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Single Pair Ethernet: 10BASE-T1L Market and Technology Insights

Maurice O' Brien

Michal Brychta

18 February 2021

Video recording of this presentation

https://youtu.be/2xt5wVd5w4s

Visit analog.com/Chronous for more information

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Strategic Marketing Manager
Maurice.obrien@analog.com

Systems Application Engineer
Michal.brychta@analog.com

Agenda

- The Future is Increased Connectivity
- Ethernet to the Edge/10BASE-T1L
  - What is 10BASE-T1L (IEEE802.3cg-2019)
  - 10BASE-T1L vs. Existing Communications
- 10BASE-T1L Market Insights
- 10BASE-T1L Technology Insights
- PoDL/SPoE Technology Insights
- ADI Chronous™

The Future is Increased Connectivity

Delivering the promise of Industry 4.0

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Increased Data

Increased Analytics

Increased Productivity

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Ethernet to the Edge/10BASE-T1L

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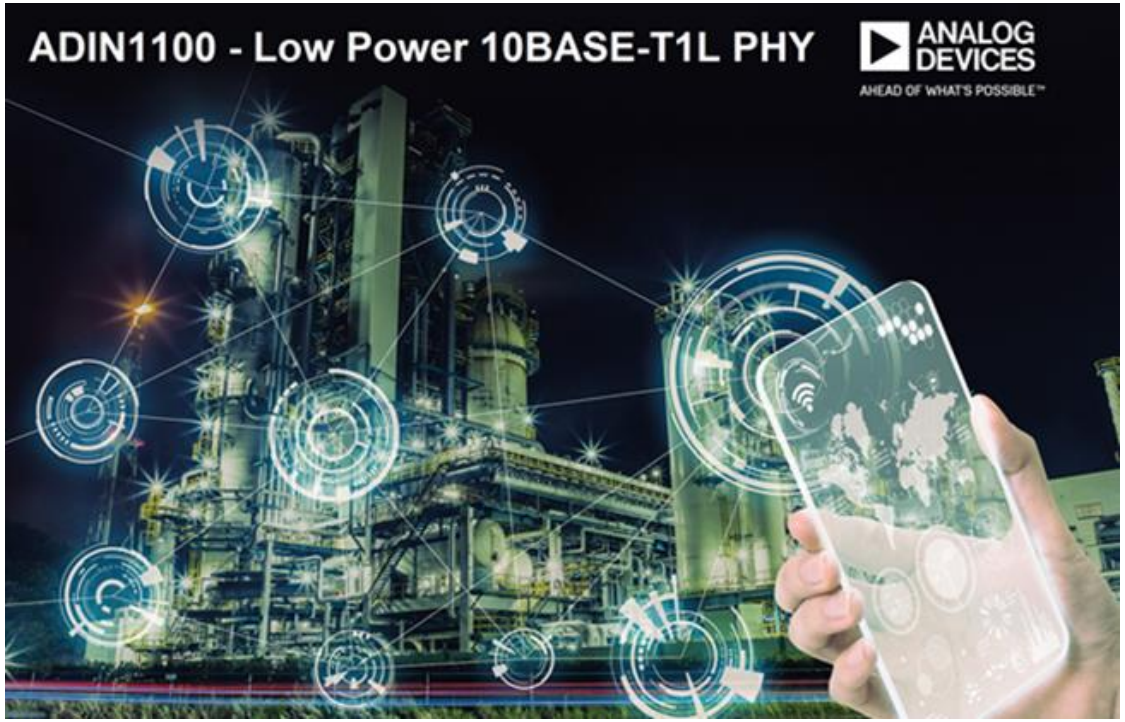
What is 10BASE-T1L (IEEE802.3cg)

- IEEE® 802.3cg™ Approved Standard Nov 7th 2019

- 10BASE-**T1L**
  - 10MBit/s
  - Power & Data over the cable
  - Single Twisted Pair
    - (Fieldbus Cable, NOT Standard CAT-x Cable)
  - Full duplex, Point to point
  - Distance up to **1km**
  - Suitable for intrinsic safe (explosive safe) applications



4-20mA HART vs. Fieldbus vs. 10BASE-T1L

Comparison	4-20mA with HART	Fieldbus	10BASE-T1L
Data Bandwidth	1.2kbps	31.25kbps	10Mbps
Higher Level Ethernet Connectivity	Complex Gateways	Complex Gateways	No Gateways Seamless Connectivity
Power to Instrument	<40mW	Limited Power	IS: 500mW Non-IS up to 60W (Cable Dependent)
Knowledge/ Expertise	Shrinking Knowledge/Expertise	Shrinking Knowledge/Expertise	Ethernet technology is very familiar to all college graduates

100BASE-TX/1000BASE-T vs. 10BASE-T1L

PHY Key Features	10/100/1000	10BASE-T1L	Benefit
Cabling	 2 or 4 pair Ethernet	 Single Pair Ethernet	Potential to reuse existing fieldbus cabling
Distance	100m	Up to 1km	Field Device Connectivity
Speed	10Mb, 100Mb, Gb	10Mb	Upgrade from 4-20mA and Fieldbus data rates
Connector	RJ45	Two Pin Connector	Small two pin connector
IS Compatibility	No	Yes	Can be used in Zone 0, Div. 1
Power	PoE	PoDL / Engineered Power	Power and Data on SPE

