ICT Infrastructure for Smart Buildings

Structured Cabling is not only for Voice & Data

Yannis Katris, RCDD

Tech Breakfast Romania, 3.07.2019

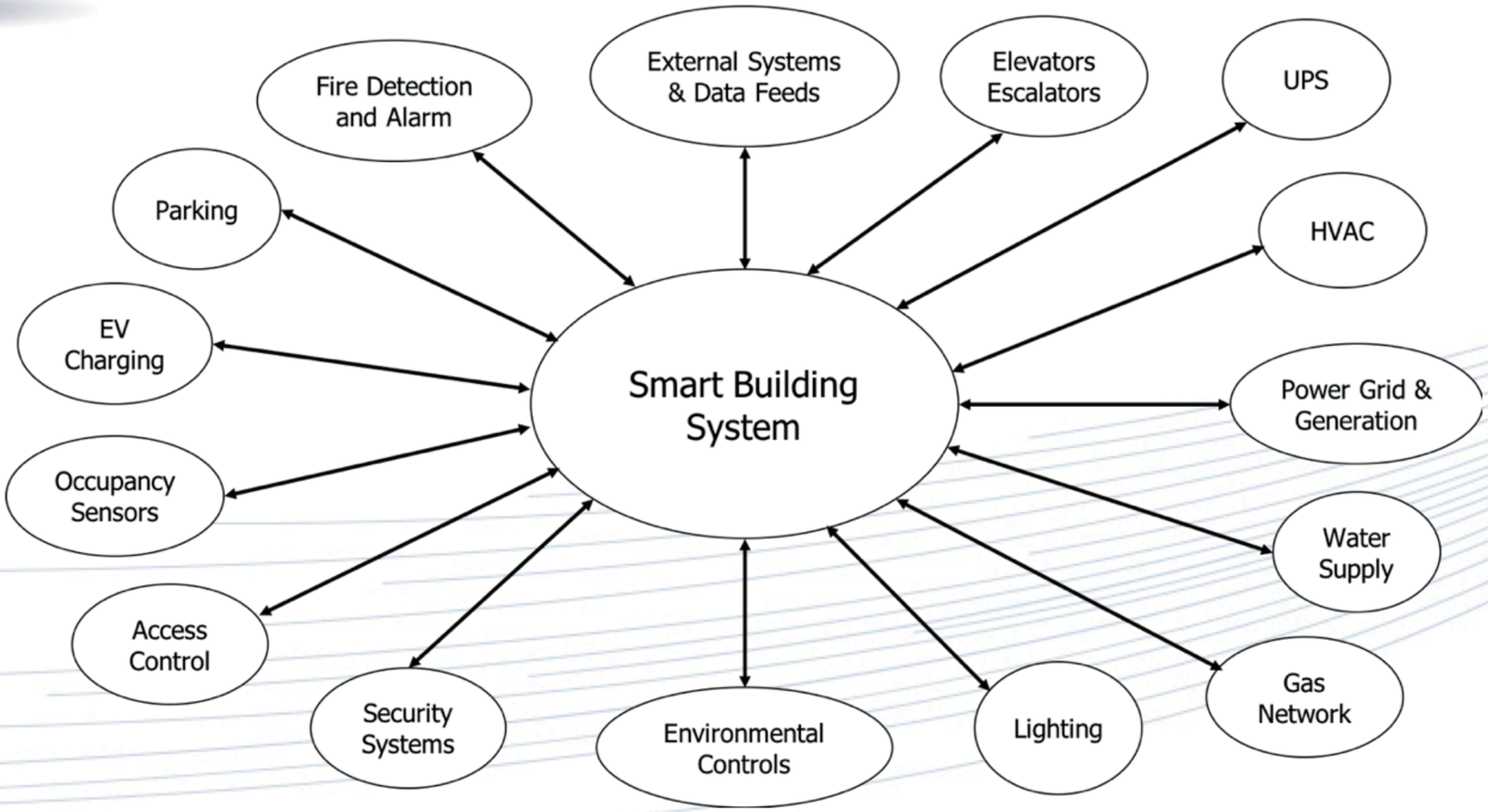
BICSI

Smart / Intelligent / Connected Buildings

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.

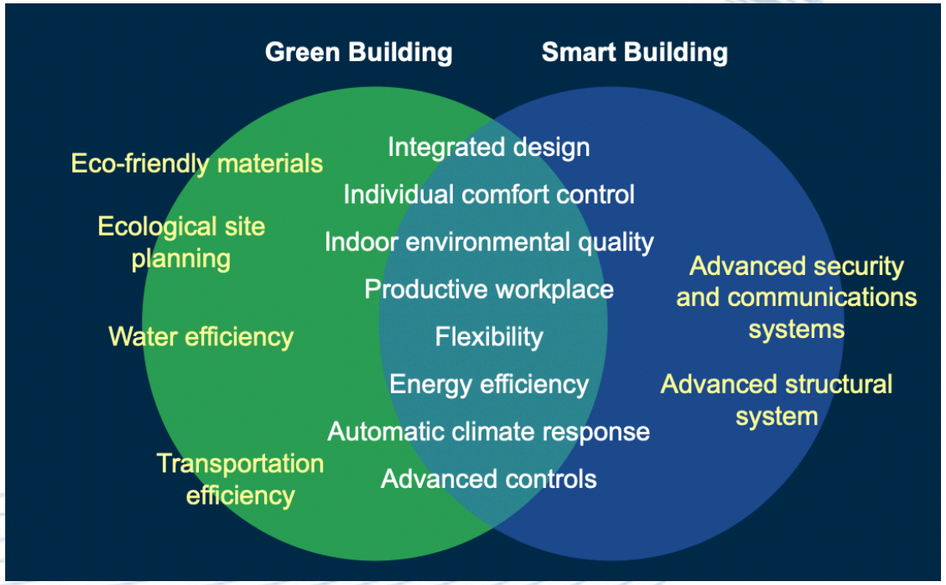
ANSI/BICSI 007-2017

Smart Building: a System of Systems

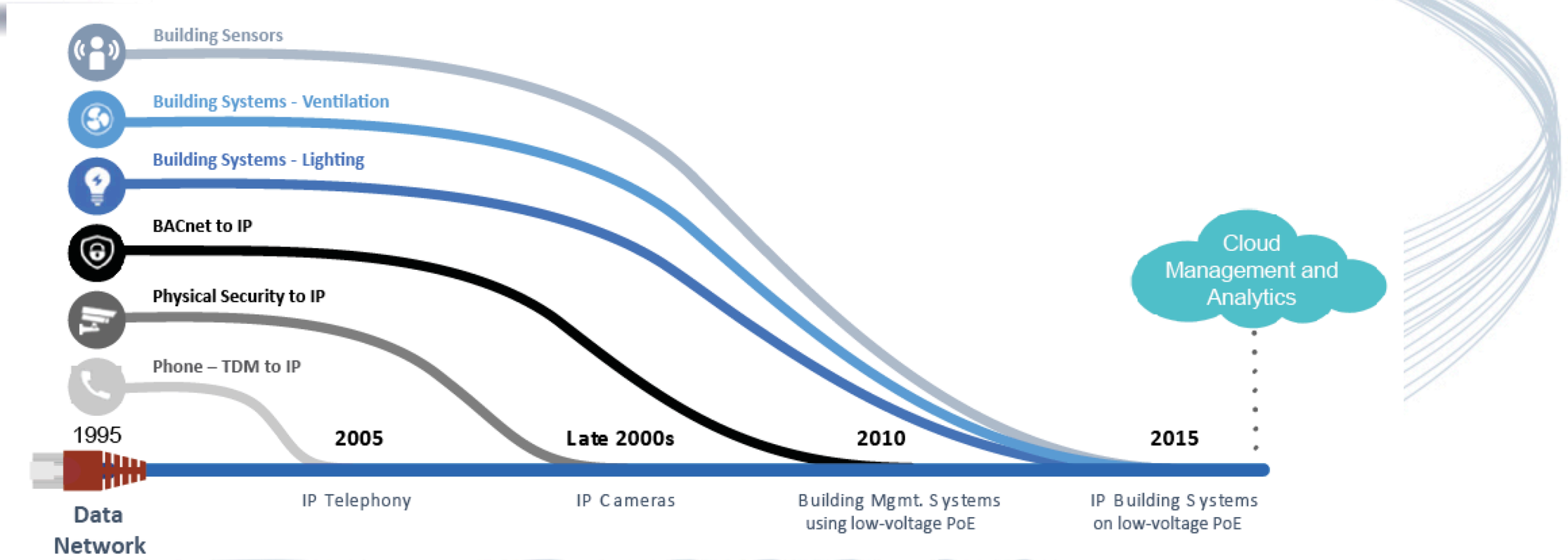


Green Buildings, Smart Buildings, Smart Cities…

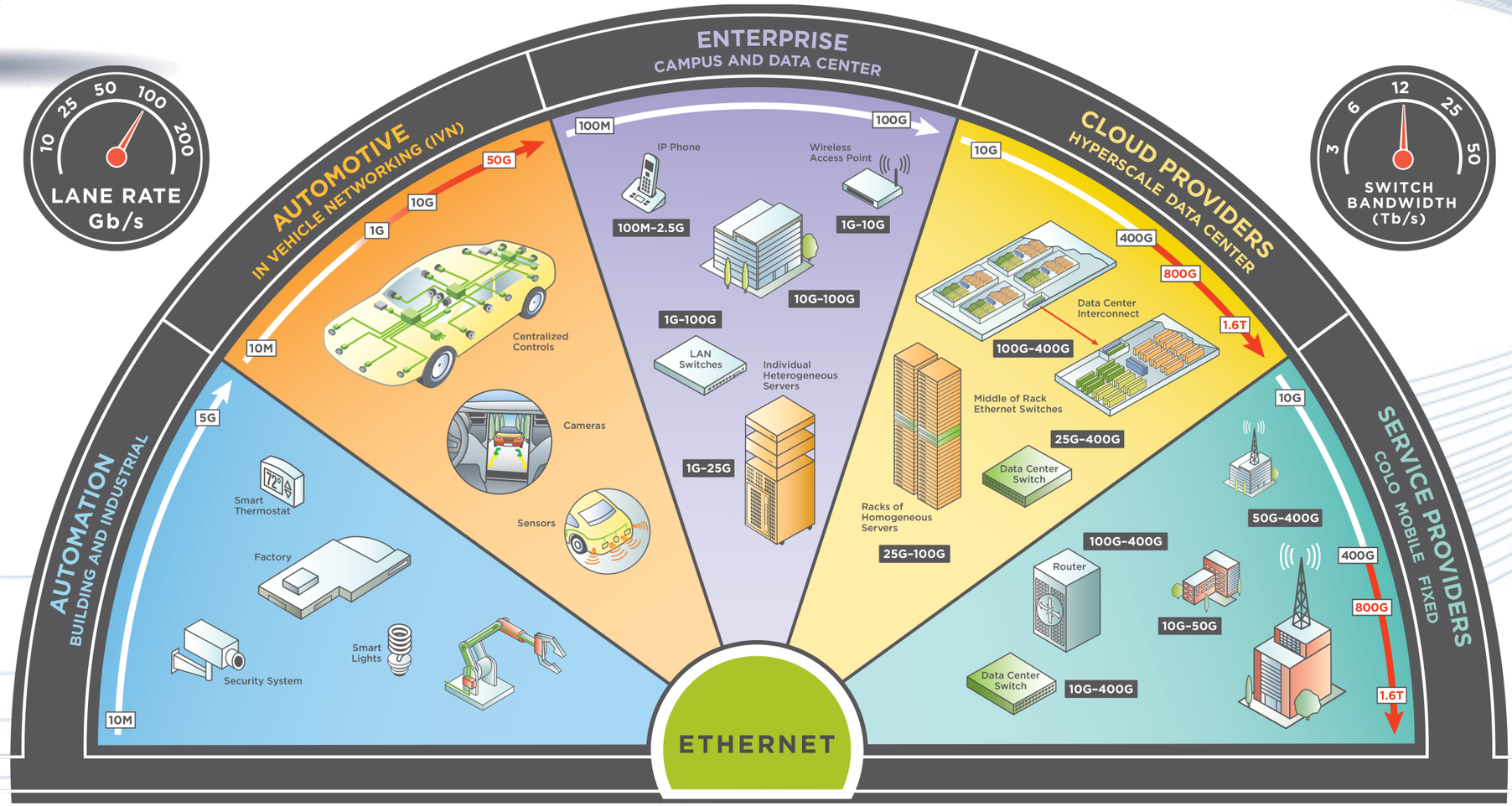
Source: Buildings Performance Institute Europe, "Is Europe ready for the smart buildings revolution?", 2017, www.bpie.eu



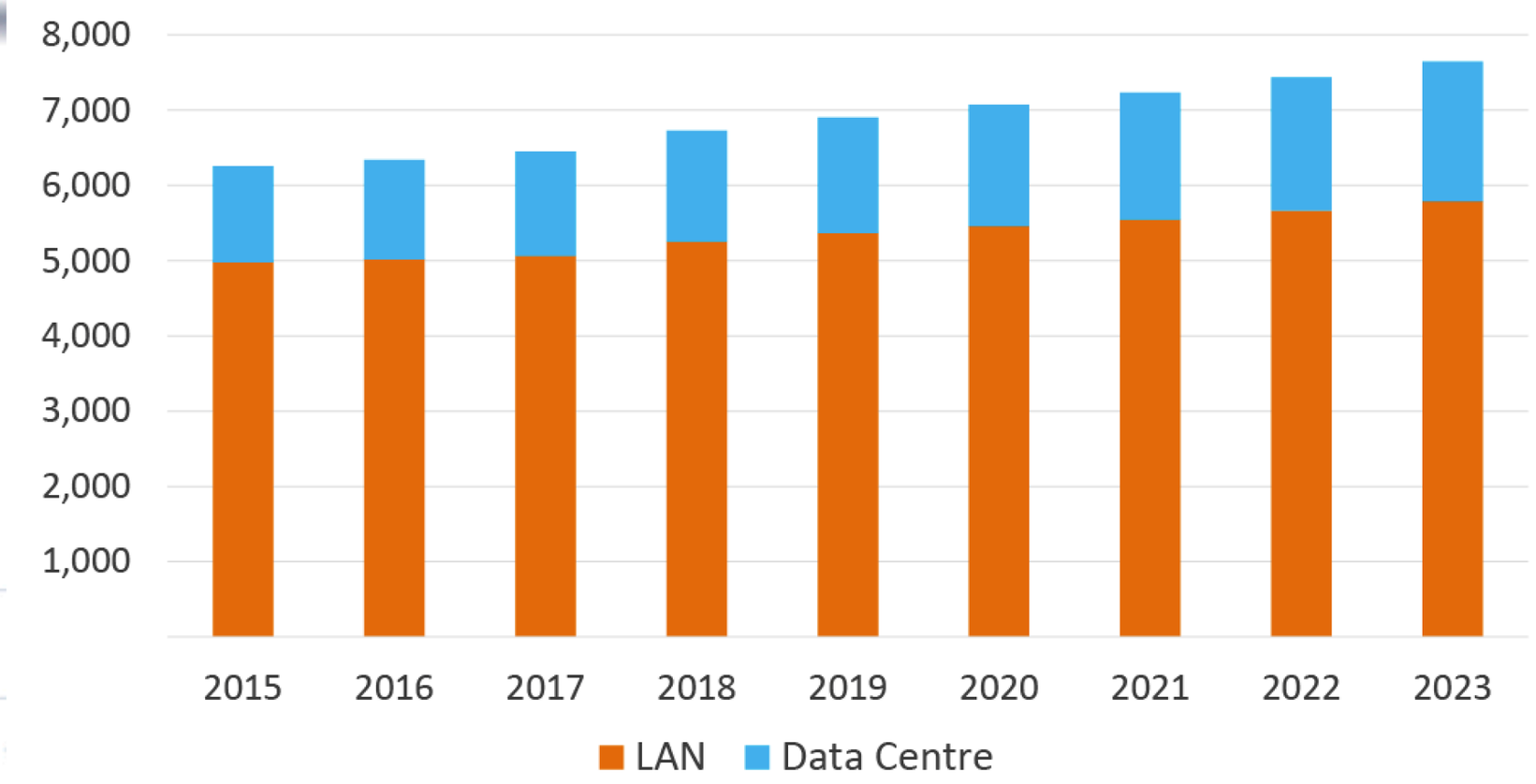
IP Convergence to Digital Building Technologies



