

**TW1STER**

HARTING T1 Industrial

One pair is enough – The new Single Pair Ethernet

Single Pair Ethernet

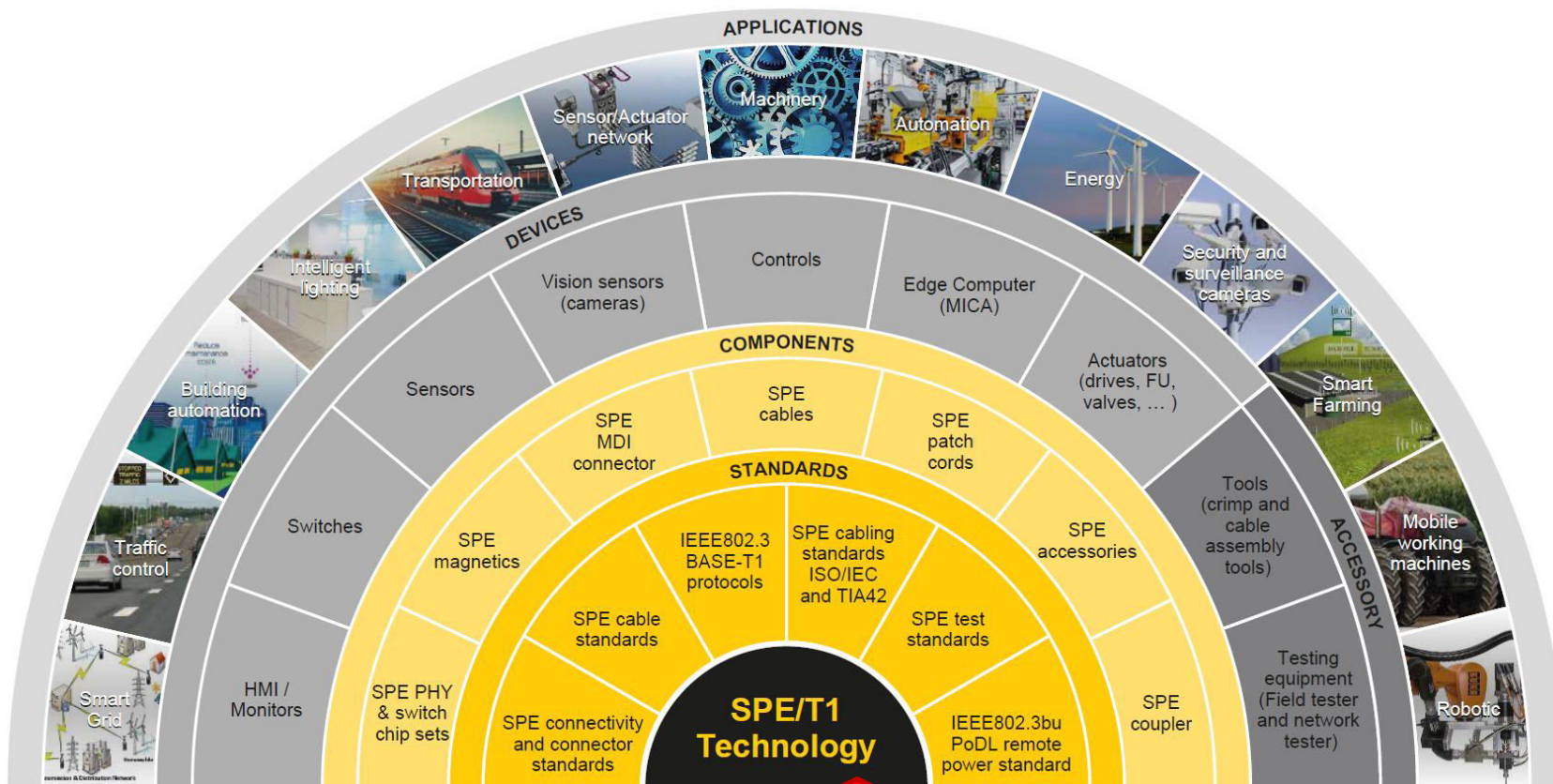
A decorative graphic featuring a blue wavy line and a blurred image of a circuit board.

Technology Overview

Single Pair Ethernet – Ecosystem



Pushing Performance



People | Power | Partnership

Matthias Fritsche | HARTING Technologiegruppe

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■ All kind of physical media are today used for Ethernet transmission:

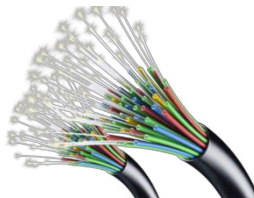
- Radio waves like WiFi



- Light like LiFi



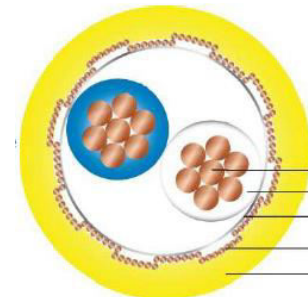
- Fiber optic cables



- Copper cables with 2 or 4 twisted pairs (MPE)



- Copper cable with just 1 twisted pair
→ **New physical media**
= Single Pair Ethernet (SPE)



■ Starting point of SPE was the BroadR-Reach® technology from Broadcom:

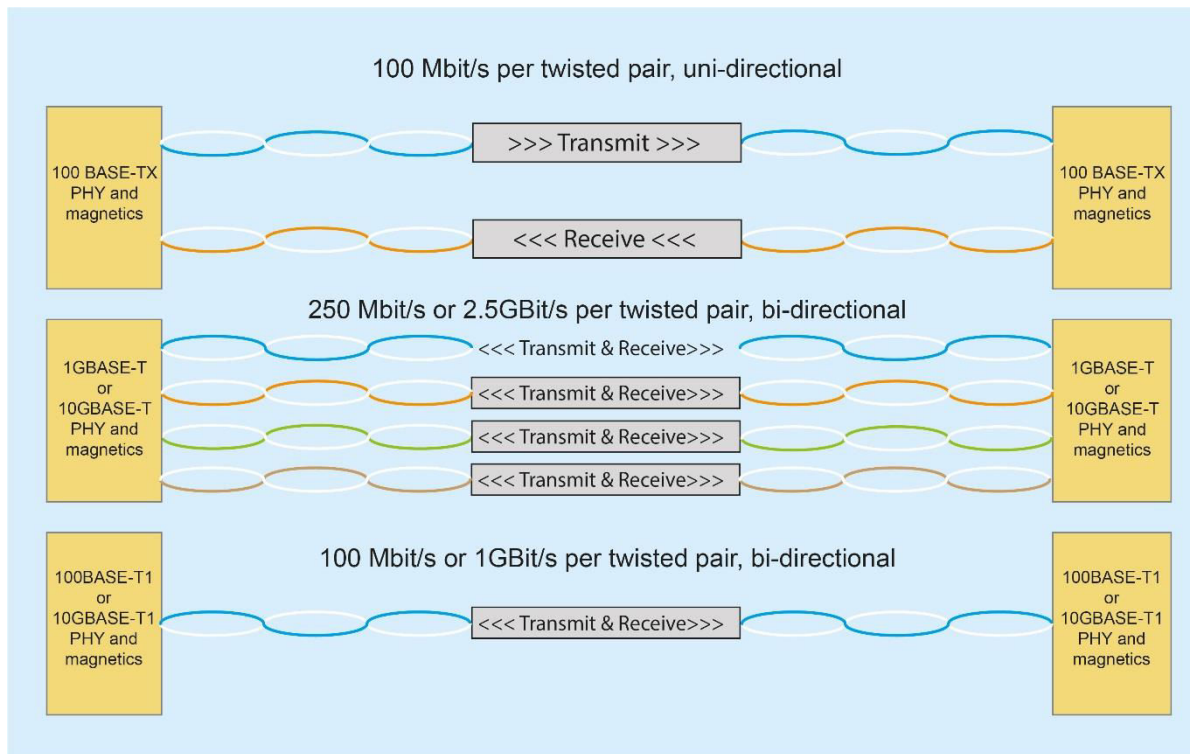
- Automotive Ethernet standard realizes simultaneous transmit and receive (i.e., full-duplex) operations on a single-pair cable.
- Officially released in December 2011, following the formation of The OPEN (One-Pair Ether-Net) Alliance Special Interest Group (SIG). <http://www.opensig.org/>
- Support by a strong group of Industry's Leading Automotive & Tech Companies



