

Concept study

Extension of IO-Link for Single Pair Ethernet transmission

Authors:

Dmitry Gringauz (Banner Engineering Corp.)

Frank Moritz (SICK AG)

Hartmut Lindenthal (Pepperl+Fuchs AG)

Dr. Franz-Otto Witte (TEConcept GmbH)

Version V1.00

January 27, 2020

File name: IO-Link_over_SPE_V100_Jan20

This document has been prepared by the IO-Link community.

Important notes:

NOTE 1 The IO-Link Community Rules shall be considered prior to the development and marketing of IO-Link products. The document can be downloaded from the www.io-link.com portal.

Disclaimer:

The attention of adopters is directed to the possibility that compliance with or adoption of IO-Link Community specifications may require use of an invention covered by patent rights. The IO-Link Community shall not be responsible for identifying patents for which a license may be required by any IO-Link Community specification, or for conducting legal inquiries into the legal validity or scope of those patents that are brought to its attention. IO-Link Community specifications are prospective and advisory only. Prospective users are responsible for protecting themselves against liability for infringement of patents.

The information contained in this document is subject to change without notice. The material in this document details an IO-Link Community specification in accordance with the license and notices set forth on this page. This document does not represent a commitment to implement any portion of this specification in any company's products.

WHILE THE INFORMATION IN THIS PUBLICATION IS BELIEVED TO BE ACCURATE, THE IO-LINK COMMUNITY MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARD TO THIS MATERIAL INCLUDING, BUT NOT LIMITED TO ANY WARRANTY OF TITLE OR OWNERSHIP, IMPLIED WARRANTY OF MERCHANTABILITY OR WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR USE.

In no event shall the IO-Link Community be liable for errors contained herein or for indirect, incidental, special, consequential, reliance or cover damages, including loss of profits, revenue, data or use, incurred by any user or any third party. Compliance with this specification does not absolve manufacturers of IO-Link equipment, from the requirements of safety and regulatory agencies (TÜV, BIA, UL, CSA, etc.).

☞ **IO-Link** ® is a registered trademark. It may be used only by the members of the IO-Link Community and non-members who had acquired the corresponding license. For more detailed information on its use, refer to the rules of the IO-Link Community at www.io-link.com.

Publisher:

IO-Link Community

c/o PROFIBUS Nutzorganisation e.V.

Haid-und-Neu-Str. 7

76131 Karlsruhe

Germany

Phone: +49 721 / 96 58 590

Fax: +49 721 / 96 58 589

E-mail: info@io-link.com

Web site: www.io-link.com

© No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

Abstract

The following study describes concepts for an integration of IO-Link communication over Single Pair Ethernet (SPE) or Advanced Physical Layer (APL) technology. It describes advantages and benefits of combining these technologies with IO-Link.

IO-Link is well known as an industrial communication interface designed mainly for factory automation. It addresses the communication to field devices – sensors or actuators. With a scalability of three different transmissions rates and a maximum cable length of 20 meters, IO-Link already covers a wide range of the requirements of today's automation applications. Overall, the ease of integration into automation systems as well as the high degree of standardization of common functionalities and device description are just two key benefits of this communication technology.

Ethernet based communication is today a standard in automation. Most fieldbus standards are using Ethernet for communication between control systems (PLCs) and field devices such as discrete I/O aggregators (I/O blocks), high-end sensors, vision systems, actuators and motors. Up to now, the cost, complexity and the lack of standardized power delivery have kept Ethernet out of simple low-cost sensors.

The current standardization of SPE – Single Pair Ethernet – opens new possibilities as well for industrial communication. The definition of the SPE-based APL – Advanced Physical Layer – addresses the requirements for communication to field devices in process automation and intrinsically safe areas.

Some of the key features of these technologies are:

- IO-Link – Point-to-point topology
- IO-Link – Simple installation using standard cables
- IO-Link – Small footprint protocol without addressing
- SPE – Communication and power supply via a twisted-pair cable
- SPE – Cable lengths of up to 1000 m
- SPE – Tolerance against reverse polarity
- SPE – Connection via terminals or industrial connections
- APL – Support for intrinsic safety applications for use in all regional markets

With the ongoing digitalization process in industry new requirements, arise for a wider variety of field devices, more functionality and information as well as a broader field of application.

1 Proposed approach

Ethernet is a collection of networking technologies used to implement local area networks (LANs) in industrial, business and home applications. It is standardized under the IEEE 802.3 family of standards.

Ethernet standards cover the lowest two layers of OSI model, Physical and Data Link layers. One of Ethernet's distinguished characteristics is a number of different physical layers that all utilize a common Data Link Layer protocol data unit, or frame. This approach permits backward compatibility between new and old physical layers. With appropriate adaptations, interoperability between Ethernet networks can be implemented between different physical layers.

In Ethernet family of standards, physical layer implementation is often called a PHY.

1.1 Ethernet Physical layer

Early versions of Ethernet utilized a thick coaxial cable and ran at a speed of 2.5 Megabits per second. As the technology evolved, new physical layers were incorporated into Ethernet standard, such as thin coaxial cable and, eventually, a cable with four twisted pairs. For 10Mbps and 100Mbps networks, four pairs are used: two to transmit data to the device and two to receive data from the device. This allowed the device to transmit and receive data at the same

time by implementing a full-duplex connection. For 1000Mbps networks, all four pairs are used to implement a full-duplex connection.

Coaxial cable-based systems shared a single cable among multiple devices and implemented a frame collision detection and avoidance technique called CSMA/CD (Carrier Sense Multiple Access/ Collision Avoidance) to avoid data corruption (frame collisions can occur when two devices start transmitting at the same time). Twisted pair-based systems use switches and point-to-point connections to implement networks with a more complicated star topology. Twisted pair systems are considered collision-free, although they can experience data frame loss in the switches under heavy load.

Ethernet physical layers are described in the form of abbreviation that lists the speed, transmission technology (baseband), maximum segment length and/or cable type. Some of the physical layers defined by the standard are:

- 10Base5 – 10-megabit, baseband, coax cable, 500 meter length
- 10BaseT – 10-megabit, baseband, twisted pair
- 100BaseT – 100-megabit, baseband, twisted pair
- 1000BaseT – 1000-megabit, baseband, twisted pair

In addition to increased speed, some of the new physical layer implementations also provided power delivery on the existing 4-pair cable. This technology is referred to as POE, or Power over Ethernet. POE typically uses separate pairs within the same cable to transmit power and data signals.

1.2 SPE – Single Pair Ethernet

SPE, or Single Pair Ethernet, is an up-and-coming Ethernet physical layer standard presently under development which is standardized as the IEEE 802.3cg. It uses the same data frame definition as all other standards in the 802.3 family but defines two new physical layers (PHYs):

- 10Base-T1L (long-reach)
- 10Base-T1S (short-reach)
- APL (intrinsic safe)

SPE was conceived as a potential replacement for several slower-speed fieldbuses, such as CAN, HART, MODBUS RTU and similar. It originated in the automotive industry and was extended to accommodate industrial automation and building monitoring applications, hence the introduction of two separate PHYs. One of the main goals of its introduction is to push Ethernet all the way to the edge devices, therefore creating a more homogeneous automation network.

