FIELDBUS INTERNATIONAL AS

Ethernet-APL enable field level ethernet in process automation

White paper

Smart instruments for Industry 4.0 which are already on the market today, are not suitable for use in all areas of process automation, for example in explosive hazardous areas or where separate power is not available. These are often based on standard or industrial ethernet with 2 to 4 pairs wiring. Main issues occur with the physical layer of which does not fulfill all requirements of process automation. Requirements such as long distance, power supply and communication via the same 2-wires and intrinsic safety.

The new Ethernet-APL (Advanced Physical Layer) meets the above requirements. Ethernet-APL is ethernet over a single pair with power deliveries. Communication distance and speed is 1000 meters and 10 Megabit/seconds respectively. Supply of power is on the same two wires as the data communication and can deliver up to 60 Watt. It has protective measures for safe use in explosive hazardous areas. This makes Ethernet-APL ideal for use in process automation. It is backed by the process automation standard development organizations FieldComm Group, OPC Foundation, ODVA and Profibus & Profinet International. Fieldbus International AS (FINT) is currently developing field device interface to take advantage of the possibilities provided by Ethernet-APL.

ethernet-apl™
advanced physical layer

Ethernet-APL enables the direct connection of field devices to higher-level systems, allowing a uniform communication infrastructure across all process management and company levels for the first time. At 10

Mbit/s, enormous amounts of data are transmitted over long ranges at least 300 times faster than with current fieldbus technologies.

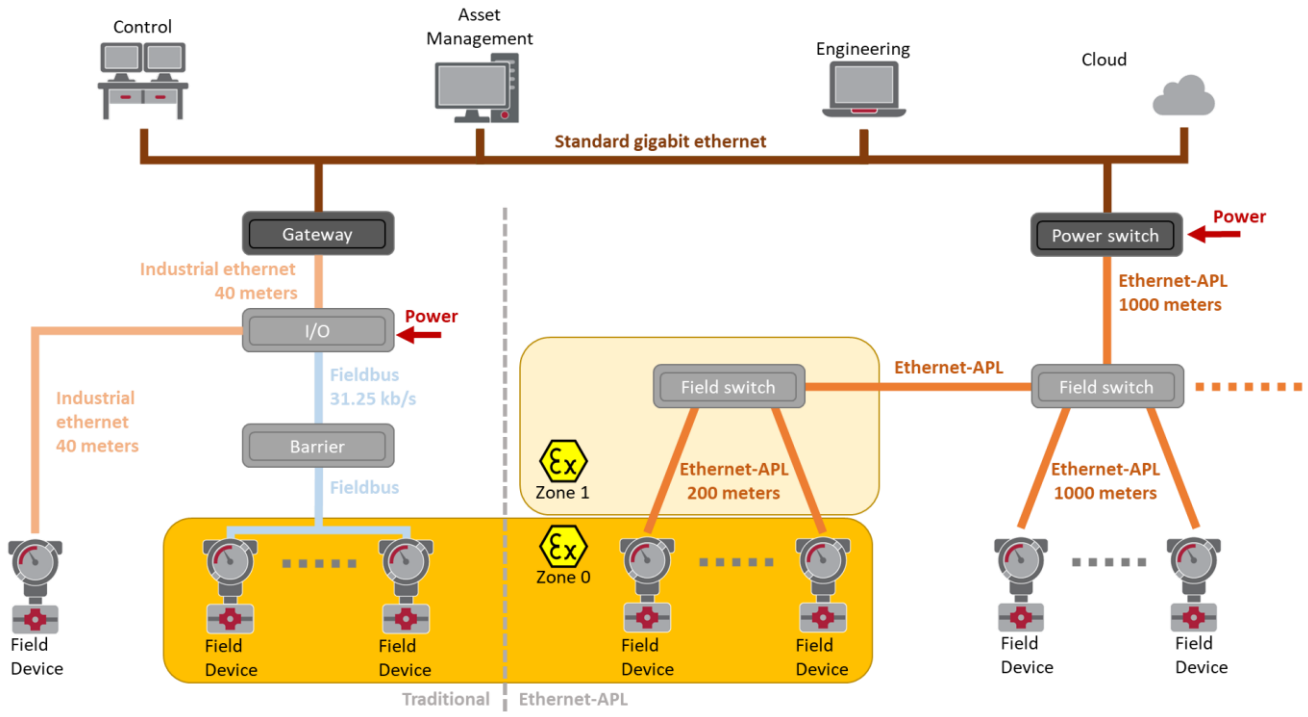

Figure 1: Traditional architecture vs Ethernet-APL in process automation

In traditional process automation infrastructures control level often called OT (Operational Technology) is separated from upper management levels often called IT (Informational Technology) which are typically Ethernet-based. OT uses communication technologies such as 4 – 20 mA and fieldbus. Standard ethernet is omitted from the field due to short range of maximum 40 meters, minimum two twisted pairs cable and it is not safe to use in explosive hazardous areas.

