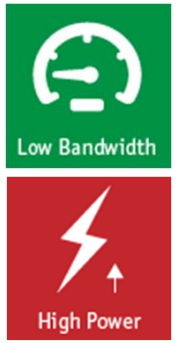


- Primary Concerns
  - Support for speeds of up to 1 Gbps
  - Pathway Design and Cable Installation
  - Temperature Rise
  - Contact Pitting
  - Power Delivery Efficiency



PoE Lighting

High Power, Low Bandwidth



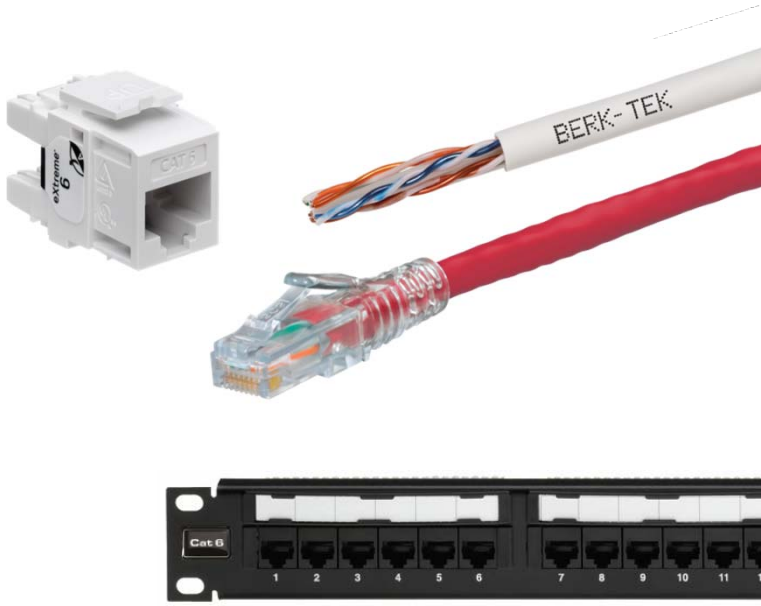
Recommendation: Cat 5e High PoE System

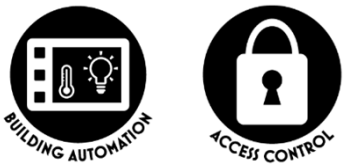
- Metal Clad Cat 5e UTP Jack
  - Retention Force Technology
- 22 AWG Cat 5e Cable
  - Lower DC resistance
  - Efficient Power Delivery
  - No Bundle Size Restrictions

Low Bandwidth, Low Power

Recommendation: Category 6 System

- Bandwidth supports many BIoT systems
- Power levels not subject to bundle size restrictions





The Future of BIoT Cabling

- Single-Pair Ethernet Draft Standards
  - IEEE 802.3cg — 10Mb/s over single pair cable
  - IEEE 802.3bu — Power over Data Lines (PoDL) for SPE PoE
  - Draft TIA 568.5 — Single Balanced Twisted-Pair Telecommunications Cabling and Components Standard
  - ANSI/TIA-568.0-D-2 Draft— Single Balanced Twisted-Pair Use Cases and Topology
  - ANSI/TIA-862-B-2 Draft — Single Balanced Twisted-Pair Use Cases and Topology

The Future of BIoT Cabling

- 802.3cg has two reach specifications
  - 10BASE-T1S — 15m
  - 10BASE-T1L — 1000m
- TIA 568.5 draft standard specifying cable and channel requirements for 15m, 40m, 400m, 1000m
  - 15, 40m reach targeted for automotive or industrial networks – Annex
  - 1000m, 400m reach targeted to support 10BASE-T1L
- Opportunities for 10BASE-T1L in the BIoT space especially for the 400m reach

The Future is Bright for BIoT

- Growth of intelligent device deployment is forecasted to accelerate
- Benefits of intelligent buildings go beyond simple energy savings
- New standards for BIoT network deployment provide guidance for better planning
- Berk-Tek has the right cabling products to support every intelligent device you want to deploy

Thank You

Questions?