Industrial Field-Bus Standards Update (Physical Layer)

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Abstract:
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 added. 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.

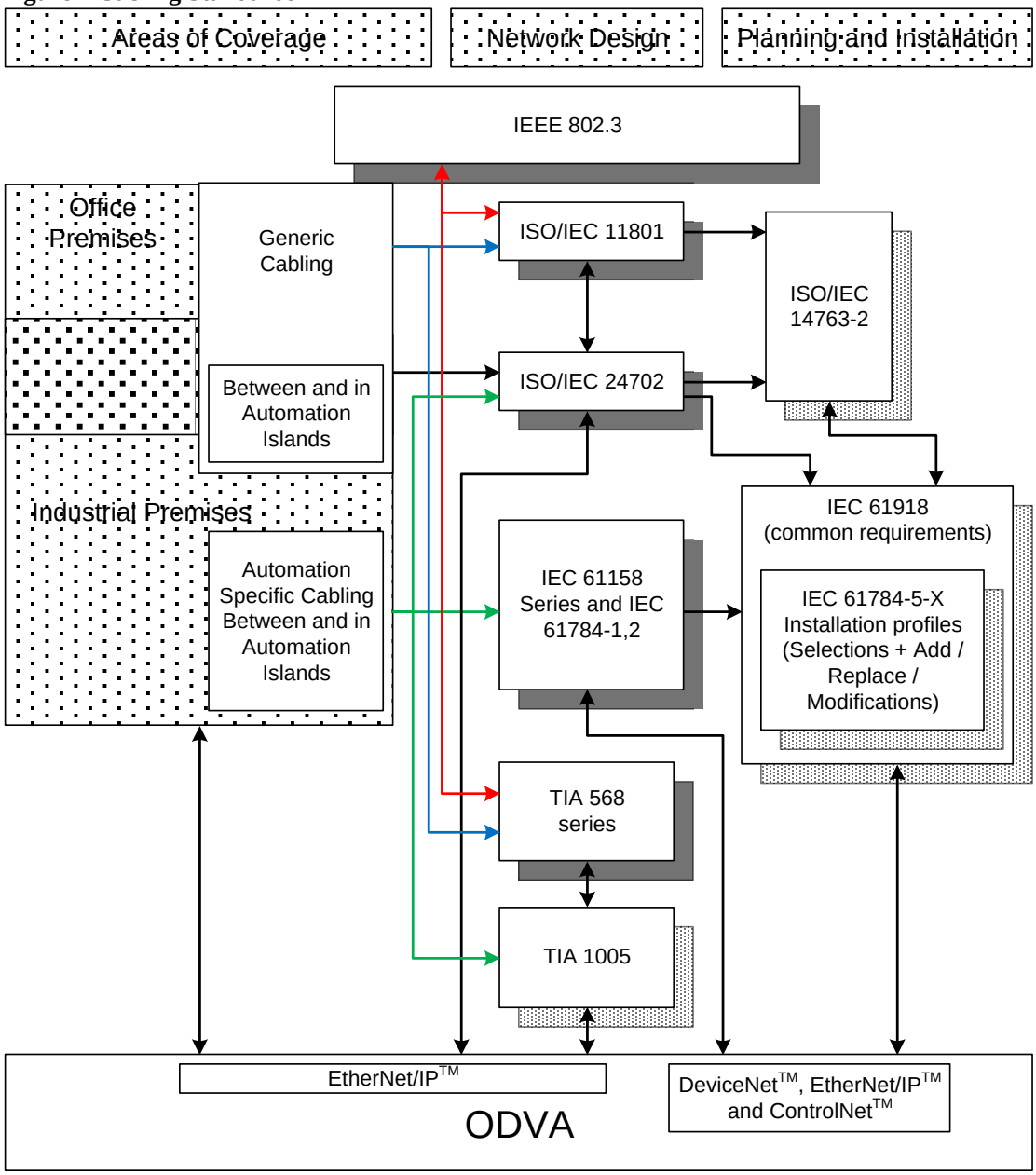
This paper will focus on the current state of these standards and bring the audience up to date on how they affect ODVA. In addition some of these standards organizations are working on new physical layers that when ready may offer a great benefit to ODVA and its networks. For example IEEE 802.3 is working on a completely new 1Gb/s network the will offer a great benefit in the total cost of ownership for ODVA customers.

Keywords:
ISO/IEC, IEC, EtherNet/IP™

Body:
Open standards are important for the promotion and adoption of networks and technology. The task of Standardizing of EtherNet™ in the industrial area has become a major activity within the national and international community. This paper will discuss the current state of the national and international standards with respect to ODVA physical layers including cabling and components.

ODVA has been a leader in the publishing of industrial Ethernet standards and planning and installation guides. Since the release of EtherNet/IP™, v1.0 in 2001 many national and international standards organizations have either released or are about to release standards for industrial Ethernet. Figure 1 shows the relationship of these standards. Figure 1 is arranged from coverage area through the Planning and installation phase with regards to the standards activities. What the reader should note with the arrows is that all the national and international standards committees are working together and exchanging information to create multiple standards at each geographical area. A lot of this work is harmonized through the efforts of ODVA members who work with the standards committees.