10BASE-T1L Market Insights

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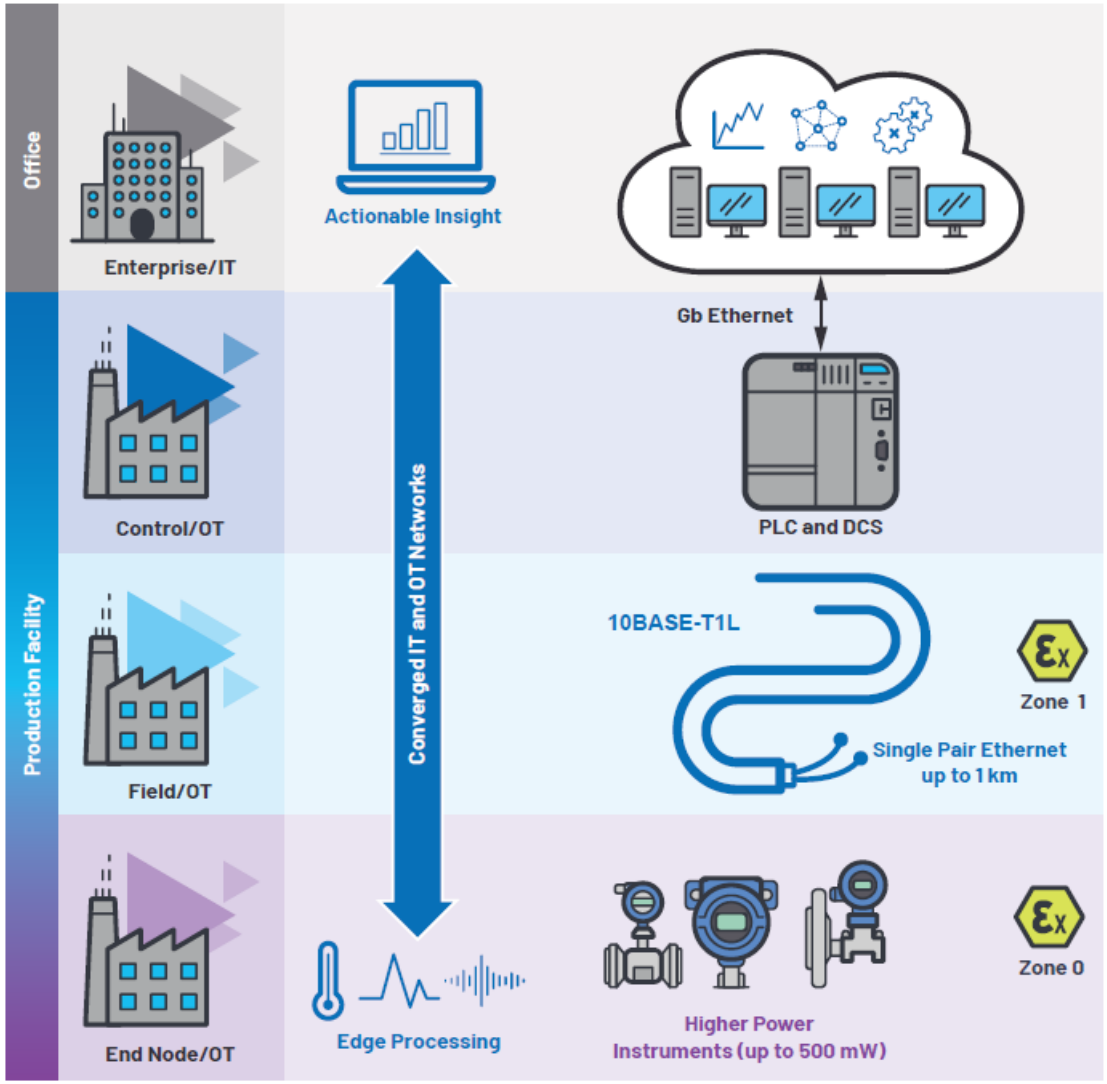
