

BASE-T, PoE, and Single Pair Ethernet for Access and Home Applications

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Chair, IEEE P802.3dg 100 Mb/s Long-Reach Single-Pair Ethernet

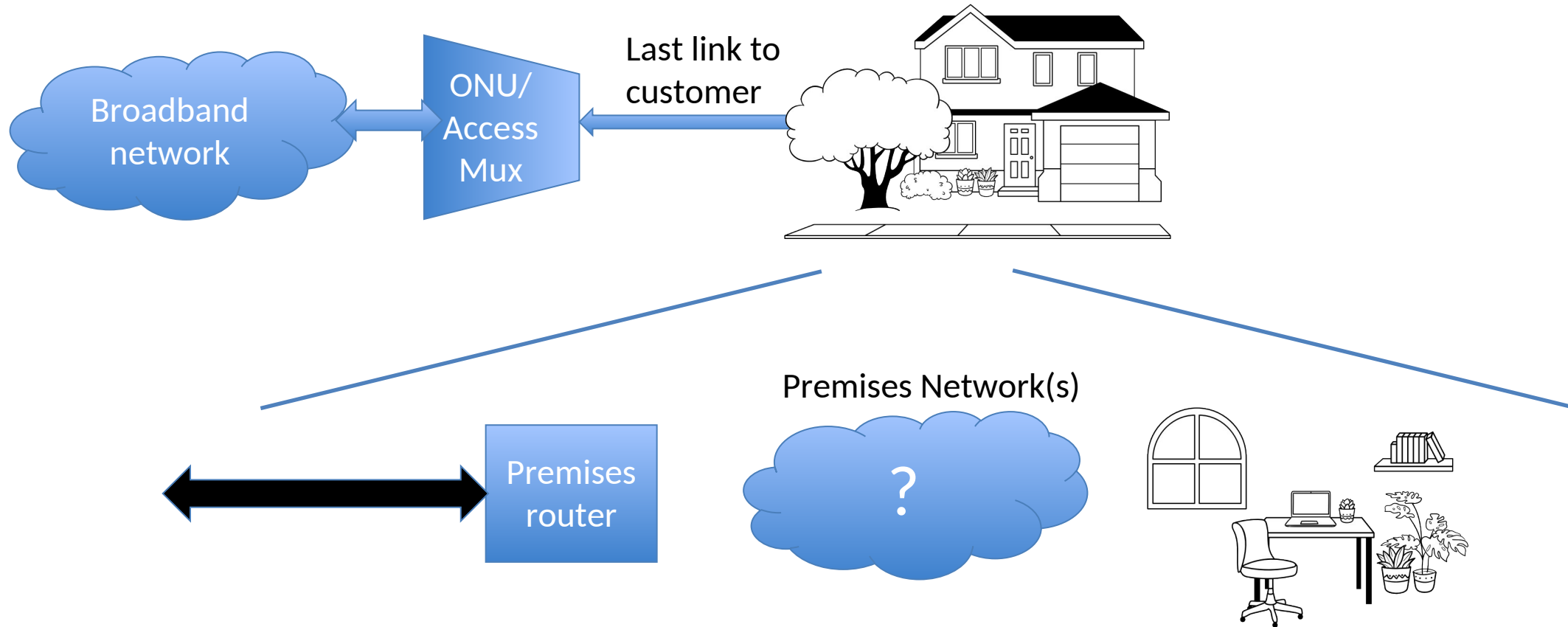
Editor, IEEE 802.3bz 2.5G/5G/10GBASE-T (past)



Wired Ethernet - So ubiquitous it is forgotten



What happens on the Premises?



IEEE 802.3 Wired Ethernet Standards on Premises

- 10/100/1000 BASE-T (IEEE Std 802.3 Clauses 14, 25, and 40)
 - 4 Pair “Category” cabling (TIA-568.2: 5E, 6, 6A; ISO Classes: D, E, EA, F)
 - Up to 100m
 - Compatible with Power over Ethernet
- 2.5G/5G/10GBASE-T (IEEE Std 802.3 Clauses 126 and 55)
 - 2.5G emerging in premises today
 - 4 Pair “Category” cabling - same as 10/100/1000BASE-T