To access field data communicating on fieldbus from the higher level, gateways are used. The gateways are complex and often do not pass through all the available metadata for diagnostics and preventive maintenance. Ethernet-APL provides the missing link, extending unified Ethernet communication all the way down to field instrumentation. High level ethernet connectivity is seamless with no complex gateways or proxies required.

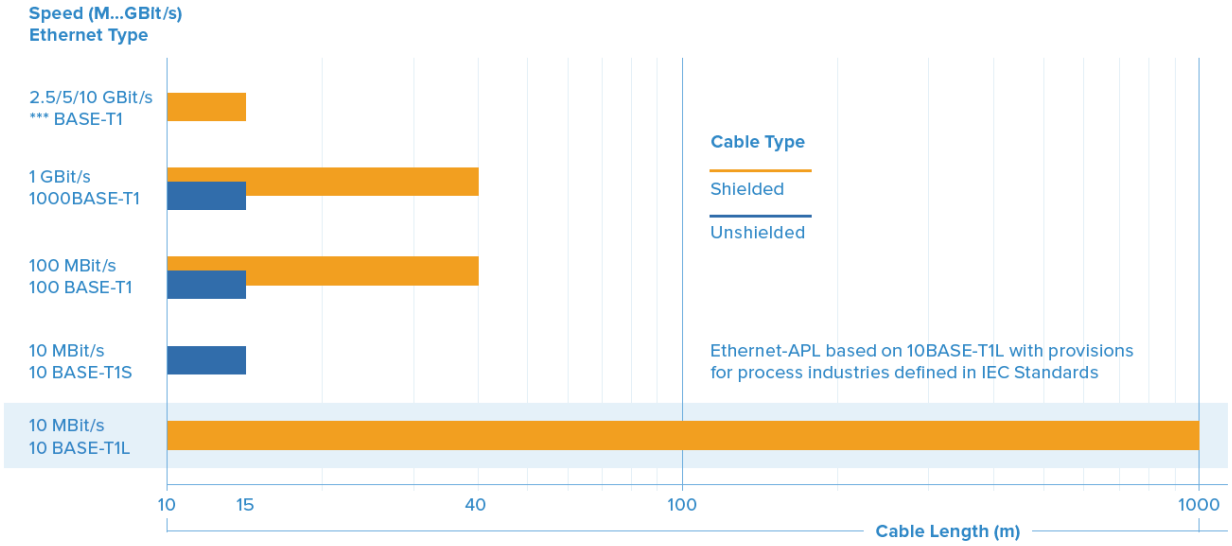

Figure 2: Cable lengths comparison of ethernet standards

Ethernet-APL is based on 10BASE-T1L, standardized in IEEE 802.3cg-2019 and is thus part of and fully compatible with the IEEE 802.3 Ethernet specification. It is a widely known network technology and thereby offering ease-of-use. One communication technology in all network levels simplifies the network design, installation, commissioning, and configuration.

Being a physical layer, Ethernet-APL is independent of any protocol or communications stack and designed for wide adoption and application in process automation. This opens for interoperability between different industrial ethernet protocols such as HART-IP, OPC UA, Profinet, Modbus/TCP, EtherNet/IP, EtherCAT and any other higher-level protocol. They can all operate simultaneously on the same network at the same time.