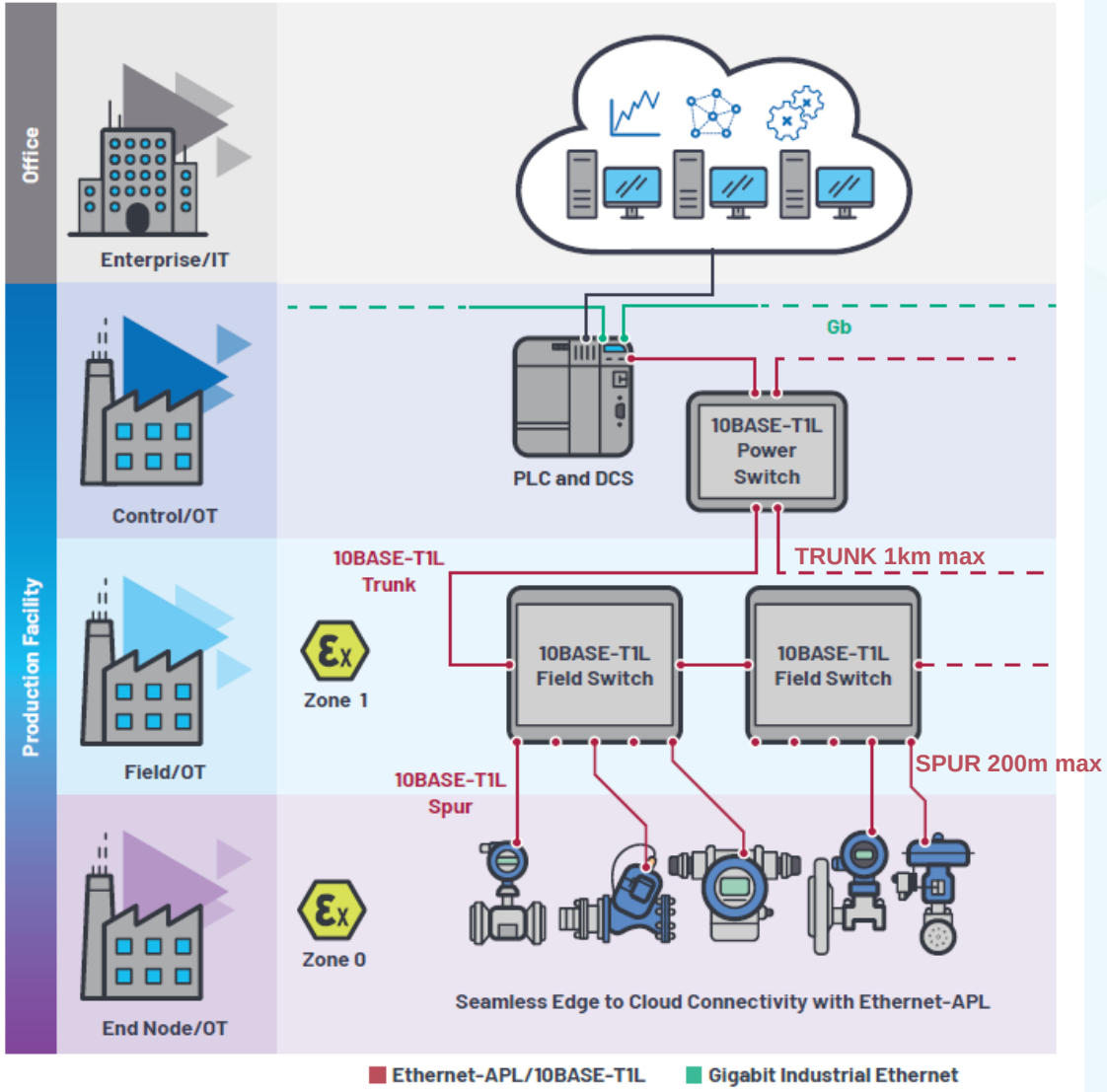
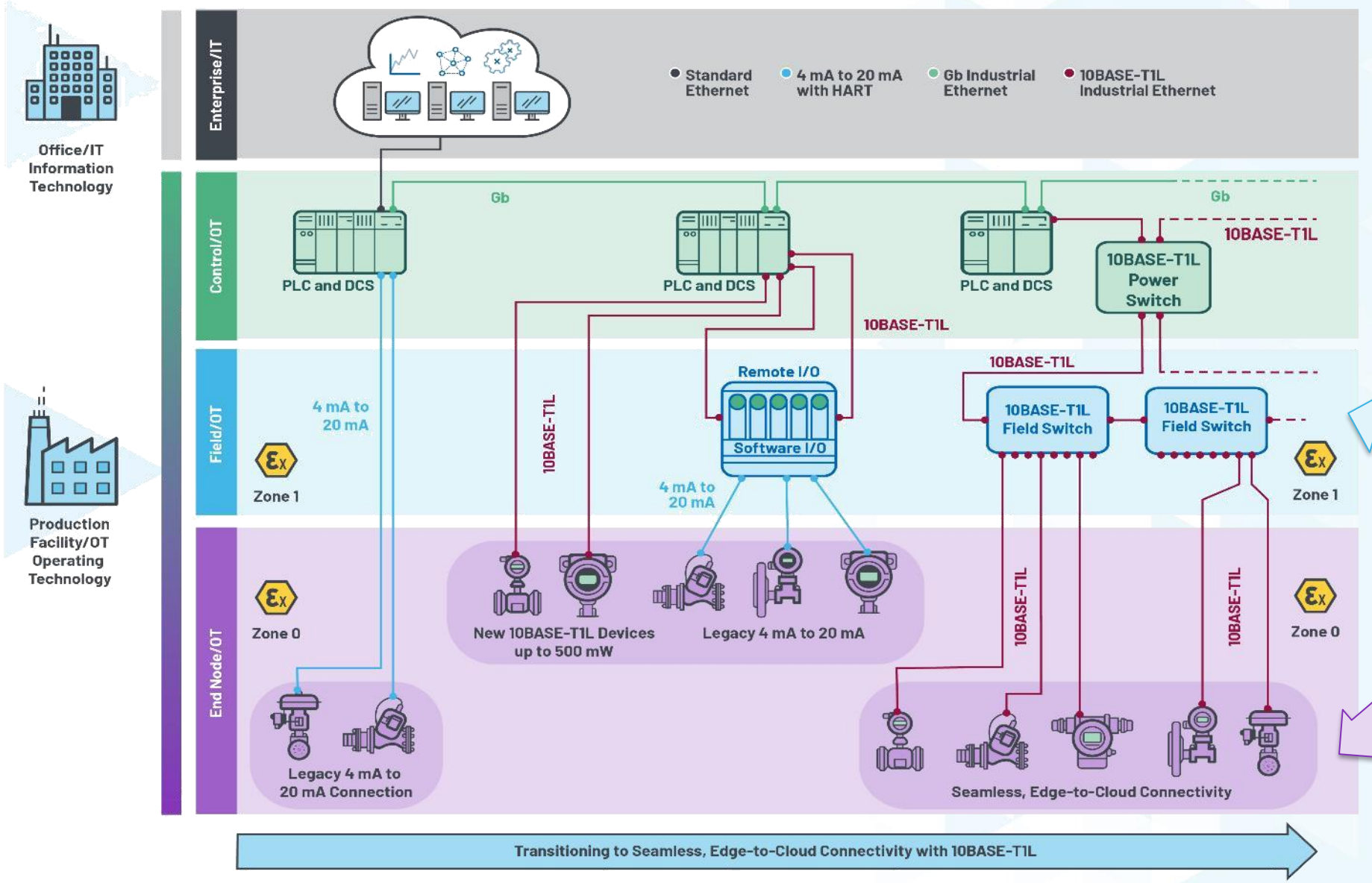
Ethernet-APL
Optimization of Process Automation with Actionable Insights