Ethernet applications



Global LAN and DC cabling market, USD million

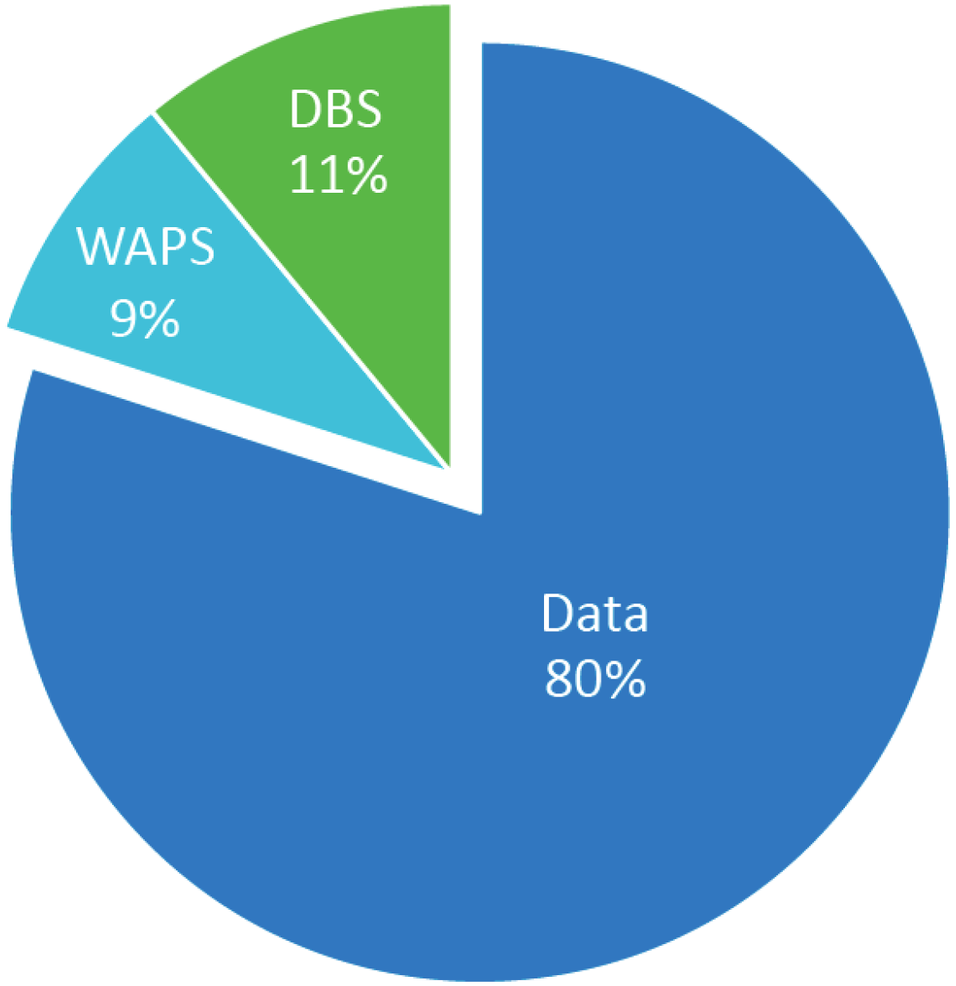


2018: USD 6.7 B
- **22% installed in DCs**

Forecast:
- **CAGR 2.6%**
- **LAN: ~ 2% per year**
- **DCs: ~ 5% per year**

Source: BSRIA 2018

Global view: Data, WAPs and IoT (wired)



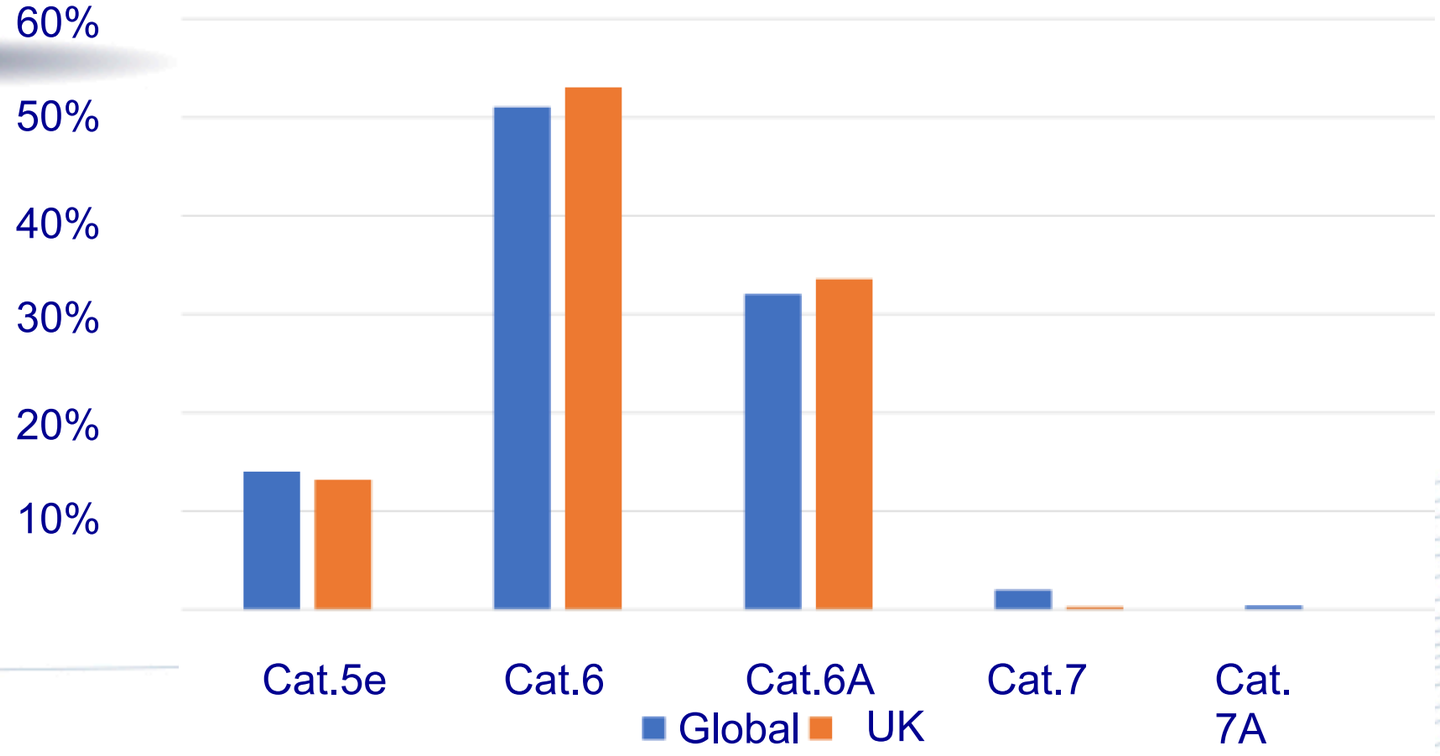
100% = 140 million outlets/links installed per year

THE 4TH UTILITY

Electricity Water HVAC Network

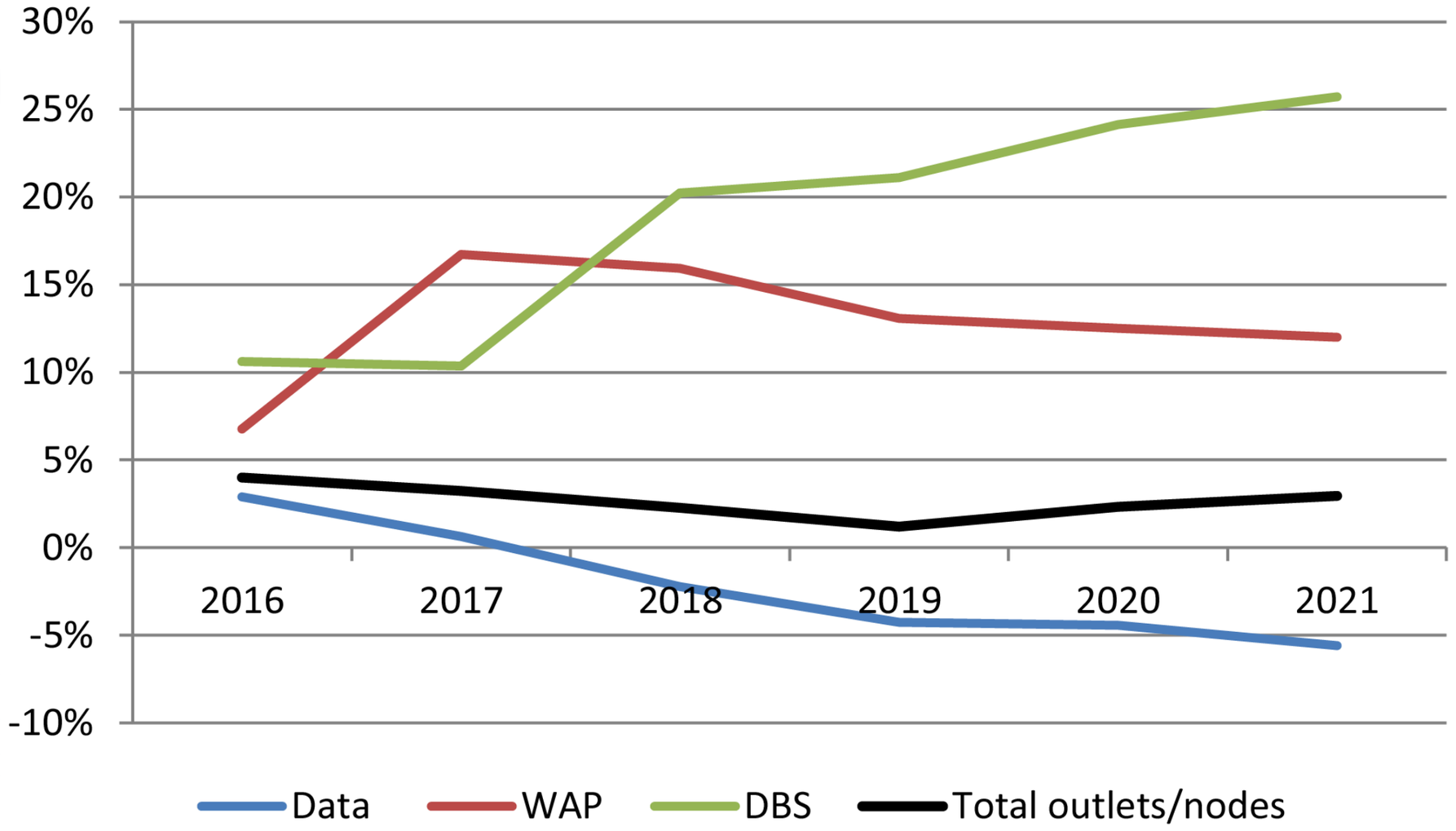
Source: BSRIA 2018

Uptake by Category (channel), Worldwide and UK (value)



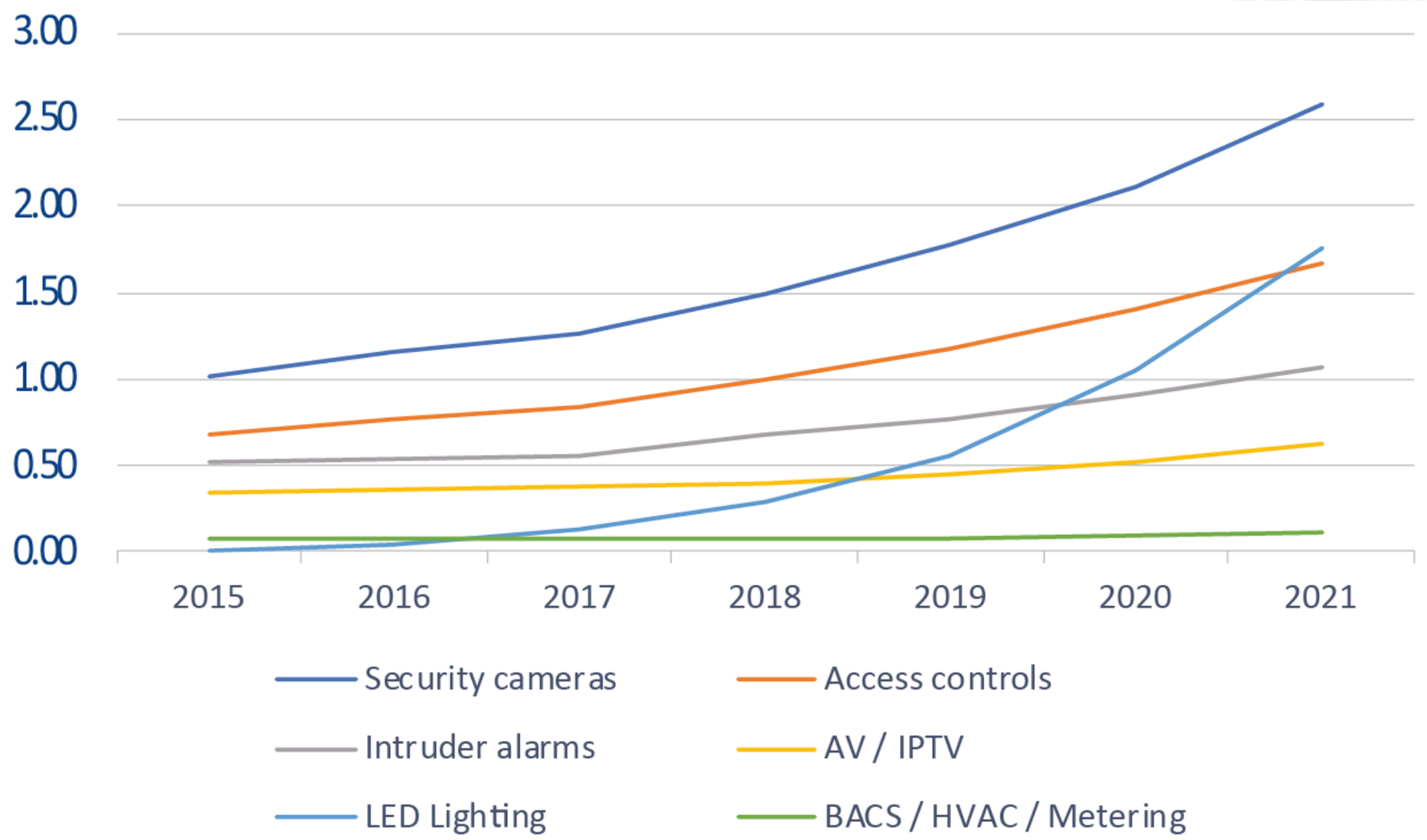
Source: BSRIA 2018

Data, WAPs, DBS and total outlets/links, growth rates, USA 2016 -2021



Source: BSRIA

Distributed Building Services, million nodes/outlets in commercial buildings by type of products, 2015-2021



Source: BSRIA „Convergence and digitalization of commercial buildings in the US" May 2017

Balanced Twisted Pair Cabling for Voice/Data & Distributed Building Services

Source: commscope.com

The Standards

- **ANSI/TIA-862-B** “Structured Cabling Infrastructure Standard for Intelligent Building Systems” (2016)
- **ISO/IEC 11801-6 : 2017** “Information technology -- Generic cabling for customer premises - Part 6: Distributed building services”
- **EN 50173-6 : 2018** “Information technology. Generic cabling systems. Distributed building services
- **ANSI/BICSI 007-2017** “Information Communication Technology Design and Implementation Practices for Intelligent Buildings and Premises”

Relevant Standard References

ANSI/TIA-568.1-D-2015

Commercial Building Telecommunication Infrastructure

- Equipment Rooms
- Telecommunication Rooms
- Telecommunications enclosures
- Backbone and horizontal Cabling
- Work Area
- Multi-Tenant Building Spaces
- Installation Requirements
- Telecommunicaton Pathways
- Fire stopping and administration

