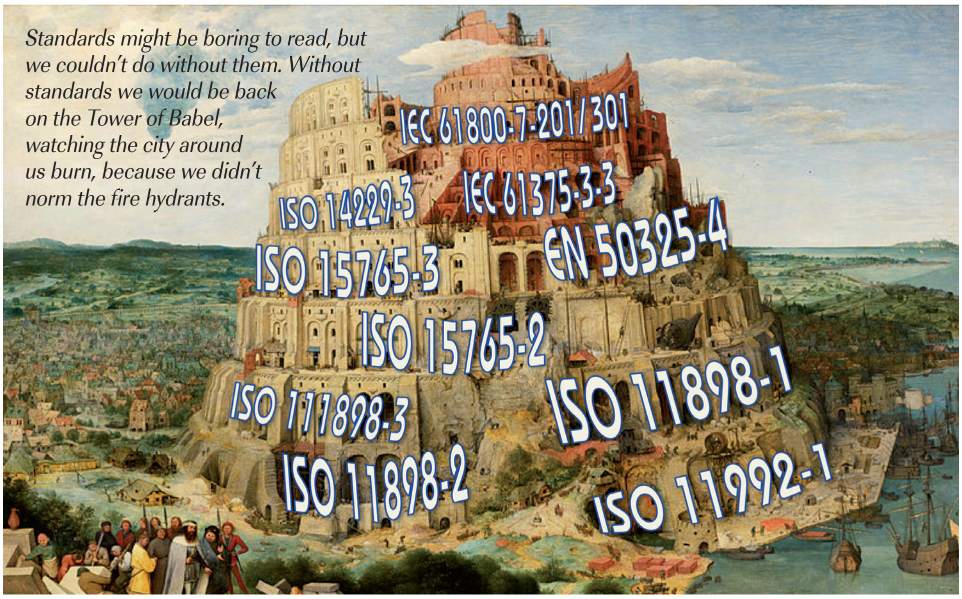
The history of standardization and CAN in a nutshell



Standards might be boring to read, but we couldn't do without them. Without standards we would be back on the Tower of Babel, watching the city around us burn, because we didn't norm the fire hydrants.

The CAN protocol has been internationally standardized since 1993 in the ISO 11898 standard. These days, all basic CAN standards are under review. The ISO 11898-1 standard is going to be upgraded and to include the CAN FD protocol extension. The ISO 11898-2 high-speed transceiver standard and its younger sisters ISO 11898-5 (low-power mode) as well as ISO 11898-6 (selective wake-up transceivers) are going to be merged into one single ISO document, to make them consistent and easier to maintain.

We all know that standards are boring to read, but we can't work without them. It's especially dull to read standards that were not made for your needs. For example, the ISO 11898 series is written for chipmakers who want to implement the CAN protocol. Users should not read them. A better way to spend your time would be to buy one of the helpful books on the topic or to search for articles and basic information on the Internet.

We do need a shared way of communication, so that different implementations can exchange messages. This is the same with human languages: If we didn't agree on paper and envelope formats as well as character sets, we couldn't communicate through mail. There would be no normed keyboards and no letters that could be read without an interpreter.

Standardization

Standardization is as old as interactions within larger human communities. The first Chinese emperor, Qin Shi Huang (260 to 210 BC), standardized not just the Chinese characters, but also the system of units and measurements as well as the currency and the width of cart axles.

War has often driven standardization. More than 2500 years ago Heraclitus stated: "War is the father and king of all." In the American Civil War (1861 to 1865), one of the reasons for the victory of the Union against the South was the standardization of their rail tracks. The problem was the difference of track gauges: The Confederate rail network was mostly in the broad gauge format, only North Carolina and Virginia had mainly standard gauge lines. Southern railroads west of the Mississippi differed widely in gauge and were isolated and disconnected. During the Civil War, the Union government recognized the military and economic advantages of having a standardized track gauge. The government worked with the railroads to promote use of the most common railroad gauge in the U.S. at the time, which measured 4 feet and 8 ½ inches, a track size that originated in England. This gauge was mandated for use in the Transcontinental Railroad in 1864 and by 1886 had become the U.S. standard.

Another example for standardization during wars is standardized rifle parts. Standardized parts are interchangeable between guns. This was a revolutionary idea by Thomas Jefferson and Eli Whitney (mechanical engineer) in the late 18th century.

Likewise the foundation of the predecessor of the DIN (German standardization body) in 1917 had a military background: The German industry wanted to optimize production during World War I (1914 to 1918), which was mainly a material battle between Germany and France.