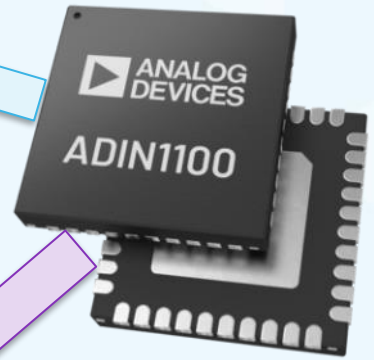




Process Automation – Transition to 10BASE-T1L

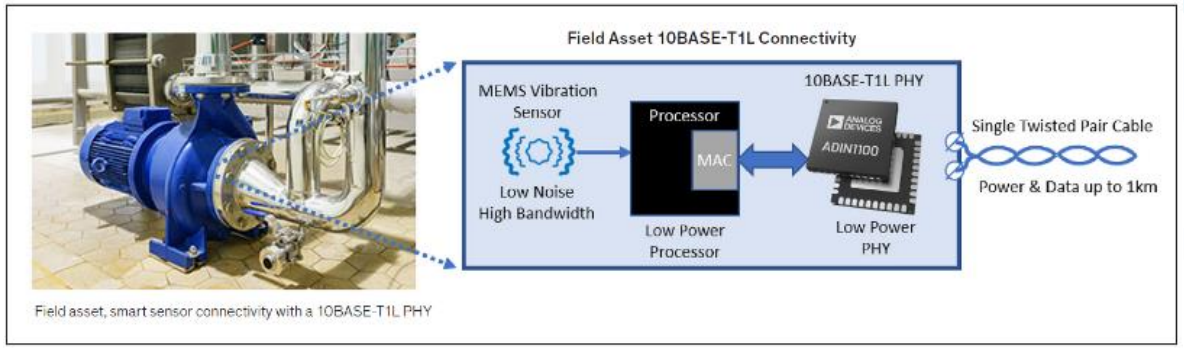


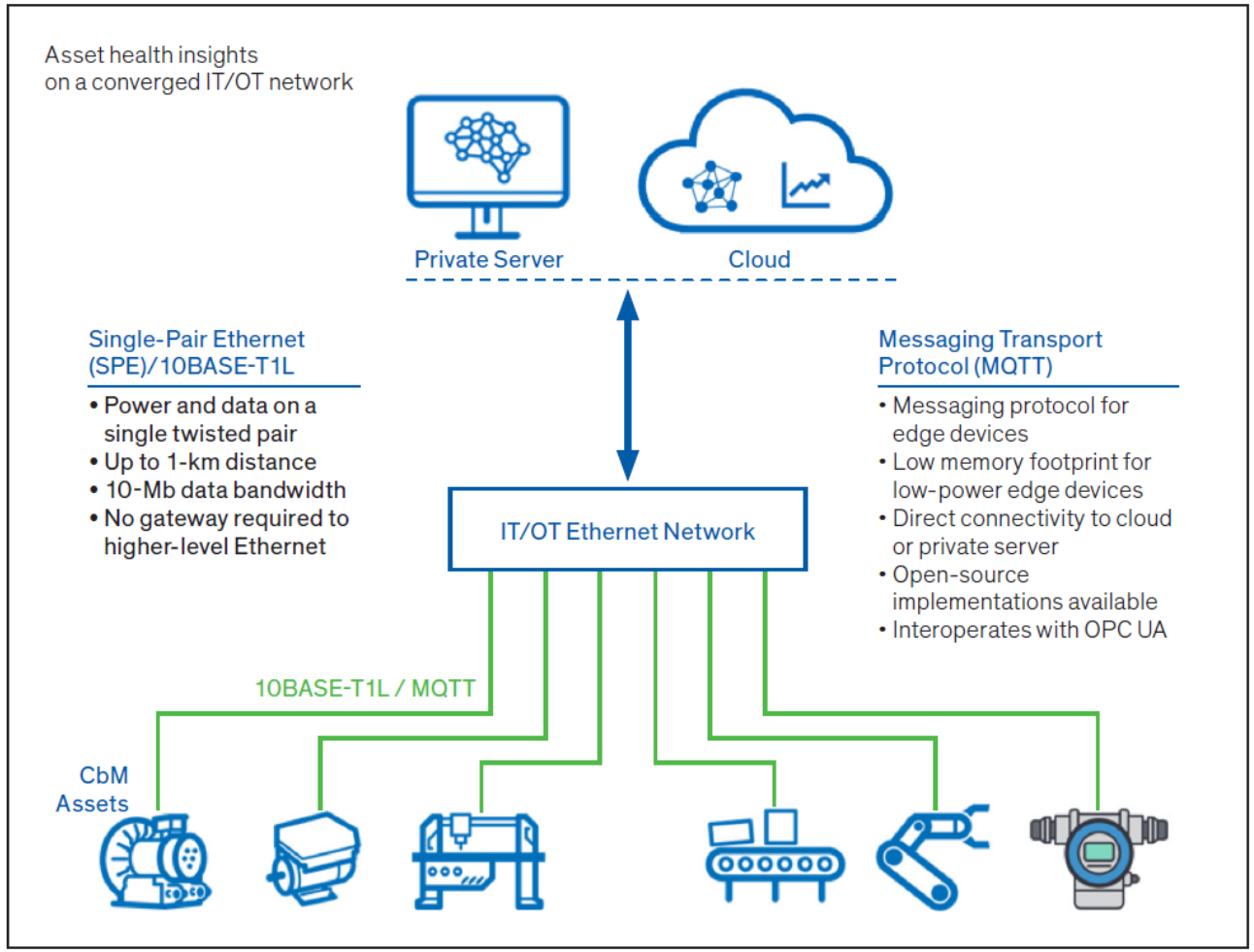
ADI Enabling Edge Connectivity with ADIN1100 10BASE-T1L PHY