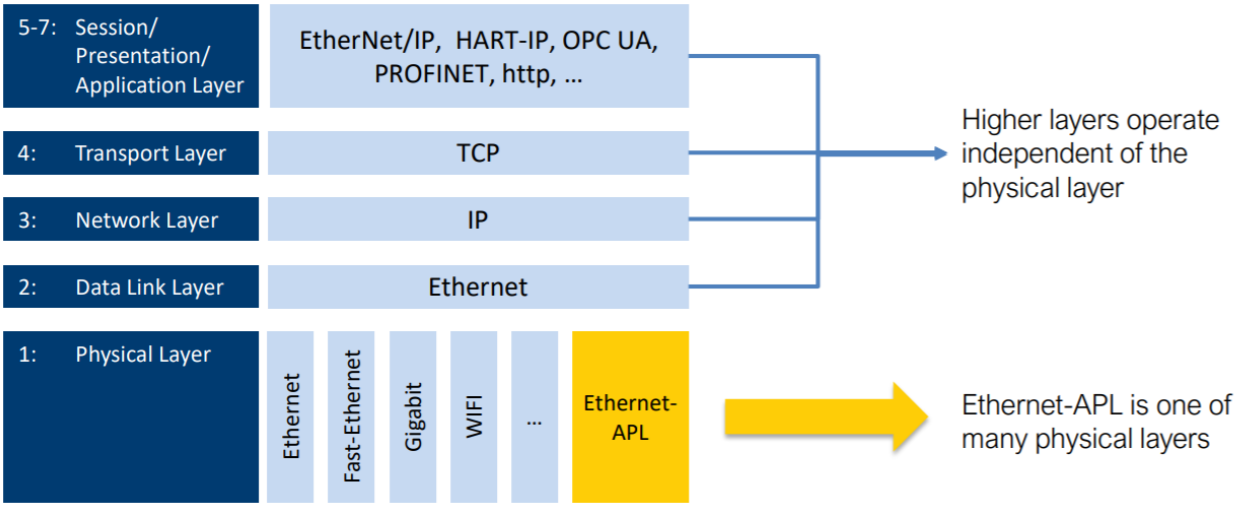

Figure 3: ISO OSI model

The user organizations NAMUR and Open Process Automation Forum (OPAF) demand open and interoperable architecture. The demands are outlined in their concepts NAMUR Open Architecture (NOA) and Open Process Automation Standards (O-PAS). Ethernet-APL represent integral components of these two concepts. It is interoperable, vendor independent and defined in open standards.

Explosive atmosphere mode is supported by Ethernet-APL. It is designed to meet the strict maximum energy restrictions. In this mode the maximum power delivery is 500 mW. Significantly more than 36 mW delivered by 4 – 20 mA system today. Ethernet-APL normally operates at 2,4 V peak amplitude. In explosive atmosphere mode for zone 0 the peak amplitude is 1,0 V limiting the maximum length to 200 meters. The Ex mode is covered in IEC TS 60079-47:2021, Explosive atmospheres - Part 47: Equipment protection by 2-Wire Intrinsically Safe Ethernet concept (2-WISE). This simplifies the certification process with an IEC Ex notified body.

The power delivery of Ethernet-APL to the edge of the network is significantly more than fieldbus and 4 – 20 mA. This will allow enhanced features on new field devices. Features such as higher performance measurements, edge processing of data, web server running on the field devices and smart maintenance. Smart maintenance involves centrally monitor the status of components and identify maintenance requirements early on. This avoids unplanned downtime and increases plant availability significantly. It is expected that it will drive production improvements and optimizations in process flows and asset management.

Single twisted pair cabling has the advantages of being lower cost, smaller size, and easier to install when compared to more complex cabling. Ethernet-APL supports a wide range of cables thicknesses such as 0,13 - 2,5 mm2 (AWG 26-14). The longer the length and the more power the thicker the cable should be.

Interoperability of Ethernet-APL devices is ensured since it is based on the established IEEE and IEC standards. This will ensure products interoperability, so that devices from different manufacturers work together without issue.

For the field installation a large advantage is that the connector interface supports screw type and spring clamp connections as well as a 2-pin connector. To further make it easy for field installation the connection is polarity independent. This will greatly reduce connection errors.

The photo below shows the Ethernet-APL prototype at the laboratory of Fieldbus International AS. The prototype is used to test and prove the concept.