There are also civil examples of standardization benefits. In 1904, a fire broke out in Baltimore. To combat the flames, reinforcements from New York, Philadelphia and Washington (DC) came to Baltimore. After they arrived, they realized that their fire hoses could not be connected to the fire hydrants. Lesson learnt, the U.S. started a lot of standardization projects. In 1904, the ANSI (American National Standards Institute) was established. A few years earlier, the British Standardization Institute (BSI) had been founded.

An increase in international business demanded worldwide standardization. This was the birth of the IEC (International Electrotechnical Commission): The inaugural meeting was as early as 1906. Originally located in London (UK), the commission moved to its current headquarters in Geneva (CH) in 1948. One year before, 25 countries founded the ISO (International Standardization Organization) to deal with all "non-electrical" standards. The ISO predecessor had already been established in 1926, but it was suspended during World War II. Today the division of labor is more or less history, because electrical equipment is used in many industries and needs to be standardized. ISO standardizes electronics too, in particular for those industries that have non-electrical roots. That is why CAN is standardized by the automotive technical committees of ISO: cars were originally ▷

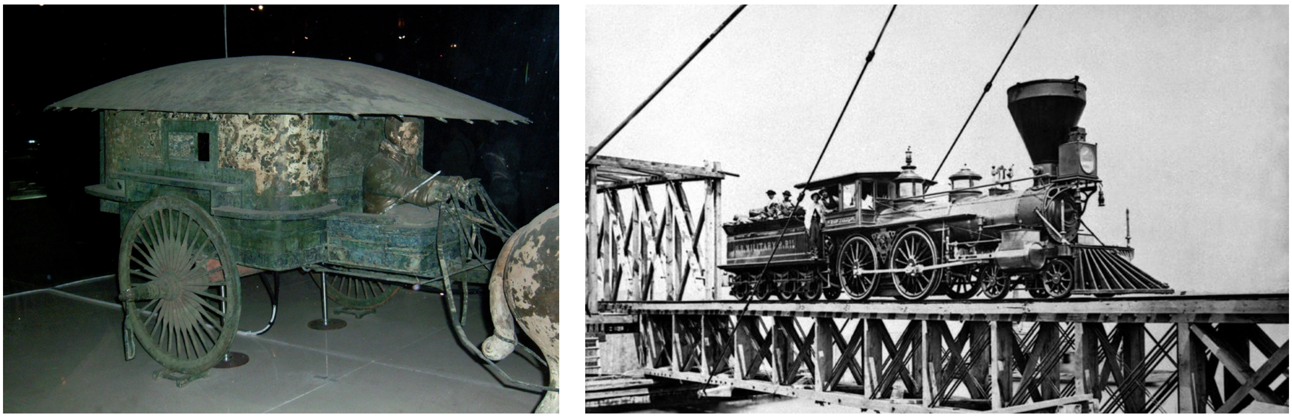


Figure 1: The war is the father of all things – the first Chinese emperor standardized among others the width of axles (left) and the Union government standardized rail tracks (right) (Photos: Wikipedia)

not defined as electric and electronics.

ISO is a voluntary organization whose members are recognized authorities on standards, each one representing one country. Members meet annually at a General Assembly to discuss ISO's strategic objectives. The Central Secretariat coordinates the standardization activities and publishes the ISO standards. There are over 250 technical committees and thousands of subcommittees, working groups, and task forces.

The IEC has a similar number of technical works. Some 10 000 electrical and electronics experts from industry, government, academia, test labs, and others with an interest in the subject develop the standards. IEC standards have numbers in the range from 60000 to 79999. The IEC is made up of members, called national committees (NC). Each NC represents its nation's electro-technical interests.

CAN-related standards in ISO and IEC

The CAN protocol was first described in a specification published by Bosch. Many people still use the terms CAN 2.0A and CAN 2.0B from back then. However, in 1993 the ISO 11898 standard was released, substituting all predecessors including the Bosch specification. The ISO standard comprised the CAN data link layer and CAN high-speed transmission. In 1995, the ISO 11898 standard was extended by an addendum describing the extended frame format using the 29-bit CAN identifier. Ten years after the publication of ISO 11898, the document was split into parts: The first part contained the data link layer and the physical signaling, while part two standardized high-speed transmission. Fault-tolerant, low-power transmission went into ISO 11898-3. At the same time, ISO started the standardization of CAN-based truck-trailer communication. The results are specified in the ISO 11992 series, which includes its on physical transmission solution and a higher-layer protocol based on J1939. This series also specifies dedicated parameter groups (signals assembled to CAN messages). All this standards are published under the roof of the Technical Committee (TC) 22. Within this TC there is also the ISO transport protocol standardized (ISO 15765-2), which is the base for several emission-related CAN-based diagnostic standards (ISO 15765-4). The ISO 14229-3 standard specifies unified diagnostic services (UDS) transmitted via CAN. Another CAN-related series is ISO 16844 standardizing tachograph communication for commercial vehicles. This standard is referenced by European regulations, but not much loved in the industry, especially not by truckers. They don't like to be watched electronically.