- Standardized as IEEE 802.3bw - 2015
- SPE will replace the today used CAN, FlexRay, LIN etc.

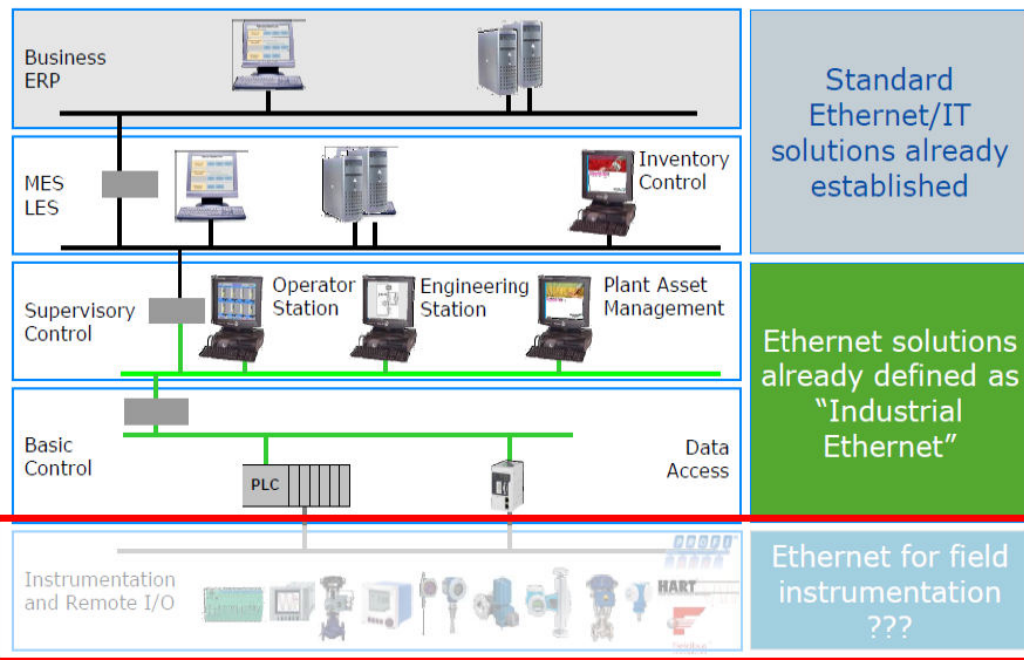
■ How SPE is working in comparison to 2-pair or 4-pair Ethernet:

- Fast Ethernet use 2 pairs, one pair to transmit and one pair to receive data
- Gigabit Ethernet use 4 pair for bidirectional parallel receive and transmit data
- Single pair Ethernet use just one pair for bidirectional parallel receive and transmit data



■ SPE can fill the gap in Industrial Networks:

- Desire to converge on one network type
- Ethernet adoption is happening where technically possible
- Non-Ethernet *fieldbuses* still required to complete communications to the edge
 - Cable lengths > 1km
 - 1200 baud to hundreds of kb/sec
 - Challenges: Combined reach & rate, special environments, cost of operation



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

Ethernet Gap at the 'Edge'

- **SPE will be only successful in the non automotive market if a standardized connector is defined and widely used. Similar like the RJ45 or also the M12 D- and X-coded connectors.**
- **HARTING tasks successfully done:**
 - Develop and standardize the SPE interface = IEC 63171-6
 - Integrate our SPE connector as MDI (Media Depended Interface) to the IEEE 802.3 protocol standards
 - Integrate our SPE connector to the relevant cabling standards at ISO/IEC and TIA 42