Industrial CbM Asset Monitoring Connectivity

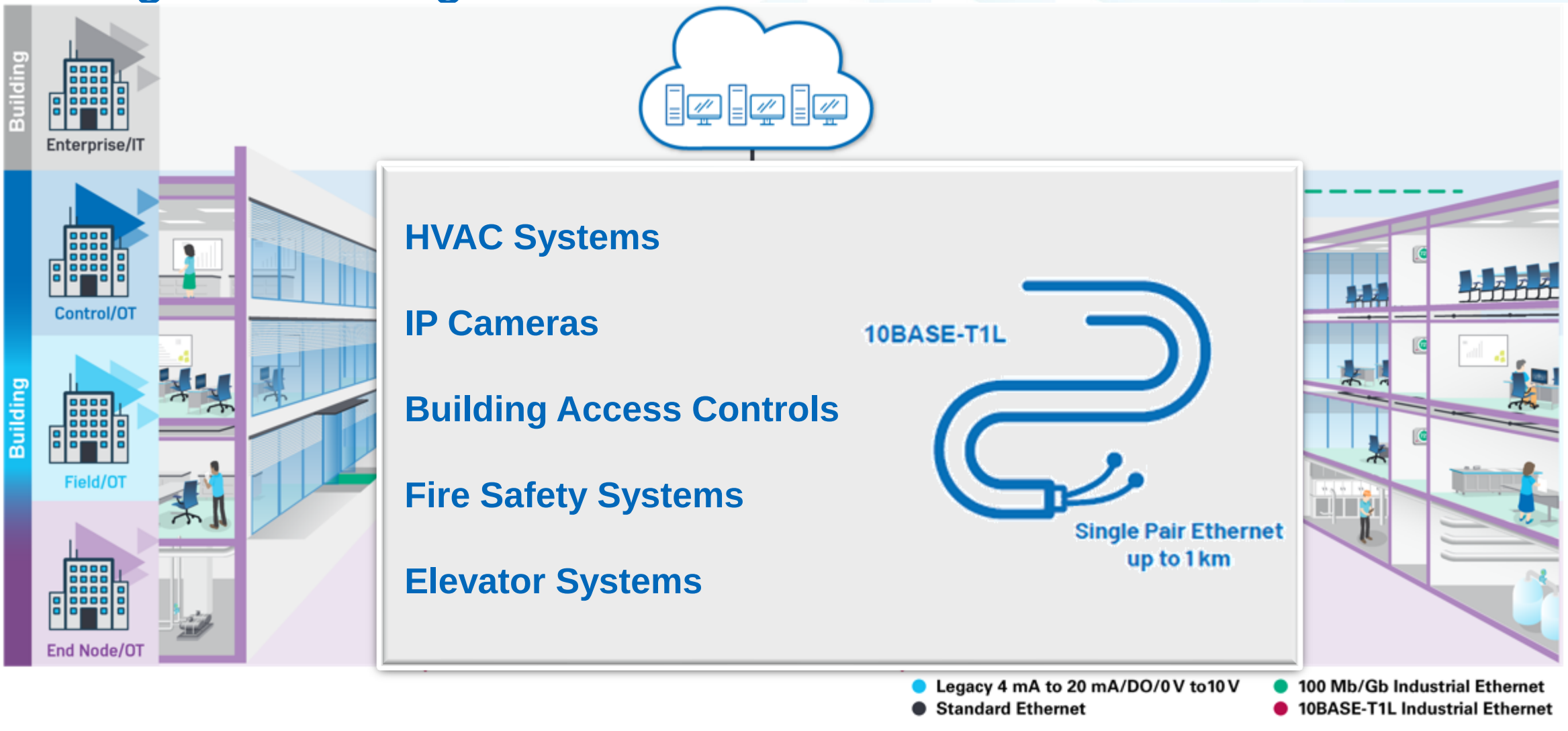
SPE/10BASE-T1L & MQTT





Seamless, Edge-to-Edge Connectivity Solutions

Intelligent Buildings Automation



10BASE-T1L Technology Insights

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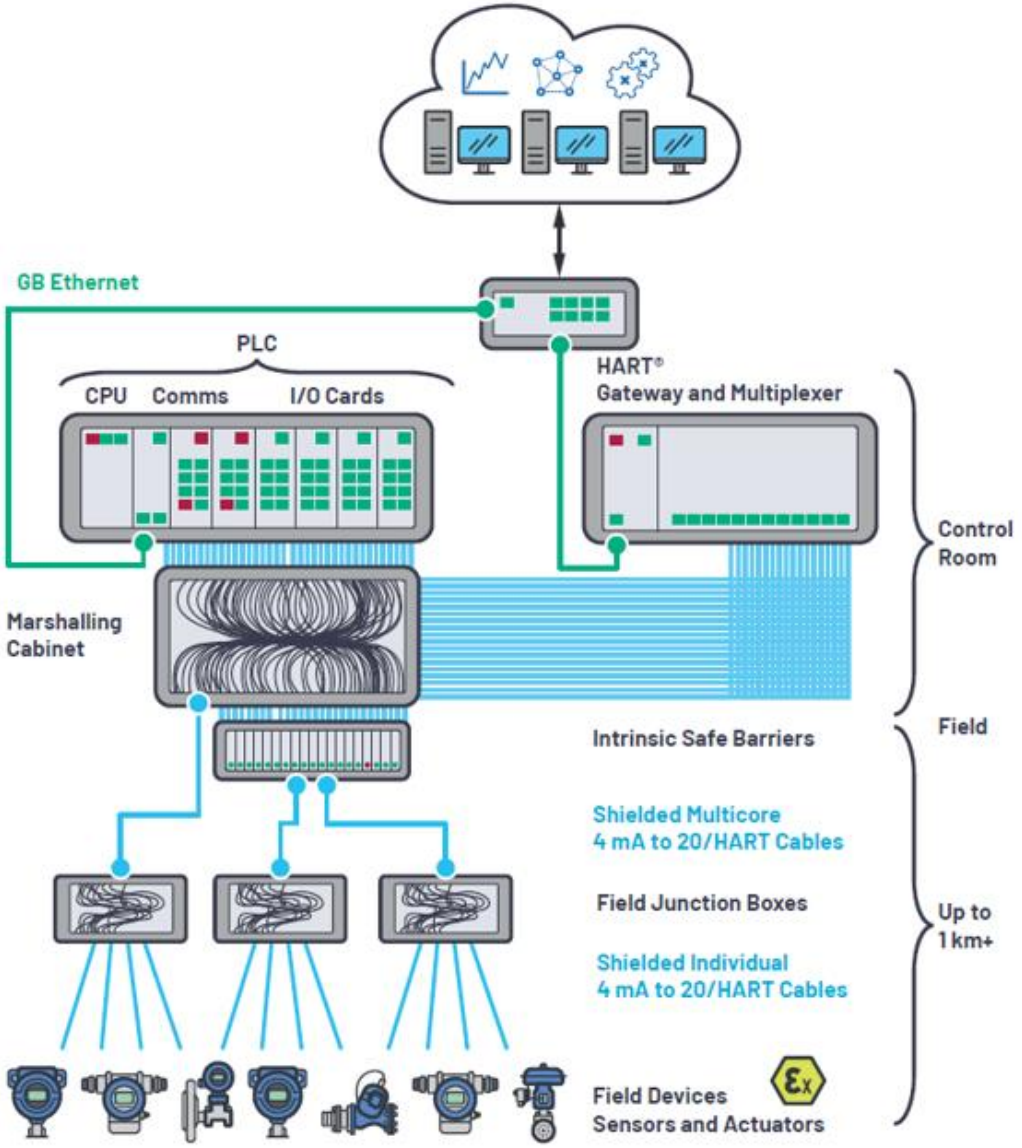
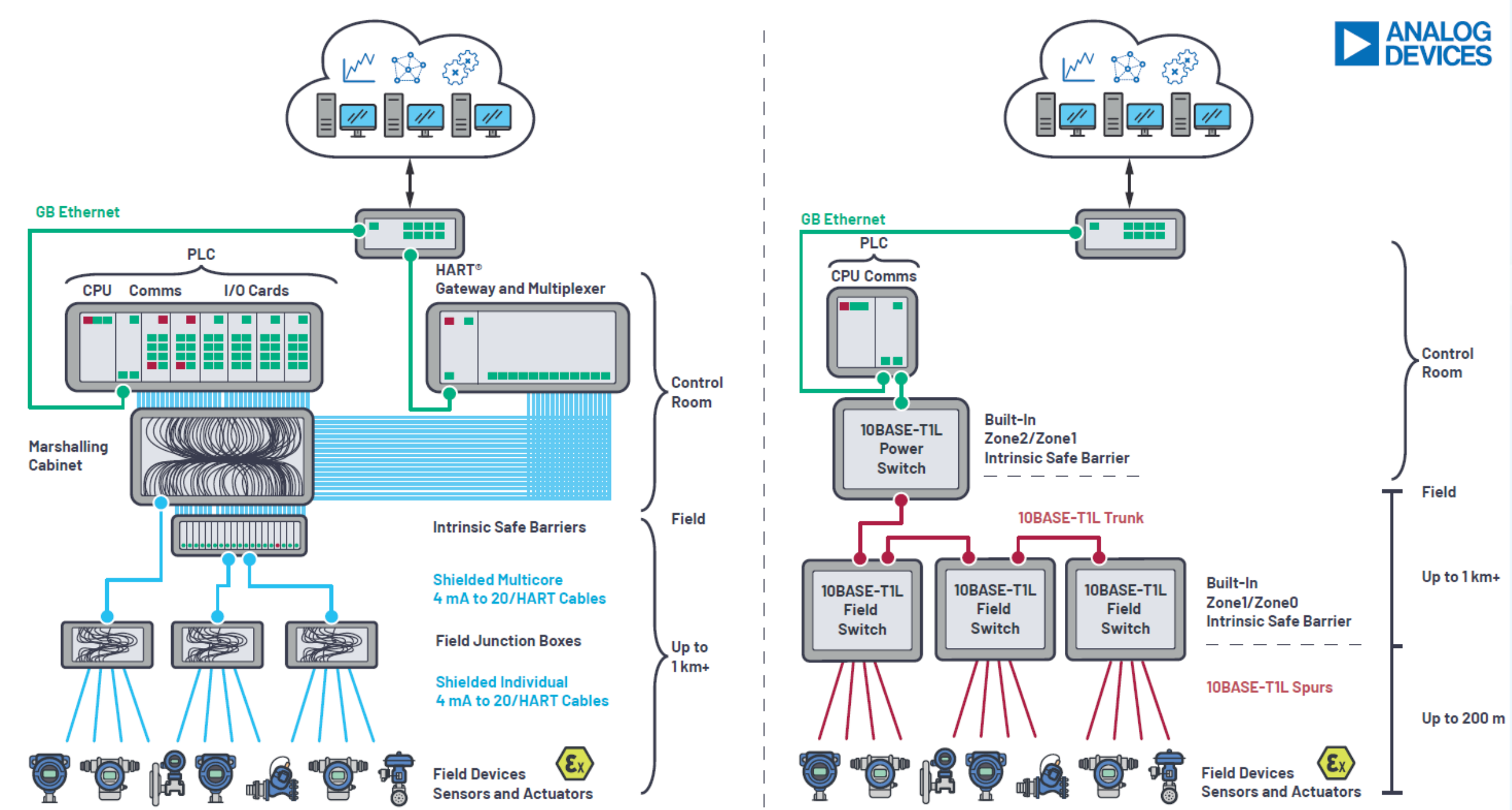
Process Control Use Case – Ethernet to the Edge



