PoE, PoE++, PoDL - Enhancements to IEEE 802.3

Bob Lounsbury
Principal Engineer, Rockwell Automation

Brad Woodman
Engineering Manager, Molex Inc.

Presented at the ODVA
2017 Industry Conference & 18th Annual Meeting
February 21-23, 2017
Palm Harbor, FL, USA

Abstract

The IOT is exploding with far reaching applications such as Automotive, Home Automation, Building Automation, and Machine to Machine. Ethernet has become the universal communications network helping to drive this technology.
This paper will look at the current status of the cabling standards such as IEC/SC65C/JWG10, ISO/IECJTC1/SC25/WG3 and ANSI TIA/TR42. In addition, this paper will focus on the status of IEEE 802.3 adaptions of standard Ethernet and the opportunities that it presents to ODVA. IEEE 802.3 committees recently published a higher level PoE (PoE++) and Power over Data link (PoDL). These new powered enhancements can provide an attractive solution for powering a range of small devices up to larger IO devices. PoE++ is attractive for Industrial as it potentially can deliver some 90+ watts to the Powered Device (PD). Even more exciting are the number of newly proposed high speed single pair Ethernet adaptions being defined. These new adaptions will simplify the wiring and reduce space needed for the cabling in industrial installations.
The national and international cabling standards are already actively engaged with IEEE 802.3 working groups helping to define the cabling requirements for these new emerging networks. This paper will discuss the new industrial channel definitions (E2E Links) being defined by ISO/IEC that promise to help our customers successfully install and test their cabling.

Keywords

Physical Layers, Ethernet, IEC, ISO/IEC, TIA, PoE, PoE++, PoDL, E2E Links, MICE, Automation Island

