



AHEAD OF WHAT'S POSSIBLE™

Future Developments in Ethernet towards Real-Time and Long Distance

Digital Transformation In Factory And Process Automation

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Trends in Industrial Automation

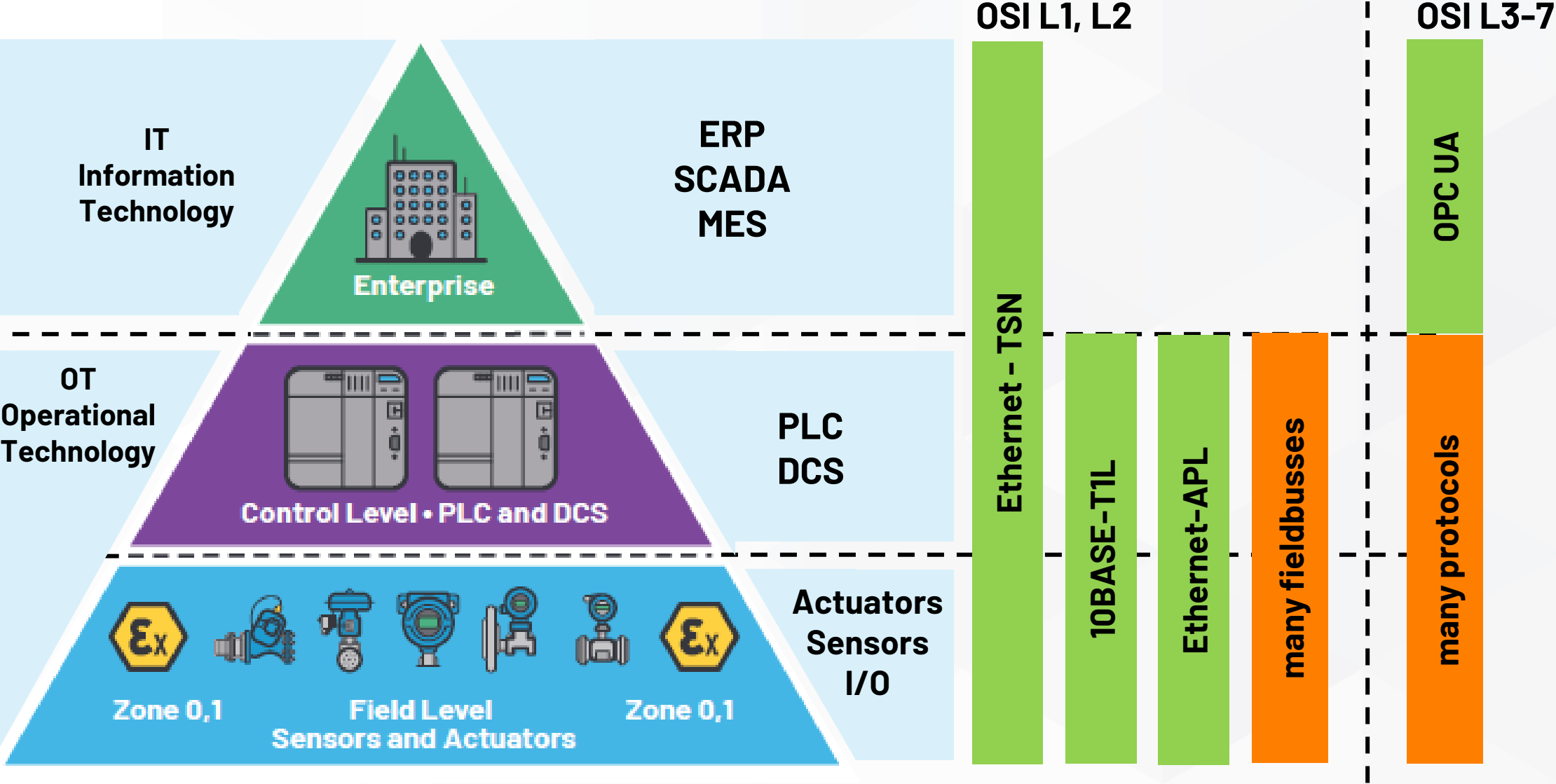
▶ **What should I build into my next product?**