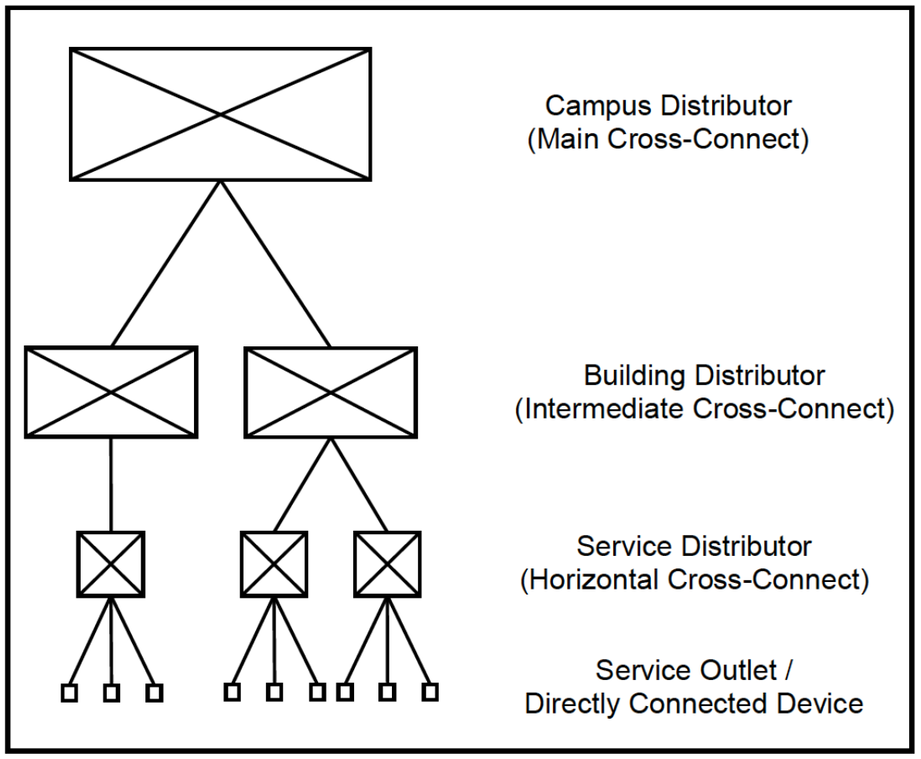
ANSI/TIA-862-B-2016

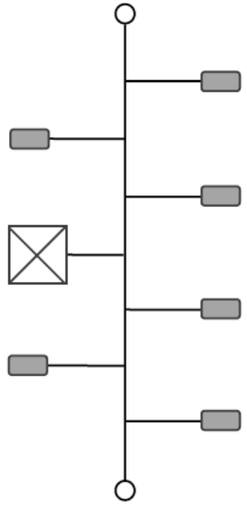
Structured Cabling Infrastructure Standard for Intelligent Building Systems

- Cabling System Structure, Topology
- Entrance
- Transmission performance requirements
- Cabling for wireless access points
- Grounding and bonding
- Power Delivery over balanced twisted-pair cabling
- Distribution rooms
- Zone enclosures
- Administration
- Separation of services
- Optional coverage area topologies
- Low voltage intelligent building systems
- Balanced multipoint data bus

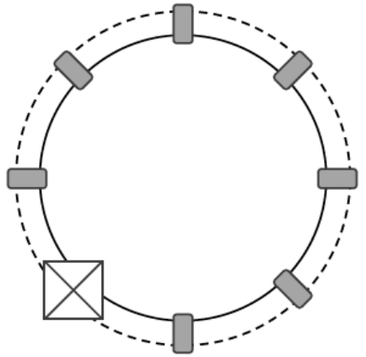
Source: TIA & ISO

Topology

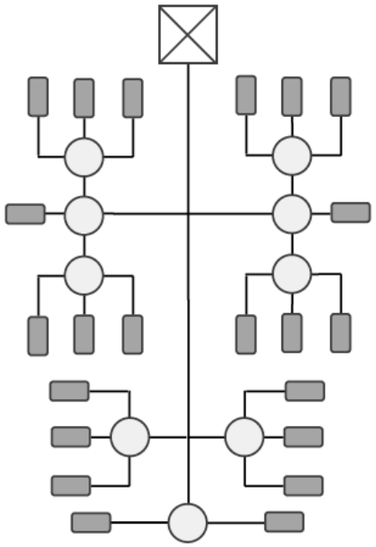




Bus Topology



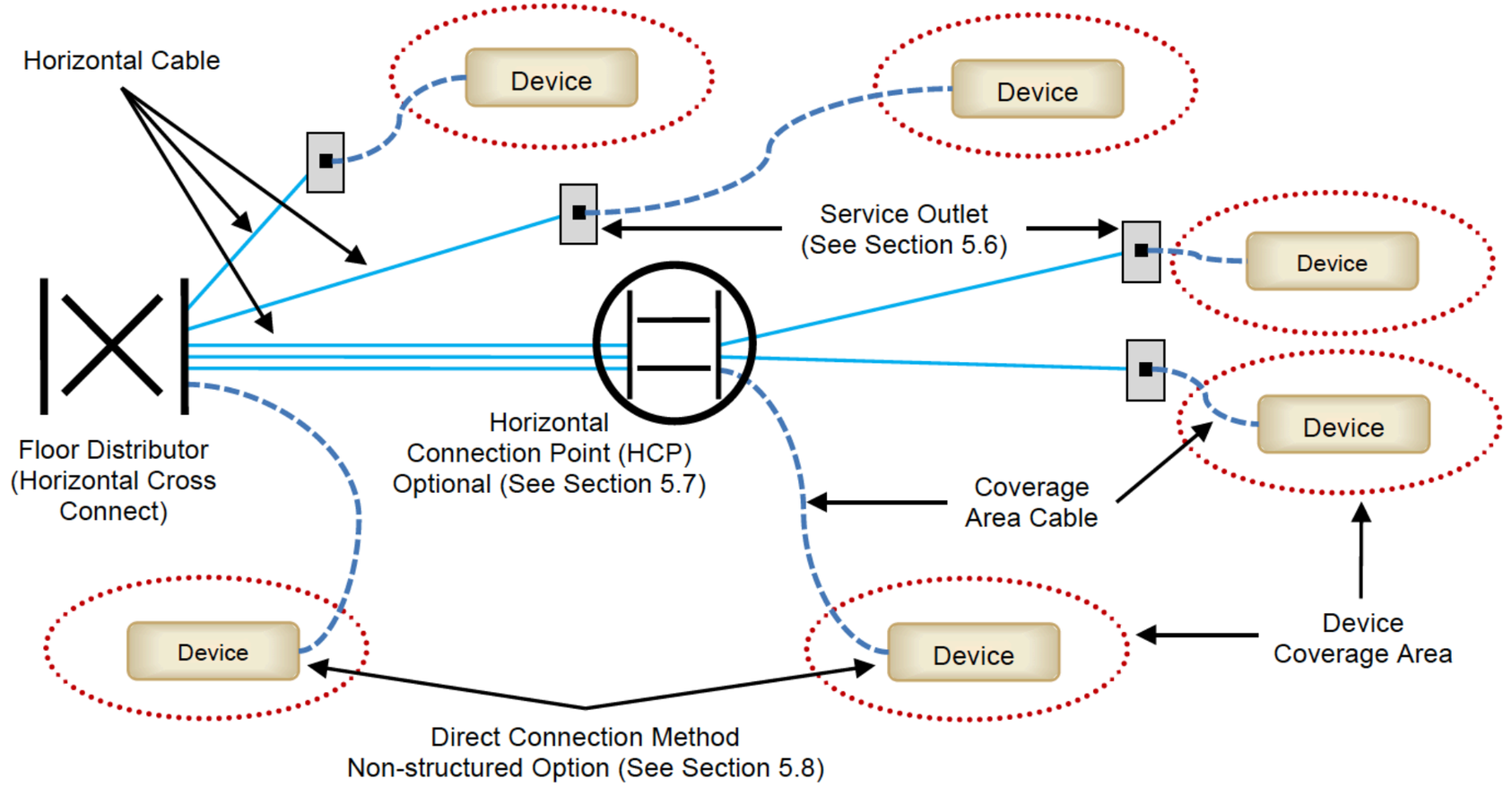
Ring Topology
(shows secondary cable)



Tree Topology

Source: ANSI/BICSI 007-2017

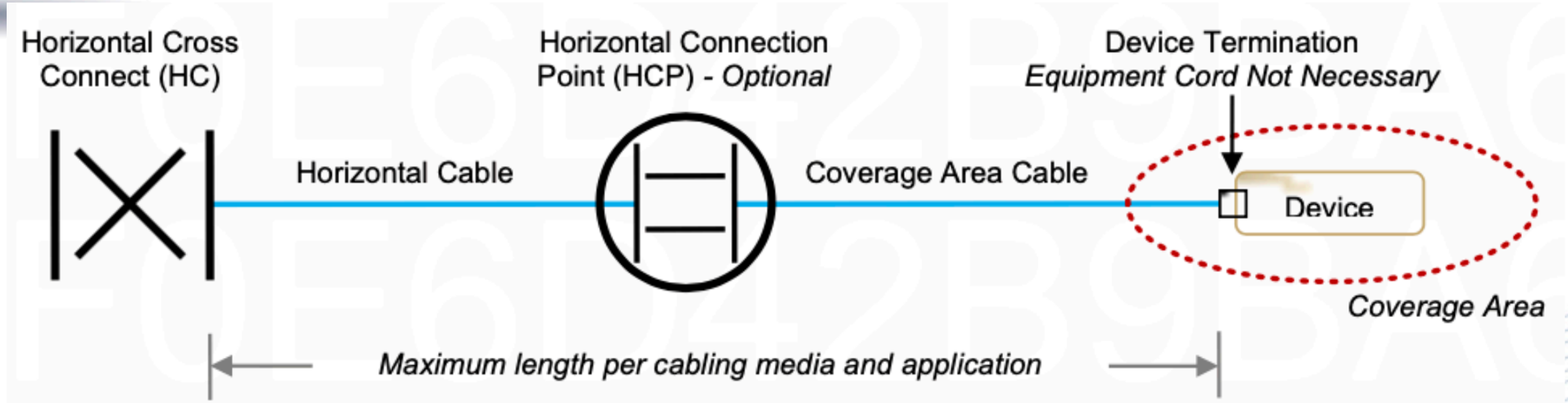
Building System Horizontal Cabling Elements within a Star Topology

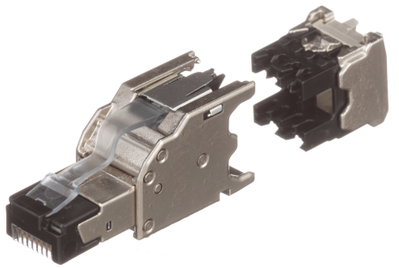


Source: ANSI/BICSI 007-2017

Modular Plug Terminated Links MPTL ("Direct Connect")

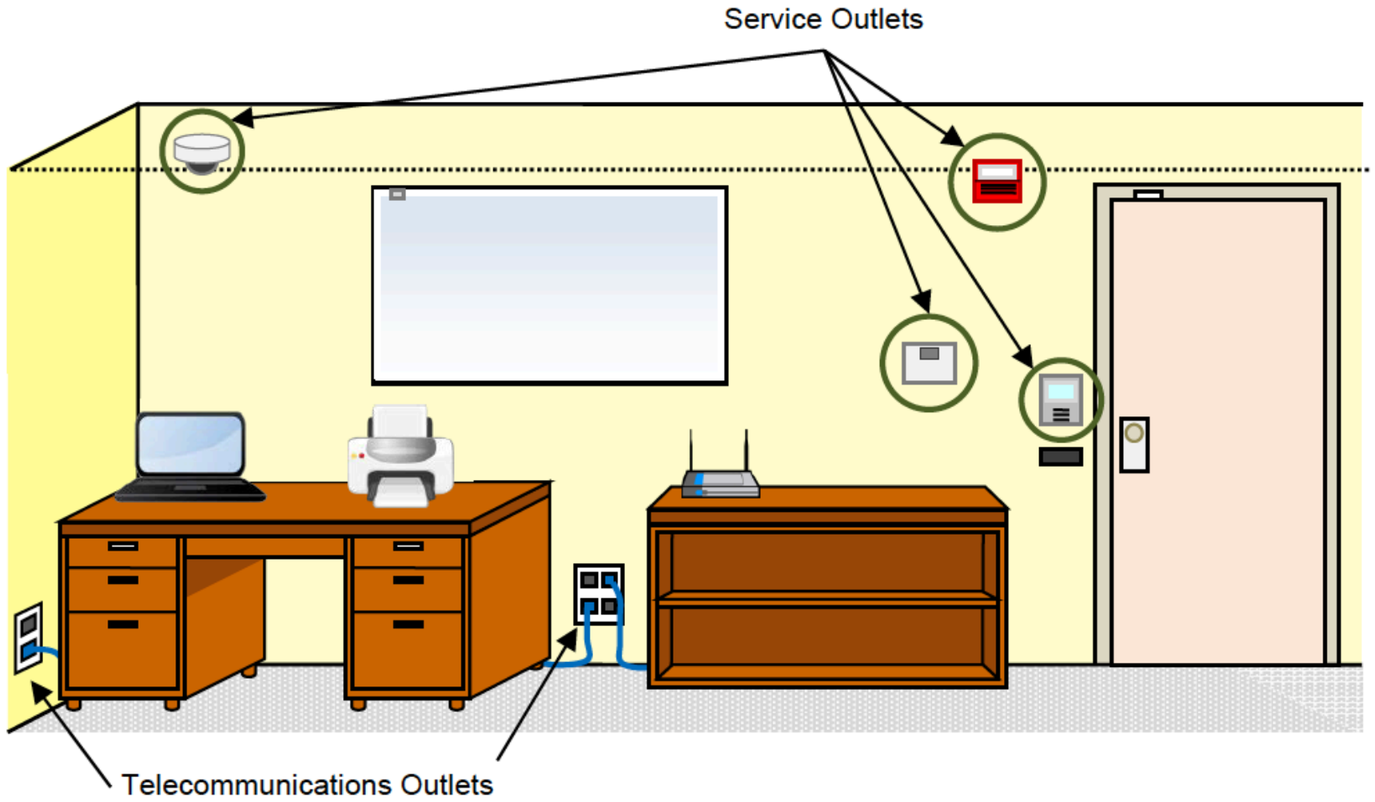
ANSI/TIA-568.2-D (2018): recognized

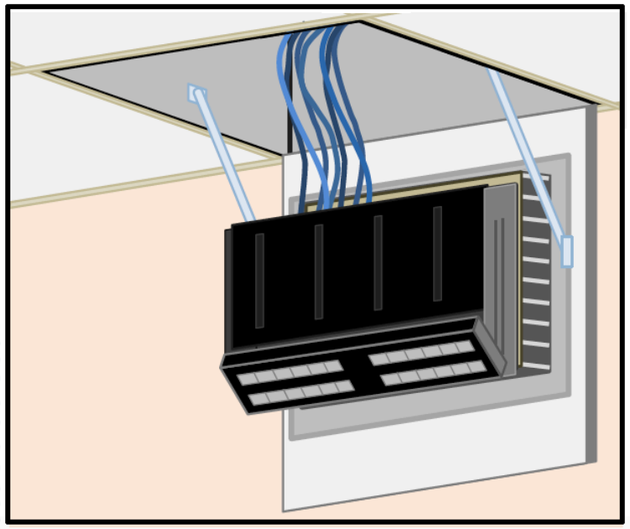




Sources: ANSI/BICSI 007-2017, panduit.com

Types of Outlets, Horizontal Connection Point (HCP)