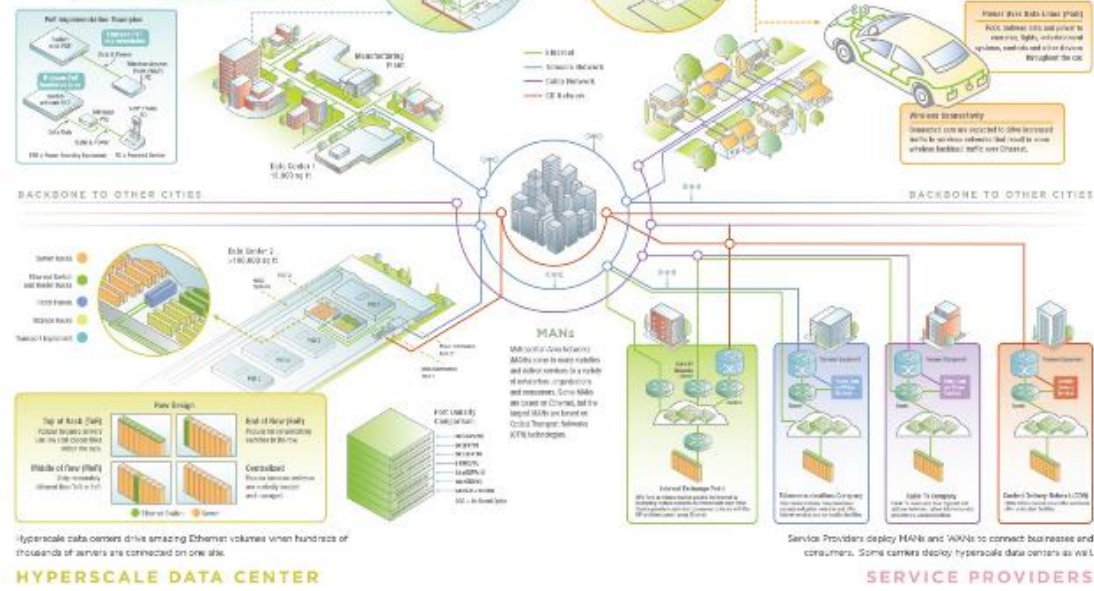
Billions of Ethernet Ports - Everywhere

ETHERNET ECOSYSTEM

ENTERPRISE AND CAMPUS

Power over Ethernet (PoE) is a growing Ethernet application that delivers power and data over Category cabling that has 4 twisted pairs of wires, with Cat 5 or better cabling recommended. 4-Pair PoE is being standardized to deliver over 70W of power over all 4 twisted pairs instead of the two pairs in PoE and PoE+

Pair	1	2	3	4	5	6	7	8
Power (W)	15.4	15.4	15.4	15.4	48	48	48	48
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HYPERSCALE DATA CENTER

Hyperscale data centers drive amazing Ethernet volumes when hundreds of thousands of servers are connected on one site.

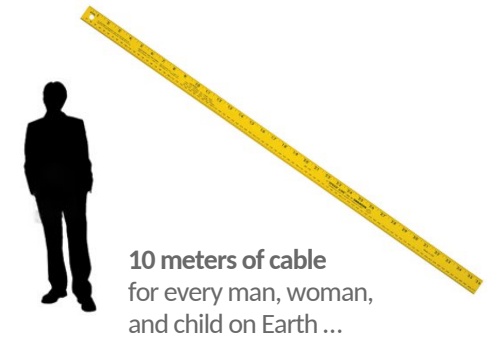
RESIDENTIAL AND CONSUMER

Most homes have wireless access points (WAPs) with 4 or more Ethernet ports. Smart TVs, network storage (NAS), and other household products come with Ethernet ports that can be used to connect the smart home.

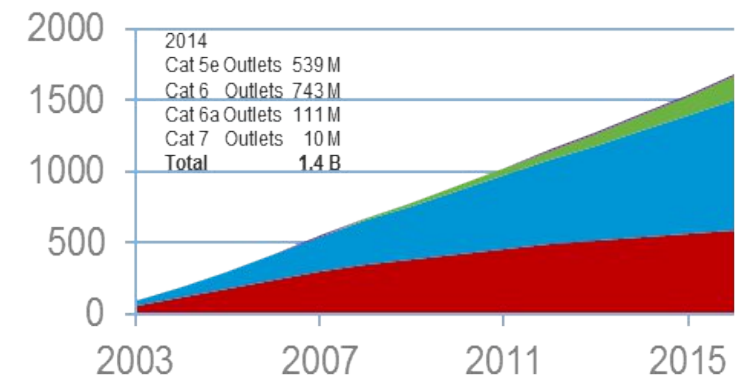
Submarine Ethernet
 Fibers of the future, deployed in a submarine way, will become the backbone for a sustainable economy by 2020. Because of its resilience to the temperature, salt, and other environmental factors, Ethernet is the ideal for deep-sea and power-line applications, and will be used in other domains throughout the sea.

Power Over Ethernet (PoE)
 PoE delivers data and power to cameras, lights, and other smart appliances, and will be used in other domains throughout the sea.

Also used in transportation
 Ethernet is used in transportation for its resilience to vibration and shock. It is used in cars, trucks, and other vehicles to connect various components.



10 meters of cable for every man, woman, and child on Earth ...



■ Cat 5e outlets ■ Cat 6 outlets
 ■ Cat 6a outlets ■ Cat 7 outlets

Installed Base: Outlets by Cable Type
 Source: BSRIA December 14

- ~70 billion meters of Cat 5e and Cat 6 cabling were sold (2003-2014)
- > 1.4 billion outlets

IEEE 802.3 BASE-T Ethernet Evolution

IEEE Standard 802.3 specifies Ethernet:

Ethernet for copper, fiber, coax, telephone-wire, cars – it's all there, including Power