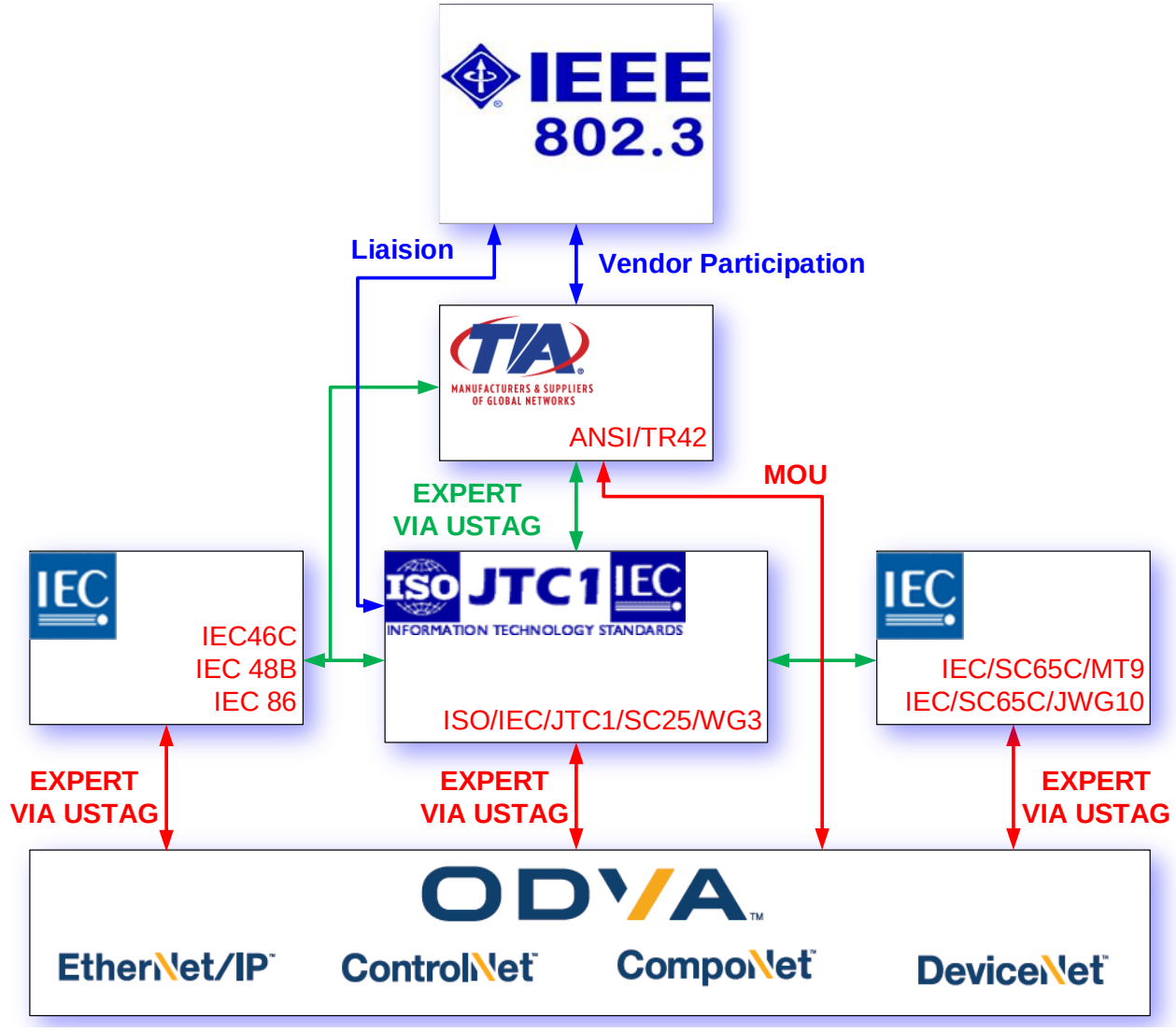
Summary

Standardization of cabling systems for communications networks has been ongoing since the early 90s. Since the initial standardization of industrial cabling systems for ODVA there have been many new high performance components and enhancements proposed. The standards organizations continue to work to provide standardization of these new components and systems. There are several national and international cabling standards that have a direct impact on networks throughout the world. These standards are either based on ODVA network standards and/or are the foundation for the ODVA networks. For example, Industrial Ethernet was first defined in ODVA and was based on TIA cabling standards. Subsequent releases of the TIA cabling standard included a variant of the ODVA industrial

Ethernet standard. Figure 1 shows a relational map of the national and international standards organizations. The work within the individual standards committees is precipitated by a cause and effect relationship of one or more standards or consortia. Developments within any one of these standards bodies can cause ripple effect for the other standards. An abstract example is a request for a new Ethernet channel to be created in IEC/SC65C/JWG10 that creates work for ISO/IEC/JTC1/WG3 and ripples to ODVA and TIA. The originating request could come from anyone of the 21+ consortia around the world.