Single Pair Ethernet

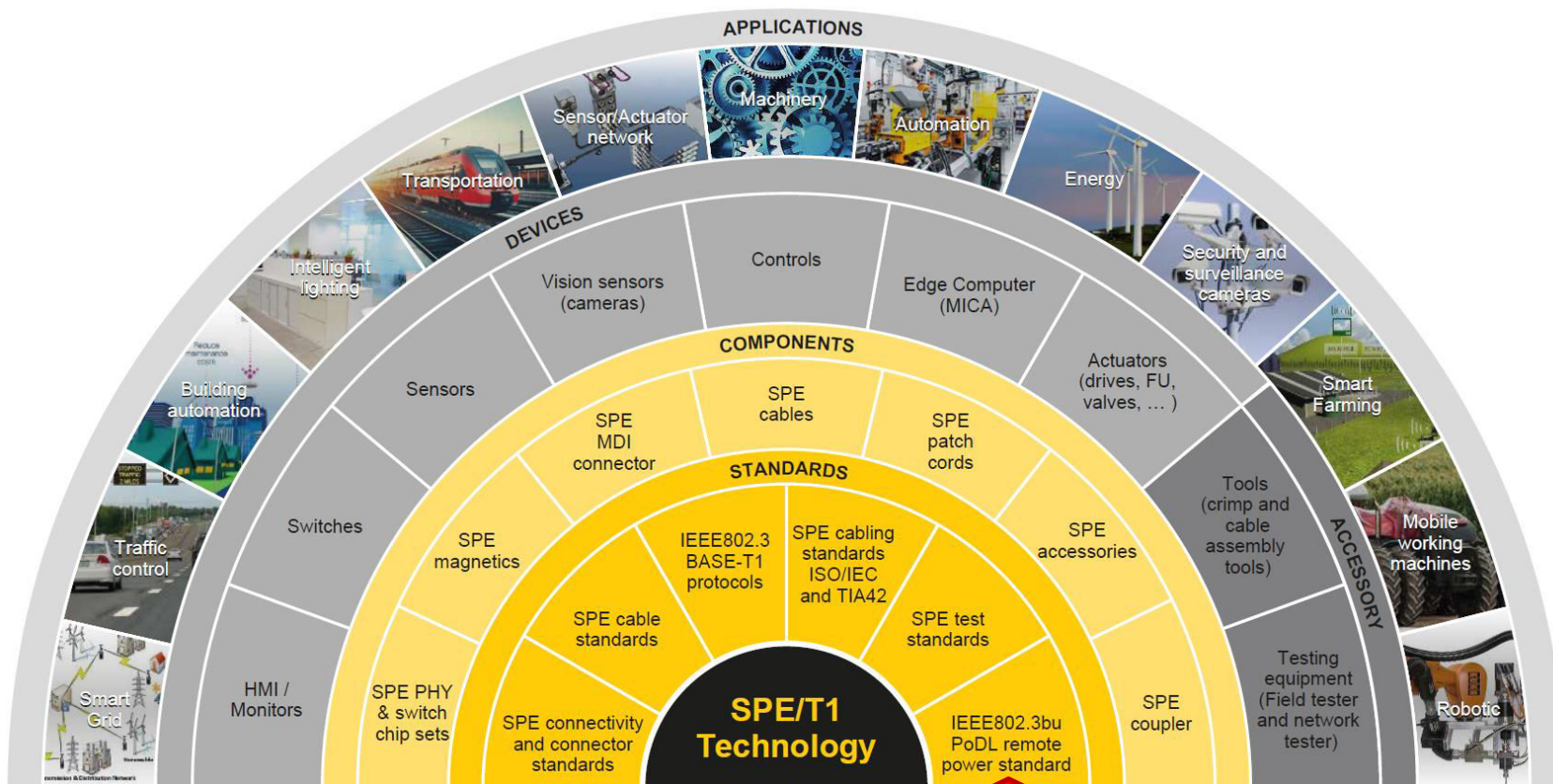
A decorative graphic featuring a blue wavy line that spans the width of the slide, with a blurred image of a circuit board in the background on the right side.

Standardization

Single Pair Ethernet – Ecosystem

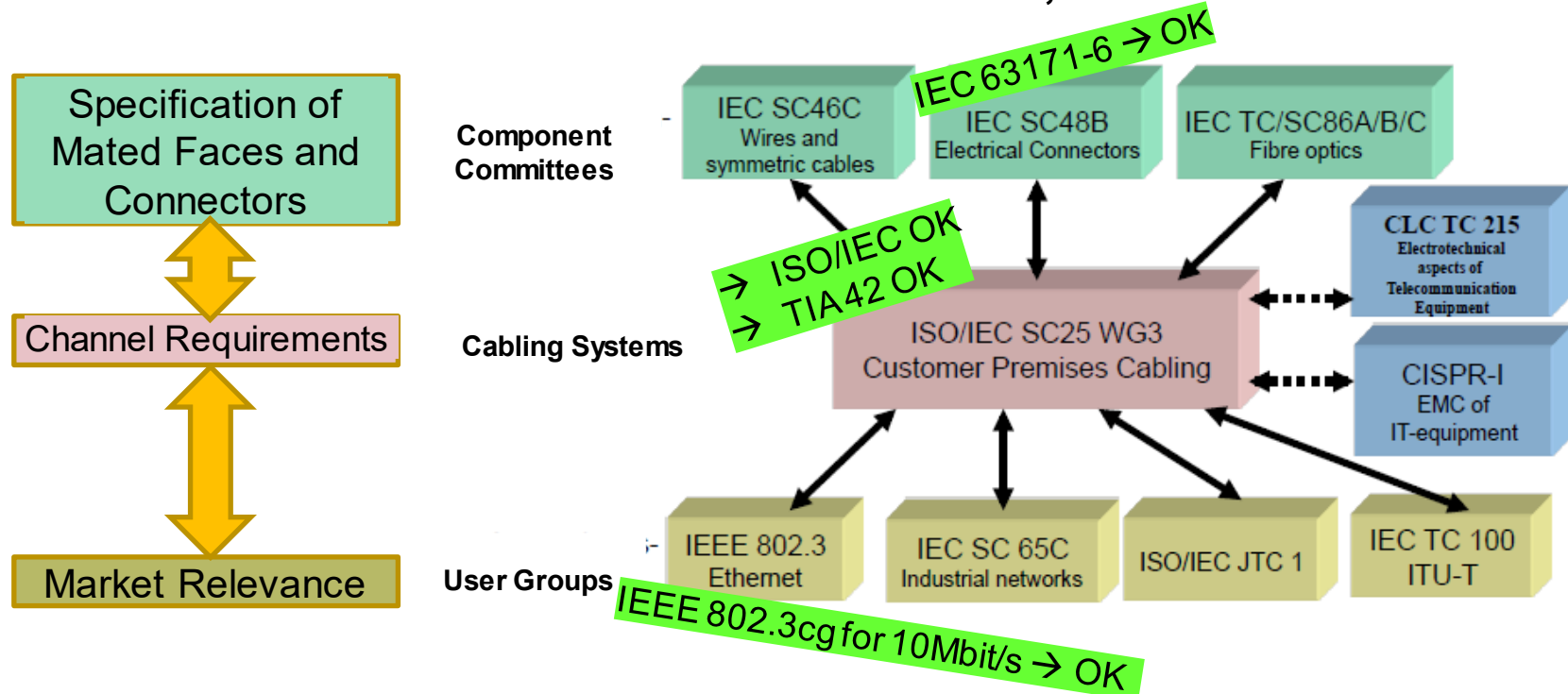


Pushing Performance



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ISO/IEC Standardization Committees for Cables, Connectors and Cabling