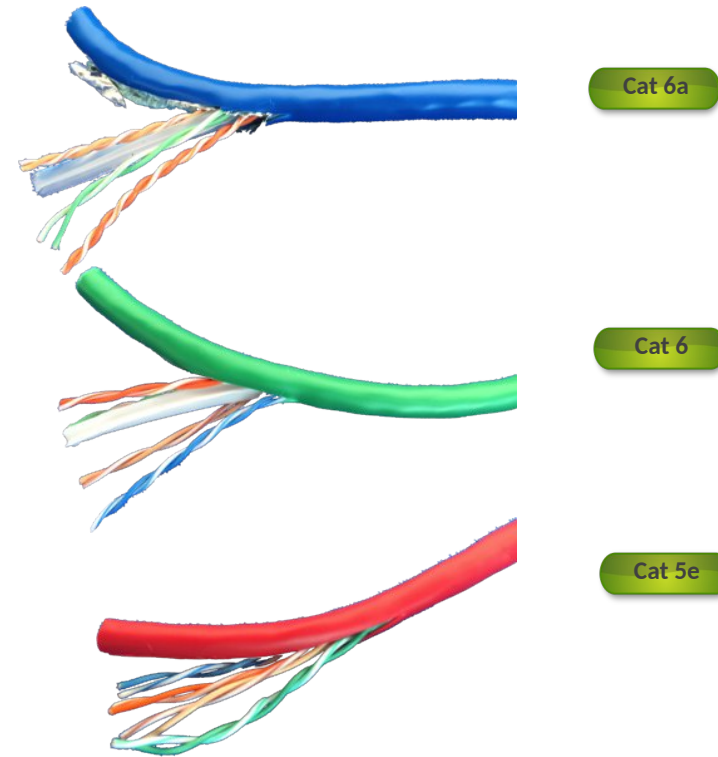
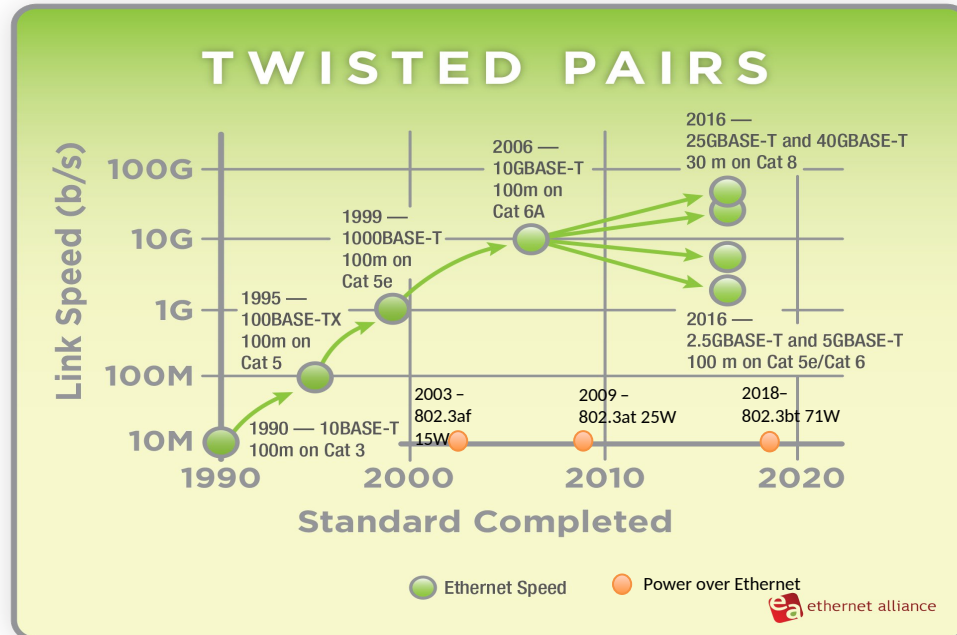
Copper Ethernet:

Today's LAN Ethernet is mostly 4-pair copper "BASE-T"

10BASE-T, 100BASE-T ("Fast Ethernet"), 1000BASE-T ("Gigabit Ethernet"), 2.5G/5GBASE-T...

Uses cabling specified by other SDOs – not IEEE 802.3

ANSI/TIA-568 specifies Category cabling: "Cat 5e", "Cat 6", "Cat 6a"



IEEE 802.3 PoE Standards

- 2-pair (Types 1 & 2) IEEE Std 802.3af-1999 & 802.3at-2009 – Clause 33
- 4-pair – (Types 3 & 4) IEEE P802.3bt-2018 – Clause 145
 - Pre-standard/trade names “PoE++”, “UPoE”

PoE Types and Classes	PoE+ – Type 2					4-Pair PoE in Standardization			
	PoE – Type 1				4	5	6	7	8
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