- **Challenges in Existing Architecture**
  - Limited Bandwidth
  - Limited Available Power at the Edge Node
  - Complex Gateway Translations
  - Complex Cabling Network
  - Intrinsically Safe Zone 0


GB Ethernet
PLC
CPU
Comms
I/O Cards
HART®
Gateway and Multiplexer
Marshalling
Cabinet
Control
Room
Field
Intrinsic Safe Barriers
Shielded Multicore
4 mA to 20/HART Cables
Field Junction Boxes
Shielded Individual
4 mA to 20/HART Cables
Up to
1 km+
Field Devices
Sensors and Actuators
GB Ethernet
PLC
CPU Comms
10BASE-T1L
Power
Switch
Built-In
Zone2/Zone1
Intrinsic Safe Barrier
10BASE-T1L Trunk
10BASE-T1L
Field
Switch
10BASE-T1L
Field
Switch
10BASE-T1L
Field
Switch
Built-In
Zone1/Zone0
Intrinsic Safe Barrier
10BASE-T1L Spurs
Field Devices
Sensors and Actuators
Control
Room
Field
Up to 1 km+
Up to 200 m
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ADIN1100 10BASE-T1L PHY

Sampling Now!

FEATURES

- **10BASE-T1L IEEE® Std 802.3cg™ -2019 compliant**
- **Supports Intrinsic Safe applications**
  - 1.0 V pk-pk & 2.4 V pk-pk transmit levels
- **Single supply 1.8 V or 3.3 V**
  - Mode dependent, multiple supplies also possible
- **Ultra-Low power consumption**
  - 1V pk-pk with Dual Supply – **39 mW**
  - 2.4V pk-pk Multiple Supplies – **75 mW**
    - Specification for all power options in datasheet
- **Small package** 40-lead LFCSP
- **Industrial temperature range** -40ºC to 105ºC