1.2.1 10Base-T1L

The first physical layer (PHY) defined in IEEE 802.3cg, which is of primary interest to this proposal, is 10Base-T1L. This PHY has the following characteristics:

- 10 megabit-per-second (Mbps) speed
- Full duplex (devices can transmit and receive at the same time)
- Use of 2-wire shielded twisted pair cable
- Power delivery over the same cable used for data using PoDL (Power over Data Line technology)
- Star topology, with Ethernet switch that also supplies power to devices
- Power control from the central location (Ethernet switch)
- Point-to-point communications between switch and devices
- Up to 1 kilometer transmit distance (hence the L, for Long-range)

1.2.2 10Base-T1S

SPE 10Base-T1S (Short Reach) PHY is defined for applications that do not require long distances. It is intended mostly for automotive and industrial in-cabinet deployment. Its primary

distinguishing feature is that it supports multi-drop configuration with up to eight nodes attached to the same cable using half-duplex communications.

Multi-drop 10Base-T1S uses a special technique called PLCA, which is an extension of CSMA/CD and allows devices to avoid collisions altogether. This technique is implemented at the PHY and appears transparent to devices that are using it, but at the expense of slight reduction in overall data throughput.

Because power delivery for 10Base-T1S in multi-drop configuration is not specified at this time, multi-drop configuration is not yet suitable for IO-Link adaptation.

10Base-T1S can also be used in point-to-point with PoDL in either half-duplex or full-duplex mode. However, the distance specified by the standard for this PHY, 15 meters, is less than the current IO-Link cable length specifications. This significantly reduces the benefits of adapting IO-Link for use with T1S PHY but does not preclude it altogether.

1.2.3 Advanced Physical Layer - APL

APL is the current standardization approach for bringing Ethernet to field level in process automation. This activity is a collaboration between the fieldbus organisations FieldComm Group, ODVA and PI as well as 11 leading companies in the field of process automation.

APL is a definition of a physical layer based on SPE 10Base-T1L, which is suitable for applications in explosion hazardous areas. APL is standardized in IEEE 802.3cg as an additional physical layer.

In comparison to SPE 10Base-T1L, APL uses PAM3 pulse amplitude modulation with 4B3T coding. Four data bits are represented by a ternary signal (+, 0, -), which reduces the required bandwidth. The encoder adapts the ternary code in the way that DC offsets are minimized.

The key features of APL are:

- Communication and optional power over 100 Ω , 2-wire shielded twisted pair cable
- 10 Mbps full-duplex communication
- Cable length up to 1000 m
- Support of intrinsically safety for zones and divisions
- Use of industrial graded connectors

An extension of APL with a 100 Mbps full-duplex communication and cable length of up to 200 m is in preparation.

1.2.4 Using 10Base-T1L for IO-Link

As can be seen from its description, 10Base-T1L physical layer provides features that are either comparable to or exceed in functionality of the existing standard IO-Link physical layer. Areas of functional overlap include the following:

- Simple cabling
- Power and data delivery over the same cable
- Star topology
- Device power control from the single central location
- Point-to-point communications between the switch (IO-Link Master) and devices
- Long range to accommodate sensor placement

Because of this functional overlap, it is possible to envision a system where the IO-Link physical layer is replaced with SPE 10Base-T1L, while preserving the functionality and implementation of core IO-Link technologies such as communications stacks.

Due to the similarity of SPE 10Base-T1L and APL, the same accounts for a replacement of the IO-Link physical layer with APL. This approach provides the potential of using IO-Link communication even in intrinsic safety applications.

Figure 1 shows the required modifications within the layer structure.

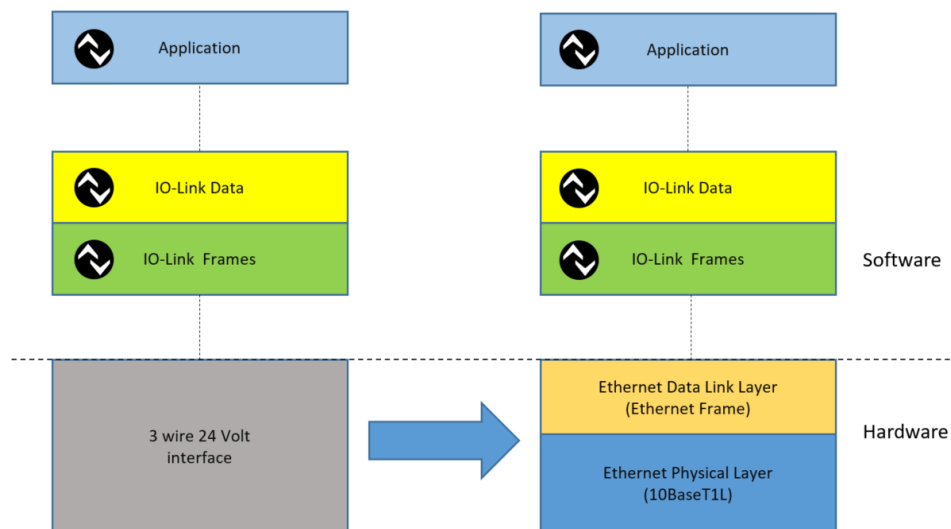


Figure 1 – Physical Layer modification

To the existing IO-Link Master and Device stack implementations, this new physical layer will provide functionality that is largely identical to the IO-Link physical layer and will incorporate existing IO-Link functions such as:

- Power control to the Device
- Device discovery
- Transmission of IO-Link frames between the Master and the Device

Additional details of this approach are provided in the sections below.

1.3 Ethernet Frame

Ethernet Frame is defined as a Data Link Layer protocol data unit. That is, data on Ethernet physical layer is transported as packets, where each packet consists of a single Ethernet frame.

There are several Ethernet frame types, with the most common type being Ethernet II. This frame type is illustrated in figure 2.

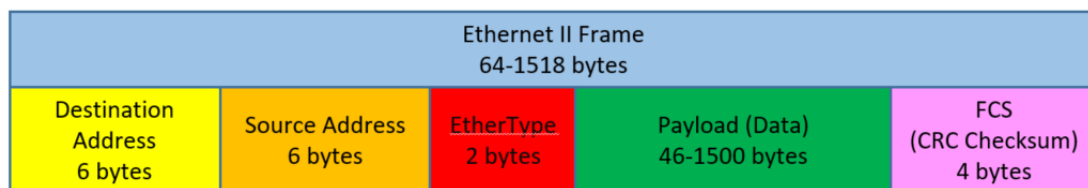


Figure 2 – Ethernet II Frame

All Ethernet frames are characterized by a 6-byte source and destination addresses, EtherType and a 4-byte checksum.

Please note that preamble and start-of-frame delimiter that are present at the beginning of the physical layer Ethernet transport, and the inter-frame gap at the end of the physical layer Ethernet transport have been excluded, for clarity. Also not shown is the optional 4-byte VLAN (802.1Q) tag. This field is not relevant for the purpose of this discussion.