Figure 1 Cabling Standards



At the 2007 CIP Networks Conference & 12th Annual Meeting I reported on the state of the standards. Since this report there have been many updates and additions to the standards. For example at that time the Generic standards were focusing on cabling for 10G. Today they are focusing on cabling for 40G and 100G with some discussions of 400G. It is this expansion that drives the technology within the ODVA Physical Layer SIGS. For industrial control including CIP motion we are moving from the 10/100 Mb/s data rates into the 1Gb/s data rates. The release of Category 6A has helped this migration in providing balance cabling technology driven by TCL and ELTCTL values documented in the national and international standards through MICE.

The industrial networking technology continues to evolve at a rapid pace, primarily in the CSMA networks such as Ethernet which is the foundation of EtherNet/IP™. There are several important standards activities at both the national and international level that have a direct impact on ODVA EtherNet/IP™ physical layer designs and communications cabling.

ISO/IEC 11801 and TIA 568 series standards were written several years ago to support Generic Telecommunications communications systems for commercial buildings. ISO/IEC 11801 is once again under major revision. The standard will soon be released as a comprehensive set of standards similar to what TIA had done with the TIA 568 Series of standards, now at Series C. ISO/IEC will have 6 parts when complete. The 6 parts will consist of;

- Commercial,
- Generic,
- Residential,
- Industrial,
- Data Centers,
- Command Control Communications for Buildings (CCCB).

For the industrial community the inclusion of ISO/IEC 24702 (Industrial) in to ISO/IEC 11801 is beneficial, since they very much related and now can share technology and resources. For example the MICE concept and its driving technology will now become all-encompassing with respect to all 6 parts of the ISO/IEC 11801 standard. Our national standard written and maintained by ANSI TIA TR42 committee, ANSI TIA-568 series will soon be released as Series D. Industrial will continue to be a separate standard ANSI TIA-1005A. The following Table 1 provides the current revision level of the relevant standards and their last release date.

Table 1 Current Revision of Cabling Standards

Standard	Name	Revision Level	Release Date
TIA 568-C series	Commercial Building Telecommunications Cabling Standard (Generic Cabling)	Various	2012
TIA 1005A	Industrial Telecommunications Cabling Standard		2010
TIA-607-B-1	Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises	Addendum 1	
ISO/IEC 11801	Information Technology Generic cabling for customer premises	2.2	2011
ISO/IEC 24702	Information Technology Generic cabling - Industrial premises	Ed1+ amendment 1	2009
ISO/IEC14763-n	Installation for Information Technology	Ed1	2012
IEC 61918	Industrial Communications Networks – Installation of communications networks in industrial premises	Ed3	2013 Stable 2018
IEC 61784-5-n	Industrial Communications Network-Profiles Part5-2: Installation of fieldbuses-installation profiles for CPF-2	Ed3	2013 Stable 2018

Major Projects Within The Standards Committees

As mentioned earlier in this paper, industrial networking technology continues to evolve at a rapid pace. Table 2 shows the active projects with in the standards community that are of interest to the ODVA community. The balance of this paper will discuss each one of these projects and the potential impact and or benefits to the ODVA networks.

Table 2 Active Standards Projects

Project	Sponsor Standards Group Consortia	Assigned Standards Group
Combine Commercial, Residential, Generic, Industrial and Data Centers into one Standard ISO/IEC11801-1-5	ISO/IEC/JTC1/SC25/WG3	Same (NWIP)
Command Control Communications for Buildings (CCCB) to be become ISO/IEC 11801-6	ISO/IEC/JTC1/SC25/WG3	ISO/IEC/JTC1/SC25/WG3 (NWIP)
Move Series of standards to D	ANSI	ANSI TIA TR42

Grounding ((Earthing)) and Bonding Industrial	ODVA, Industrial Consortia	ODVA, TIA-TR42.9 and ISO/IEC/JTC1/SC25/WG3
1 Gig Cabling (4 Pair) for Industrial	Industrial consortia	ODVA, TIA-TR42.9
M12-8 X coded Connector	ODVA and IEC/SC65C/JWG10	SC48B, TIA-TR42.9
Reduced Twisted Pair Gigabit Ethernet	Automotive and Industrial	IEEE 802.3 bp
End to End Link	IEC/SC65C/JWG10	ISO/IEC/JTC1/SC25/WG3 (NWIP) Also includes JMTG
Mixed Cabling	Siemens and IEC/SC65C/JWG10	IEC/SC65C/JWG10

As mentioned earlier in this paper ISO/IEC/JTC1/SC25/WG3 has a New Work Item Proposal (NWIP) to combine several standards into the ISO/IEC 11801 standard. The ISO/IEC 11801 standard is a parallel standard at the international level to ANSI TIA-568-C series standards. The important change in this standard is the inclusion of the industrial standard ISO/IEC24702 into the ISO 11801 structure. This will be done as Part 3 of the standard. This provides a greater sharing of the technology and concepts between the two standards. In addition CCCB will be added to ISO11801 under another NWIP. CCCB has a lot of commonality to that of the industrial networks since these standard addresses building control needs such as Heating Ventilation Air Conditioning/ HVAC.