▶ **Key Trends**

- Increased and Enhanced Connectivity
- Ethernet, IT/OT Network Convergence
- Standardization, Security, Scale
- Vendor Independence
- Openness, Accessibility



Seamless Edge to Cloud Connectivity



Time Sensitive Networking - TSN



TSN – Network Convergence

Any Speed, Any Port

Flexible **Port Configurations** operating at 10M, 100M, or 1G, copper or fiber,



Redundancy

IEEE802.1CB Frame Replication & Elimination
HSR / PRP protocols for seamless fail-over
MSTP for loop breaking

Quality of Service

IEEE802.1Q Scheduled Traffic, Latency, Frame Preemption, Queuing, Stream Filtering & Policing

TSN Profile Support

Tailored features to support **IEEE/IEC 60802** AND additional features for IEC61850

Time Synchronisation

IEEE802.1AS-2020
IEEE 1588 Default profile
IEEE C37.238-2017 Energy profile

Ethernet - 10BASE-T1L





▶ Institute of Electrical and Electronics Engineers

- IEEE 802 Networking standards
- IEEE 802.3 Ethernet
- IEEE 802.3 Clause 146: 10BASE-T1L
- Published as IEEE 802.3cg™-2019

▶ Implementation

- PHY 10BASE-T1L (RGMII)
- MAC-PHY (SPI)
- 2-Port Switch PHY (SPI)



PHY Key Features	10/100/1000 BASE-TX	10BASE-T1L
Cabling		
	2 or 4 pair Ethernet	Single Pair Ethernet
Distance	100m	Up to 1km
Speed	10Mb, 100Mb, Gb	10Mb
Connector	RJ45	Two/Three Pin Connector
Explosive Environments	No	Yes 
Power	PoE	SPoE or Engineered Power 

Ethernet-APL (Advanced Physical Layer)



- ▶ Specifications for Process Control
 - 10BASE-T1L (referring to IEEE) for data
 - IEC TS 60079-47 (2-WISE)
Engineered power for explosive environment
 - Network topologies – Trunks (1000m) & Spurs (200m)
 - IEC 61158-2 Type A cables
 - Connectors

APL Port Profile Spec. 1.0				
Voltage Class	15V		50V	
Class #	A	C	3	Units
P_{PS}	0.54	1.1	57,5	W
I_{PS}	55,56	95	1250	mA
U_{PL}	9.0	10.6	28.8	V
P_{PL}	0.5	1	36	W