1.4 EtherType

EtherType is a two-octet (2-byte) field in the Ethernet frame. It is used to specify which high-level protocol is being encapsulated by Ethernet frame. EtherType field is always located right before the frame payload, as shown in the following figure.

**Figure 3 – EtherType**

Some of the well known Internet and Fieldbus EtherType values are:

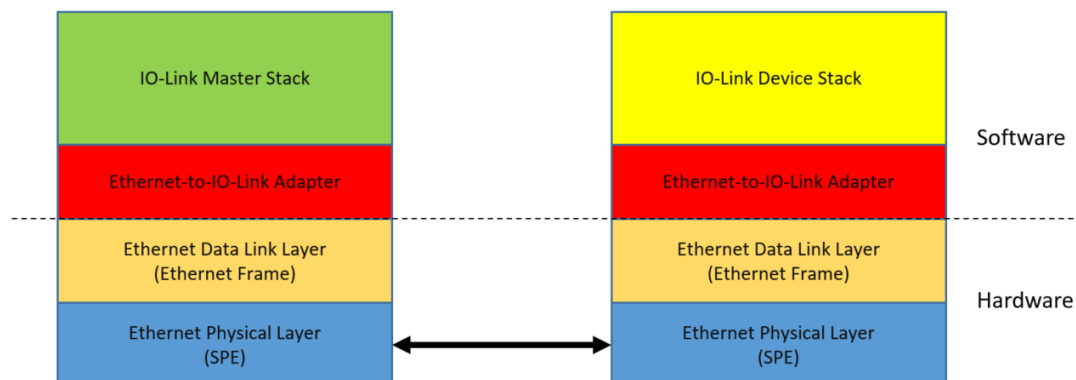
- IPv4, 0x0800
- Profinet, 0x8892
- EtherCAT, 0x88A4

1.5 IO-Link integration with Ethernet

IO-Link integration with Ethernet relies on utilizing a new EtherType, which will be allocated specifically for the use of IO-Link community. This custom EtherType will allow the delivery of the Ethernet packet in which it is used directly to the IO-Link stack.

This approach provides for a much simpler and smaller implementation than the more traditional Ethernet fieldbus implementations that rely on Internet Protocol suite (TCP/IP, UDP/IP, etc.) for communications. It can be implemented in microcontrollers with a very small memory and persistence footprint and that meet the overall IO-Link goals of low-cost and lightweight implementation.

Figure 4 shows the layer structure for Master and Devices with the Ethernet physical layer.

**Figure 4 – IO-Link stack representation**

Using this design approach, only the Physical Layer is replaced. The rest of the IO-Link implementation, including Application and Master and Device stacks with IO-Link Data Link Layer remains unchanged.

From figure 4, it can be seen that an additional software component, Ethernet-to-IO-Link adapter, is necessary to accommodate the transition to the new Ethernet physical layer. This adapter allows to avoid changes in the IO-Link Master and Device stacks, and is meant to provide functionality that is currently available in IO-Link physical layer, such as:

- Device power control
- Device discovery
- IO-Link frame transfer

Device power control is performed on request from the IO-Link Master stack. The adapter provides the necessary interface between the low-level Master power control interface and the SPE PoDL functions that control the power to the Ethernet port.

Device wake-up takes the form of Device discovery. It is performed in the adapter layer and can consist of initial message exchange and validation between the Master and the Device after the IO-Link Device boots up.

After the power-up and wake-up/discovery, the adapter reports the presence of communications link to the IO-Link stack. From there on, the exchange can follow the rules outlined in the IO-Link specifications.

Another major function of the adapter is to encapsulate the IO-Link frame within the Ethernet frame while it is sent over the new Ethernet physical layer.

Several ways are possible to achieve this encapsulation. A sample approach is illustrated figure 5. In all cases, to conform to IO-Link specifications, there is a one-to-one correspondence between the IO-Link and Ethernet frames.

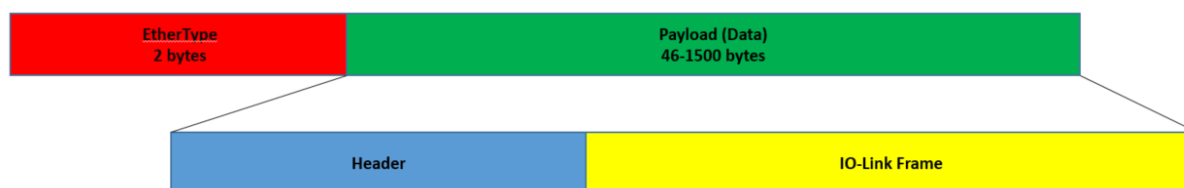


Figure 5 – IO-Link Ethernet frame

Encapsulation can consist of a fixed-length, versioned header that describes the IO-Link frame contained in the payload, followed by the IO-Link frame. A sample header is illustrated in figure 6.

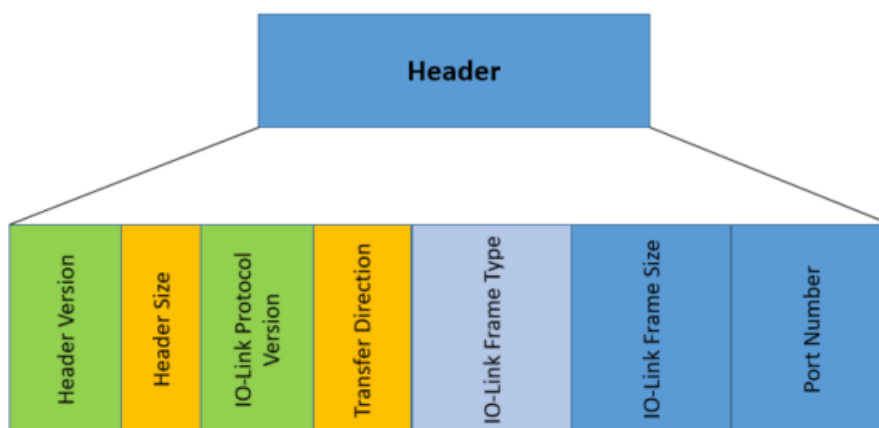


Figure 6 – IO-Link payload header

An IO-Link frame can then be carried completely intact, without any modifications from its current form, apart from the timing. If the resultant encapsulated data is smaller than the minimum Ethernet payload, the adapter layer can add padding to the data accordingly.