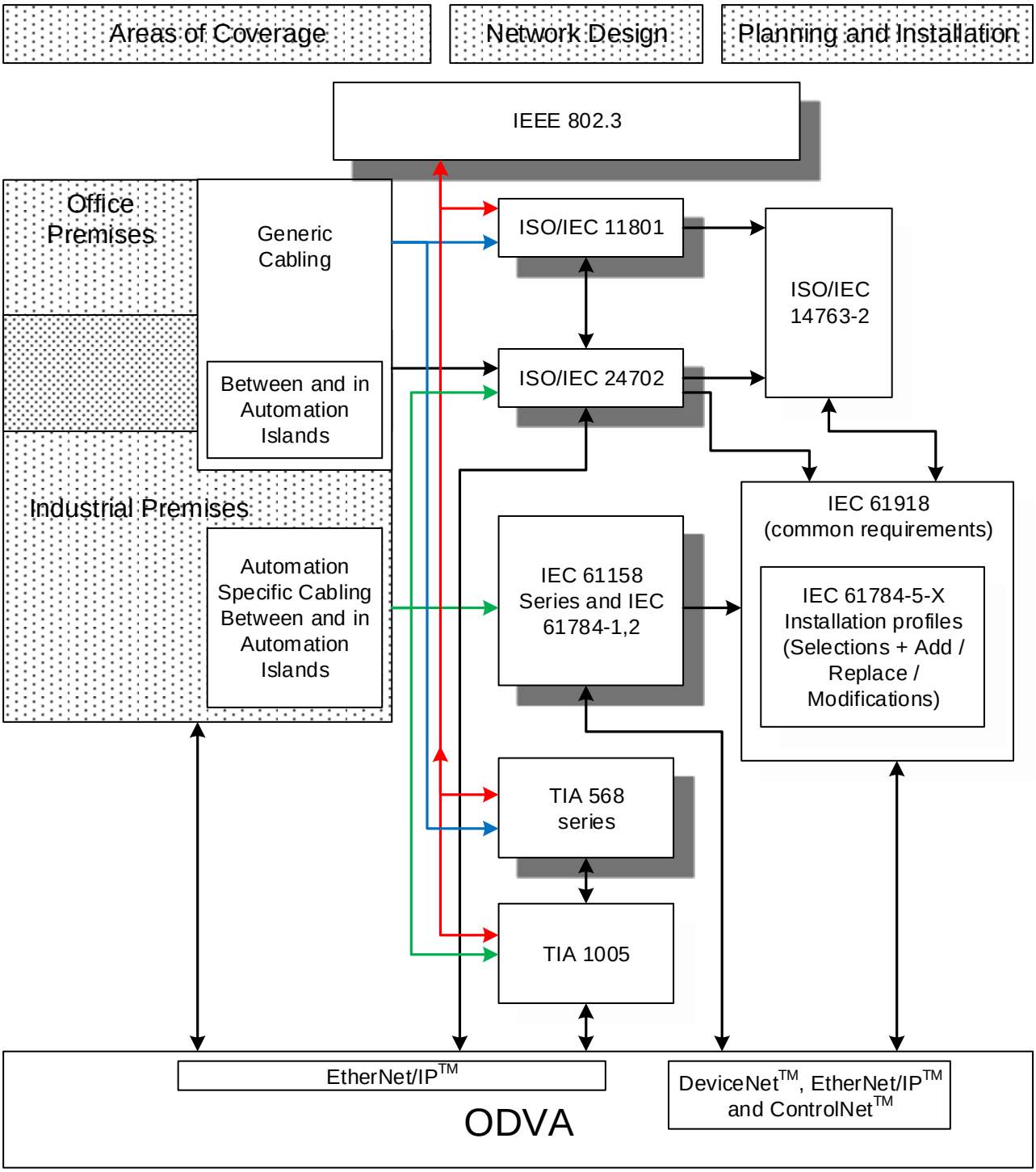
This Presentation will focus on the current state of these standards and bring the audience up to date on how they affect ODVA. In Figure 1 below you note that the standards committees are tightly linked and work together to create a complete system. Most of the connections are through Experts and Liaisons working between the committees. Figure 1 starts with the component definitions on the left side providing technology to the cabling committees in the middle and then the installation committees on the right. Through ODVA members, ODVA provides input to the national and international standards committees.

Figure 1 The interconnection of Standards Bodies



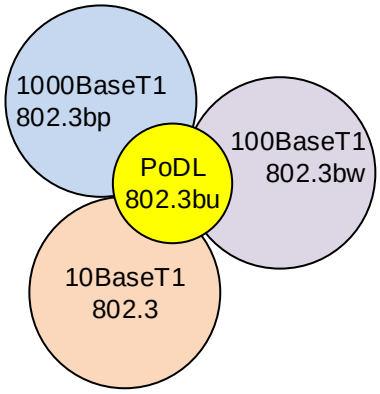
The root of many of the industrial Ethernet enhancements comes from the enabling work of IEEE 802.3. The cabling standards work together with IEEE802.3 and with other national and international cabling standards to publish a comprehensive set of standards taking the audience from the design and planning phase to the installation and verification/certification phase of a network infrastructure. Figure 2 below shows how the standards documents are coupled together in a similarly to figure 1.

Figure 2 The interconnection of Standards documents



Using the well-used adage “Ethernet to the edge” we find that there are many changes to the standards. For example, adding 1000Base-T applications to industrial has caused new connectors to emerge (M12-8 X- coding). We will see new cables emerging in support of industrial 1000Base-T as well.

Over the past 15 years, these standards have continued to evolve and expand. In the recent two years IEEE 802.3 have added two new Ethernet networks/applications and are in the process of adding two new Ethernet networks/applications. These new networks are aimed at expanding Ethernet into new spaces and applications. For example, one of the most exciting applications are three, unshielded or shielded single pair physical layers, 1000Mb, 100Mb and 10 Mb.



IEEE 802.3bp (1000BaseT1) was published June, 2016. 1000Mb/s over a single pair cable either shielded or unshielded cable. 802.3bp has two different lengths and environments. Link segment type A is referenced as Automotive and total length is 15 meters. Link segment type B is referenced as Industrial and the total length is 40 meters. 802.3bp will require a new PHY for the physical layer of the OSI model.