Just after the year 2000, Bosch started to extend the CAN protocol by a time-triggered protocol. It is an unanswered question if this is a session layer or if it doesn't fit in the OSI reference model at all. But it was standardized in ISO 11898-4 and is known as TTCAN. Up to now it has not made its way into the industry. Some chipmakers have implemented it, but it is not in use. The same happened to the ISO 15745-2-2 standard describing an XML-based framework for CAN-based networks, which has never been used in industrial automation systems. I was personally involved in its development, but understood little of what the IT experts were discussing. This is one of the standards that are just paperwork and eating memory space on computers. They are not really ecologically valuable, especially when considering the traveling. Anyway, standardization can sometimes be slow and eat a lot of work-time.

ISO TC 23 is the home of the ISO 11783 series (also known as Isobus), which standardizes the communication between tractor and agriculture equipment (so-called implements). This standard is based on the J1939 higher-layer protocol. The ISO 13628-6 standard describes the general requirements for subsea equipment using CAN networks to link sensors and meters to the subsea control unit. These CAN applications make use of the CANopen application layer and the related CiA 443 CANopen profile for SIIS level-2 devices.

In the IEC organization, there are also some CAN-related standards. First of all the IEC 61375-3-3 standard has to be mentioned: It describes the CANopen-specific implementation of CAN networks within rail vehicles; locomotives as well as coaches. This includes some physical layer specifications and some functions originally specified in CiA 301 and CiA 302. Another IEC standard, IEC 61800-7-201/301, specifies the CiA 402 CANopen profile for drives and motion controllers.

Of course there are also two European Cenelec standards related to CANopen: EN 50325-4 specifies the CANopen application layer and EN 50325-5 describes the CANopen Safety protocol extension. Cenelec and CEN, the European standardization bodies, were established in 1973 respectively in 1961. Today, they work in close cooperation with IEC and ISO, in order to avoid double standardization. Or in other words: the try not to re-invent the wheel.

No standards without sponsors and editors

To put it bluntly, all standardization activities are driv- ▷

en by interests of individuals or companies – sometimes both. Bosch backs the current activities regarding the ISO 11898 series. The C&S Group performing the related conformance testing of CAN silicon supports all conformance test plans. Of course, the market-leading semiconductor manufacturers and some carmakers spend a lot of effort on pursuing CAN standardization.

The editor of ISO 11898-1 is Florian Hartwich from Bosch. During the development of the document there were many contributions from different experts, in particular from GM, Mercedes, and Renesas. The related CAN conformance test plan, standardized in ISO 16845-1, was edited by Andreas Meidrodt from the C&S Groups. A college of him, Christoph Wosnitza, does the paperwork for ISO 16845-2, the conformance test plan for ISO 11898-6 (selective wake-up CAN transceivers). Bernd Elend from NXP volunteers as editor of the harmonized high-speed transceiver standard (ISO 11898-2). Without these editors, who also spend some of their free time on editing the documents, the standards would not meet the deadlines given by the rules of ISO.

Every ISO or IEC group needs a convener and a secretary. The secretary is normally a representative of a national standardization body. Volunteers for conveners are always welcome, because this position is unpaid. But sometimes, there are political discussions and arguments about who gets which position, because no country or company should dominate in a group. Traditionally, Germany is strongly represented in automotive-related committees. Standardization does not only have a technical dimension; it also has a political one.

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Standardization is slow

The process of standardization is sometimes slow compared to the development of technology. Because of this, technology is often introduced first and standardized later. Standardization is slow, because all parties should have the chance to comment on the provided drafts and proposals. On the other hand, the slow process avoids standardizing technology that disappears again soon. In the beginning, I found it harrowing to wait. In the meantime, I have learned to be more relaxed and patient. For example, when we started to standardize the CAN FD protocol, only Bosch and some other experts actually developed the protocol. But while we were preparing the committee draft for voting, we received a lot of valuable ideas and comments from other experts. In the end, this improved the CAN FD protocol and will increase its acceptance in the industry. Of course, the standardization process should not be so slow that the document is never published. Therefore, ISO and IEC establish project deadlines that have to be met.