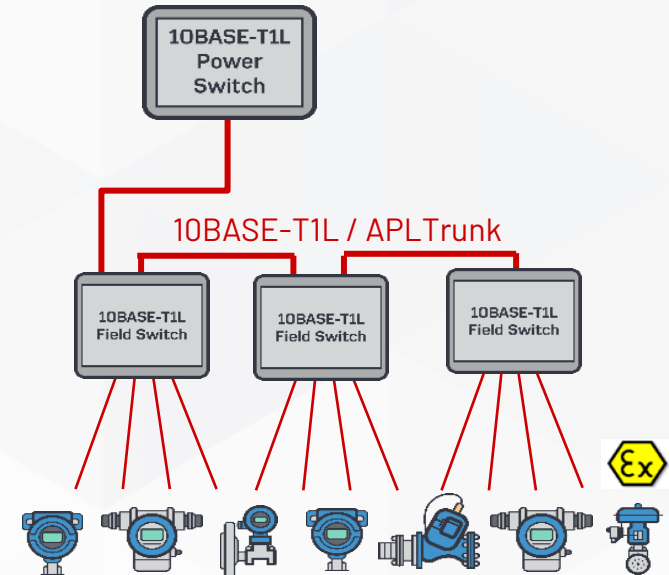
Standards Organizations