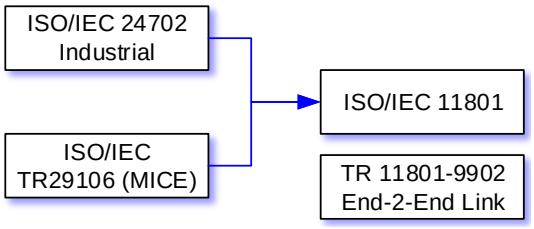
IEEE 802.3bw (100BaseT1) was published October, 2015. 100Mb/s over a single pair cable either shielded or unshielded cable. 802.3bw was developed for both automotive and industrial environments. Overall length up to 15 meters. 802.3bw will require a new PHY for the physical layer of the OSI model.

IEEE 802.3cg (10BaseT1) is looking to be published late 2018. IEEE 802.3cg is for the 10Mb and will focus on industrial and building automation as their primary customers. This network has the potential of providing channel lengths of 1000 meters (10X that of any other IEEE defined Ethernet application). 802.3cg will require a new PHY for the physical layer of the OSI model. Allowing up to 10 inline connectors for the 1000 meters.

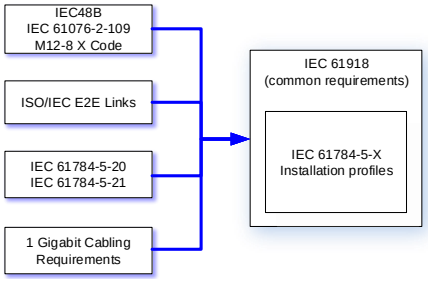
All three new applications have the potential to provide power to the communications channel to the device. IEEE 802.3bu Power over Data Link (PoDL) was published October, 2016. IEEE 802.3bu defines the power insertion, detection, and extraction scheme to serve all three of the single pair applications. The detection methods of voltage/current configurations used for 2 and 4 pair Ethernet networks will be used in these three applications with some modification to the protocol.
The three single pair networks fit well with the direction of industrial Ethernet in that they will open doors to sensor/actuator level Ethernet enabled devices. As copper costs continue to fluctuate in the market place the need to reduce copper content in the cabling will become more important. In addition as the need to provide smaller devices increases, reduced connector and PHY designs can help with PCB space. The estimated PCB board space savings of a single pair Physical Layer is about 55%.
So far, I have focused on the single pair applications.

However, there is one other application that is worth mentioning that has future use in industrial, is the recently published IEEE 802.3bz, September 2016. As part of the long term migration strategy 2.5G and 5G physical layers might have a place in industrial. The bandwidth needs of industrial still do not match the aggregate needs of a campus sized back bone. However, there are two factors to consider for the future, high bandwidth devices such as vision and the migration of devices from non-Ethernet based networks onto the industrial Ethernet control network. This migration may create a need for a mid-bandwidth backbone.
Why 2.5/5G over 10G, the answer is in cost and power requirements. While 10G is becoming more popular, it comes at a high cost and high power needs. In our harsh environments power is heat.

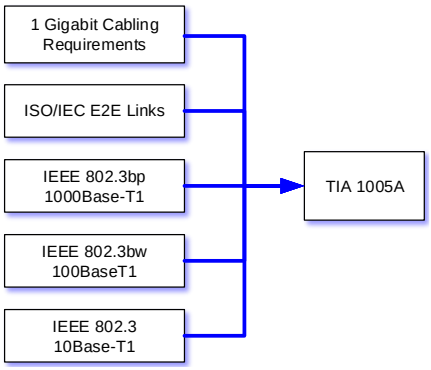
I have already discussed the enhancement in IEEE 802.3. Now I will focus on the enhancements to ISO/IEC/JTC1/SC25C/WG3. This committee is responsible for the international standardization of generic cabling. The well-known standard, ISO/IEC 11801 is currently be redrafted as a comprehensive standard in 6 initial parts. The important highlights of this work is the incorporation of the industrial standard ISO/IEC 24702: 2006 in to part 3 of ISO/IEC11801. The MICE concept, originally a Technical Report (ISO/IEC TR29106:2007) will be integrated into ISO/IEC/11801. This is very important as this takes the informative nature of the MICE concept and makes it normative. In a parallel development is the creation of a new channel called "End 2 End Link". This new channel has several reference implementations that are very similar to a normal channel of 1 to 4 connections. However, the main difference is that it includes the performance of the two end plugs of the channel. This new channel came at the request of the industrial installation committee within IEC/SC65C/JWG10. Here we saw a need to help the customers identify potential connection installation issues at the two ends of a channel. Primarily to the benefit of our industrial customers who choose to build their systems "in place" through the use of field installable connector options. The approach is to define a whole set of new limit lines that include the performance of the connections at the end of the channel in the definition and test limits. Following the final release, it is expected that field testers will have the ability to measure and detect performance problems up to the customer equipment interfaces. The estimated release time for both ISO/IEC11801 and TR 11801-9902 is late 2017. There are discussions within the committee about including the End-2-End Link Technical Report (ISO/IEC 11801-9902) into the release of ISO/IEC 11801.