Ultra-Low Power 10BASE-T1L PHY

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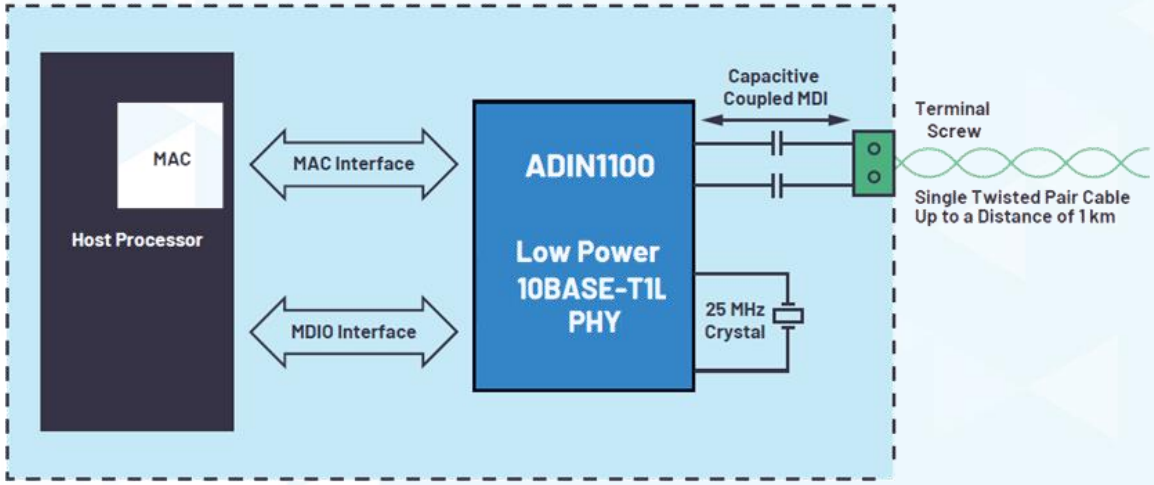
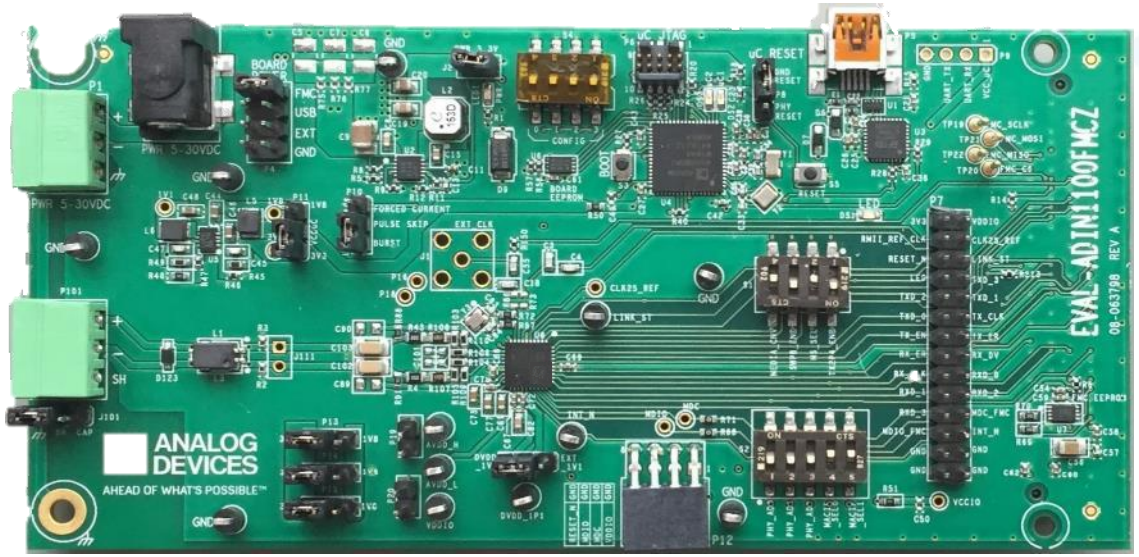
ADIN1100 10BASE-T1L PHY

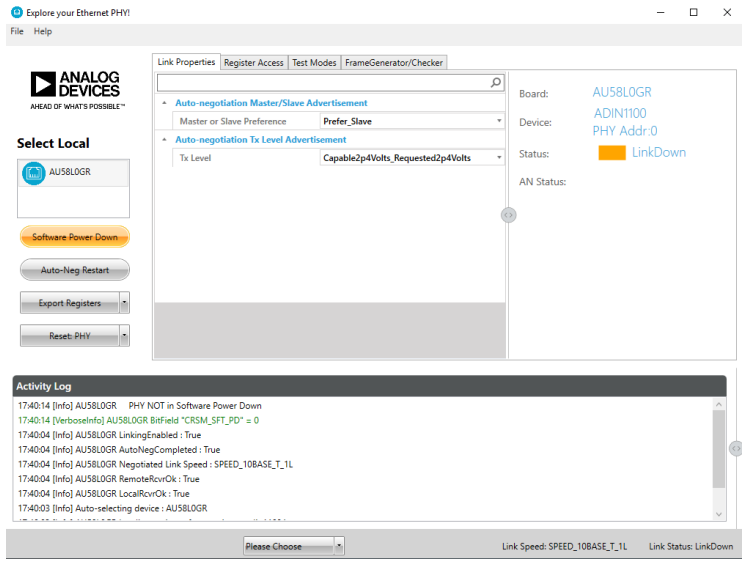
- **Configurations**
  - Unmanaged using hardware pin strapping
  - Managed via management interface (MDIO)
- **Standard PHY Data Interface**
  - MII, RMII, RGMII Interface
  - 25 MHz crystal oscillator/clock input frequency
  - 50MHz clock input for RMII
- **10BASE-T1L Modes**
  - 1.0 V pk-pk & 2.4 V pk-pk transmit levels
  - Master / Slave
  - Auto-negotiation
- **Diagnostics**
  - Frame Generator and Checker
  - Multiple Loopback Modes
  - IEEE Test Mode Support
  - Cable Diagnostics



Simplified 10BASE-T1L Connectivity Diagram

EV-ADIN1100FMCZ-U1





EMC Tests to Date

- IEC 61000-4-4 electrical fast transient (EFT)
  - (±4 kV)
- IEC 61000-4-2 ESD
  - (±8 kV contact discharge)
- IEC 61000-4-2 ESD
  - (±15 kV air discharge)
- IEC 61000-4-6 conducted immunity
  - (10 V)
- EN55032 radiated emissions
  - (Class A)
- Testing ongoing – Consult Datasheet for latest information