TIA's current focus is to revise the standards to Series D. There is little or no impact to Industrial since combining TIA 1005A is not part of this effort. However this effort is consuming a lot of the committee's resources. The generic cabling subcommittee TR 42.7 is working on the next generation cabling 40G with IEEE 802.3 while finishing up test schedules for 10G cabling.

All three committees (ISO/IEC/JTC1/SC25/WG3, ANSI TIA TR42 and ODVA are working on the initial release or revision of a Grounding (Earthing) and Bonding standard. ODVA will have its own Grounding (Earthing) and Bonding standard that is focused on ODVA networks. This standard will take information from both the ISO and ANSI TIA versions. Due to the lack of industrial focus and detail in the two national and international standards it's not possible to just point our ODVA community to these standards. The ODVA Ground (Earthing) and Bonding standard is due out this calendar year as a Technical Bulletin.

One of the most exciting and technical additions to the Industrial standards is 1Gig cabling. Both ODVA and ANSI TIA TR42.9 are working on a new class of cabling to support industrial 1G channels. This class of cables will have specific attributes aimed at reducing the effects of noise on 1G control channels. These new channels require 4 pair cables. Since they require a 4 pairs to be present in the cable we no longer would have had a sealed small form factor connector like the M12-4 D code connector. Therefore ODVA has adopted a M12-8 X code connector into the standard as of 2013. This new connector supports data rates up to 10G. This work is expected to be completed this calendar year (2014).

With the rapid expansion of CSMA networks, the automotive manufactures are moving to Ethernet based communications networks for Automobiles. There is a project in IEEE 802.3 to create a new copper network for in car use. This network is expected to be deployed in some European cars by 2018. This network is called Reduced Twisted Pair Gigabit Ethernet (RTPGE). The length of a channel is approximately 15 meters (that of a USB) channel. The project includes noise studies which is new for IEEE 802.3. The end solution will be a new class of PHYs most likely only supporting RTPGE channels consisting of 1 twisted pair. One of the challenges is S/N in the car with inexpensive cabling components. This is the reason for the short channel. Like CAN bus networks of which DeviceNet™ is based on, there is a lot in common with industrial environments and automotive environments. In addition with the reduction of cable elements and simplification of the connectors has a lot of benefit for industrial. The industrial Ethernet consortia's are interested in this new channel. One of the major hurtles to overcome is the short 15 meter channel length. While the majority EtherNet/IP™ channels are less than 5 meters this restriction still hinders a wide deployment of such a channel. It is expected with optimized cabling designs the channel can be extended to approximately 40 meters. This covers more than 80% of the channels found in industrial control applications. One other obstacle in the adoption of this new PMD, is that the new PHY is expected to only support a 1G RTPGE channel. This means that vendors will have to provide a unique set of products just supporting this channel. It is expected that this new PMD will be release from IEEE 802.3 in early 2015 with PHYs following.

Another project of importance to Industrial is the End to End link (E2E). This project addresses the way our cables are deployed in the industrial installations. Most of our channels are links that consist of two plugs and a long cable, i.e., a long patch cord. Cords that are longer than 20 meters are outside the Generic standards. Currently the requirements for testing cords is a sub set of the performance measurements of a channel and only includes Return loss and Insertion loss. Channel tests do not include the plugs at the two ends of the channel. Since most of our channels (links) are constructed in place, there is a higher probability that the installer has compromised the channel performance at the back end of the two end connectors. Wire preparation is extremely important during the connectorization of Ethernet cables. Since the two plugs are outside the testing scope of a channel these issues can go un-verified and cause problems that are difficult to find. This project address this by creating a new channel (link) that has a complete set of transmission parameters that include both plugs at the two ends of the channel thus End to End Link. This essentially is a new channel for the industry. It is expected that this work will be completed by early 2015. Most of the work is being done in the Joint Modeling Task Group (JMTG) reporting into ISO/IEC/JTC1/SC25/WG3. This project was requested from IEC/SC65C/JWG10 (Joint Working Group for Field Bus Installation)

Mixed cabling is a project that is being worked on in IEC/SC65C/JWG10. This project will, if successful allow the mixing of 2 pair and 4 pair cables in a single channel. It most likely will be limited to shielded cables only. This project is expected to solve the problems where customers have installed 4 pair horizontal cables and has a need to connect to 10/100 mb/s PMDs with 2 pair cords. Doing so will cause two of the four pairs to float without a connection or termination. Normally this is not a good practice since the high impedance of the un-terminated pairs can cause degraded performance in the active two pairs. Individually shielding the pairs in the horizontal segment of the channel will reduce the interaction of the pairs with one another (cross talk). This project is expected to complete in 2014.

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