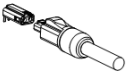




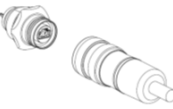
IEC CDV 61076-3-125 © IEC: 2019

– 13 –

5.2 Isometric view and common features

5.2.1 Connector Styles

Table 1 – Connector styles

Style	Description	Picture
2P-L-L	PLUG ¹ - Free 2-way IP20 connector with male contacts, latch locking	
2J-L-L	JACK ¹ - Fixed 2-way IP20 connector with female contacts, latch locking, intended for PCB mounting	
6P-S8	PLUG ¹ - Free 2-way IP65/67 connector with male contacts, size 8 ² , snap-in locking	
6J-S8	JACK ¹ - Fixed 2-way IP65/67 connector with male contacts, size 8 ² , snap-in locking, intended for single hole mounting	
6P-P8	PLUG ¹ - Free 2-way IP65/67 connector with male contacts, size 8 ² , push pull locking	
6J-P8	JACK ¹ - Fixed 2-way IP65/67 connector with female contacts, size 8, push pull locking, intended for single hole mounting	
6P-M8	PLUG ¹ - Free 2-way IP65/67 connector with male contacts, size 8 ² , M8-screw locking	
6J-M8	JACK ¹ - Fixed 2-way IP65/67 connector with female contacts, size 8 ² , M8 thread locking, intended for single hole mounting	
6P-M8C	PLUG ¹ - Free 4-way connector with male contacts, size 8 ² , M8 thread locking	
6J-M8C	JACK ¹ - Fixed 4-way connector with female contacts, size 8, M8 thread locking, intended for single hole mounting	
6P-P12	PLUG ¹ - Free 2-way IP65/67 connector with male contacts, size 12 ² , push pull locking	
6P-M12	PLUG ¹ - Free 2-way IP65/67 connector with male contacts, size 12 ² , M12 thread locking, intended for single hole mounting	
6J-P12	JACK ¹ - Fixed 2-way IP65/67 connector with female contacts, size 12 ² , push pull locking, intended for single hole mounting	
6J-M12	Identical to 6J-P12 but with M12 thread locking instead of push pull	
6J-C12	Combination of 6J-P12 and 6J-M12. With both, M12 thread and push pull locking.	

¹ The terms PLUG and JACK are used only for easier reading since they are widely used.

² The designation "size 8" and "size 12" indicates roughly the diameter of the jack in millimeters.

5.2.2 Common features

Not applicable.

IEC 63171-6 (former IEC 61076-3-125) Connectors for electronic equipment

- Product requirements

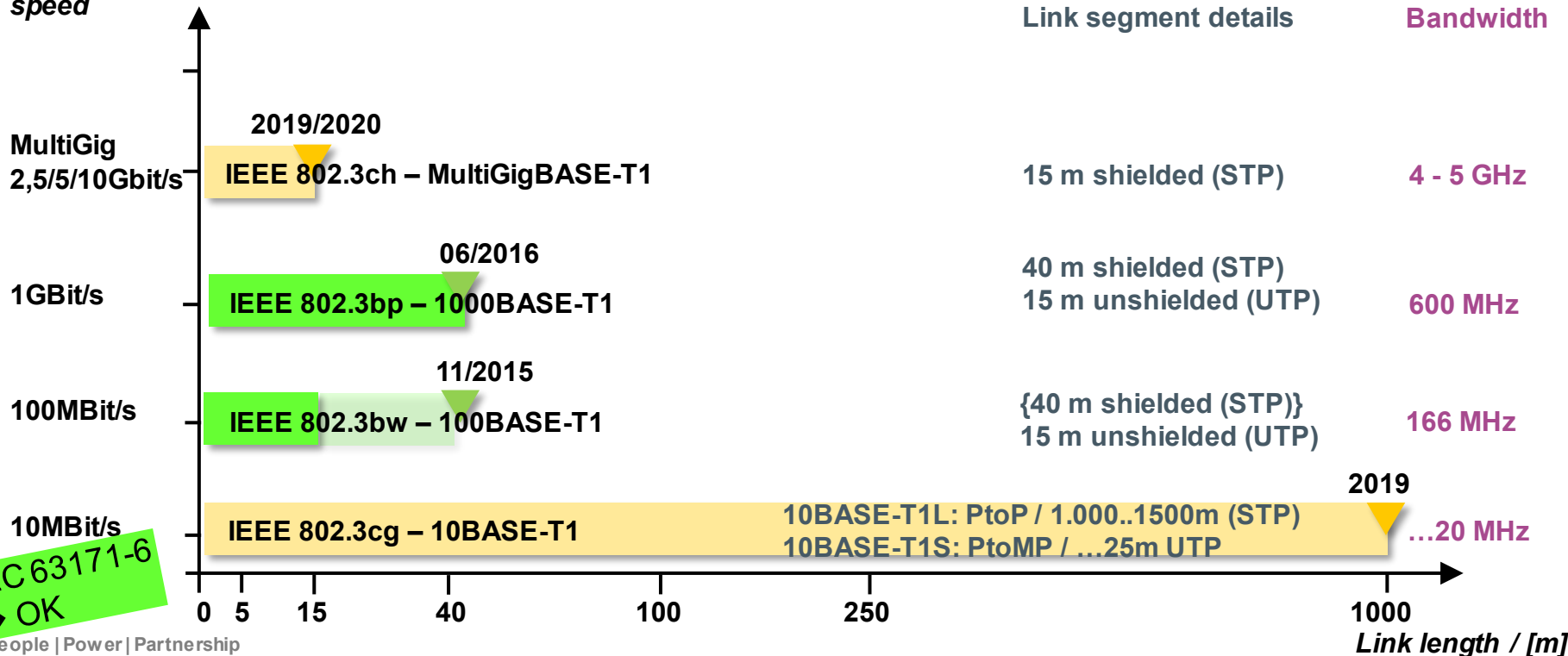
- Detail specification for 2-way, shielded, free and fixed connectors for data transmission up to 600MHz with current carrying capacity