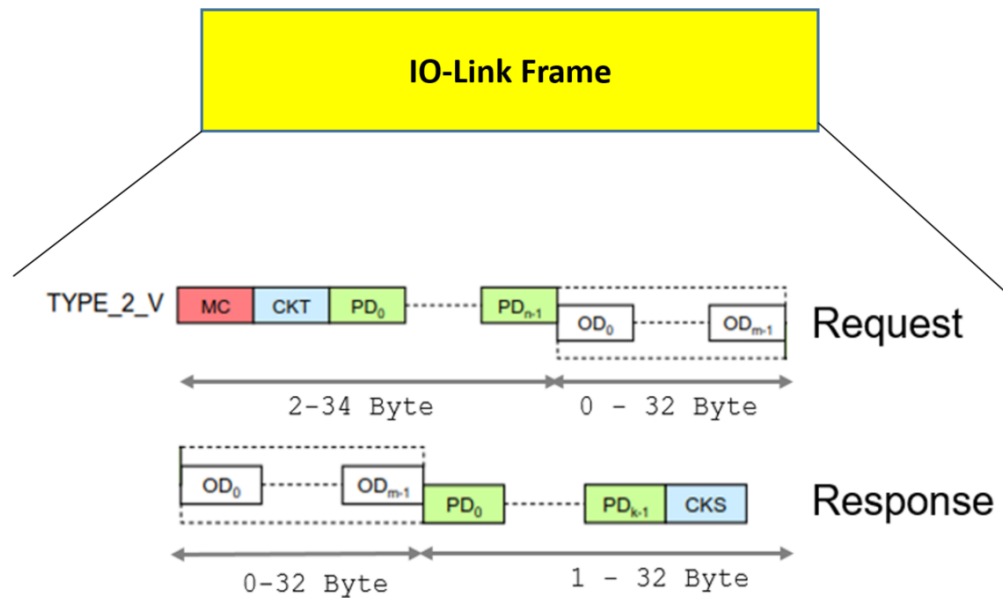


Figure 7 – IO-Link payload

1.6 Topologies

The typical IO-Link topology in standard automation systems is well known and established.

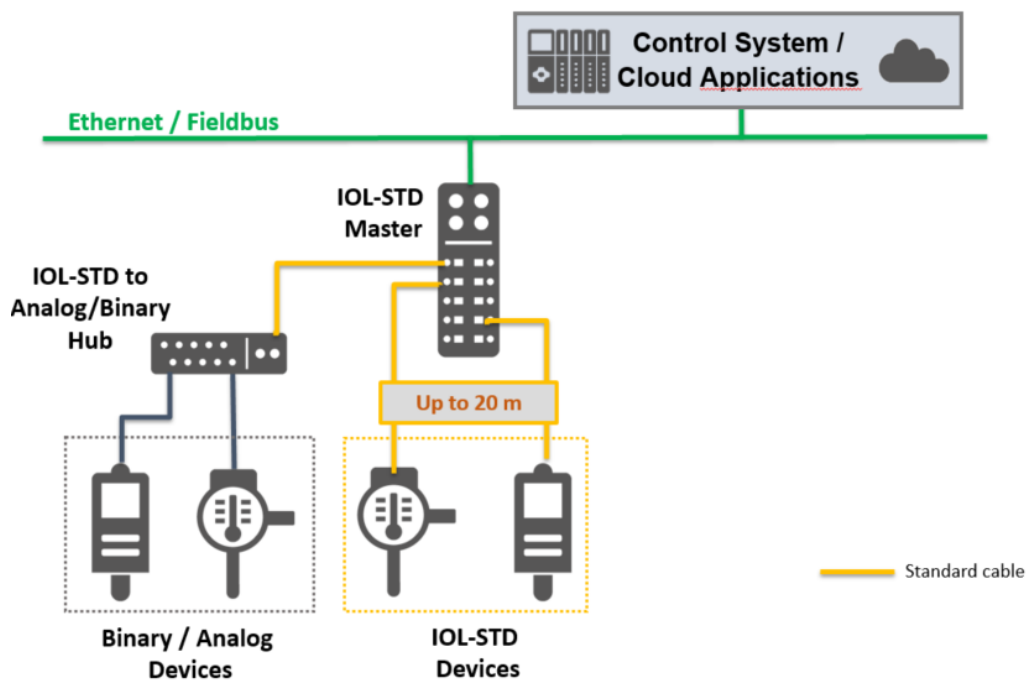


Figure 8 – IO-Link standard topology

With the variable transmission rate of the IO-Link communication and a cable length of up to 20 m a broad field of applications are already possible.

1.6.1 Proposed IO-Link SPE topology

By changing the physical layer from the IO-Link standard to SPE, the possible topology will remain widely unchanged. The range for IO-Link Devices attached over a SPE connection, however, extends to up to 1000 meters.

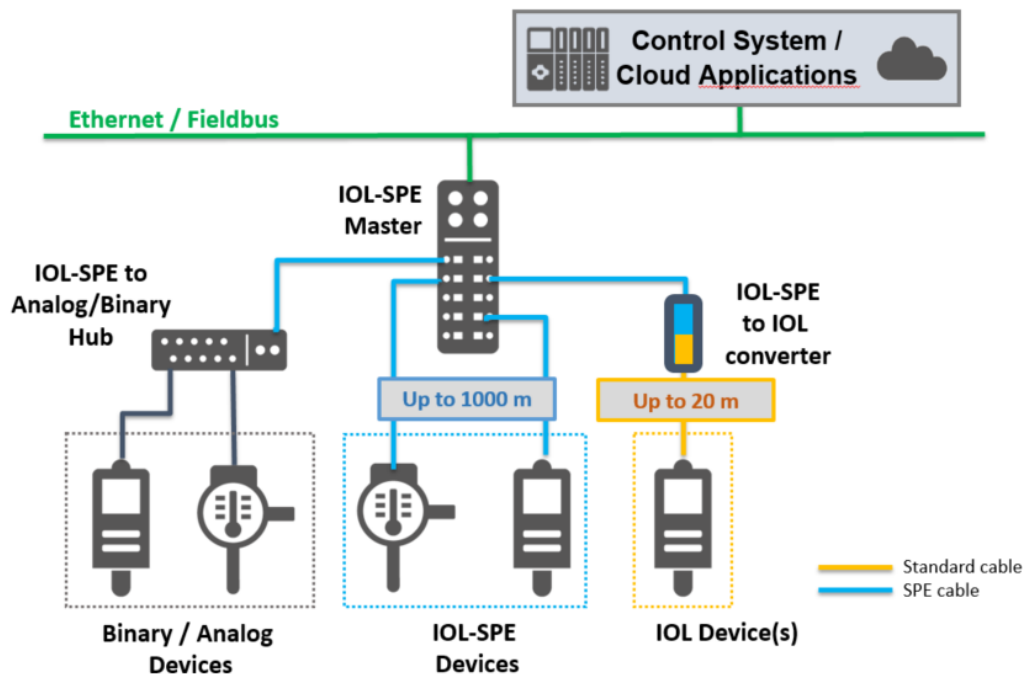


Figure 9 – IO-Link topology using SPE physical layer

As in IO-Link standard applications, I/O-hubs are also possible with IO-Link SPE, offering even more benefits due to lower possible cycle times and an increased distance range.

An additional option is a converter from IO-Link SPE to the standard IO-Link wiring, which allows using standard IO-Link Devices attached to an IO-Link SPE Master.

1.6.2 Proposed IO-Link topology with range extension

The introduction of an IO-Link SPE physical layer addresses as well requirements for an extended distance range for Device connection in standard IO-Link environments.