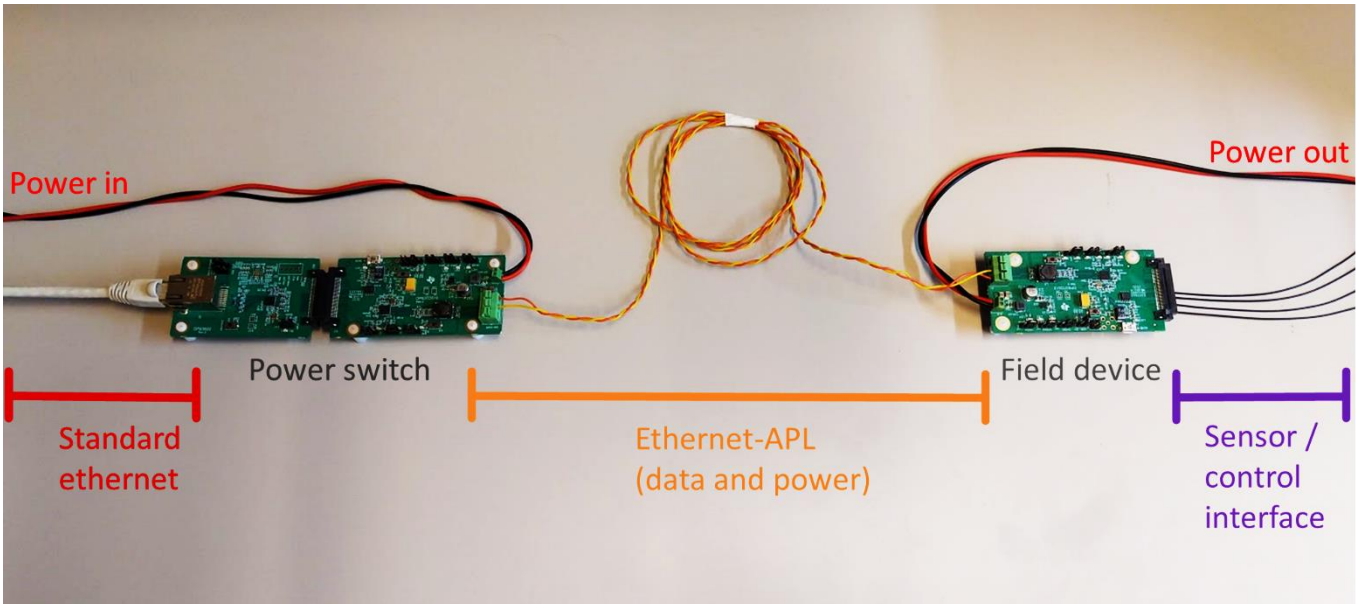

Figure 4: Prototype of Ethernet-APL at Fieldbus International AS, December 2020

Ethernet-APL quick facts

- IEEE Std 802.3cg-2019: Single pair ethernet and power delivery
  - Speed: 10 Mbit/s
  - Length: 1000 meters (Ex mode: 200 meters)
  - Power: 60 Watt (Ex mode: 500mW)
- Explosive atmosphere safe in all zones (Ex ia)
  - IEC TS 60079-47: 2-WISE (2-Wire Intrinsically Safe Ethernet)
- Cable: single pair (2 wire), 0,13 - 2,5 mm^2 (AWG 26-14)
  - Example: IEC 61158-2, Type A (fieldbus cable)
- Connector interface
  - Polarity independent
  - Connector independent
    - Examples: 2-pin connector, Screw-type, Spring-clamp
- Compatible with industrial ethernet protocols
  - HART-IP
  - OPC UA
  - Ethernet/IP
  - Profinet
  - EtherCAT
  - Modbus TCP

REFERENCES

1) IEEE 802.3cg-2019 - IEEE Standard for Ethernet - Amendment 5: Physical Layer Specifications and Management Parameters for 10 Mb/s Operation and Associated Power Delivery over a Single Balanced Pair of Conductors, https://standards.ieee.org/standard/802_3cg-2019.html
2) IEC TS 60079-47 ED1, Explosive atmospheres - Part 47: Equipment protection by 2-Wire Intrinsically Safe Ethernet concept (2-WISE), https://www.iec.ch/dyn/www/f?p=103:38:4046770105552::::FSP_ORG_ID,FSP_APEX_PAGE,FSP_PROJECT_ID:1331,23,102802
3) Ethernet to the field, FieldCommGroup White paper, https://library.fieldcommgroup.org/10218/AG10218/1.0/#page=1

ABBREVIATIONS

Ethernet-APL	Ethernet advanced physical layer
Ex	Explosive atmosphere
FINT	Fieldbus International AS
HART	Highway Addressable Remote Transducer
HART-IP	Highway Addressable Remote Transducer over IP by FieldComm Group
HMI	Human Machine Interface
I/O	Input / output
IIoT	Industrial internet of Things
Industry 4.0	Fourth industrial revolution
IT	Information technology
NOA	NAMUR Open Architecture
OPAF	Open Process Automation Forum
OPC Foundation	standard organization for industrial automation
OPC UA	OPC Unified Architecture
OT	Operational technology
WirelessHART	Wireless Highway Addressable Remote Transducer