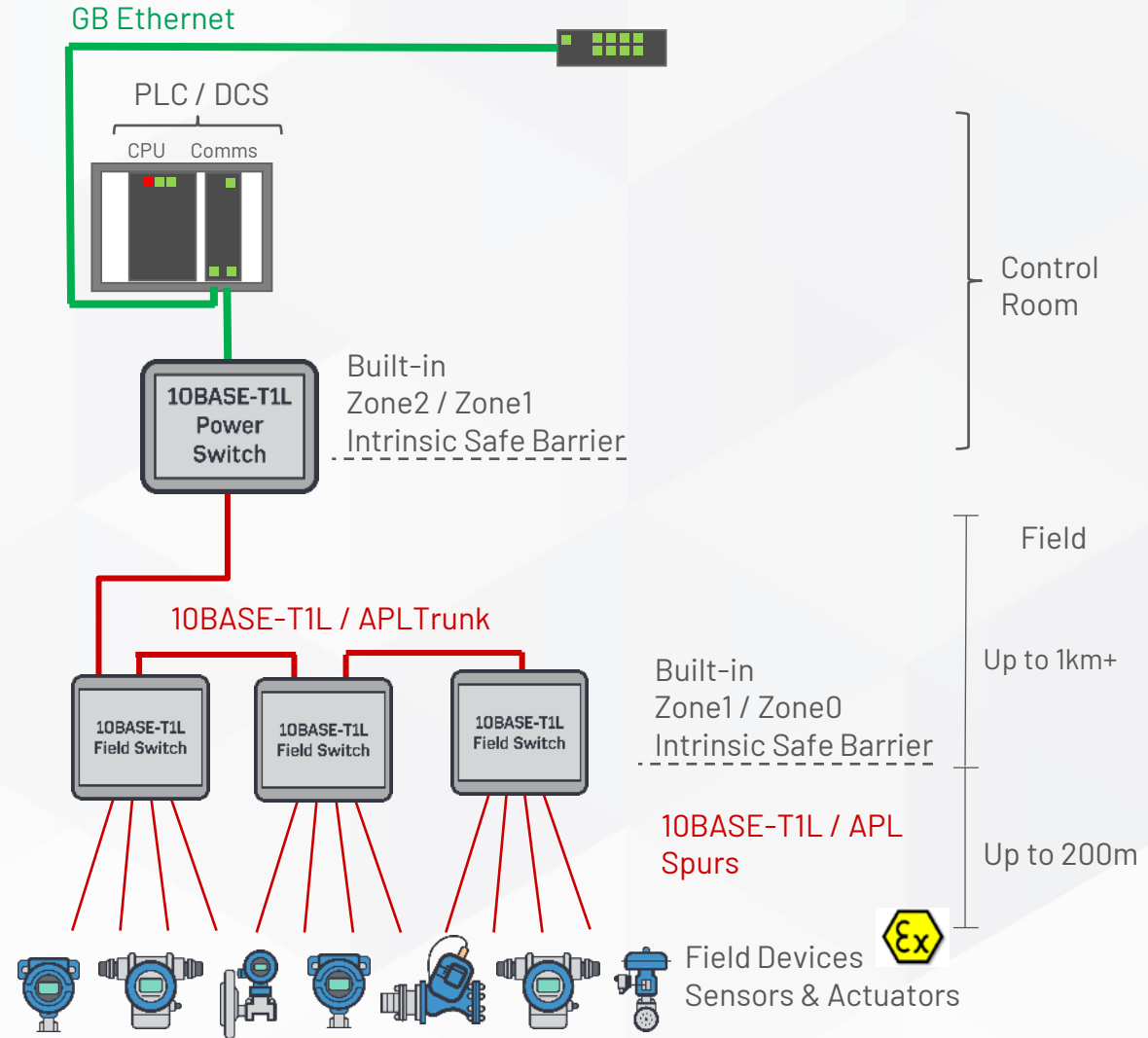
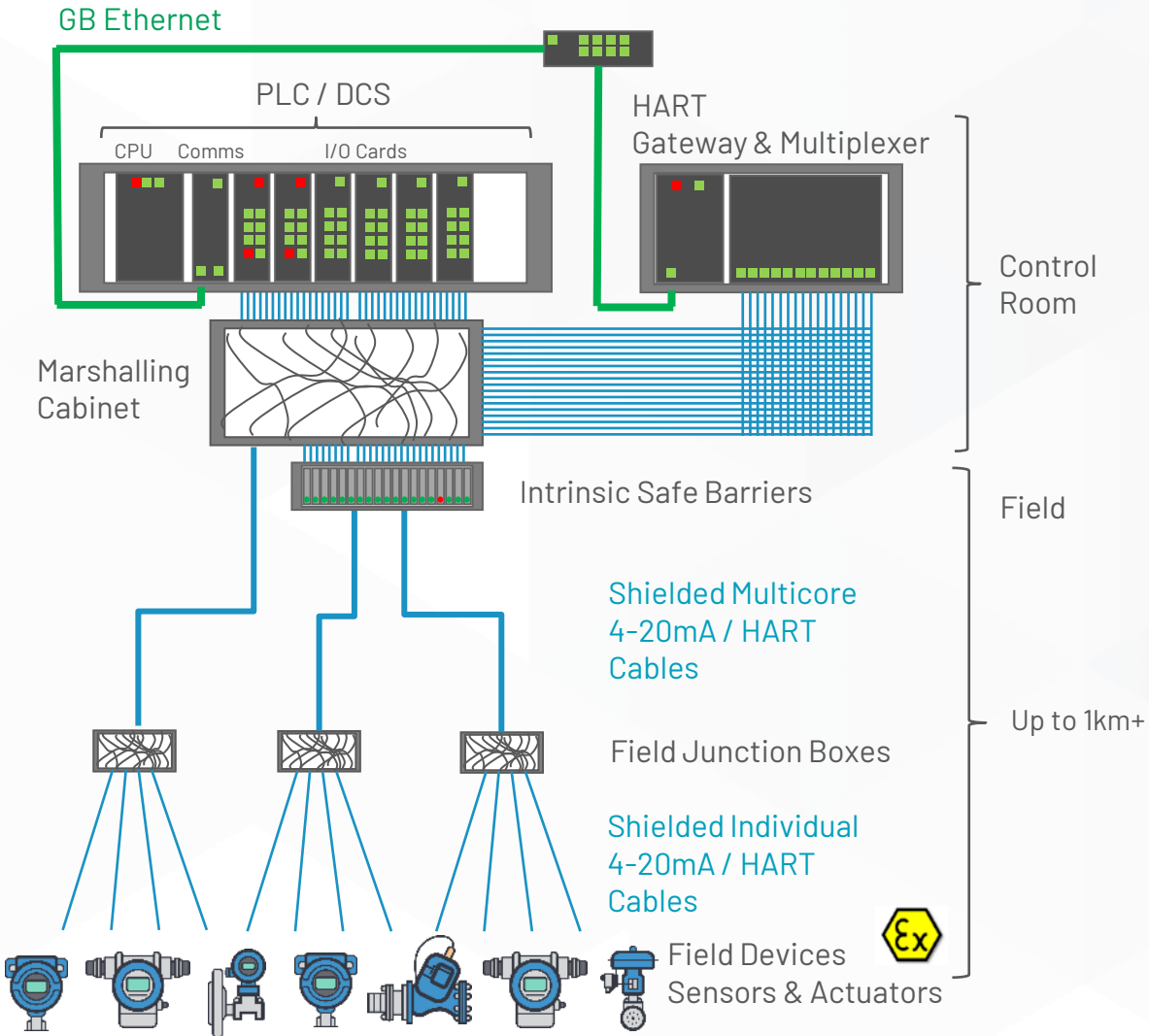
Industry Partners