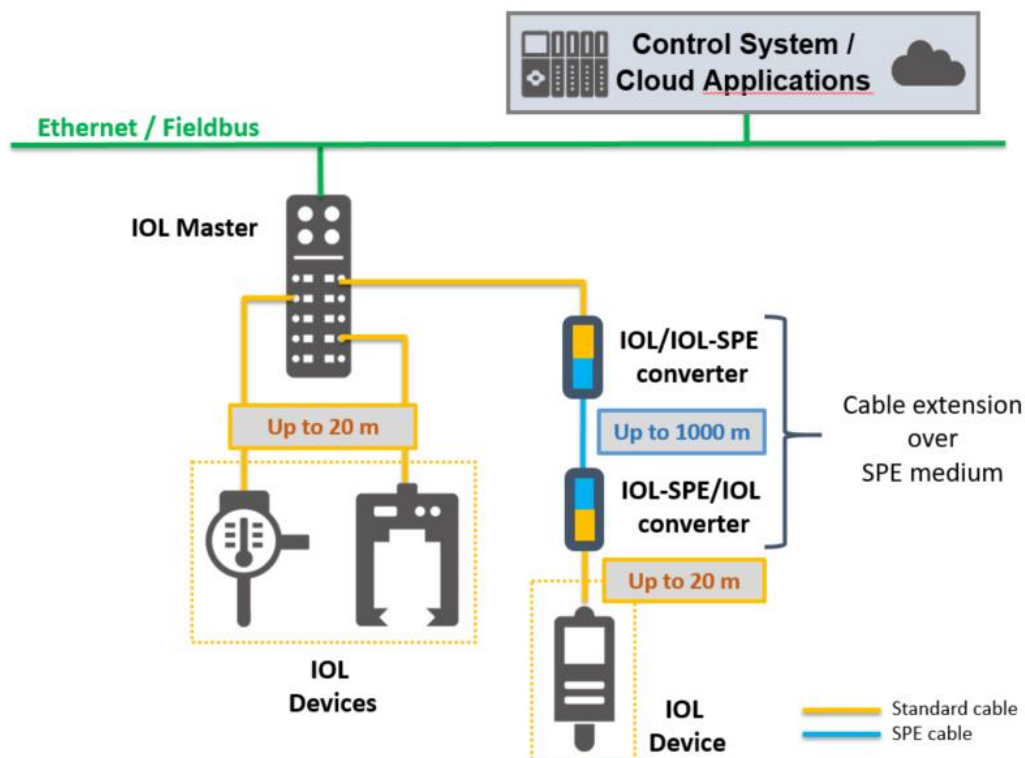


Figure 10 – Standard IO-Link topology with SPE based range extension

With two converters - from IO-Link standard to IO-Link SPE and back – it is possible to attach standard IO-Link Devices over a distance of up to 1000 meters distance to the IO-Link Master. This topology has similar characteristics as existing IO-Link repeater solutions, but offers by far wider distances between Master and Device.

1.6.3 Proposed IO-Link APL topology

One important extension in the range of IO-Link applications is offered by making use of the APL (Advanced Physical Layer) interface definitions and hardware. This makes IO-Link communication possible in explosion hazardous areas, while the topologies of the IO-Link standard as well as IO-Link SPE system are preserved.

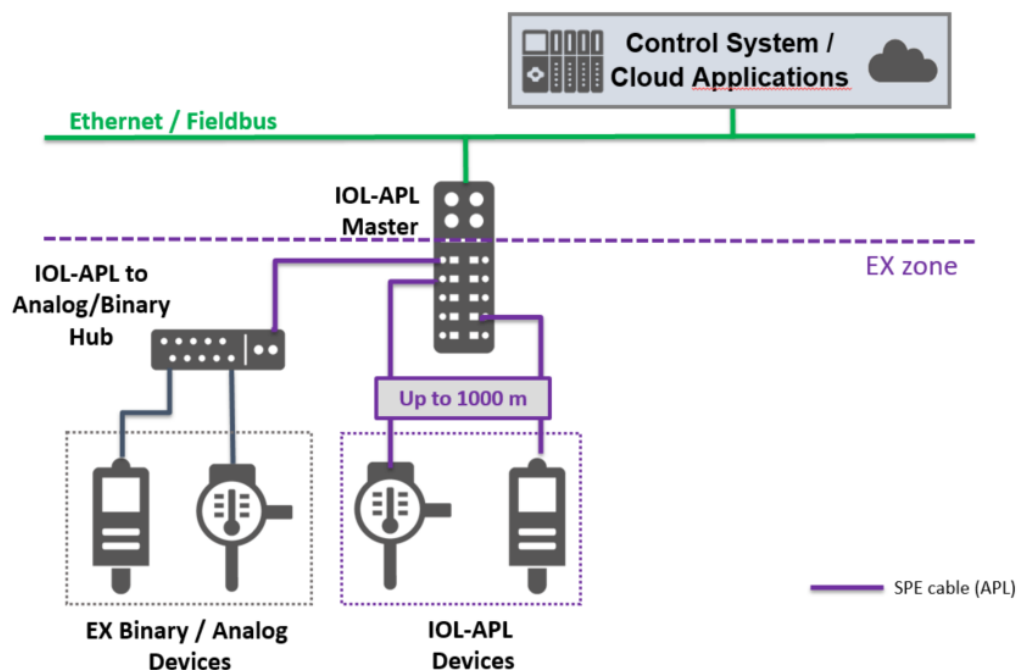


Figure 11 – IO-Link topology using APL

The definition of APL allows use in intrinsic safety applications from Ex Zone 2 down to 0.

In analogy to IO-Link standard and IO-Link SPE, IO-Link APL as well offers the possibility of providing a hub structure. These hubs allow the connection of legacy intrinsic safe field devices. The process data of these Devices are transmitted over IO-Link APL communication from the hub to the Master.

Another possibility using IO-Link APL is intended for applications, where only one or few devices need to fulfill the intrinsic safety requirements, as shown in figure 12.