4 – Pair PoE–Type 3

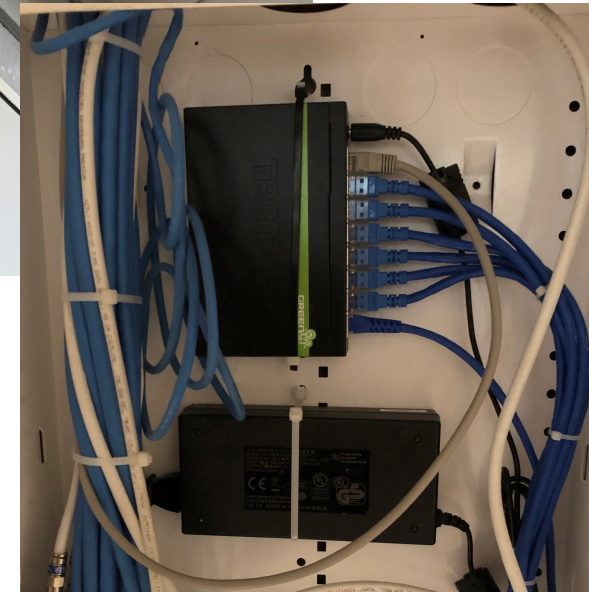
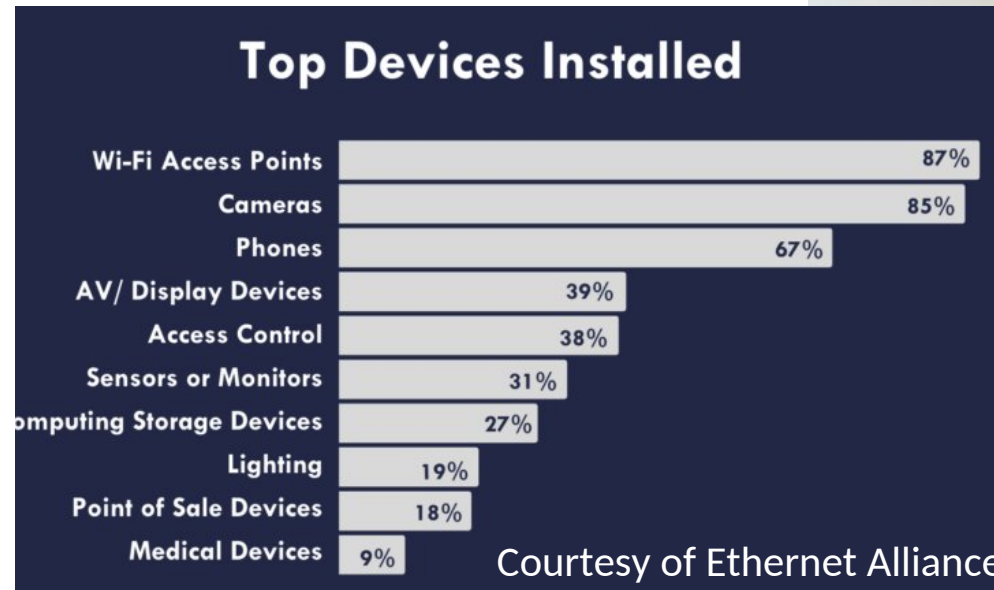
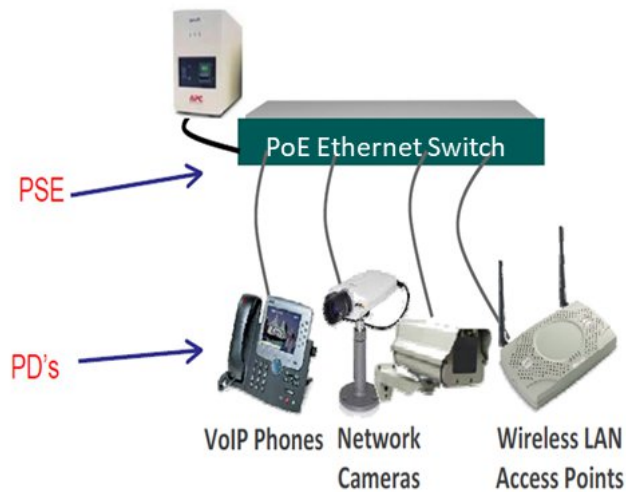
4 – Pair PoE Type 4

Power over Ethernet (PoE) – Enabling Access to Extend to IoT

- Low voltage (SELV / NEC® Class 2 Power)
- Compatible with BASE-T Ethernet / same wires as data
- 2-pair (Clause 33) & 4-pair (Clause 145) variants