Status: CDV / Completion expected end of 2019

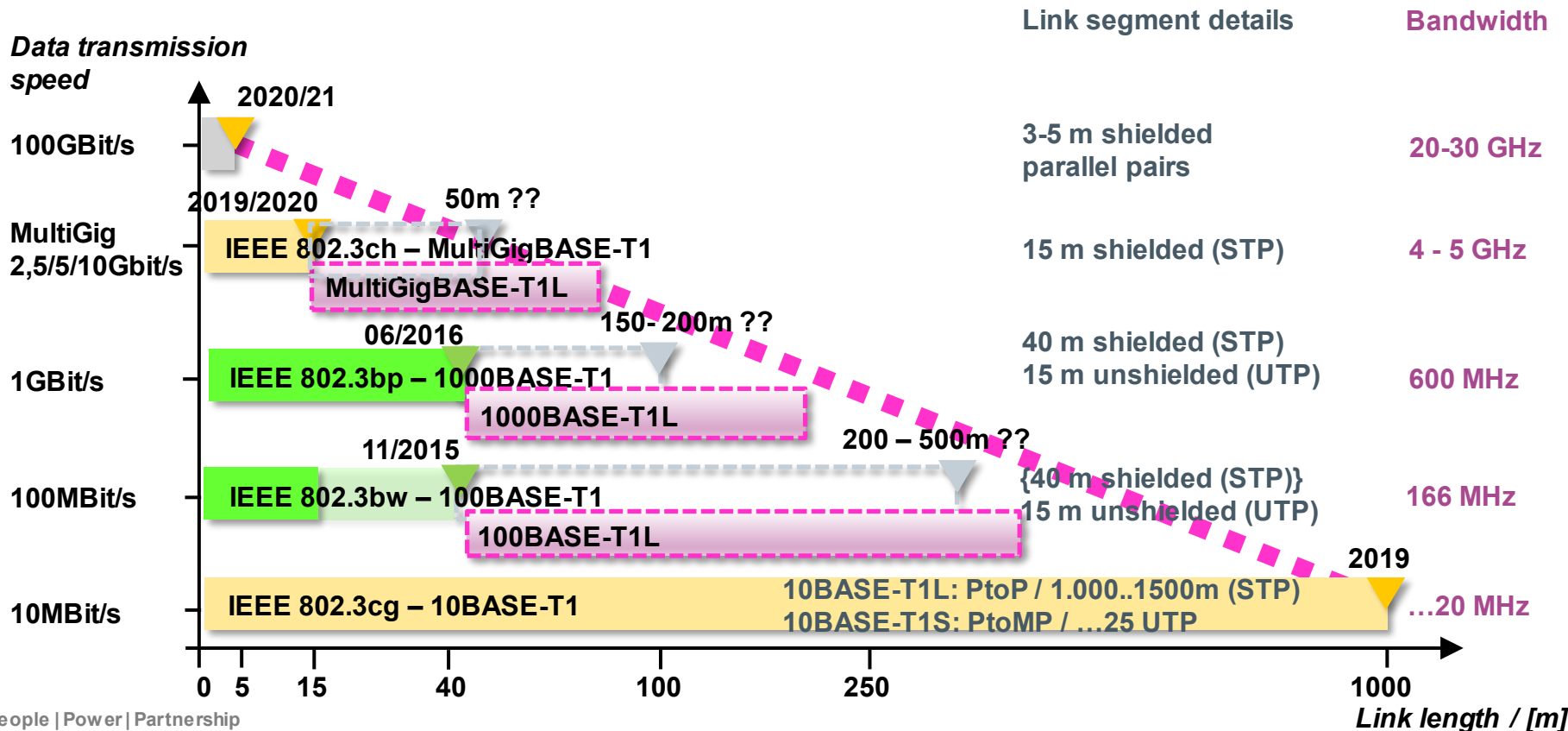
P. 13 ff. refers to the 2 pin SPE plug and jack connector designed by HARTING and the 4 pin (2 data pins and 2 power pins [60V / 8A]) designed by TE Connectivity



Data transmission speed



IEC 63171-6
→ OK

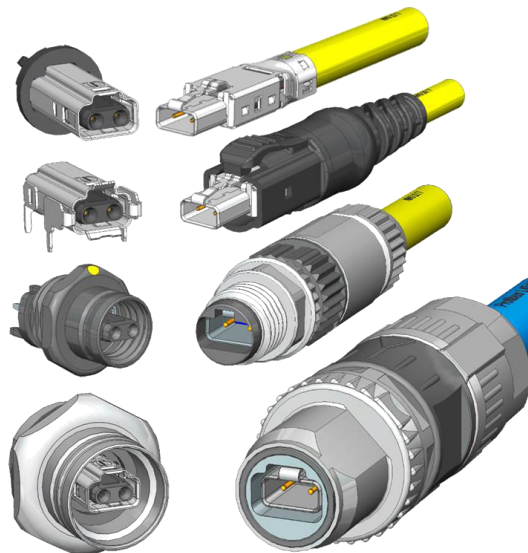
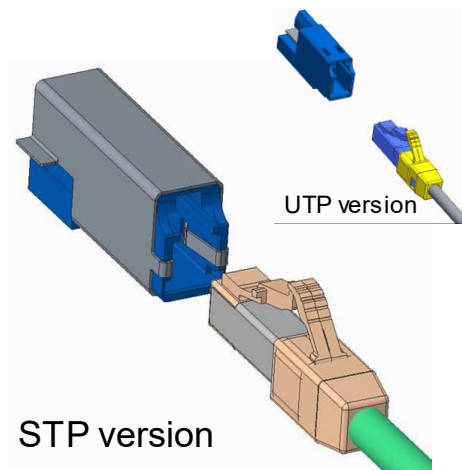


SPE connector mating face selection process results from TIA TR42 and ISO/IEC SC25 WG3:



LC style for $M_1I_1C_1E_1$ acc. IEC 63171-1
from CommScope

Industrial style for $M_2I_2C_2E_2$ and $M_3I_3C_3E_3$
acc. IEC 63171-6 from HARTING



IP20

M8 IP65/67

M12 IP65/67

SPE connector mating face selection process results go to:

ISO/IEC SC25 WG3



- ISO/IEC TR 11801-9906: TECHNICAL REPORT:
Balanced 1-pair cabling channels up to 600 MHz
- ISO/IEC 11801-3 (industrial premises)

TIA TR42



TIA-1005-A-3:
TELECOMMUNICATIONS INFRASTRUCTURE STANDARD FOR
INDUSTRIAL PREMISES ADDENDUM 3 –
Industrial cabling for single pair Link Segment Type B,
1000BASE-T1 for MICE 2 and MICE 3 environments