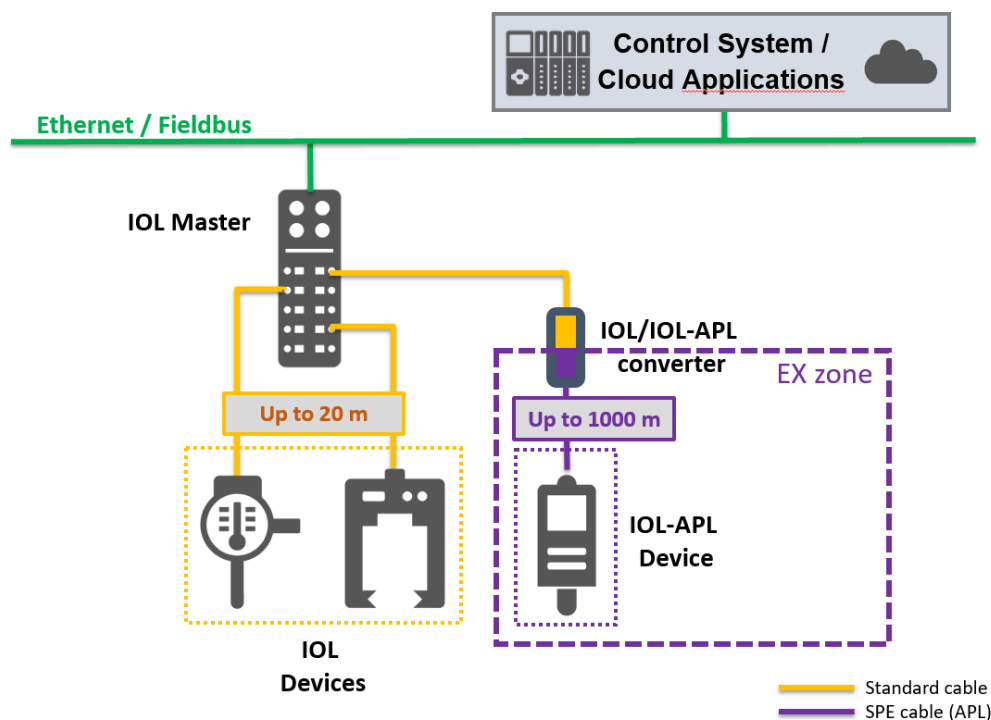


Figure 12 – IO-Link standard to IO-Link APL converter

An IO-Link standard to IO-Link APL converter allows the connection of one IO-Link APL field device. The converter, of course, needs to fulfill all requirements for intrinsic safe power delivery and isolations.

1.7 Comparison of IO-Link Standard vs. IO-Link SPE/APL

Using Ethernet 802.3 for the physical layers and transmitting native IO-Link frames has some impact regarding distances, communication startup and compatibility to SIO modes.

SPE benefits:

- No wake up procedure to start communication (leads to lean protocol stacks)
- Shorter process data cycles even at 10Mbit/s speed
- Cable length up to 1000 meter possible
- Possible addressing of more than one device

	IO-Link Standard (3-wire)	IO-Link SPE/APL
Connector	M12,M8,M5, wires	<i>Not yet defined</i>
Power supply	included	included
Port Classes	A,B	"A" only
SIO Mode	yes	no
Communication startup	Wake-up	no Wake-up required
Process data cycles	typical 2.3 ms (for 38k4 kBaud) aprox. 1.0 ms (for 230.4 kBaud)	less than 0.1 ms (for 10 Mbit/s)
Max. cable length	20 meter	1000 meter
Transmission speed	4.8 / 38.4 / 230.4 kBaud	10 / 100 / 1000 Mbit/s

2 Protocol extensions

The goal of this chapter is to describe some of the potential and future IO-Link protocol enhancements that can occur if a faster and higher bandwidth physical layer is adapted for use with IO-Link. It does not make any assumptions about the preservation of or backward compatibility to the existing protocol implementation. Instead, it tries to document some of the future additions that have been envisioned at the time of this writing.

Enhancements listed in the following sections do not necessarily have any correlation with each other, nor are they necessarily mutually exclusive.

2.1 IO-Link Ethernet Frame Size

Existing maximum IO-Link frame size is an excellent compromise between the needs of small devices and the desired process data cycle time.

With a faster physical layer like Ethernet, it may be possible to increase the size of the IO-Link frame, also increasing the size of process data without adversely affecting the cycle time.

This will allow devices that have higher process data bandwidth requirements, like RFID or barcode readers, to be adapted to use IO-Link. Higher bandwidth will also significantly speed up some of the fundamental functions outlined in BLOB Transfer and Firmware Update Profile document.

2.2 Device addressing

Current IO-Link protocol is point-to-point. Device addresses are not explicitly specified in the protocol frame. However, devices can still be addressed directly from the control system using a unique Master identifier and a physical Master port number to which the Device is attached. This arrangement permits the control system to identify a specific IO-Link Device but allows only one Device per Master port.

With the larger overall data capacity of the Ethernet frame (up to 1500 bytes), it is possible to use this extra capacity to introduce secondary Device addressing. This secondary addressing can allow multiple Devices to be accessed through a single IO-Link Master port. It should be reiterated that introduction of any kind of new addressing scheme will cause significant changes to the IO-Link system design and the existing IO-Link to Fieldbus mappings.

Secondary Device addresses can be added to the IO-Link Ethernet payload header, example of which was given in chapter 1.5. The following figure shows an example of such expanded payload header that can accommodate multiple frames of variable size.

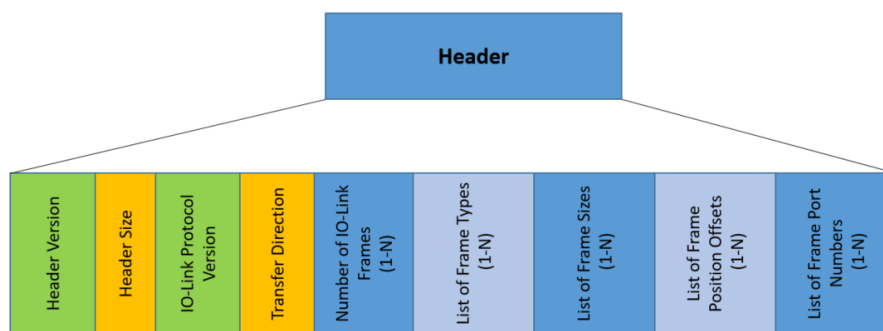


Figure 13 – Sample header structure accommodating multiple IO-Link frames

One of the ways of implementing secondary addressing is to introduce a notion of a virtual port. A virtual port is a unique address used to differentiate multiple Devices that are connected to a single physical port on the Master.

A virtual port identifier can be produced in several ways, depending on the specific topology:

- Assigned during Device discovery by the IO-Link Master
- Ethernet device MAC address can be read from the device during discovery
- In case of aggregation, aggregator physical port number can be used

Using virtual port addressing, Devices can be accessed either directly or through a Device aggregator.

2.2.1 Direct Device addressing

The example of direct Device addressing can be seen in 10Base-T1S multi-drop topology. Multiple Devices share the same physical connection to a Master port over the same single-pair cable. Example of such a topology is given below in figure 14.

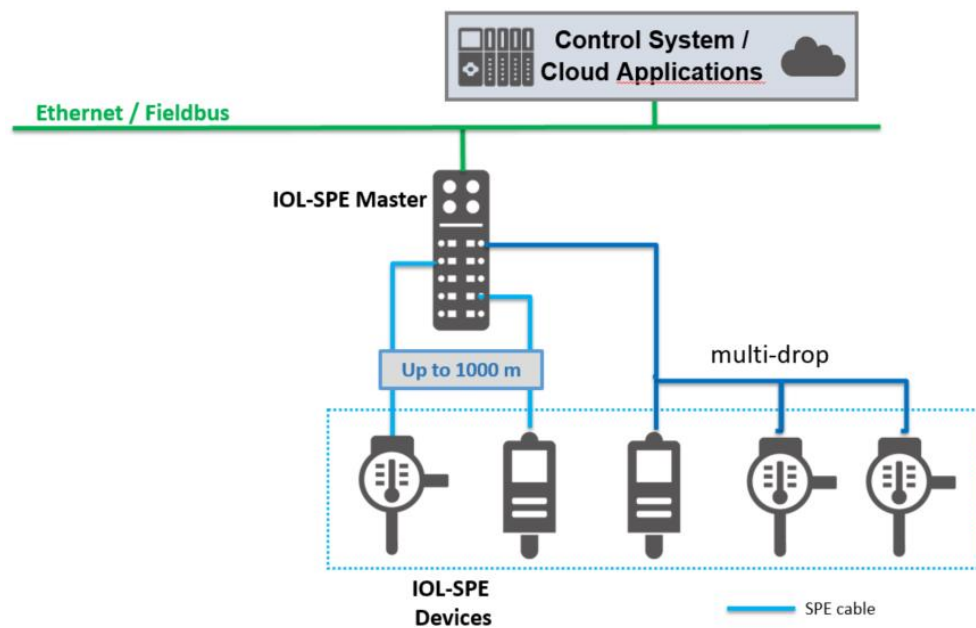


Figure 14 – IO-Link SPE topology with multi-drop approach

When the controller system needs to identify a specific Device, it can distinguish it by using a unique Master identifier, Master physical port number and the Device virtual port identifier.