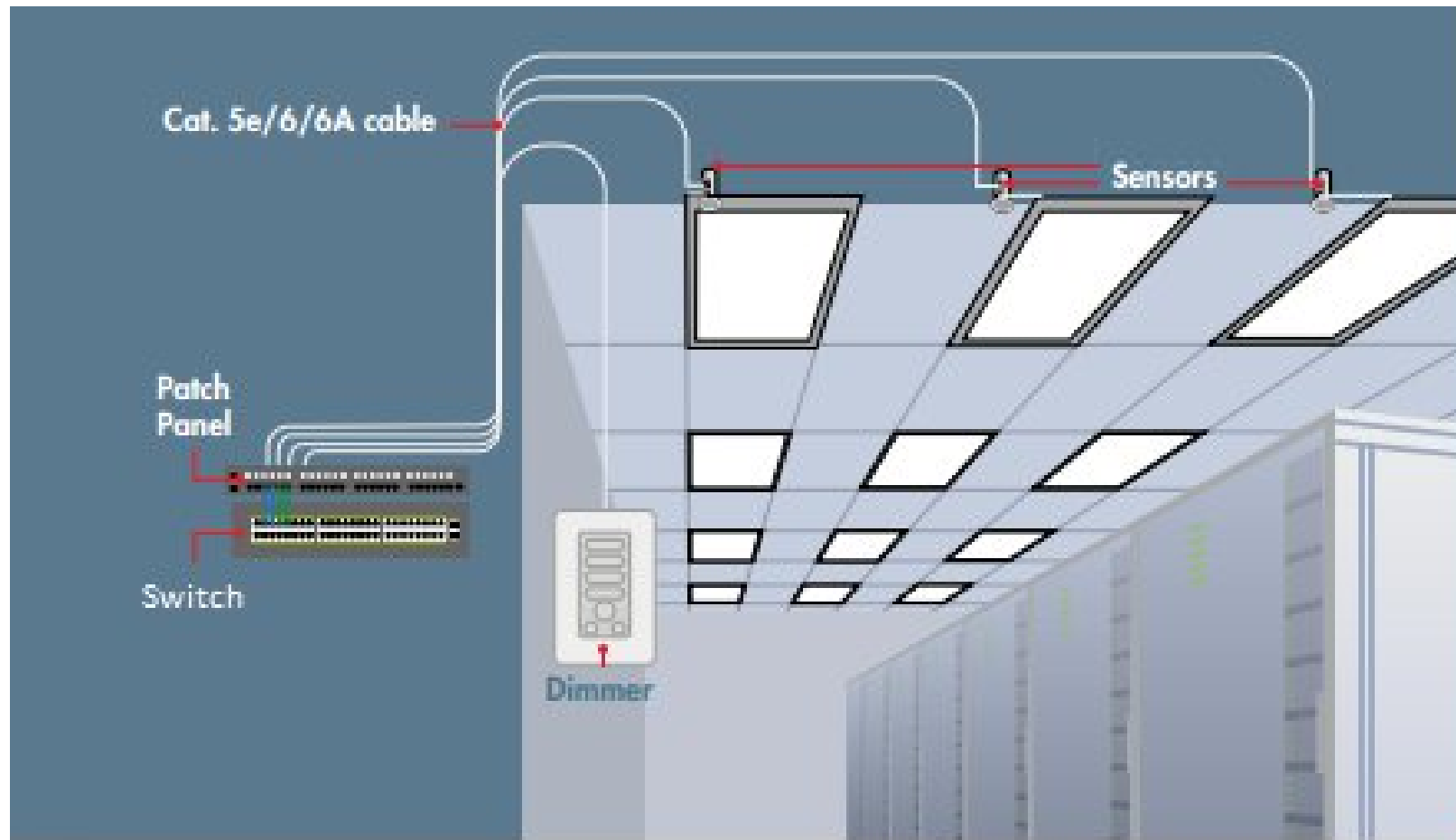


UPS – Battery Backup



Power Inspires New Uses for Ethernet on the Premises

Power brings Ethernet to the (non-IT) premises infrastructure:
Operational Technology (OT)



Promise of Ethernet for the OT Network

Improved Cybersecurity

- Improved cybersecurity via Ethernet adoption

Flatter Networks

- Reduce or eliminate protocol translation gateways

Single Connection

- Power and data delivered with one connection

Plug and Play

- Simpler and easier to deploy

SPE Advantage

- Suited for the target environments and topologies.
- “Right Sized” for the sensor market

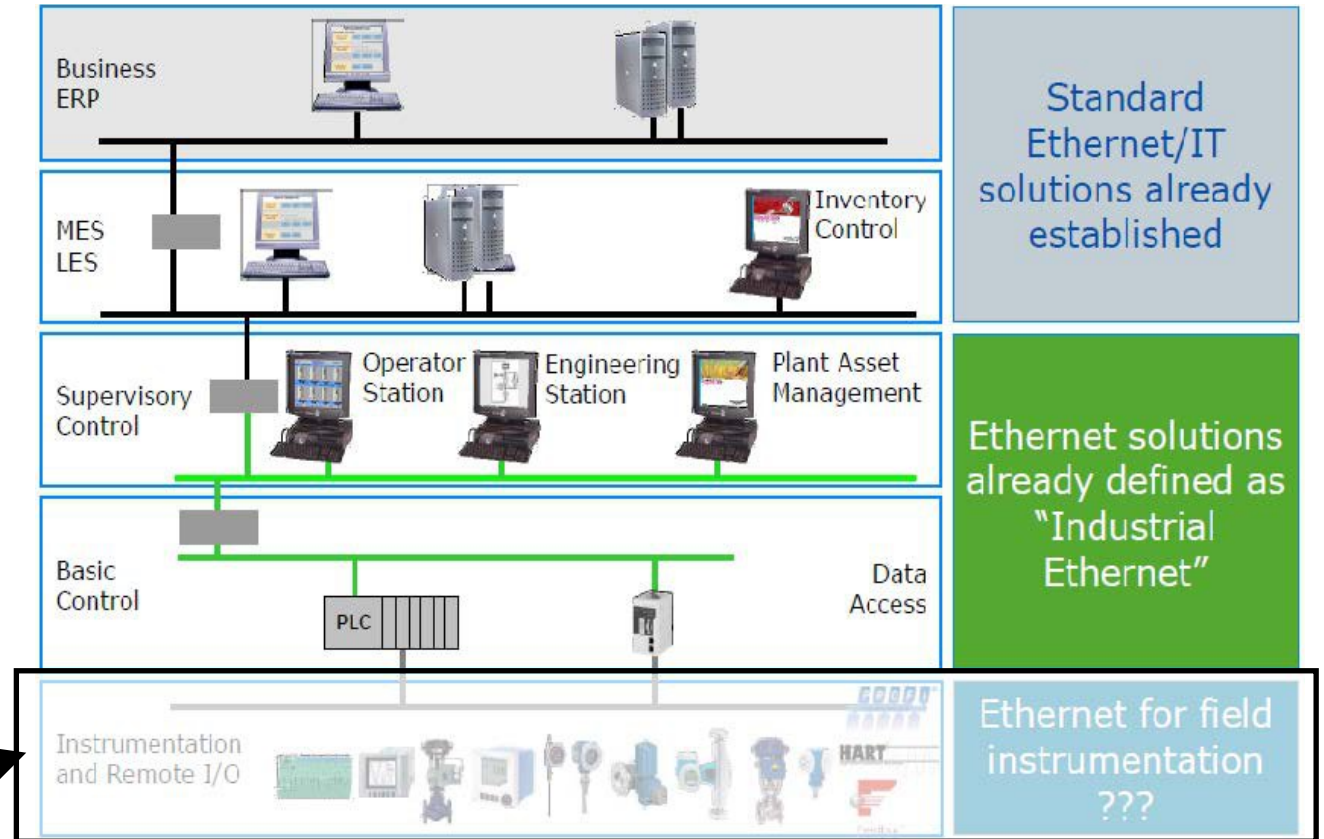
Single Pair Ethernet (SPE) in the OT Edge: IEEE 802.3cg-2019, IEEE P802.3dg and IEEE P802.3da