Single Pair Ethernet

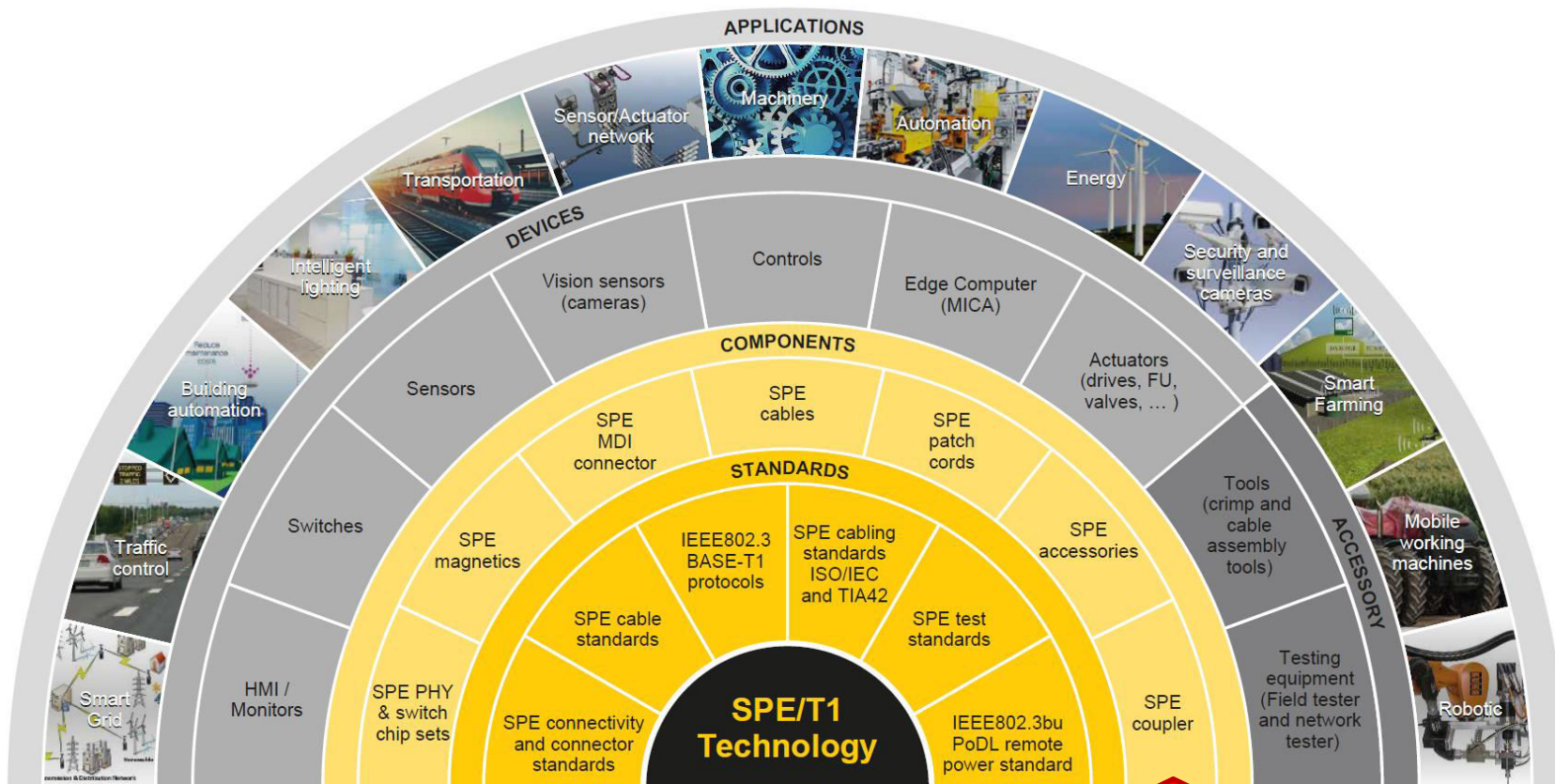
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Connectivity

Single Pair Ethernet – Ecosystem

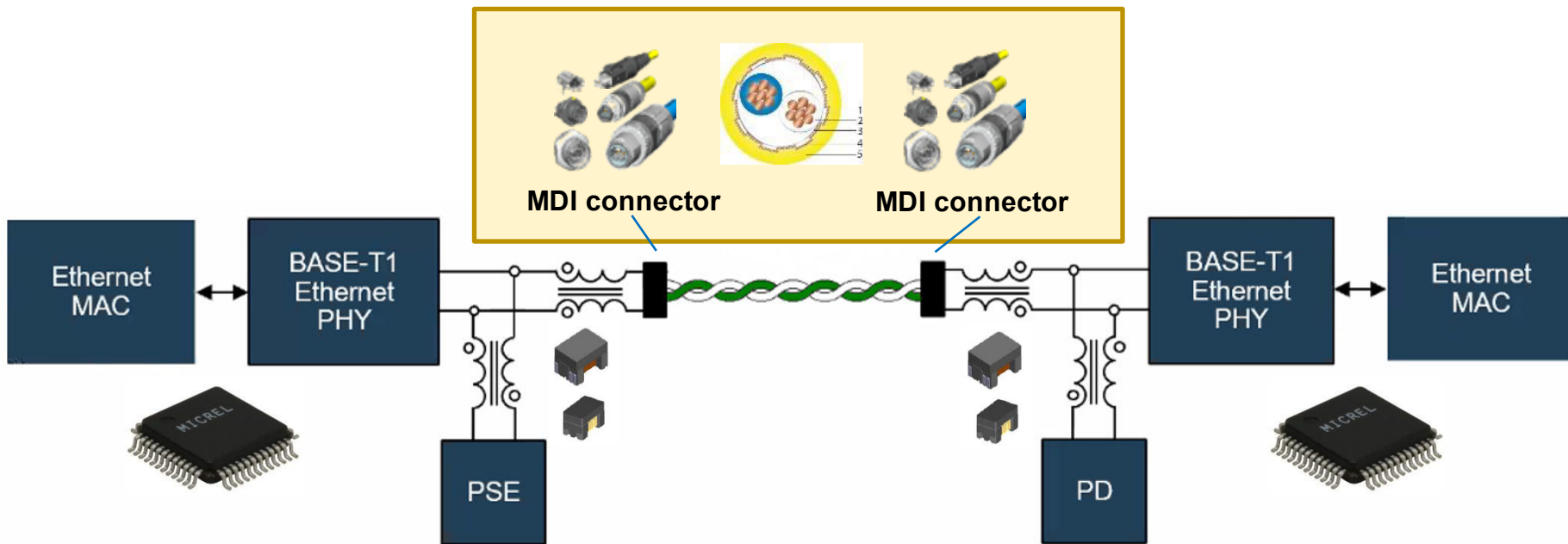


Pushing Performance



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■ Principe of a SPE link with PoDL remote powering:



→ All single components must be available to start the design of SPE devices.

The HARTING SPE connector based on IEC 63171-6

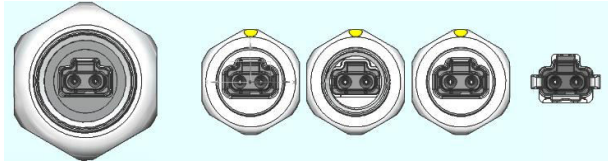
Connector type	Locking mechanism
1 pair core container same container used in all MICE3 connector housings with stainless steel shielding	n.a.
IP20 jack and plug for cables AWG26 up to AWG22 (18) (solid and stranded) Cable diameter 4 – 6 mm	metal latch
IP65/67 jack and plug in M8 housing for cables 26AWG up to AWG22 (18) (solid and stranded) Cable diameter 4 – 6 mm	locking screw, optional: PushPull* *compatible to the locking screw
IP65/67 jack and plug in M12 housing for cables AWG26 up to AWG16 – esp. for IEEE802.3cg (solid and stranded) Cable diameter 4 – 12 mm	locking screw, optional: PushPull* *compatible to the locking screw