It should be noted, that in case of direct Device addressing there is a one-to-one correspondence between that IO-Link frame and the Ethernet frame: a single Ethernet frame encapsulates a single IO-Link frame.

2.2.2 Multiple Device aggregation

In case of aggregation, IO-Link Devices are not attached directly to the Master port. Instead, an intermediate infrastructure component – called 'aggregator' - is placed between the IO-Link Master connected to a Fieldbus and the IO-Link Device.

Examples for aggregator topologies are shown in figure 15 and figure 16 below.

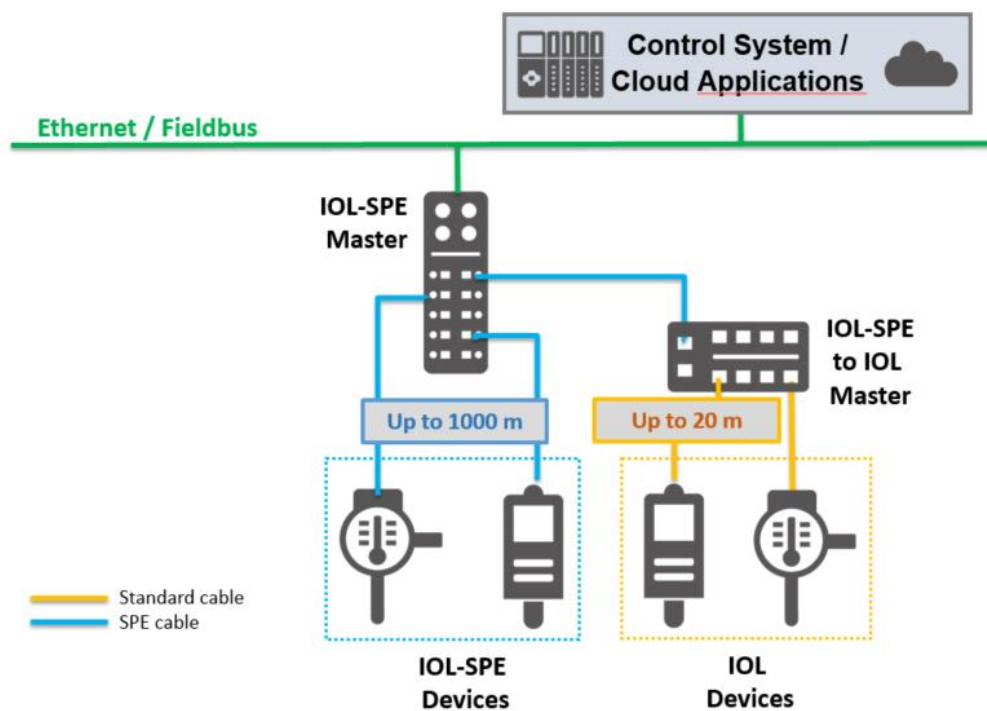


Figure 15 – IO-Link standard to IO-Link SPE aggregator

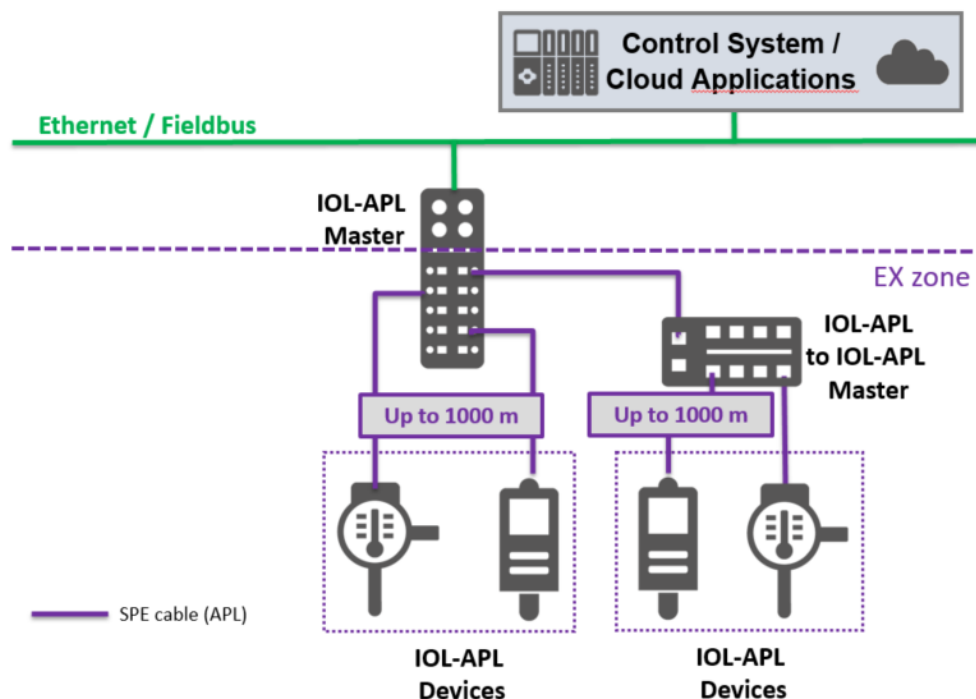


Figure 16 – IO-Link APL aggregator

The aggregator is not an IO-Link hub. It uses IO-Link SPE or APL to communicate with the Master. The communication with the Devices uses either IO-Link standard or IO-Link SPE/APL.

The aggregator combines IO-Link frames it receives from Devices into a single Ethernet frame and sends this frame to the Master. Master responds with a similar compound frame. Upon receipt of this compound frame, the aggregator separates it into individual IO-Link frames and sends them to the appropriate Device.

Each Ethernet frame sent between the Master and the aggregator contains IO-Link frames for all Devices that are attached to the aggregator. The aggregator provides a routing path between the Master and Devices and may or may not interpret these frames. As of this writing, it is assumed that the aggregator will be based on a partial IO-Link Master stack functionality.

To address IO-Link Devices attached to the aggregator, aggregator physical port numbers can be used as a virtual port number.