Industrial & Building Automation:

Non-Ethernet fieldbuses are still required to complete communications to the edge

- Cable lengths up to 1km
- 1200 baud to hundreds of kb/sec
- Challenges: Combined reach & rate, special environments, cost of operation

Ethernet Gap at the 'Edge' →

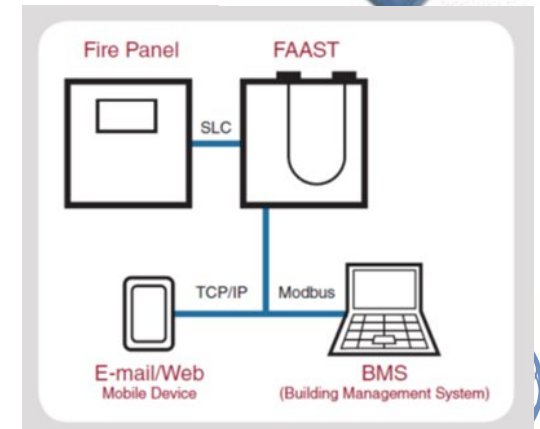
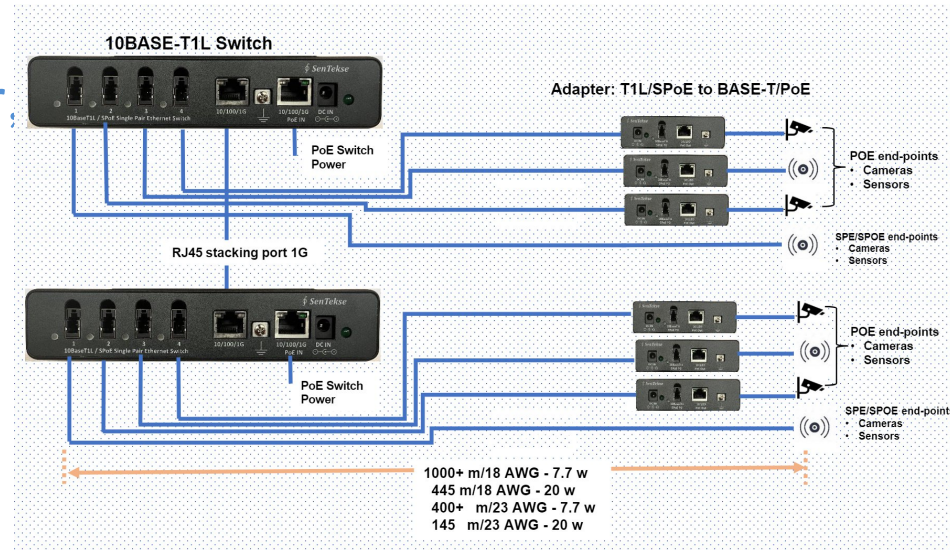
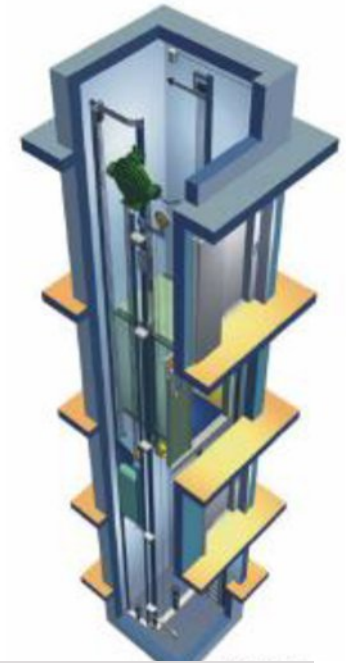
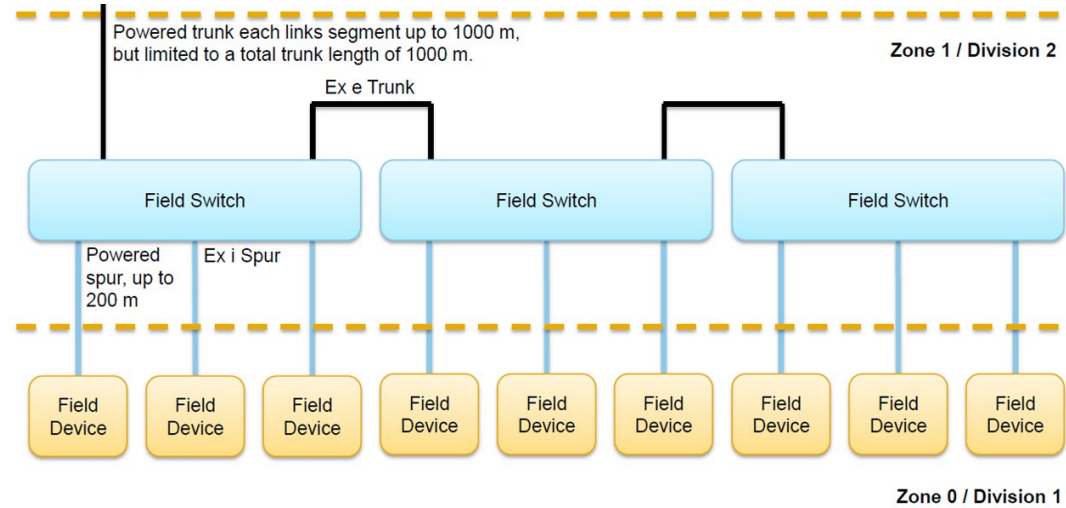