Still, it is boring to read standards. In particular, if you are not familiar with the specific standardization language. But we need these formal rules on how to write standards: we need a standard that tells us how to create standards. One of the reasons for the need is to avoid misunderstandings and misinterpretations when translating the standard into different languages than the two official ones: English and French. ◀

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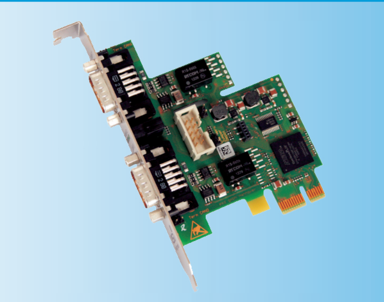
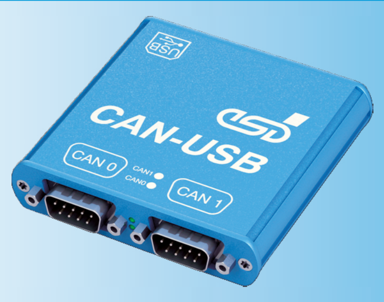
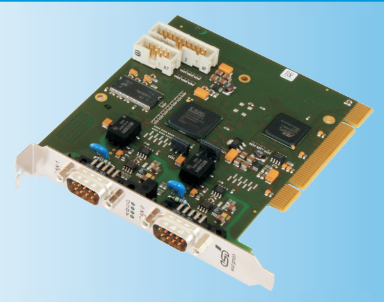
CAN-PCIe/402



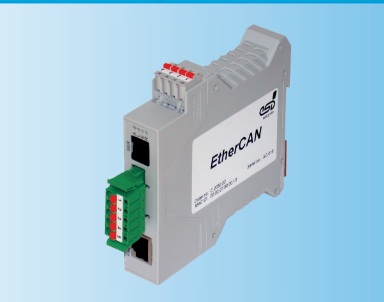
CAN-USB/400



CAN-PCI/400



Ethernet



CAN-USB/2

Gateways

CAN-PCIe/402
- up to 4 high performance PCI Express CAN interfaces
- DMA busmaster
- Powered by esd Advanced CAN Core (esd-ACC)
- MSI (Message Signaled Interrupt) support
- Electrically isolated
- Provides high resolution hardware timestamp

CAN-USB/400
- 2 high performance CAN-USB interfaces
- Powered by esd Advanced CAN Core (esd-ACC)
- USB 2.0 with high speed data rates of 480 Mbit/s
- Electrically isolated
- Provides high resolution hardware timestamp
- Error injection for advanced diagnostic
- IRIB B timecode as option

CAN-PCI/400
- up to 4 high performance CAN interfaces
- Powered by esd Advanced CAN Core (esd-ACC)
- Electrically isolated
- Provides high resolution hardware timestamp
- Error injection for advanced diagnostic

CAN-PCI104/200
- PCI104-CAN interface
- One or two CAN interfaces for PCI104 bus

EtherCAN
- 10/100 BaseT ETHERNET-CAN Gateway
- Electrically isolated
- Configuration and Diagnostics by webbrowser

CAN-USB/2
- CAN-USB interface
- Intelligent CAN interface with ARM 7
- USB 2.0 with high speed data rates of 480 Mbit/s
- Electrically isolated
- Provides high resolution hardware timestamp

Gateways
- EtherCAT-CAN
- PROFINET-CAN
- PROFIBUS-CAN
- PROFIBUS-DeviceNet
- EtherNet/S7-CAN

Operating Systems
esd supports the real-time multitasking operating systems VxWorks, QNX, RTX, RTOS-32 and others as well as Linux and Windows 32/64Bit systems

CAN Tools
- CANreal: Display and recording of CAN message frames
- CANplot: Display of online/offline CAN data
- CANrepro: Replay of pre-recorded CAN message frames
- CANscript: Python scripting tool to handle CAN messages
- COBview: Analysis and diagnostics of CANopen nodes

The tools are free of charge on the driver CD or can be downloaded at www.esd.eu

esd gmbh • Vahrenwalder Str. 207 • 30165 Hannover • Tel: (0511) 372 98-0 • Fax: (0511) 372 98-68 • info@esd.eu • www.esd.eu
esd electronics Inc. • 70 Federal Street • Suite 2 • Greenfield • MA 01301 USA • Phone: 413-7723170 • us-sales@esd-electronics.com • www.esd-electronics.us