The HARTING SPE connector based on IEC 63171-6



Pushing Performance

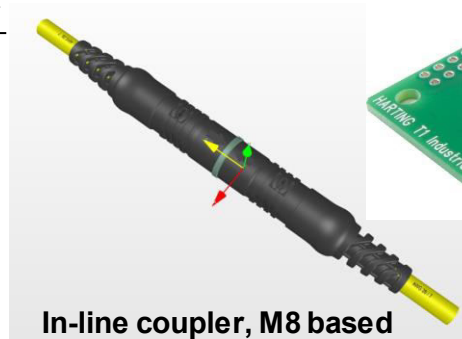
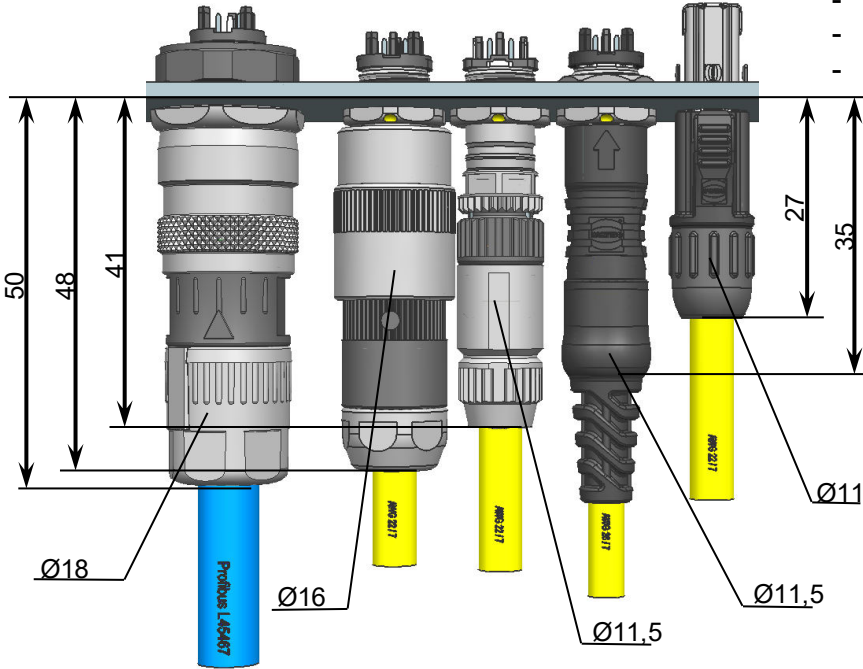


Possible variants from right to left:

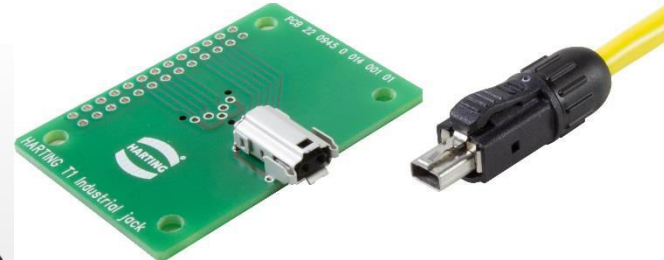
- IP20 style
- M8 SnapInn
- M8 Screw locking
- M8 PushPull locking
- M12 PushPull locking
- M12 Screw locking possible but not shown



Prototype M8 style, plug overmolded and straight PCB THR jack with housing



In-line coupler, M8 based

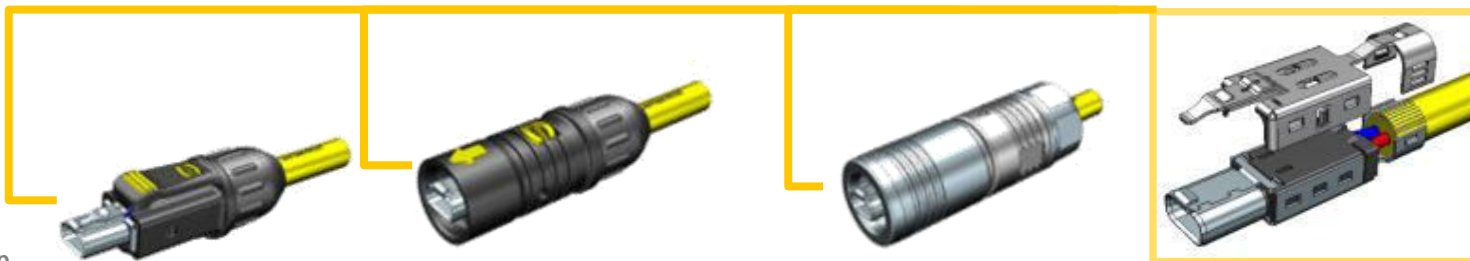


Serial parts IP20 style, plug and angled PCB THR jack

The HARTING SPE connector based on IEC 63171-6

- Delivers best HF performance and head room for remote powering (up to 1000mtrs.)
- Future-proof → prepared for higher bandwidths and bigger loads
- Using existing and already standardized housings/dimensions and locking mechanisms → simple implementation, cost effective new device design
- IP20 interface pluggable with locking to IP65/67 M8 and M12 connector versions for testing and configuration set ups (usually non permanent use)
- Connector standard will be published in 2019
- First SPE connectivity products will be launched in 2019
- Modular product concept – always the same plug and receptacle inserts are used

IP20 SPE plug mated
with M12 SPE jack



The TE hybrid SPE connector based on IEC 63171-6

This 2+2-pin M8 connector for separate data transmission and power supply (60V DC / 8A) is also part of the new IEC 63171-6 (former IEC 61076-3-125) standard.