Source: ANSI/BICSI 007-2017

Telecommunications Rooms and Telecommunications Enclosures

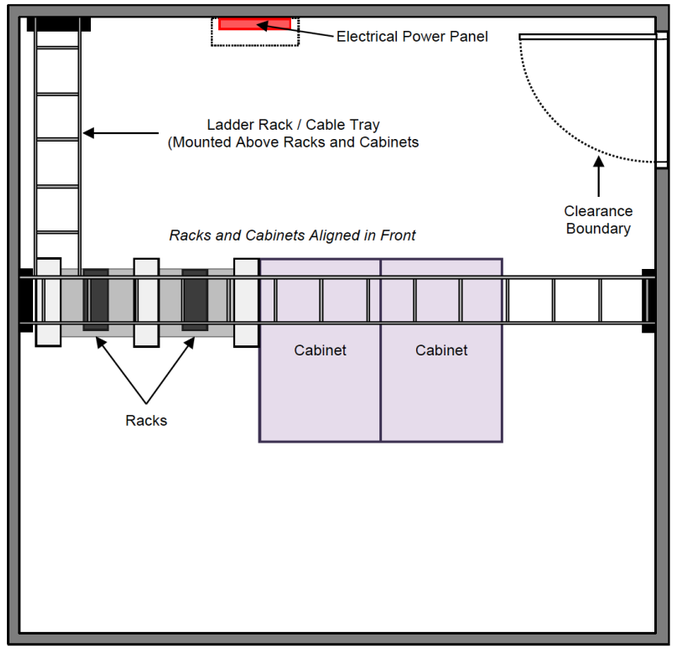


Figure 5-3
Example Layout of a Mixed Cabinet and Rack Row

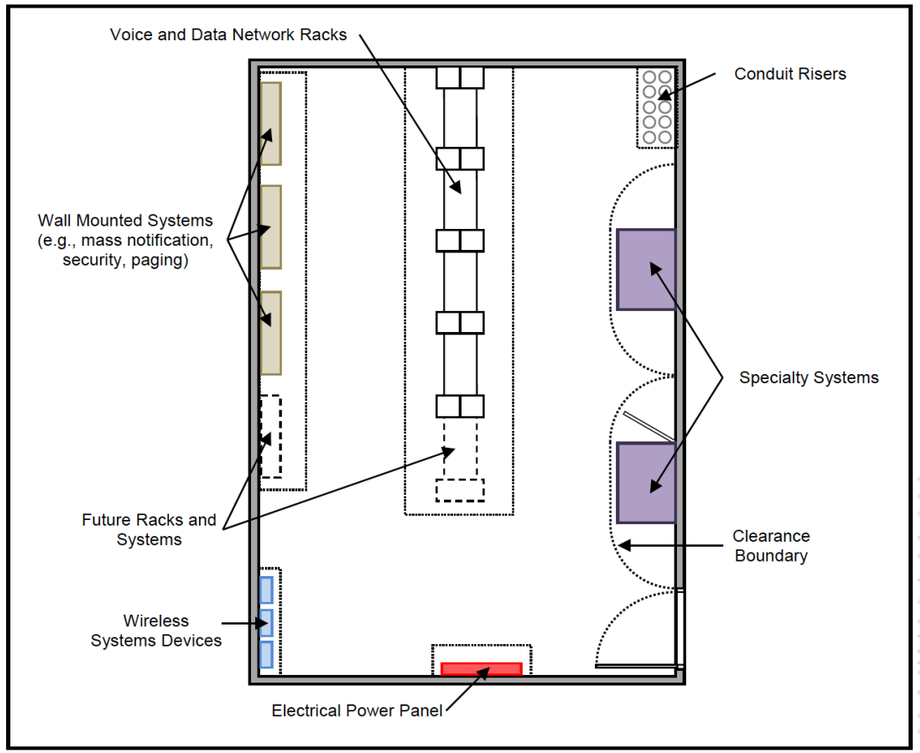


Figure 5-4
Example TR Supporting Multiple Systems

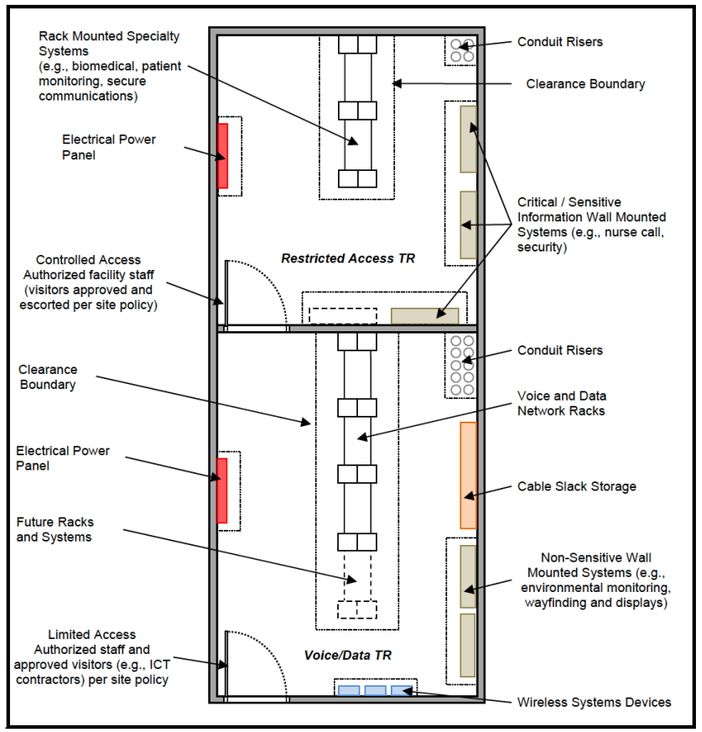
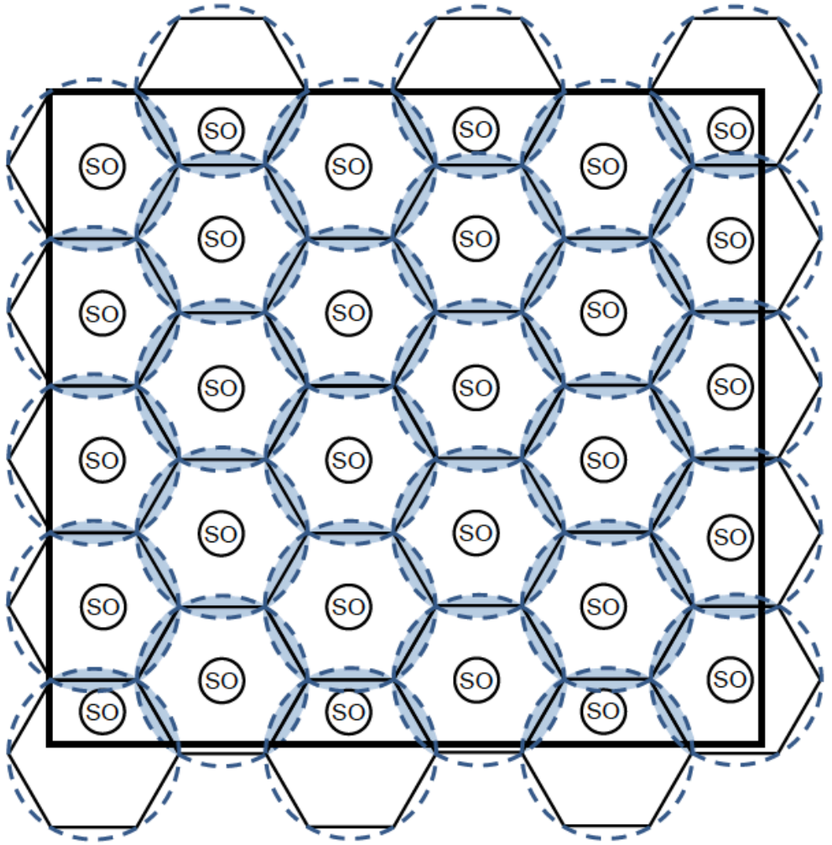


Figure 5-5
Example TR Providing Supporting Restricted Access

Source: ANSI/BICSI 007-2017

Zone Cabling, Service Outlet Coverage Area Patterns

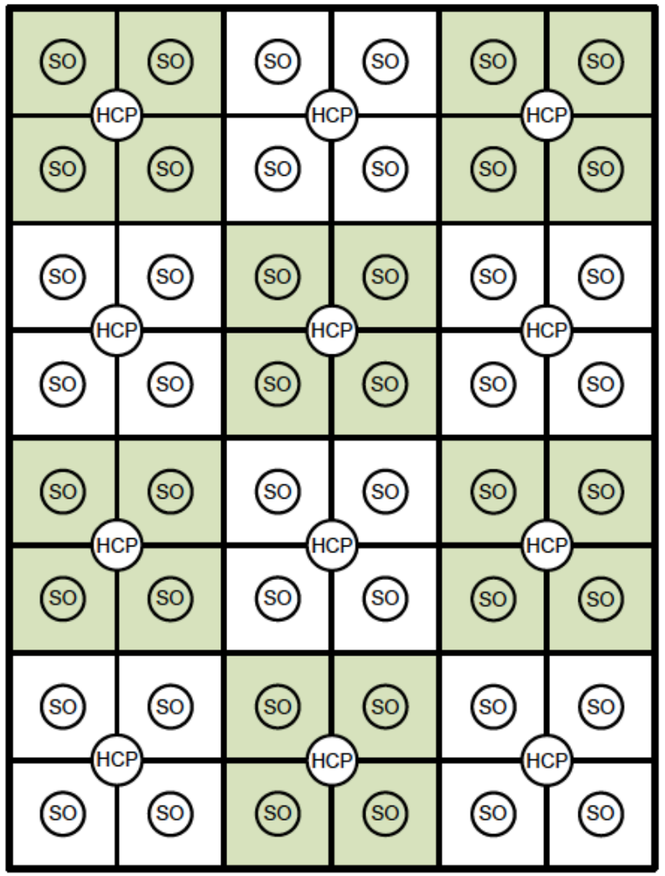
square: max 18.4 x 18.4m
Hexagonal: max 22.5x19.5m

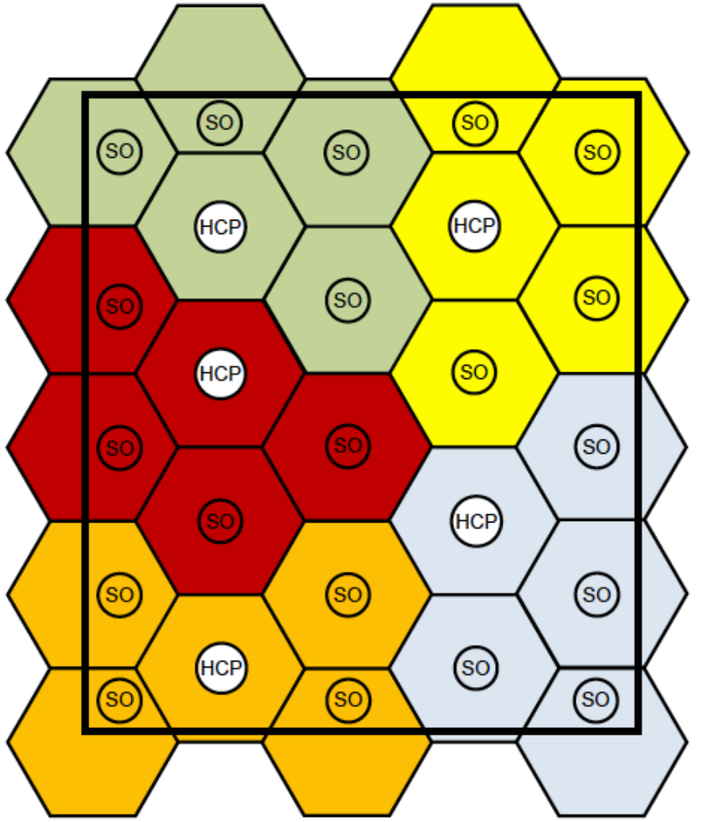


Source: ANSI/BICSI 007-2017

Zone Cabling, the use of a Horizontal Connection Point

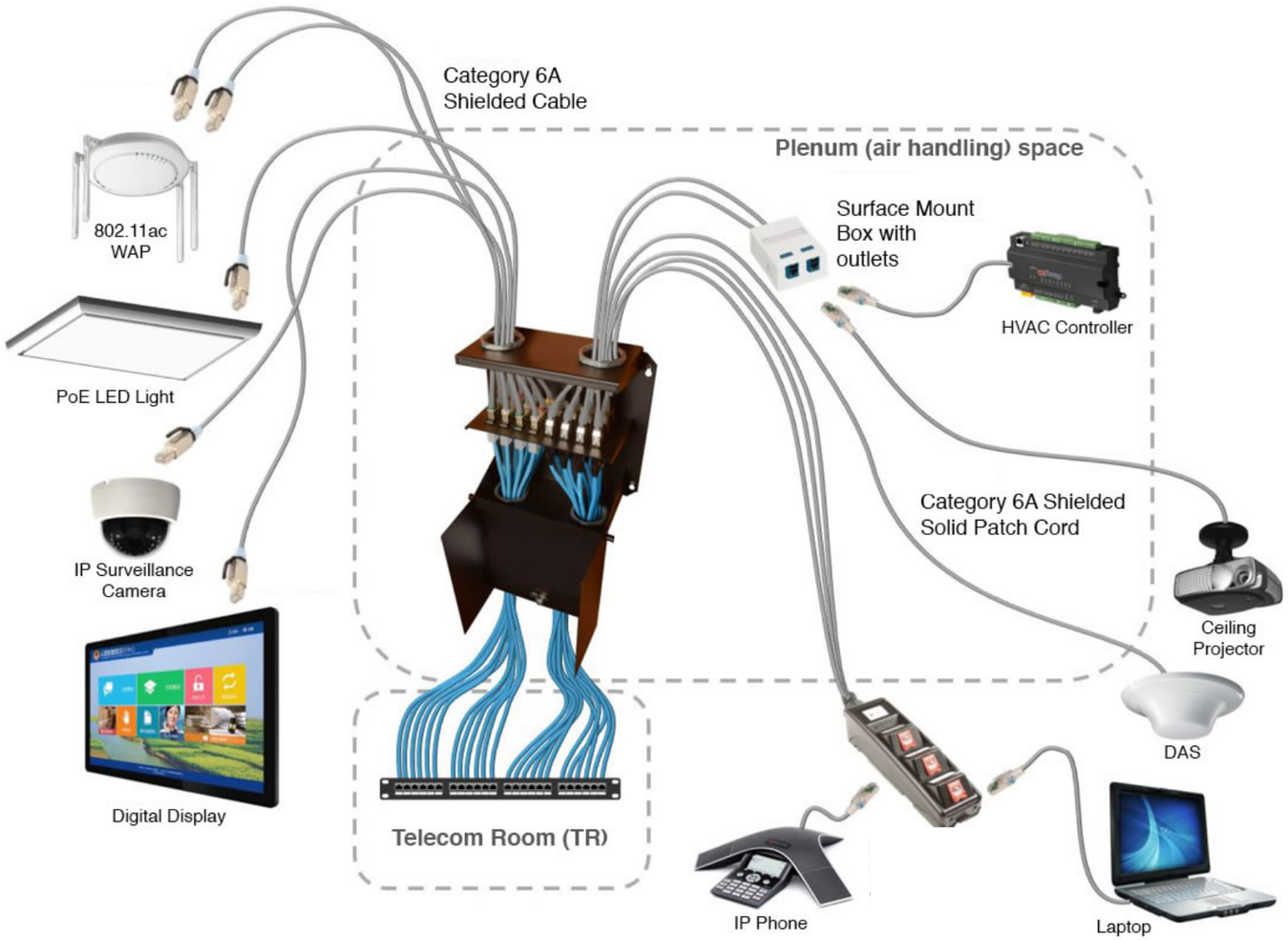
For SO coverage areas further than 17m af a TR, a HCP is recommended to consolidate cabling.





Source: ANSI/BICSI 007-2017

Zone Cabling, the use of a HCP

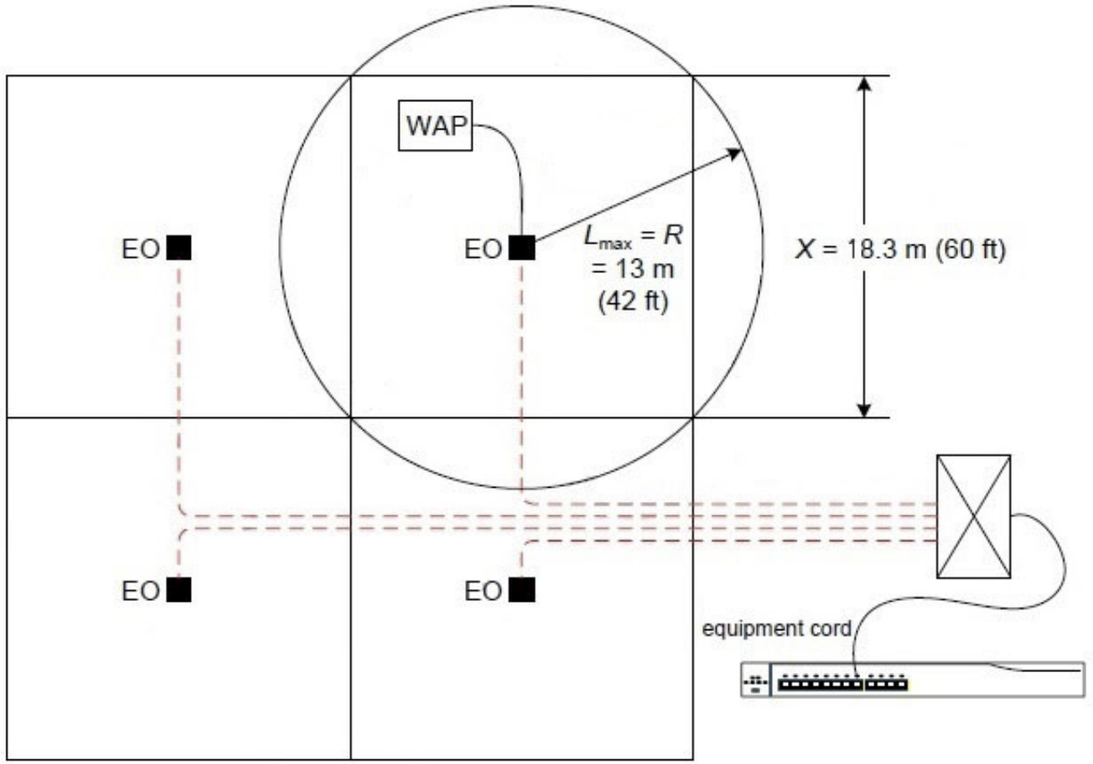


Source: siemon.com

TSB-162-A “Telecommunications Cabling Guidelines for Wireless Access Points”