2.3 Cascading IO-Link Ethernet Devices and deterministic operation

A different option to connect multiple IO-Link Devices to a single Master port is a cascade topology. An example of cascade topology is given in figure 17.

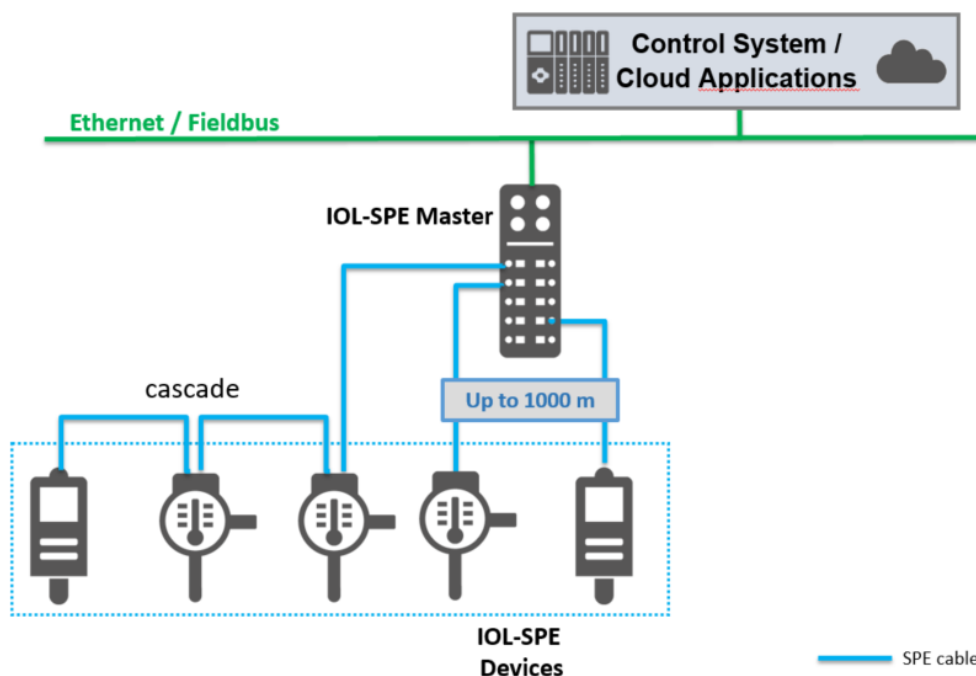


Figure 17 – IO-Link SPE topology with cascading approach

In a cascade topology, each Device has two Ethernet connectors, and Devices are daisy-chained to each other. All the Ethernet frames on such a network are passing through each Device and are interpreted by each Device.

Prior to the start of the operation, the Master discovers and counts all the Devices in the chain. During this discovery process, each Device also learns its position in the chain. This allows the Master to pre-allocate space for IO-Link frames in the Ethernet frame for each Device in the chain. This technique can be viewed as a form of Time Division Multiplexing, where each Device gets a known and pre-allocated transmission time slot, resulting in high degree of determinism.

The compound Ethernet frame sent and received by the Master contains multiple IO-Link frames, one for each Device in the chain.

There is no explicit Device addressing used in this topology. Addressing is implied, and Devices are addressed positionally instead: the first IO-Link frame placed in the Ethernet frame is meant

for the first Device in the chain, closest to the Master, the second IO-Link frame for the second Device, etc., and the last IO-Link frame in the Ethernet frame for the last Device.

The advantage of this approach is response determinism and performance. With appropriately selected and/or custom-designed hardware, Ethernet frame propagation and IO-Link frame removal/insertion operations can be performed at nearly the line speed, making this approach suitable for closed-loop control applications.

2.4 Time stamp

For the purpose of this document, it is proposed that time stamping is implemented as part of the future meta-data section in the IO-Link Ethernet encapsulation header.

2.5 Time Sensitive Networking (TSN)

TSN is a layer 2 technology. It now becomes possible to extend TSN down to individual Devices over the IO-Link SPE connection.

3 Application examples

The additional features provided by IO-Link SPE or APL allow an extension of the possible range of applications.

3.1 Range extension

All applications requiring more than 20 meters distance between Master and Device can now be solved by IO-Link SPE with or without IOL/SPE converter. Typical application areas are high bay warehouse shuttles with sensors onboard or distributed sensors for level monitoring in tank facilities.

3.2 Control loops / motor feedback

By using SPE with 100Mbit/s transmission speed or even in future 1Gbit/s for IO-Link communication, it will be possible to replace traditional motor feedback interfaces in order to control high dynamic motor application. This may be done by TDM (Time Division Multiplex) or optional TSN (Time Sensitive Networks).

3.3 Intrinsic safe areas

Special applications targeting environments with ATEX requirements can be solved by use of IO-Link APL interfaces as a specialized version of SPE.

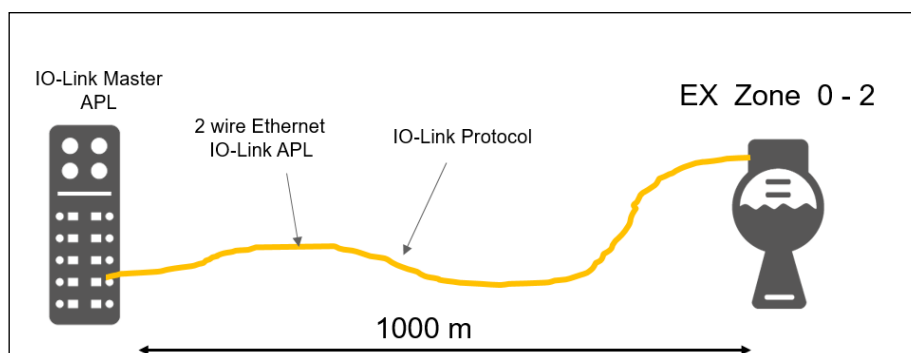


Figure 18 – ATEX application

3.4 Conveyor application

Within conveyor applications, usually longer distances than 20 meter are required. This can be solved by using an IO-Link standard to IO-Link-SPE converter or by using a cascaded topology.

Typical applications are band conveyer e.g. in cement production plants or conveyer used in warehousing and package distribution hubs.

4 Conclusion

The proposed approach combines the benefits of IO-Link and SPE/APL standards.

The key features and advantages are:

- Range - cable length up to 1000 meters
- Speed - more than 20 times faster than COM2 (200 times faster with 100 Mbit)
- Application - potential support for control loop applications
- Application - intrinsically safe applications with APL
- Compatibility - simplicity of IO-Link integration and existing tools are unchanged
- Scalability - possibility for topology extensions
- Security – reduced security requirement by avoiding TCP/IP in implementation

All aspects of the IO-Link data model are preserved, ensuring easy and seamless integration with existing tools and automation systems, while opening the door to a broad range of new applications.

© Copyright by:

IO-Link Community
c/o PROFIBUS Nutzerorganisation e.V.
Haid-und-Neu-Str. 7
76131 Karlsruhe
Germany
Phone: +49 (0) 721 / 96 58 590
Fax: +49 (0) 721 / 96 58 589
e-mail: info@io-link.com
<http://www.io-link.com/>



IO-Link