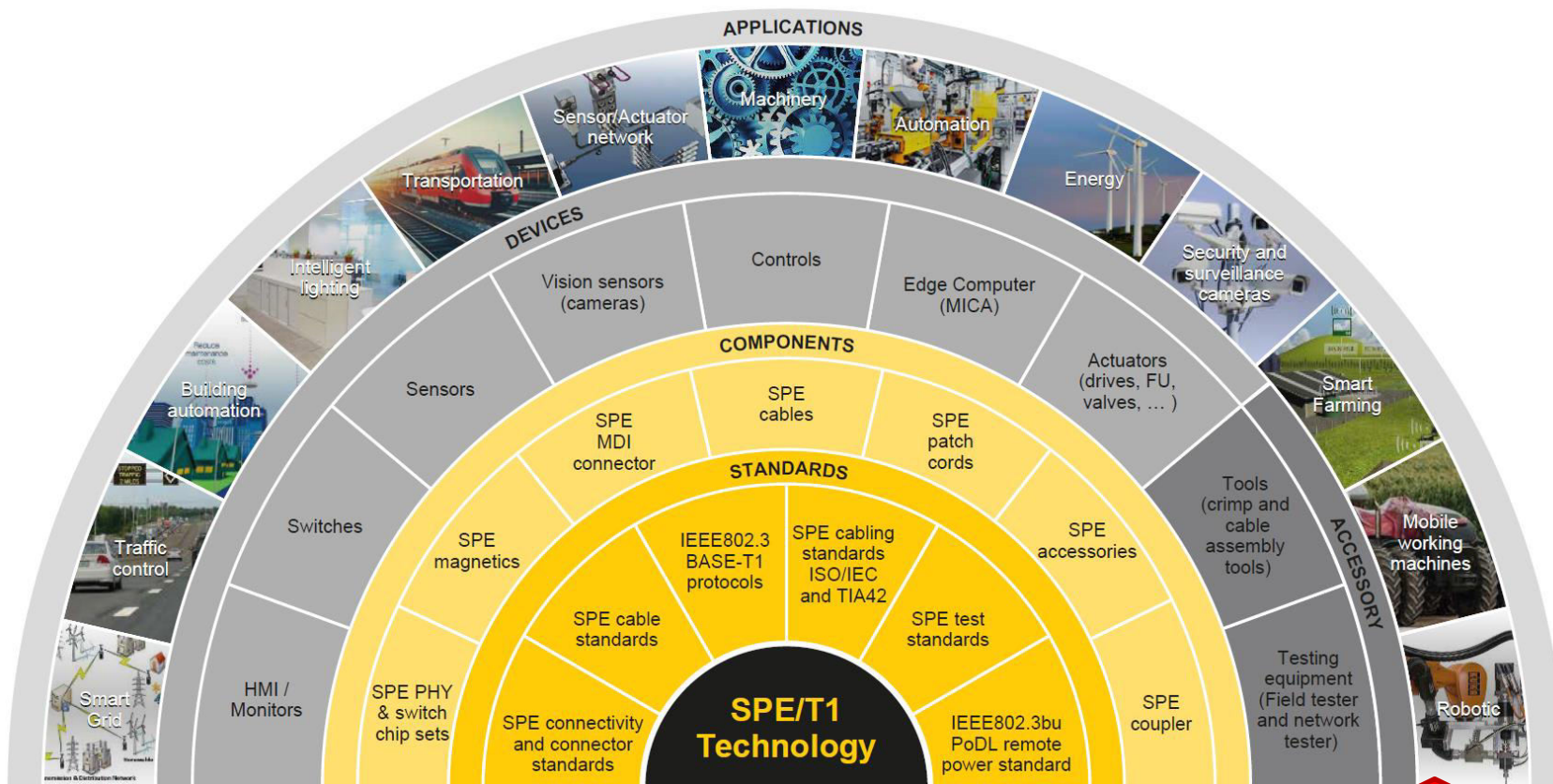


Single Pair Ethernet



Applications / Use cases

Single Pair Ethernet – Ecosystem



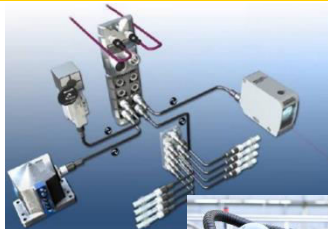
■ Megatrends in Information- and Communication Technology

- Cloud & Edge Computing
- Industrial Internet of Things - IIoT
- Industrie 4.0
- Smart Technologies

■ Impact of Megatrends to Connectivity and Cabling

- Higher Transmission Performance
 - higher Bandwidth/Data Rate and parallel Remote Powering
- IP based Data Services replace Bus Services
- Smaller design of Connectors - Miniaturization
- Simple but confident operation

Automation



Robotics



Transportation



Machinery



and many others

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Major Benefits:

IP based Communication up to the Field Level

Shorter Installation Time for Field Devices

Simplifying Parametrization and Initialization

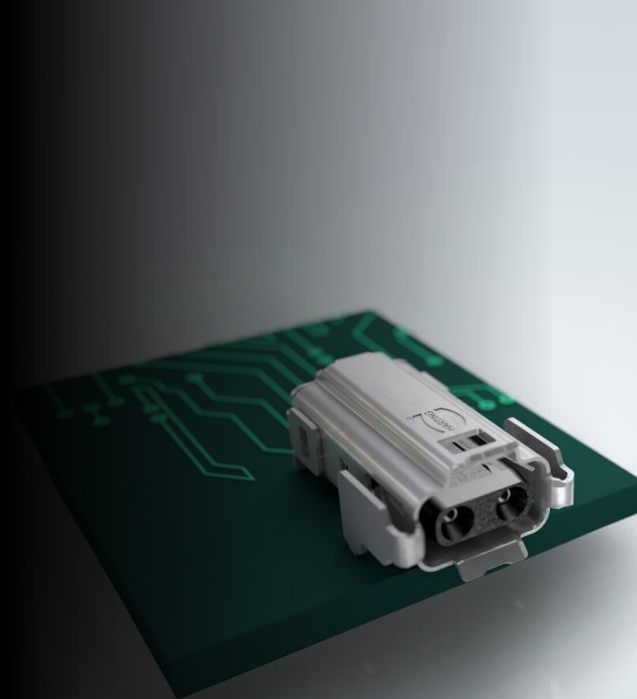
Easy Operation and Maintenance
in a common IP-based Network

Space saving and weight reduction Cabling

10MBit for Process Automation and
Gigabit Ethernet for Automation Networks

In combination with TSN the perfect
infrastructure for IoT and IIoT

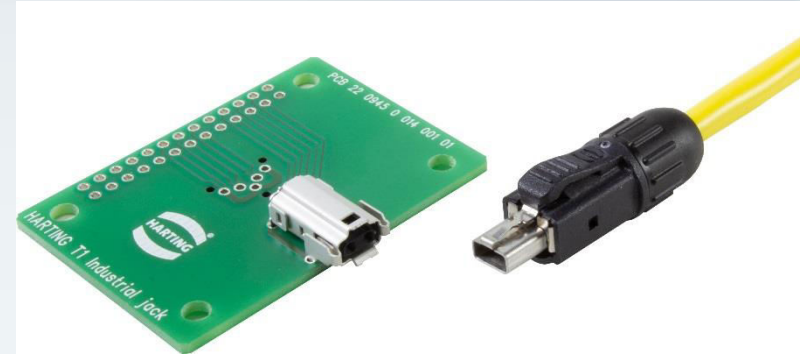
SPE - Single Pair Ethernet



HARTING T1 Industrial

– The connectivity for Single pair Ethernet (SPE)

- Combining Ethernet data transmission and power supply (PoDL = Power over Data Line) in one single interface
- Ready for SPE standards:
 - IEEE 802.3cg – 10BASE-T1 – 10Mbit/s up to 1.000m
 - IEEE 802.3bw – 100BASE-T1 – 100Mbit/s up to 40m
 - IEEE 802.3bp – 100BASE-T1 – 1000Mbit/s up to 40m
 - IEEE 802.3bu – PoDL – Power over data Line to deliver power to the connected SPE devices
- High shock and vibration resistance and long service life that boasts 5,000 mating cycles
- Very compact, less weight and installation space compared to other Ethernet systems
- Mating face for IP20 and IP65/67 standardized according to IEC 63171-6
- Listed at MDI connector proposal at IEEE 802.3cg and in the way to implemented as connectivity at ISO/IEC 11801-x





Thank you!