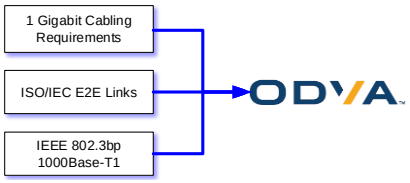
The current stability date of the installation standards is 2018. That seems a long way off, but the work has already begun to create the new editions of the standards. This collection of installation standards consists of one umbrella standard, IEC 61918 and 21 consortia standards (profiles) IEC 61784-5-n (n = 1 to 21. Each consortia have its own profile number. For example, ODVA networks are found in IEC 61784-5-**2**. Due to the expansion of Ethernet, the national and international standards and the set of installation standards must be updated. Most of the profiles are at edition 2 revision level and will be re-released at edition 3 in 2018. This year two new Ethernet based industrial profiles were added. The 2018 release will include the End-2-End Link definitions and new connectors supporting 1gigabit sealed connectivity. In addition, it expected that the performance requirements of 1gigabit channels will be included. This input will come from TIA and ODVA and is based on research performed on 1gigabit channels in high noise environments.



ANSI/TIA is a national standardization committee consisting of many sub groups. Within the sub group 42 there are approximately 16 subcommittees. Subcommittee 42.9 is responsible for publishing the industrial cabling standard. The current revision level of this standard is ANSI/TIA 1005-A. The most recent addition to this standard was the M12-8 X-coding sealed connector for harsh areas supporting data rates up to 1 gigabits. Currently there is a void in the area of cable specifications to support 1 gigabit channels. A draft addendum is currently being reviewed for these new cable specifications. Another draft addendum that TIA 42.9 is reviewing is for the requirements for incorporating of IEEE 802.3bp in the industrial environment that includes connector requirements. In addition, it is expected that future releases of this standard will include End-2-End Link definitions defined by ISO/IEC/JTC1/SC25C/WG3.



With the enhancement of Ethernet networks, EtherNet/IP can use these new technologies to reduce size, cost while making it easier for the end customer to deploy. A task group of EtherNet/IP Physical Layer SIG have completed a series of electrical performance tests of both UTP and STP cables for 1G. This task group is currently working on compiling all the test results and drafting up the minimum electrical performance for TCL, ELTCTL, and coupling attenuation for cabling in an E_3 environment. These new electrical performance requirements for 1 G cabling will be incorporated into Chapter 8.



By the publication of this paper, the SIG should have completed the rewrite/reorganization of Chapter 8, which will allow easy incorporation of new network applications such as 1G for industrial copper in tables and sections of Chapter 8. Chapter 8 will have a section for E2E, which will be referencing End-2-End Link Technical Report (ISO/IEC 11801-9902). The SIG will monitor the efforts from TR42.9 on their creation of a cabling standard for IEEE 802.3bp for both the connector and cable requirements. Upon completion of the TR42.9 standards, this SIG will review and incorporate the requirements for IEEE 802.3bp into Chapter 8. The SIG will be creating a new task group for updating the current planning and install manual for EtherNet/IP to incorporate all the additions and changes from the updated Chapter 8. Once this planning and install manual is updated and released, the SIG will forward this information to IEC/SC65C/JWG10 to be incorporated into IEC 61784-5-2.