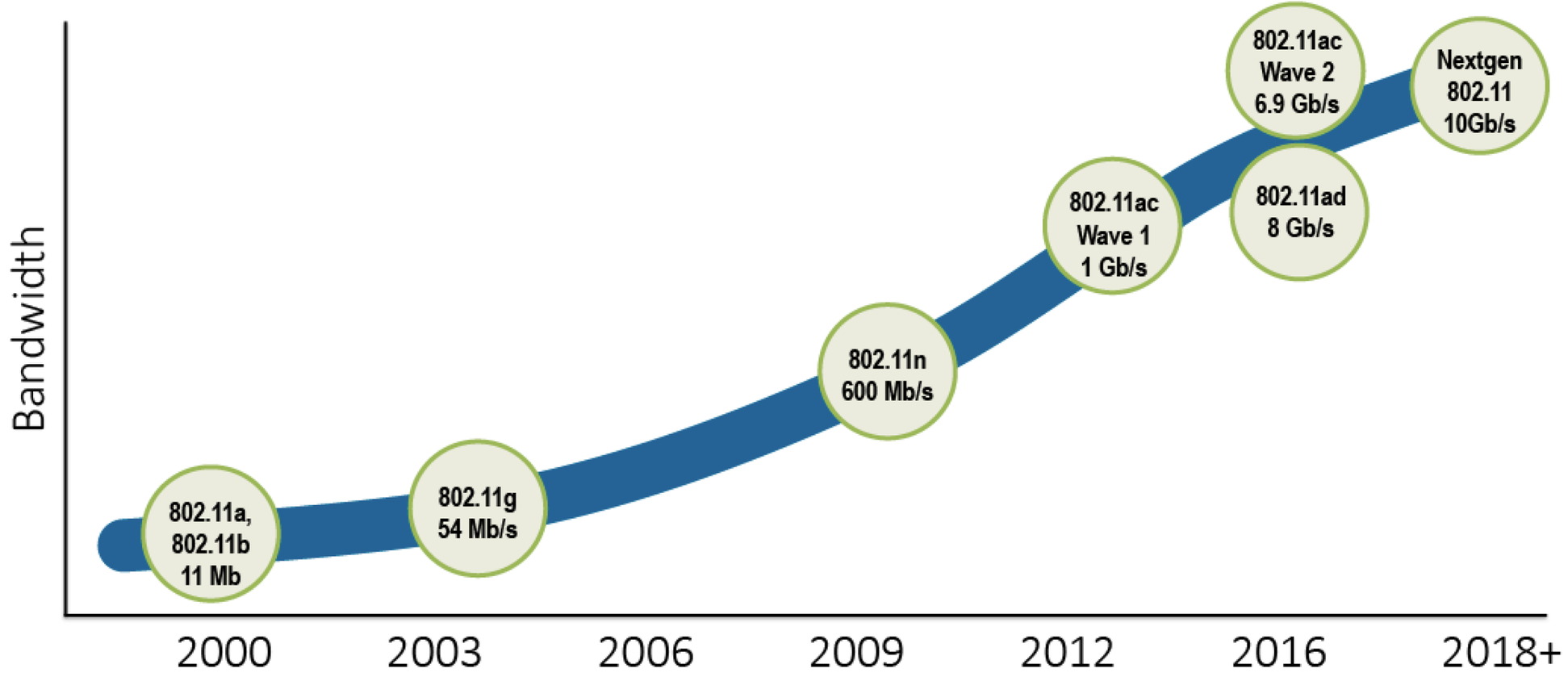
EO – Equipment Outlet
18.3m square cells

Pre-cabling using the square cell grid strategy that allows easy plug-in and flexible positioning of WAPs

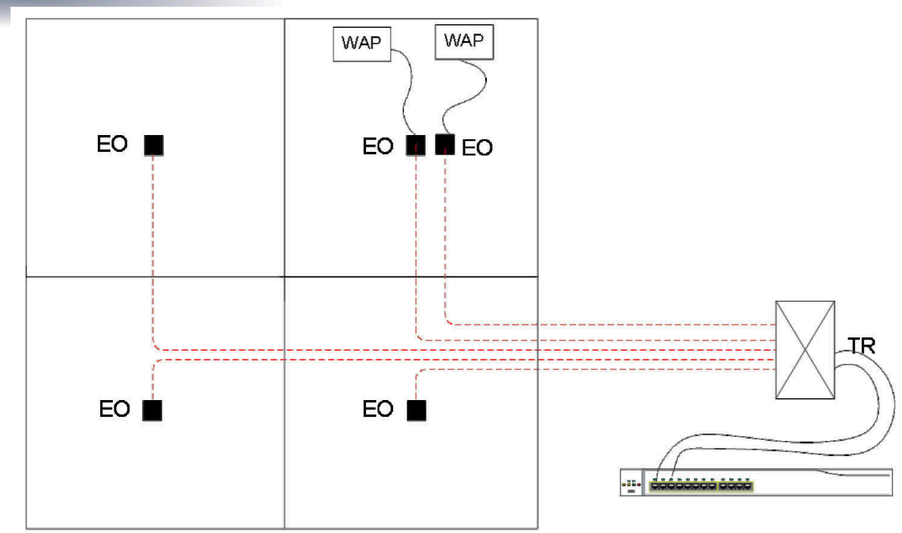


ANSI/BICSI 008-2018 Wireless Local Area Network (WLAN) Systems Design and Implementation Best Practices.

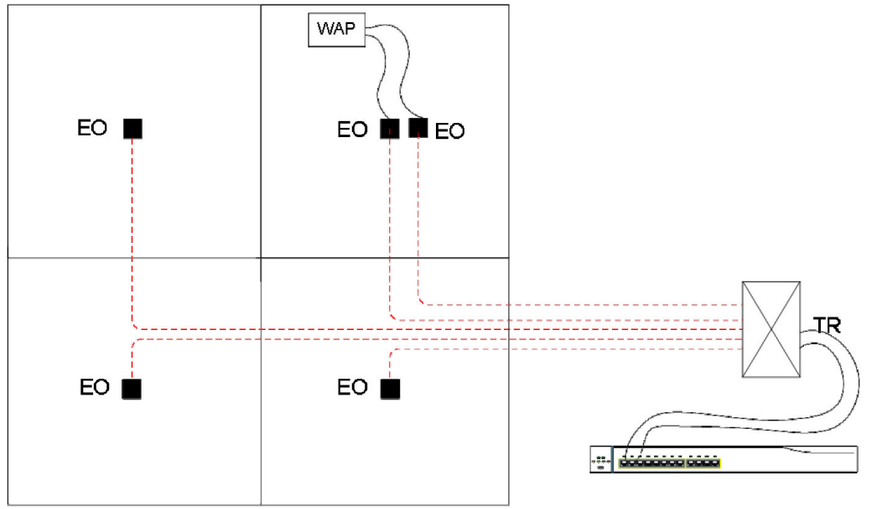
Wi-Fi Evolution



TSB-162-A, ANSI/BICSI 008-2018



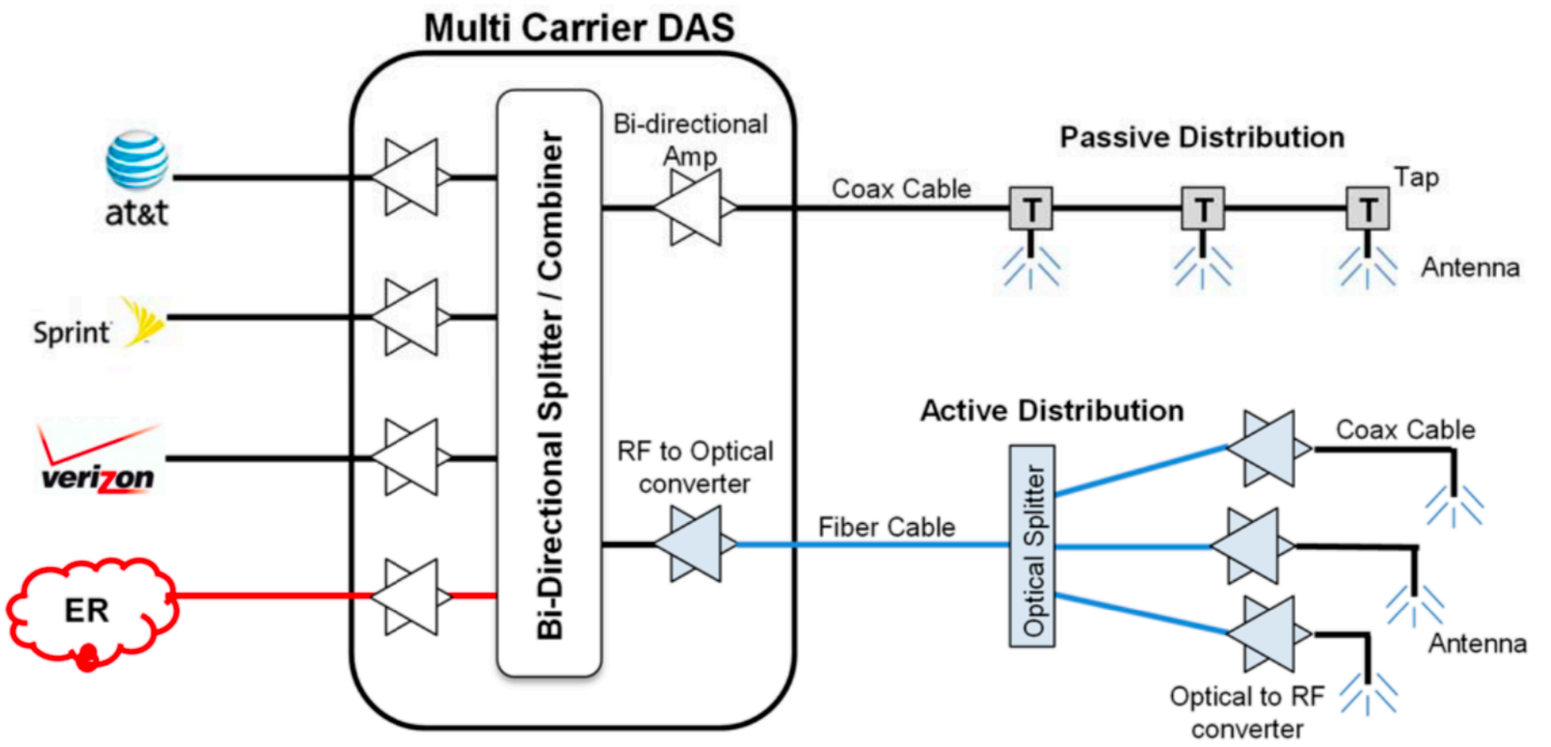
Addding an additional WAP to a cell



Link aggregation

Cat. 6A, OM3

Distributed Antenna System (DAS), Small Cells, VoWiFi



ANSI/BICSI 006-2015 Distributed Antenna System (DAS) Design and Implementation Best Practices.

Source: PANDUIT "The Future of In-Building Wireless" CPDG05--WW-ENG

Remote Powering - Power over Ethernet (PoE)

Three standards: 802.3af
802.3at
802.3bt

Nine Classes/ Wattage Levels

Four Types: 1 & 2 (2-pair)
3 & 4 (4-pair)

Names: PoE
PoE+
PoE++
UPOE

PoE Types and Classes	2-Pair PoE – Type 1				2-Pair PoE+ – Type 2	4-Pair PoE in Standardization			
Class	0	1	2	3	4	5	6	7	8
PSE Power (W)	15.4	4	7	15.4	30	45	60	75	90
PD Power (W)	13	3.84	6.49	13	25.5	40	51	62	71.3
	4-Pair PoE–Type 3					4-Pair PoE Type 4			

NEXT ETHERNET ERA
ethernet alliance

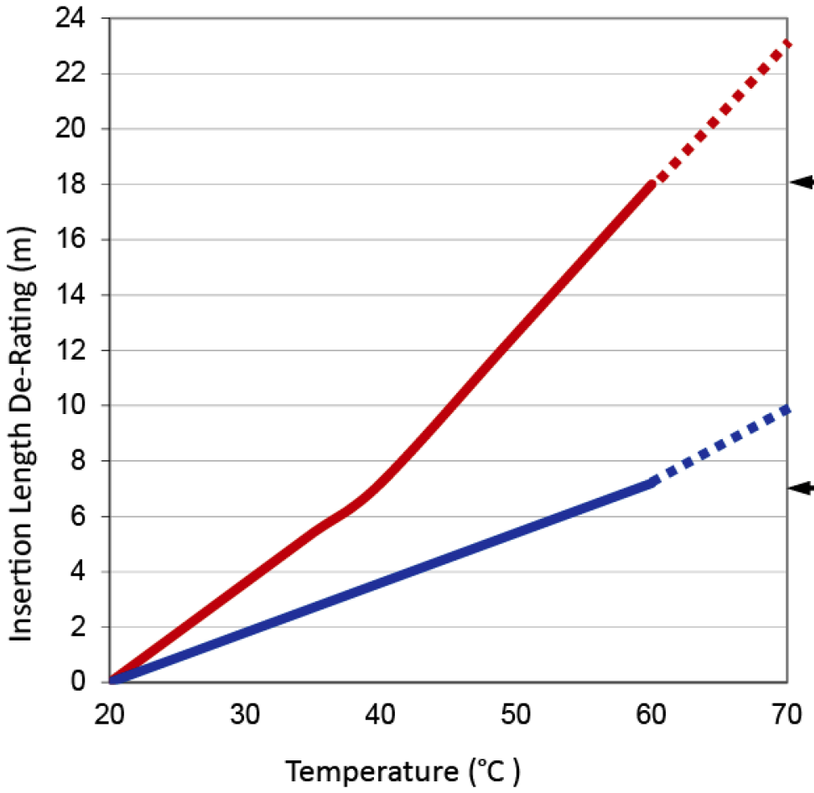
BICSI

Remote Powering - Power over Ethernet

Standard, Transmission Method	Power at Source	Maximum Current per Conductor	Applications
IEEE 802.3af **Type 1** 2-pair **PoE**	15.40 W	0.175 A	802.11n WAPs, Access Control, Thin Clients, IP Phones, fixed IP Cameras, Thin Clients, Occupancy Sensors
IEEE 802.3at **Type 2** 2-pair **PoE+**	30 W	0.3 A	PTZ IP Cameras, Alarm Systems, Video IP Phones, RFID Readers
IEEE 802.3bt **Type 3** 4-pair **PoE++**	60 W	0.3 A	Access Control, PTZ IP Cameras, 802.11ac WAPs, Point-of-Sales Readers, LED Lighting, Info Kiosks
Cisco UPOE	60 W	0.3 A	Access Control, PTZ IP Cameras, 802.11ac WAPs, POS Readers
IEEE 802.3by **Type 4** 4-pair **PoE++** (4PPoE)	100 W	0.5 A	Televisions, Desktop Computers, Video Conferencing, High Power Wi-Fi
Power over HDBaseT **(PoH)**	100 W	0.5 A	Televisions, Desktop Computers….