- ▶ APL Documents:
- ▶ <https://www.ethernet-apl.org/library>
- ▶ APL Port Profile Specification:
- ▶ <https://library.fieldcommgroup.org/10186/TS10186/1.0/#page=1>



Connectivity in Process Control

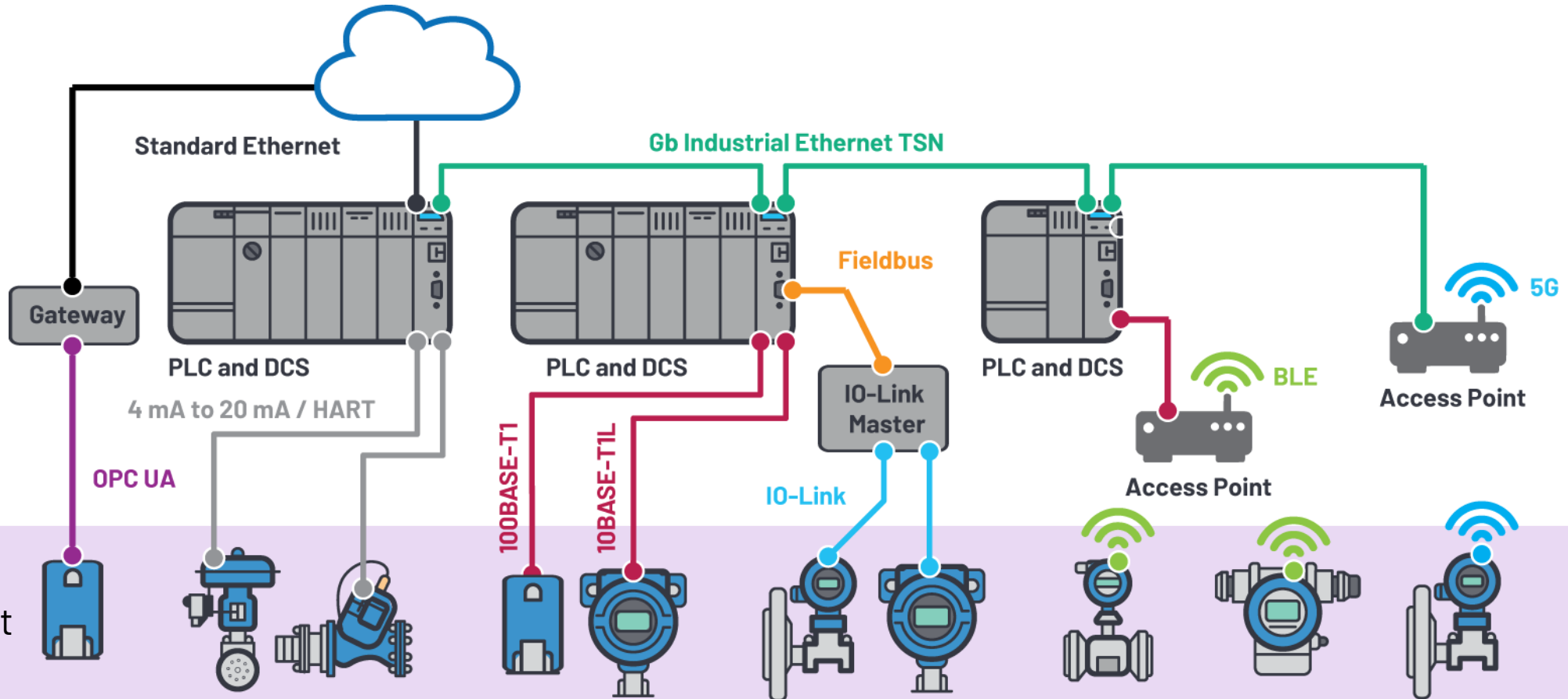


▶ **OPC UA – Open Platform Communication Unified Architecture**

- Client Server
- PubSub down to OSI Layer 2
 - UDP Broadcast
 - UADP Binary Messages
- FLC – Field Level Communication
- FX – Field eXchange
 - C2C (M2M), C2D, D2D
- Companion Specifications
- IEC 62541 – open62541, FreeOpcUa