PoDL/SPoE Technology Insights

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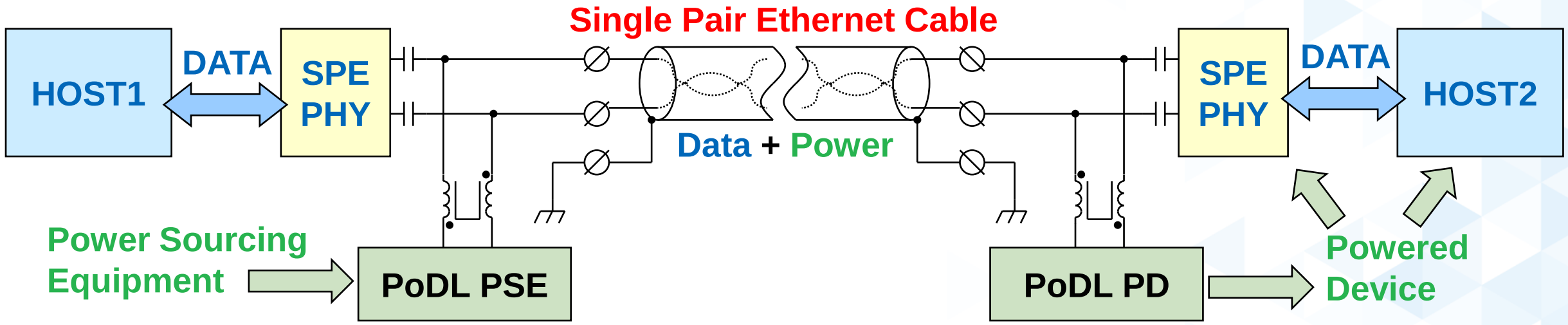
Power over Data Line (PoDL)/Single Pair PoE (SPoE)

10BASE-T1L: IEEE Std 802.3cg™-2019

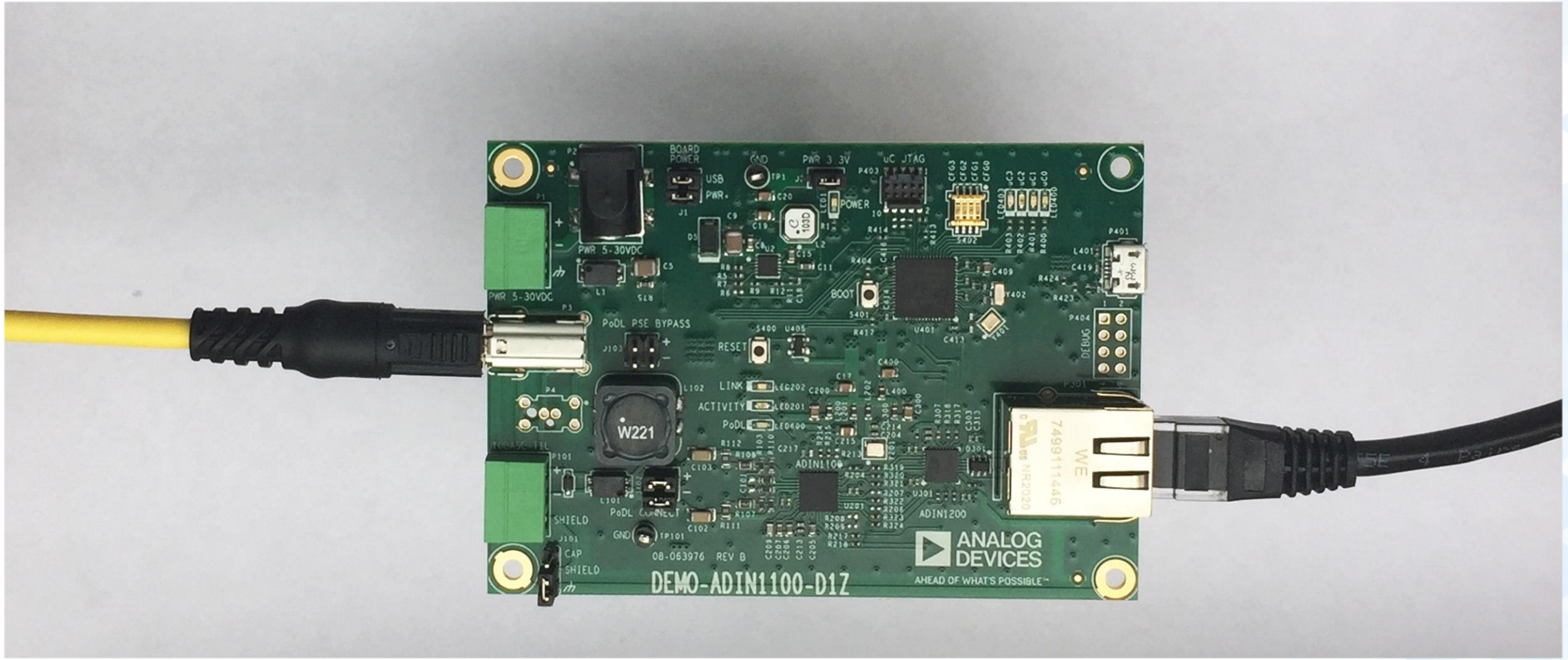
Class	10	11	12	13	14	15
$V_{PSE(max)}$ (V)	30	30	30	58	58	58
$V_{PSE\_OC(min)}$ (V)	20	20	20	50	50	50
$V_{PSE(min)}$ (V)	20	20	20	50	50	50
$I_{PI(max)}$ (mA)	92	240	632	231	600	1579
$P_{class(min)}$ (W)	1.85	4.8	12.63	11.54	30	79
$V_{PD(min)}$ (V)	14	14	14	35	35	35
$P_{PD(max)}$ (W)	1.23	3.2	8.4	7.7	20	52

- PoDL - Power over Data Line
  - PoDL is PoE for one-pair Ethernet PHYs
- PoDL is an industry standard: IEEE Std. 802.3bu
- IEEE Std. 802.3cg further specifies PoDL for 10Mbps industrial systems
- Intended for industrial sensors, factory automation, Internet of Things, etc.
  - Safe, fault-tolerant and easy to install
  - Anywhere that both data and power over just two conductors is valuable



ADIN1100 Media Converter with Harting Connector

10BASE-T to 10BASE-T1L with PoDL PSE



10BASE-T1L Articles and Videos

- Articles
  - Enabling Seamless Ethernet to the Field with 10BASE-T1L Connectivity
  - Ethernet-APL: Optimization of Process Automation with Actionable Insights
  - PROFINET to the Edge: Single Pair Ethernet
  - New Single Pair Ethernet with PROFINET

- Videos
  - ADI: Enabling Ethernet to the Field with 10BASE-T1L Connectivity
  - ADI & 10BASE-T1L & Gb: Future Ethernet Physical Layers in Industrial Systems

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The End