Source: BICSI 007, cisco.com, hdbaset.org

Channel Length De-rating with Temperature

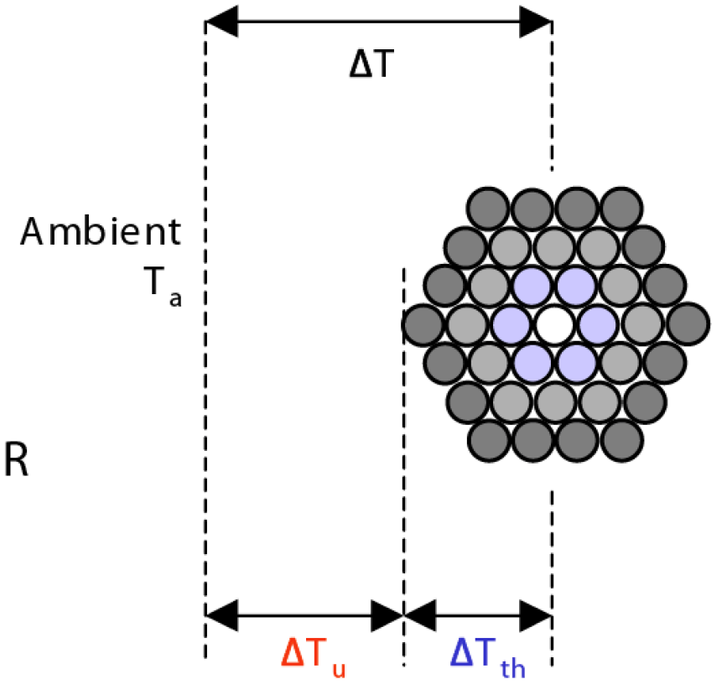


TIA, ISO/IEC Cat. 6A U/UTP
Subtract 18 m at 60°C

TIA, ISO/IEC Cat. 6A F/UTP
Subtract 7 m at 60°C

CENELEC-CLC/TR 50174-99-1 “Cabling Installation Part 99-1: Remote Powering”

R = resistance of conductor [Ω/m]
d = cable diameter [m]
i_c = conductor current [A]
n_c= number of conductors per cable carrying current
N = number of cables in the bundle
ρ_{th}= cable type effects
ρ_u= installation environment effects



$$P = N \times n_c \times i_c^{\,2} \times R$$

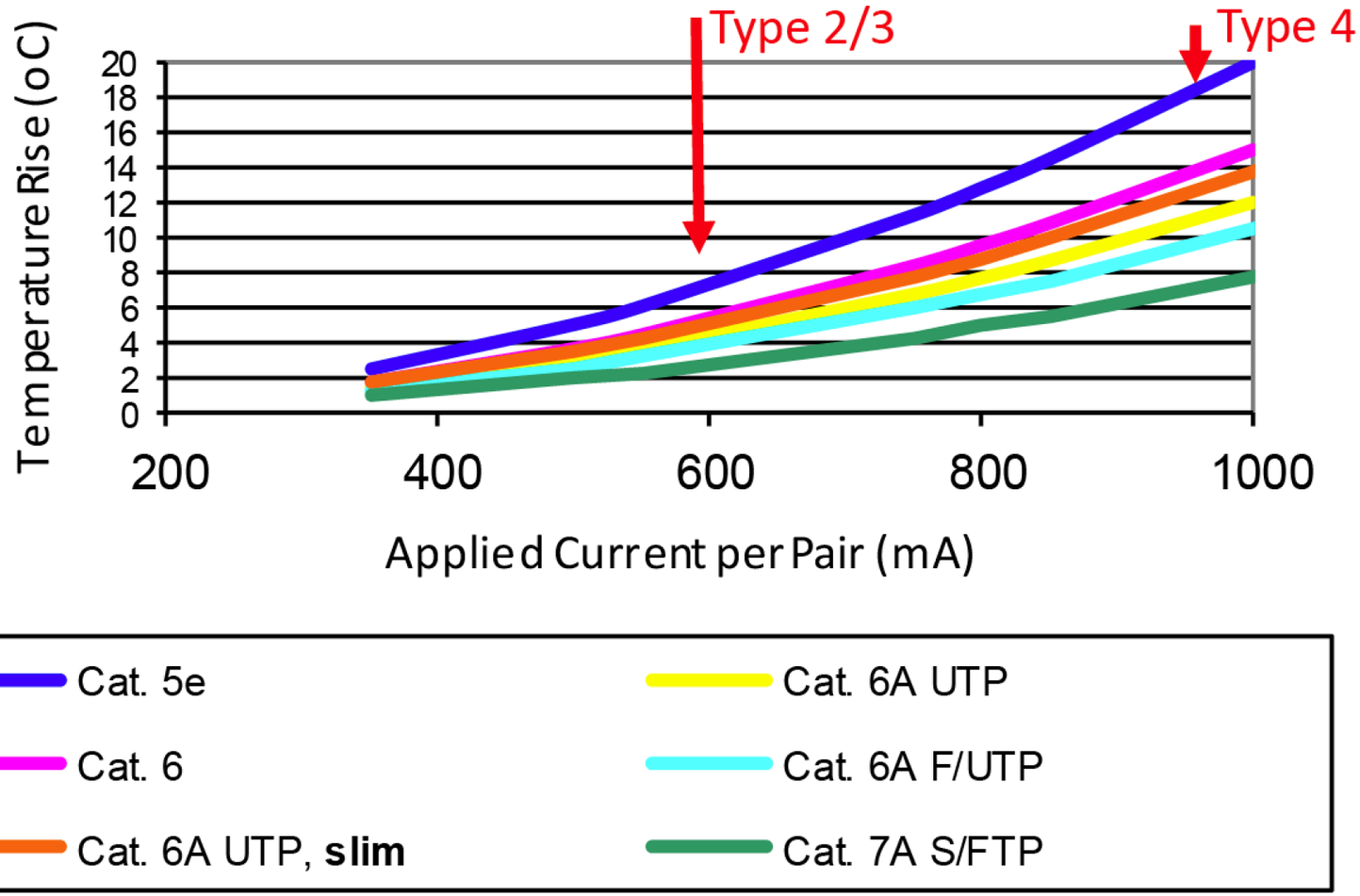
$$\Delta T_u = \frac{\rho_u \times P}{\sqrt[4]{0{,}75 \times \pi^6} \times d \times \sqrt{N}} \approx \frac{\rho_u \times P}{5{,}182 \times d \times \sqrt{N}}$$

$$P = N \times n_c \times i_c^{\,2} \times R$$

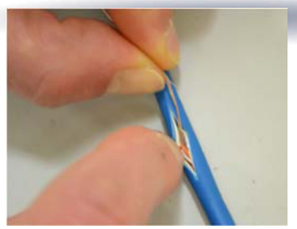
$$\Delta T_{th} = \frac{\rho_{th} \times P}{4 \times \pi} \approx \frac{\rho_{th} \times P}{12{,}6 \times \pi}$$

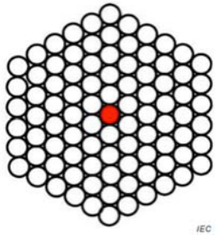
Source: CENELEC - CLC/TR 50174-99-1

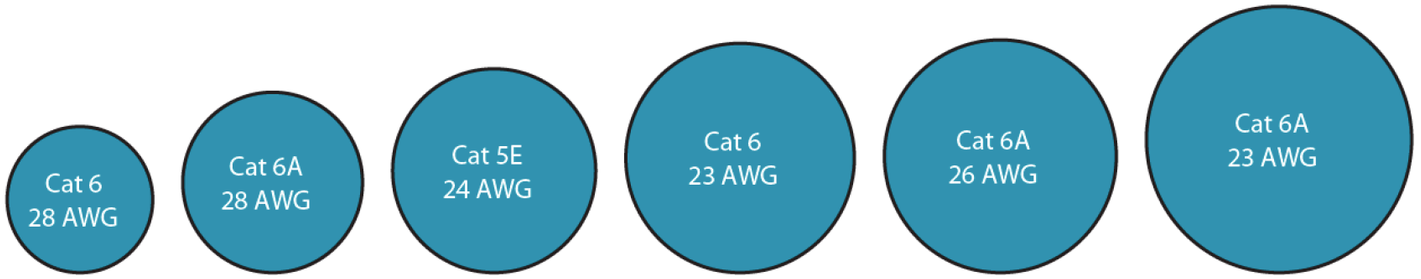
PoE Cable Temperature Rise vs. Current in 100-cable Bundle

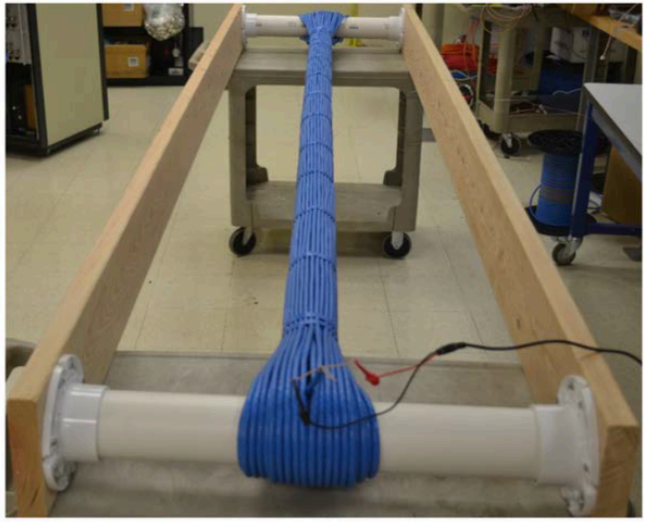


PoE – Cable Bundles - Heat: Testing







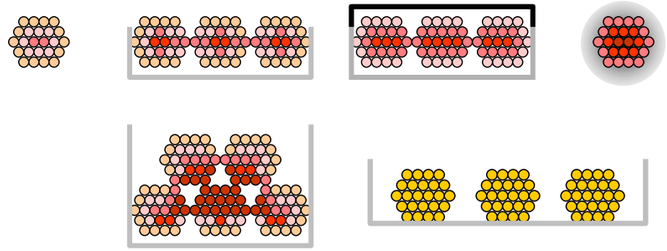


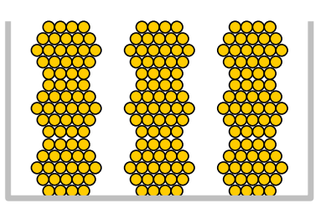
Cable Type	PoE / PoE + Maximum Bundle Size (2-pair, up to 600mA)	PoE++/HDBaseT Maximum Bundle Size (4-pair, up to 960 mA)
Cat 6 28 AWG	48	24
Cat 6A 28 AWG	48	24
Cat 5E 24 AWG	Tested up to 100 cables	61
Cat 6 23 AWG	Tested up to 100 cables	72
Cat 6A 26 AWG	Tested up to 100 cables	48
Cat 6A 23 AWG	Tested up to 100 cables	Tested up to 100 cables

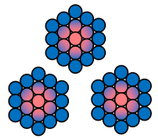
Source: panduit.com

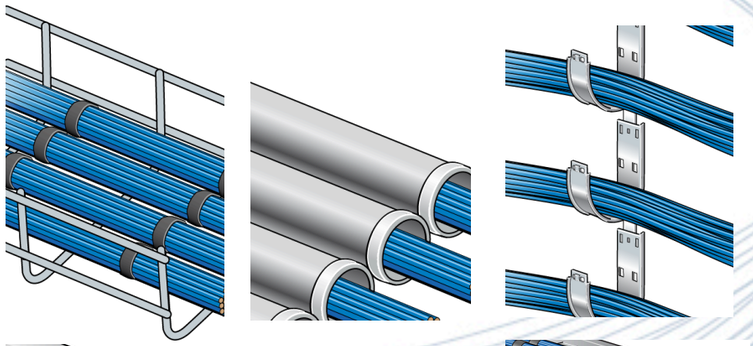
Rule of thumb: **a maximum of 24 cables per bundle**

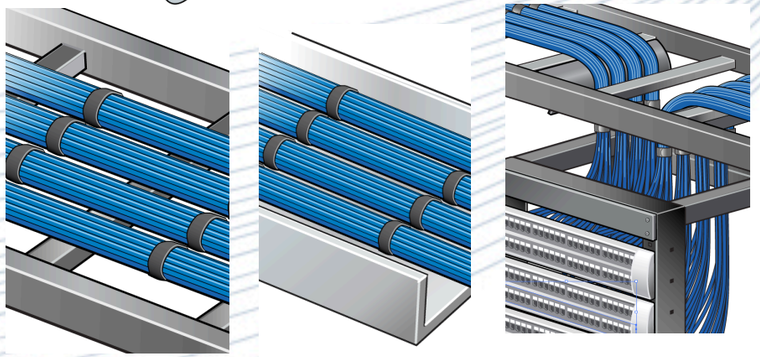
(allowing a 24 AWG or larger gauge sizes to be within the cable temperature rating of 60°C when installed in worst-case conditions)









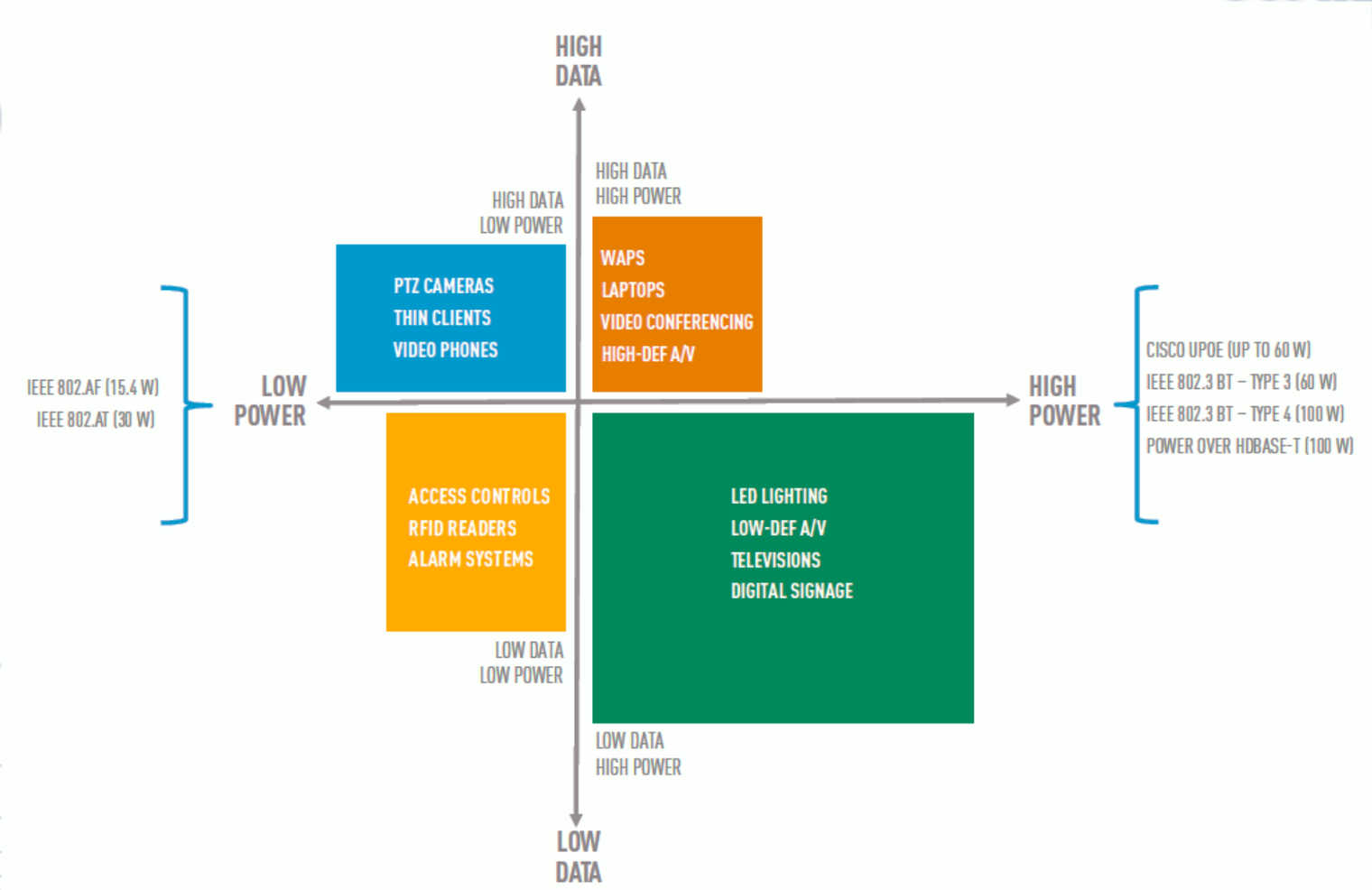


TIA-569-D-2-2018

- *Additional Pathway and Space Considerations for Supporting Remote Powering Over Balanced Twisted-Pair Cabling* (July 2018)
- Pathways differ in regard to geometry and contact area between cables, pathway, and air
- Provides general guidance on heat dissipation of various pathways by bundle size

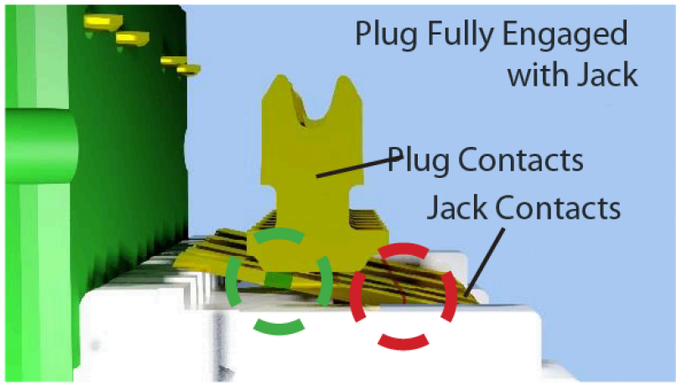
Source: commscope.com, various

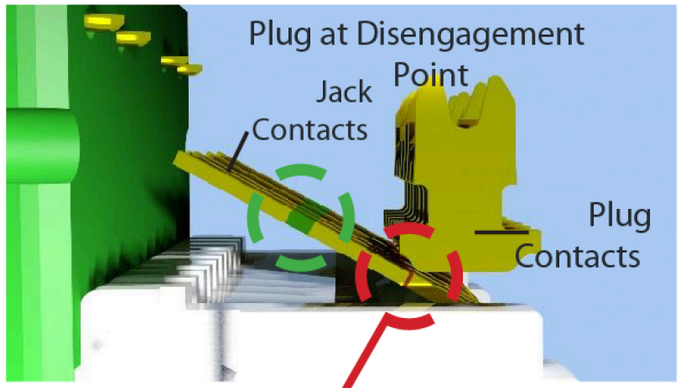
When selecting the category of cable, take into consideration the mix of power and data.