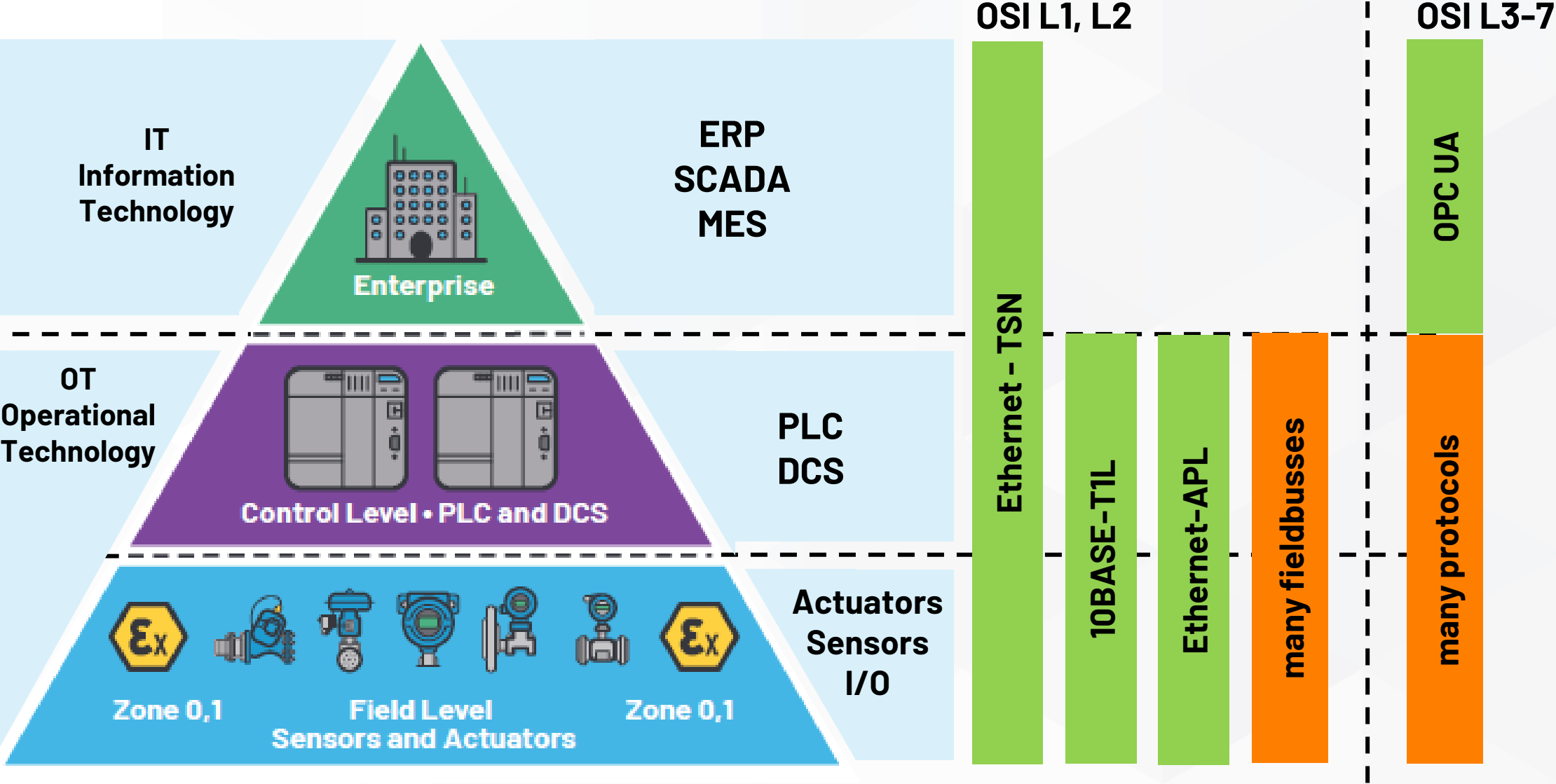


Industrial Edge Sensing Solutions

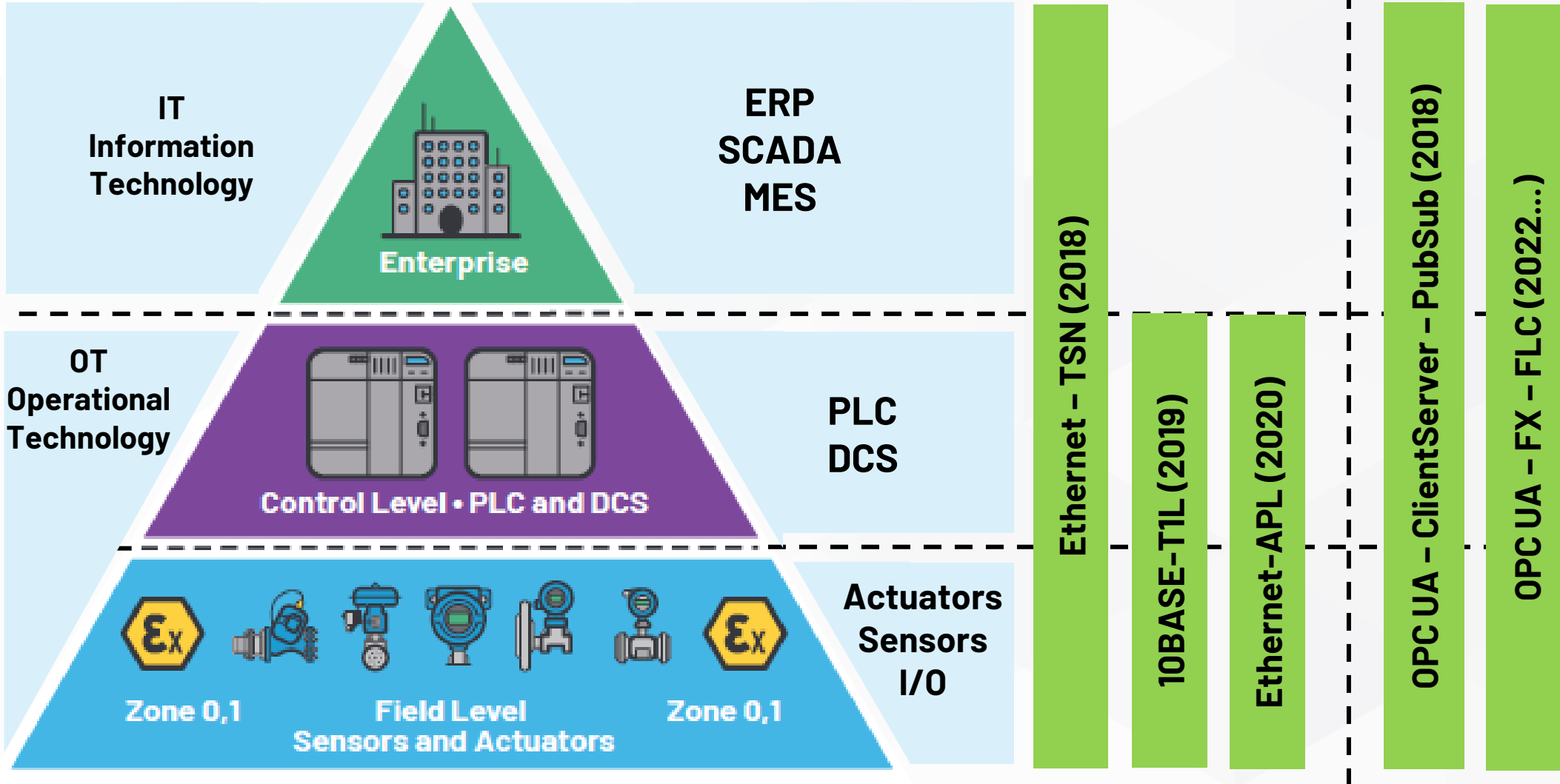


Wide range of sensing modality and connectivity options

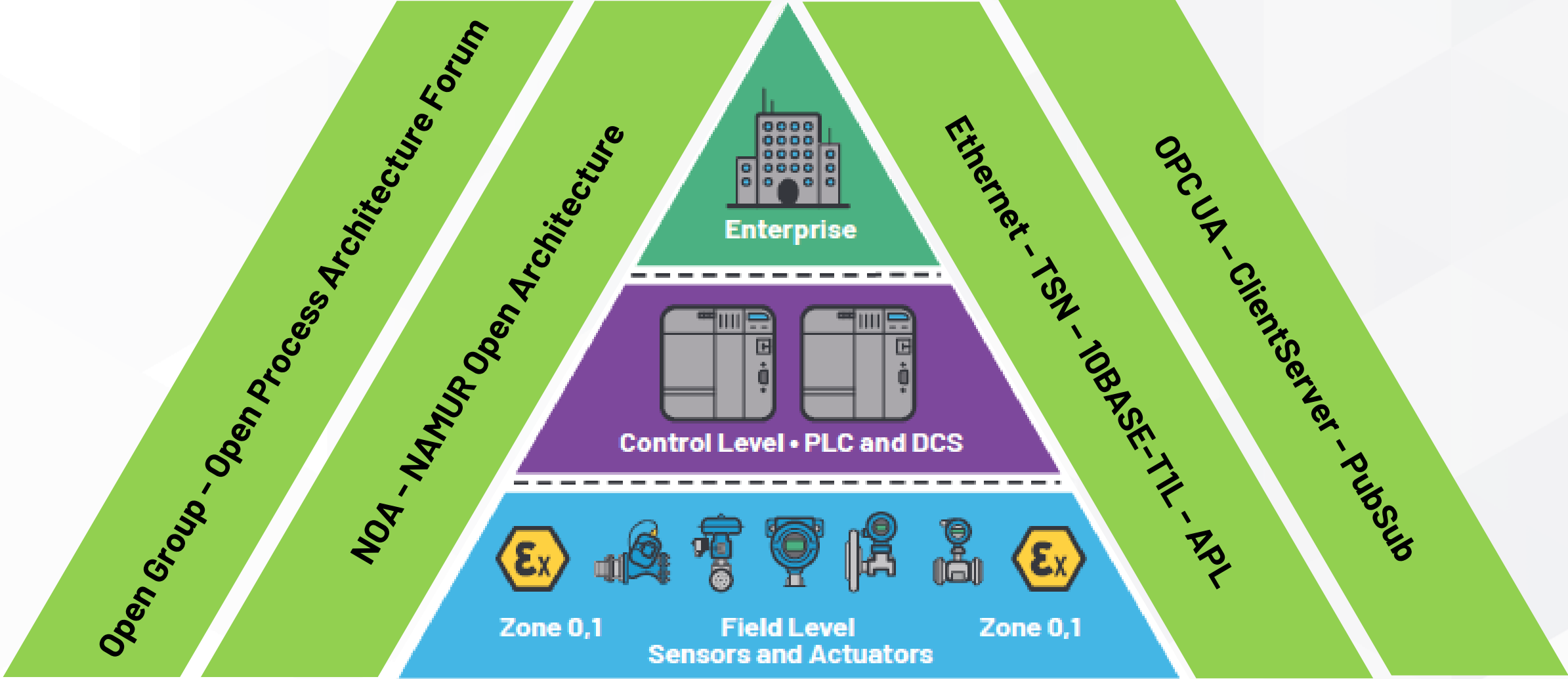
Seamless Edge to Cloud Connectivity



Seamless Edge to Cloud Connectivity



Seamless Edge to Cloud Connectivity



Achievements

- Remove Protocol Conversions
- Removing Gateways
- Open Source Hardware & Software Platforms
- Accelerating Design
- Remove Hierarchical Structure of Automation Networks
- Merging All Levels
- Vendor Independent Communication in Real-time
- 10BASE-T1S, 100BASE-T1 Complementing
- 100BASE-T1L in Standardization



What should I build into my next product?

▶ **Ethernet with TSN**

- Increased and Enhanced Connectivity
- IT/OT Network Convergence

▶ **Ethernet into the Field Level**

- Single Pair Ethernet, APL

▶ **Consider the Industry Timeline**

▶ **Watch the Standardization**

- OPC UA The Hot Candidate

▶ **Opportunity & Risk**

- Vendor Independence, Extensibility, Collaboration, Openness, Accessibility
- Accelerating Design, Open Source





**Digitizing the Factory Floor
to Uncover New Insights**



**Empowering the Intelligent Edge
in Process Automation**



AHEAD OF WHAT'S POSSIBLE™

**INDUSTRIAL
AUTOMATION**

Transforming Industry Together



**Creating Sustainable
Enterprises of the Future**

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**Engineering Intelligent Robots
for Agile Manufacturing**