Credit: Dr.Raimund Sommer, Endress+ Hauser, ODVA Industry Conference, Oct. 2014.

From https://www.ieee802.org/3/cfi/0716_1/CFI_01_0716.pdf

IEEE 802.3cg Started as Process Control, but...

- Every time I turn around, someone has a new use....
 - Security
 - Building Controls / Sensors
 - HVAC control and monitor
 - Fire systems...
- Fueled by IoT & Wireless
- Ethernet ease of use, Power, and Interoperability are the keys to success



Enabling the 802 Networking Beyond the Physical Layer (802.1 Time Sensitive Networking (TSN))

TSN - synchronization

- **Precision Time Protocol** (e.g., IEEE 1588 default, 802.1AS, IEC 62439-3, SMPTE 2059)
- Tracking events
- Coordinating actions

TSN - Latency

- **Frame Preemption (IET)**
- Credit Based Shaper
- **Scheduled Traffic**

TSN - Reliability

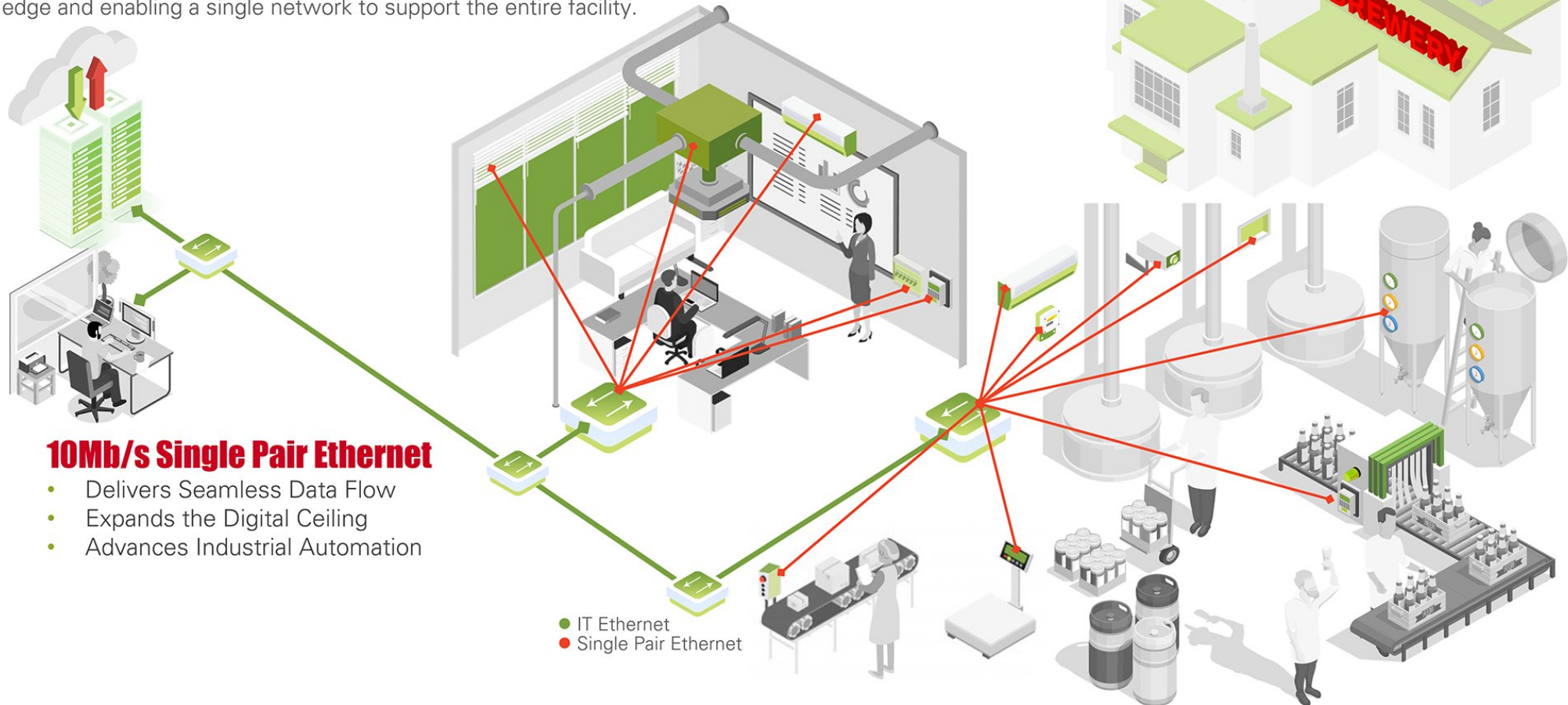
- Frame Replication and Elimination
- Path Control and Reservation
- Per-Stream Filtering and Policing