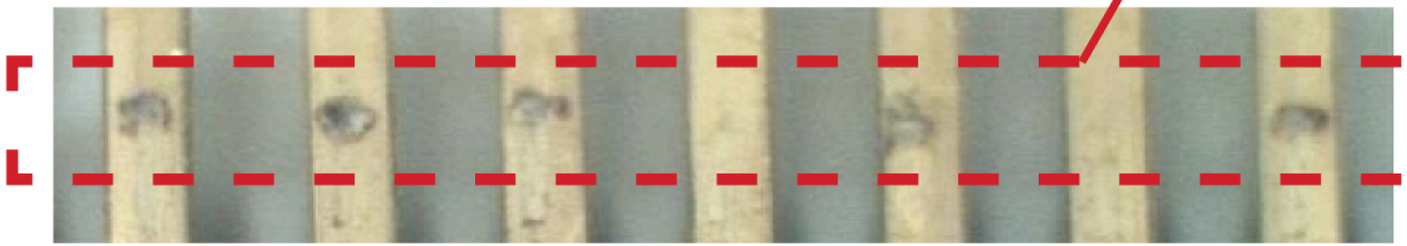


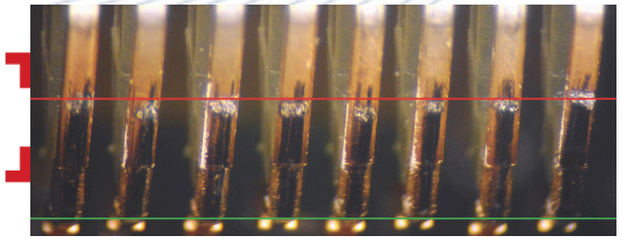
Source: BICSI ICT Today magazine, Jan-Feb 2017, Carol Everett Oliver, RCDD, ESS

PoE – Arcing during unmating cycle; Spark Erosion



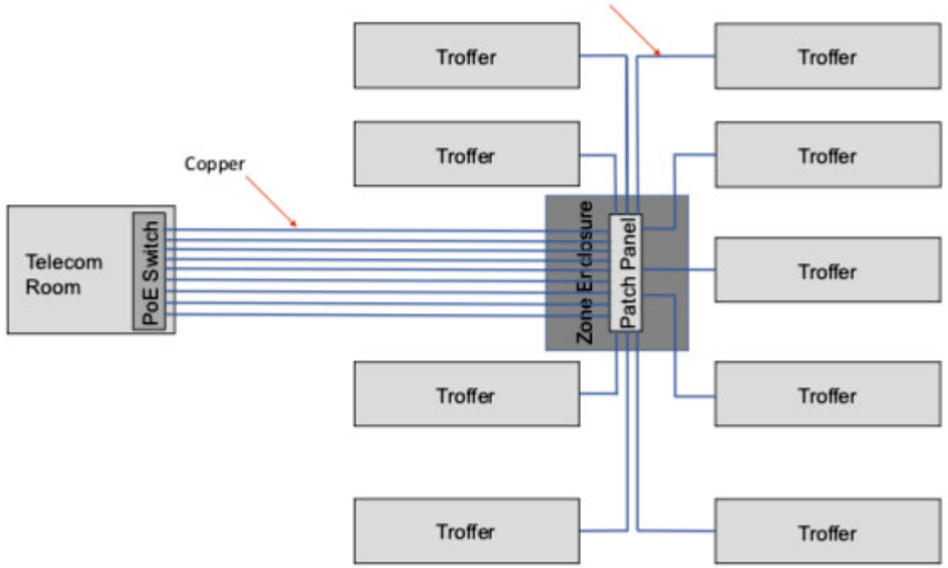




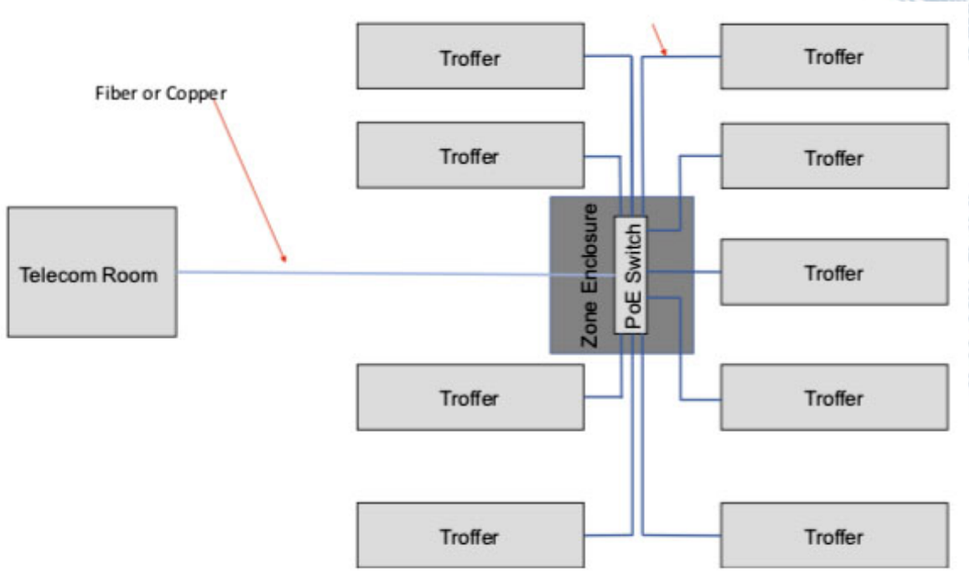


Source: panduit.com, rdm.com

PoE for Lighting: Centralized vs. Distributed deployment



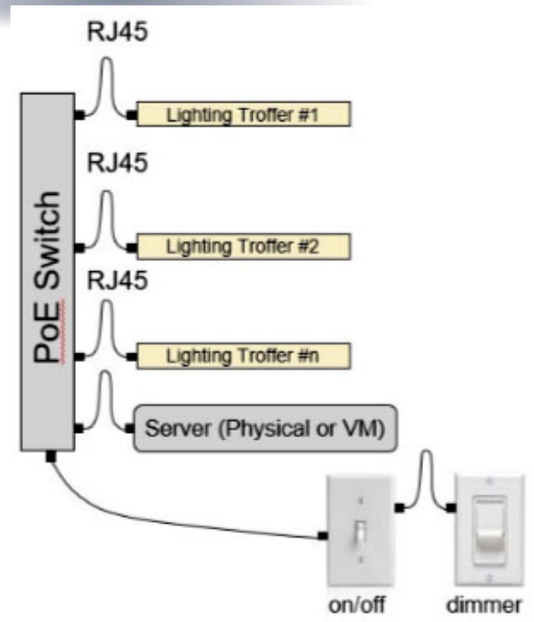
Centralized PoE switch zone cabling deployment (most common)



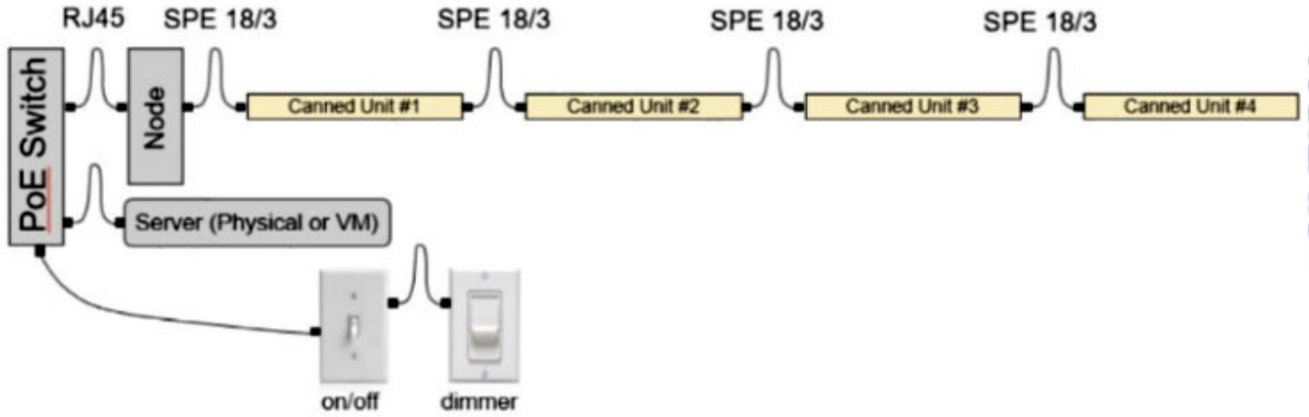
Distributed PoE switch zone cabling deployment

Source: panduit.com

PoE for Lighting: Directly-attached vs. Node-centric architecture



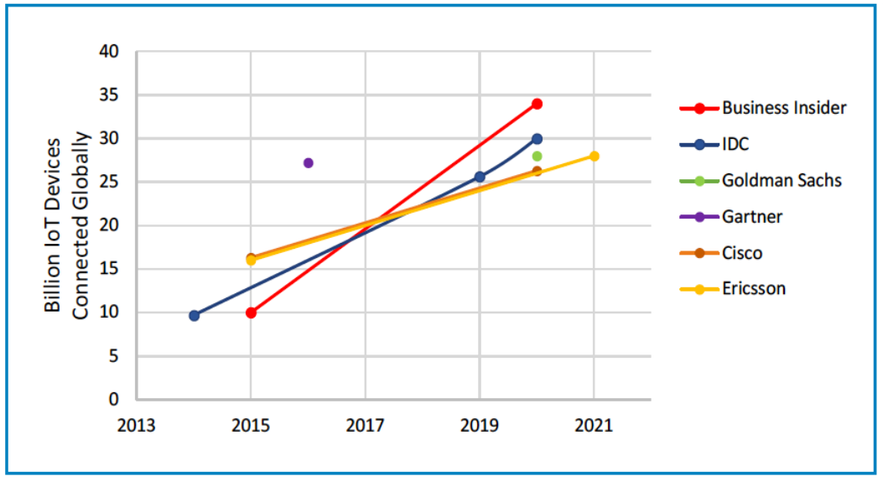
Directly-attached architecture



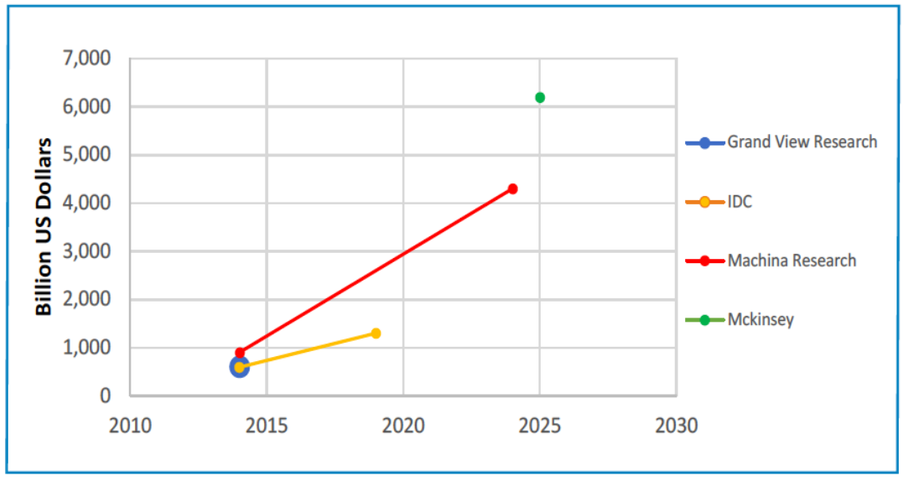
Node-centric architecture

Source: panduit.com

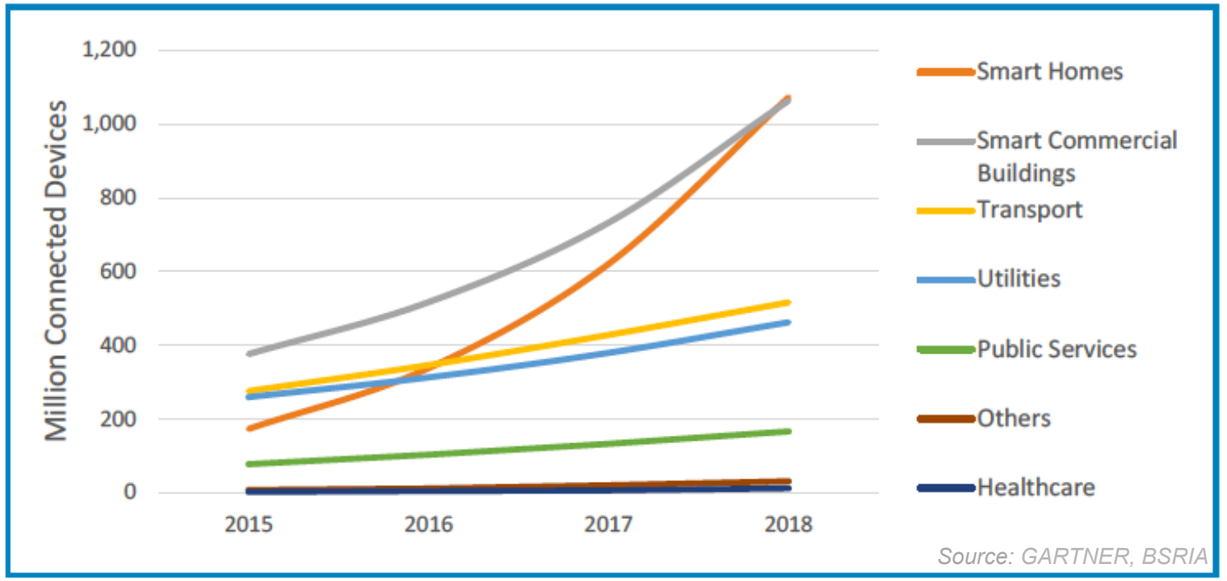
Internet of Things



Estimated number of devices IoT



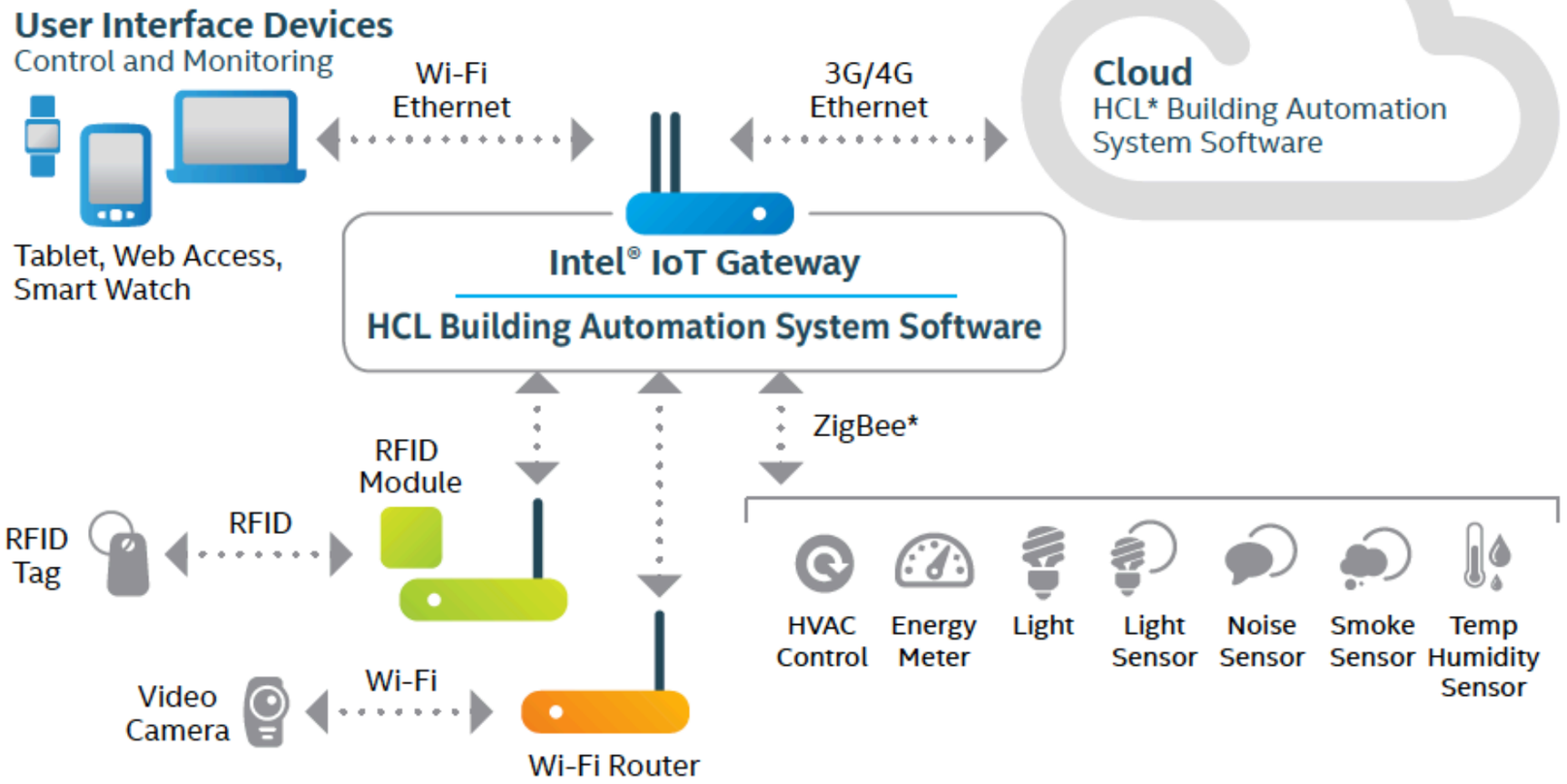
Forecast for the total value of IoT



Number of connected devices in smart cities

Source: as indicated, interpretation by BSRIA WP 9/2018

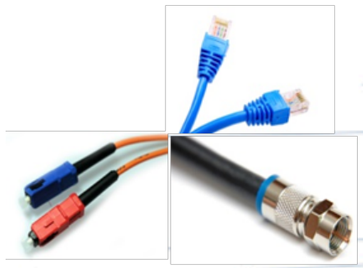
IoT: Building Automation System (BAS) Configuration Example



Source: intel.com/iot & hcl.com

Intelligent Building IoT Communication Technologies

Wired	WPAN	W-Mesh	WLAN	WWAN
• Ethernet, Coax, Fiber, etc. considered as a single category	• ANT+ • *Bluetooth* ® – Classic & Smart Ready • *Bluetooth* ® Smart	• ZigBee PRO • ZigBee RF4CE • ZigBee Multi-Protocol • EnOcean • ISA100.11a • WirelessHART • Z-Wave • Other 802.15.4	• 802.11a/b/g • 802.11n • 802.11ac • 802.11ad • Other 802.11 • DECT ULE • Other 2.4GHz • Other Sub-GHz	• 2G Cellular • 3G Cellular • 4G Cellular

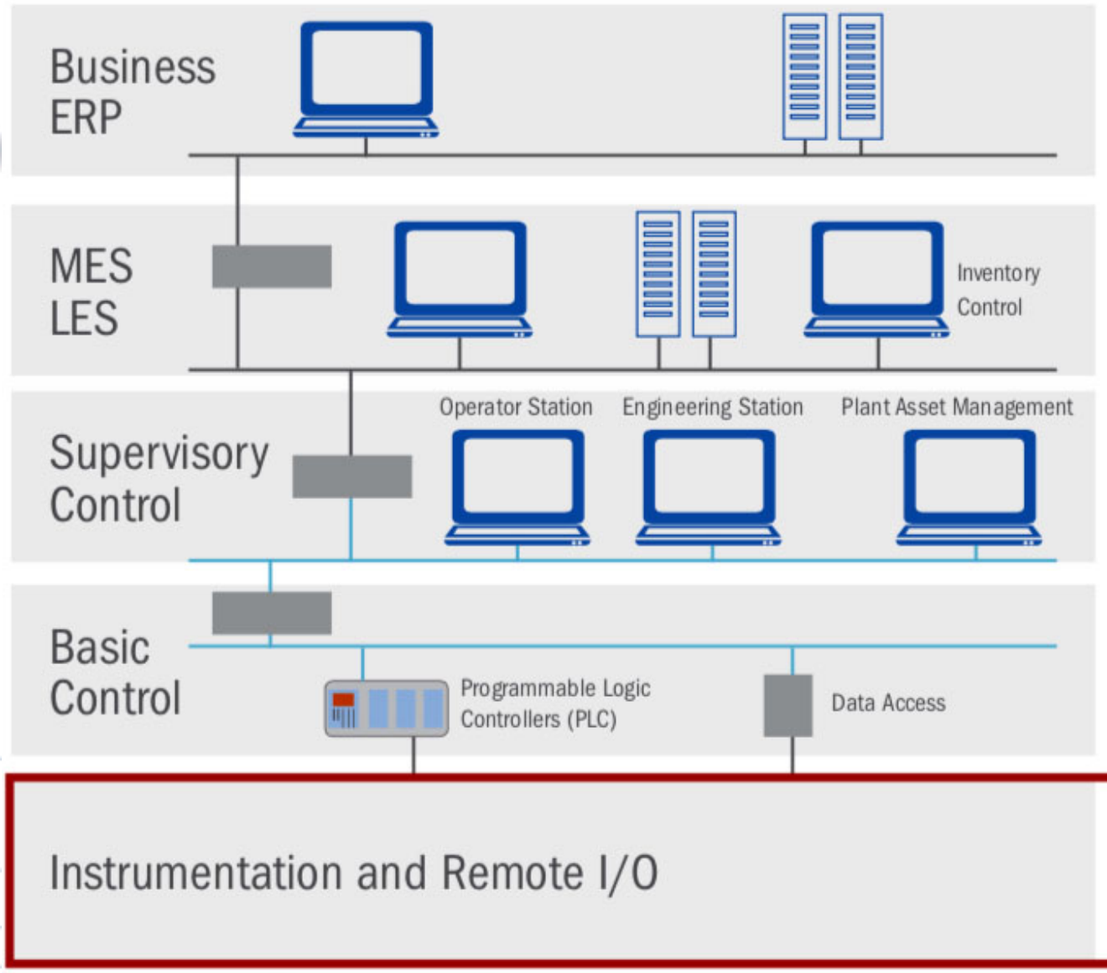


ANT+ *Bluetooth* Z-WAVE ISA100 WIRELESS ULE UltraLowEnergy WirelessHART Wi Fi WiGig CERTIFIED by Wi-Fi Alliance

Source: caba.org

Bicsi

Ethernet gaps...



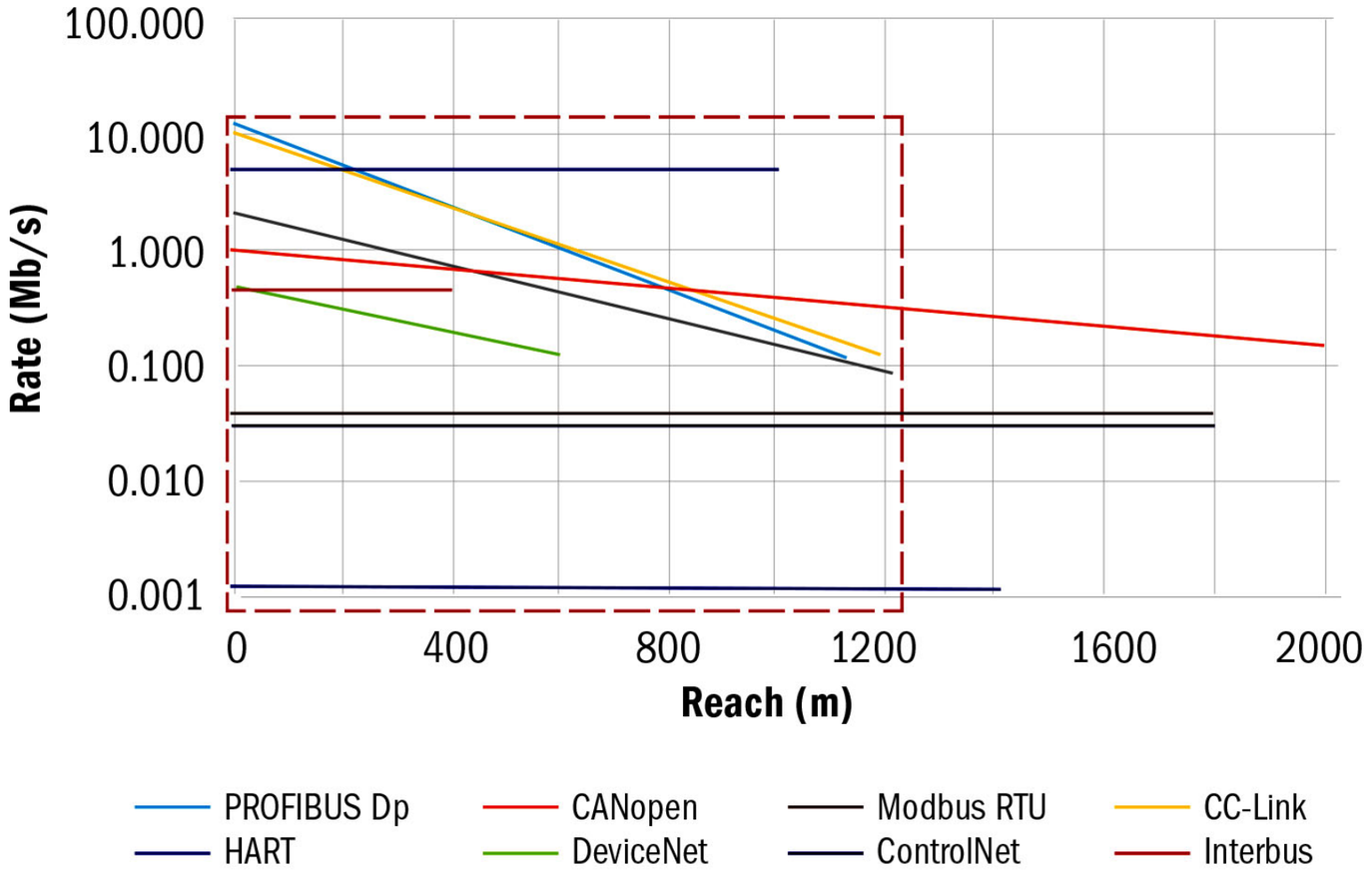
Standard Ethernet/IT solutions already established

Ethernet solutions already defined as "Industrial Ethernet"

Ethernet for field instrumentation ???

Source/credit: Dr. Raimund Sommer, Endress and Hauser, ODVA Industry Conference, Oct. 2014

Fieldbus Reach and Rate



Source: IEEE 802.3 CFI_01_0716.pdf

SPE – Single Pair Ethernet

Standard	IEEE	Data transfer rate	Reach	Use in:
100BASE-T1	802.3bw-2015	100 Mb/s	over 15m	automotive
1000BASE-T1	802.3bp-2016	1 Gb/s	over 40m	automotive

IEEE P802.3cg Task Group; Start: July 2016 - projected for publication in 2019:

Standard	IEEE	Data transfer rate	Reach	Use in:
10BASE-T1S	802.3cg	10 Mb/s	at least 15m	Automotive & Industry
10BASE-T1L	802.3cg	10 Mb/s	up to 1000m	Industry & Buildings

also: PoDL (Power over Data Lines); up to 13.6W

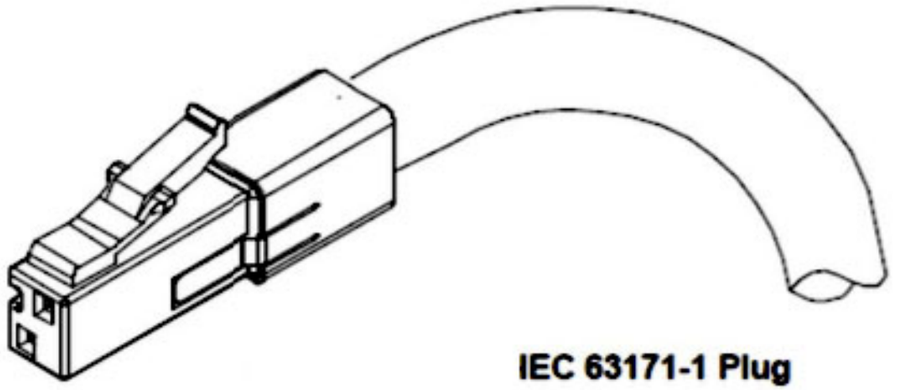
TIA-568.5 (pending) Single Balanced Twisted-Pair Cabling Channel Configurations

Reach	Topology	Possible Name	Bandwidth
1000 m	1000 m AWG 18 (1.02mm) solid or stranded conductors cable plus up to 10 connectors	SP1	0.1 – 20 MHz
100 m	90 m AWG 23 (0.57mm) solid conductors cable, 10 m AWG 24 (0.51mm) or 8 m AWG 26 (0.40mm) cords, plus up to 4 connectors	SP2	0.1 – 600 MHz
40 m	30 m AWG 22 conductors cable, 10 m AWG 22 (0.64mm) cords plus up to 4 connectors	SP3	0.1 – 600 MHz
15 m	11 m AWG 26 (0.40mm) conductors cable, 4 m AWG26 (0.40mm) cords, plus up to 4 connectors	SP4	0.1 – 600 MHz

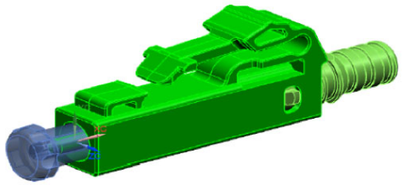
Developing TIA Single Balanced Twisted-Pair Cabling Standards

Number	Title	Environment
ANSI/TIA-568.0-D-2	Single Balanced Twisted-Pair Use Cases and Topology	Enterprise Customer Premises ($M_1I_1C_1E_1$)
ANSI/TIA-568.5	Single Balanced Twisted-Pair Cabling and Components Standard	Enterprise ($M_1I_1C_1E_1$)
ANSI/TIA-862-B-2	Single Balanced Twisted-Pair Use Cases and Topology	Intelligent Building Systems ($M_1I_1C_1E_1$)
ANSI/TIA-1005-A-4	Single Balanced Twisted-Pair Use Cases and Topology for Industrial Premises	Light/Heavy Industrial

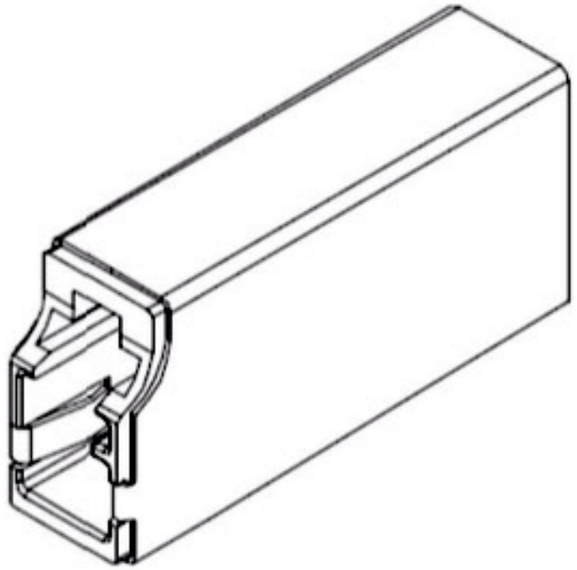
TIA & ISO/IEC identified a single-pair connector design



IEC 63171-1 Plug



Fiber LC Connector



IEC 63171-1 Jack

Source: www

Information Technology, Operational Technology

***OT** is hardware and software that detects or causes a change through the direct monitoring and/ or control of physical devices, processes and events in the enterprise.*

IT	OT
User-centric communication	Machine-to-machine communication
Managed by IT experts	Maintained by facility operations
Sensitive corporate data	Critical building functions
Unpredictable traffic behavior	Predictable device behavior

Source: BICSI ICT Today magazine, May-Jun 2018, Dan Ronald; Gartner IT Glossary

Summary

- A smart building is a philosophy; and a strategy to implement-it
- IoT in building industry: it’s here to stay
- Structured cabling adapts to the new needs, basic design principles remain. Standards are more important than ever.
- PoE applications are growing; attention to the way we cable
- Zone cabling supports convergence of data networks, Wi-Fi uplink connections, and a wide range of sensors, detectors, actuators...
- Single-pair Ethernet opens new roads.

Întrebări?

Mulțumesc!

yannis.katris@telectrik.ro

0722 283 888

TeleCTrik

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