TSN - Resource Management

- Stream Reservation Protocol
- Link-local Registration Protocol
- LLDPv2 for MultiframeData Units
- Multicast and Local Address Assignment

10Mb/s Single Pair Ethernet

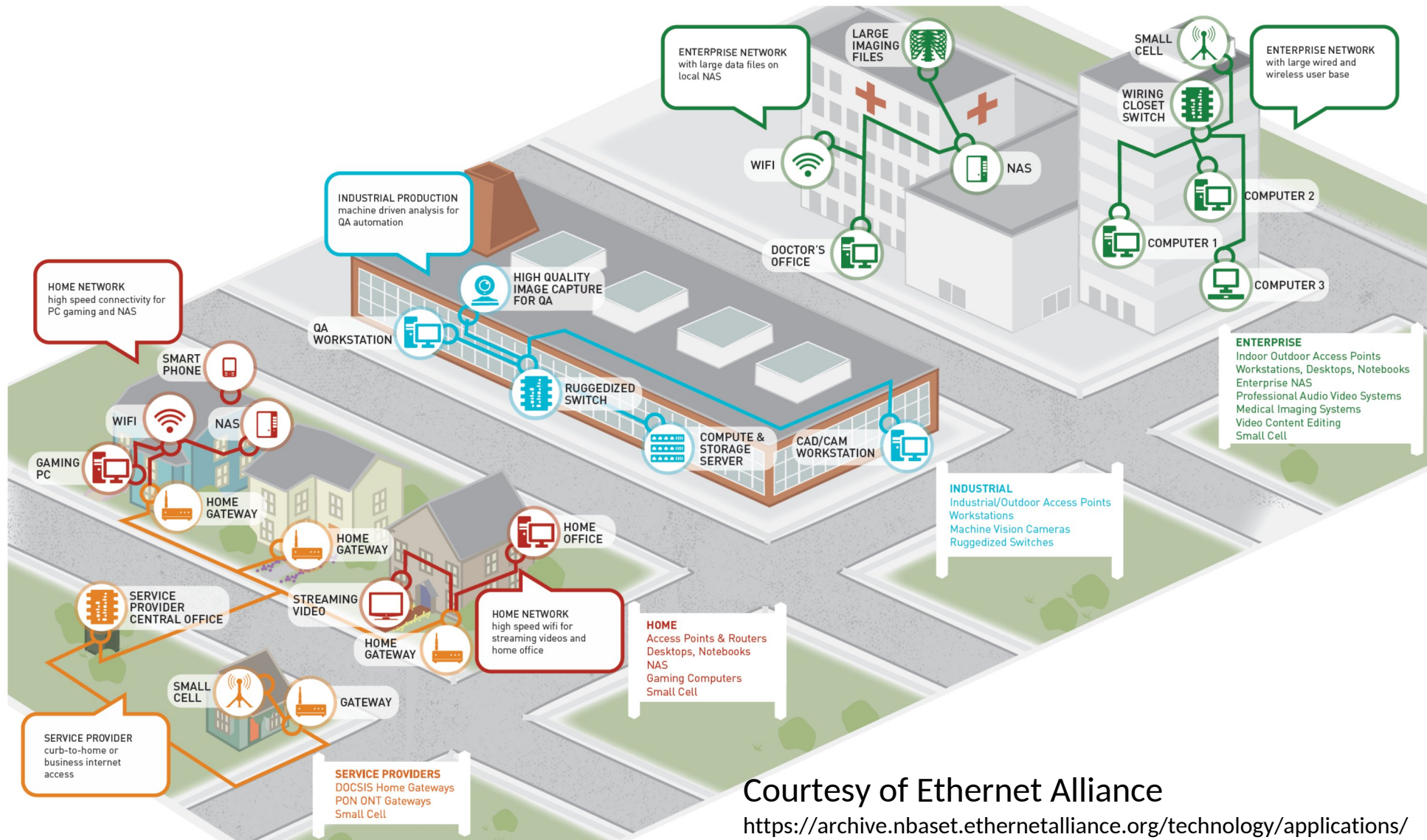
Device communications in buildings and machine often use auxiliary power to operate and use gateways to convert and transmit data. Single Pair Ethernet brings Ethernet communications and power to these devices over two wires and familiar topologies. No batteries, and no gateway programming – simplifying IoT to the edge and enabling a single network to support the entire facility.



Building on 802.3cg - IEEE P802.3da & IEEE P802.3dg

- Two follow-on projects to 802.3 cg are currently active in Building/Industrial Automation
- IEEE P802.3dg 100 Mbps Long-Reach Single Pair Ethernet PHY
 - Higher-speed follow on to 10BASE-T1L: 500m at 100 Mbps
- IEEE P802.3da 10 Mb/s Single Pair Multidrop Segments Enhancement
 - Refinements to the specifications for 10BASE-T1S for longer-reach, more plug-and play multidrop
 - An associated power protocol for multidrop mixing segments

Connecting the Wired/Wireless/Access Ecosystem



Courtesy of Ethernet Alliance

<https://archive.nbaset.ethernetalliance.org/technology/applications/>

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