20 years of CiA 401

CiA 401, the CANopen device profile for generic I/O modules was released in 1996. Nowadays version 3.1.0 is effective. The next version will include the mapping for 64-byte PDOs.

The predecessor CiA 401 profile specification was developed by the Esprit project developing the CAL-based communication profile. After handing over to CiA (CAN in Automation) for further development and maintenance, the profile for modular I/O devices was released CiA-internally as version 1.3 in 1996 and implemented by several companies, e.g. Selectron and Weidmüller. The editor was Martin Jaeggi from Selectron. In those times, CiA members edited the specifications. Today, CiA engineers do it.

The CiA profile supported from the beginning different digital I/O granularities. Besides the mandatory 8-bit digital process data, 16-bit or 32-bit access was specified as well as a bit-wise access. The latter was not very often implemented. For analog I/Os the profile provides 16-bit resolution (mandatory) as well as 32-bit, floating point, and manufacturer-specific data types.

The version 1.4 pre-defined just two PDOs (process data objects). The next version (2.0) used already predefined PDOs. The first PDO transmitted digital inputs respectively received digital outputs. The other three PDOs contained each four analog I/O values. In case of other I/O port capability, the devices need to be configured. In order to avoid this, CiA 401 version 3.0 introduced the "M"-bit in the device type object (index 1000h). It indicates that a manufacturer-specific PDO mapping is implemented.

Since version 3.1 the profile has been split into two parts. Part 1 specifies generic I/O modules, while part 2 describes several joystick implementations with dedicated PDO mappings and some specific parameters. There is also the CiA 852 recommended practice for CiA 401-based operator environment sub-systems developed for construction and mining machines. An important contributor for CiA 401-2 and CiA 852 was Dr. Heikki Saha, in those days working with Sandvik in Finland.

The recommendation has not been implemented very often. On the contrary, the CiA 401 generic profile is one of the most used I/O specifications: perhaps, it is the most implemented one. In CiA’s CANopen Product Guide several companies advertise their CiA 401 compliant devices.

Modular CANopen I/O devices from Beckhoff, B&R, Eaton (Moeller), Festo, Schneider Electric, Wago, and others have been on the market for many years. And there are more CiA 401 implementations. Some of them are very specific, e.g. I/O devices in IP65-rated enclosures from Turck and others. Many of the CANopen suppliers for construction machines and off-road vehicles provide I/O modules compliant to CiA 401. CiA 401 hero Selectron has changed its business focus from automation broadliner to specialist for rail vehicle supplier over the last 20 years.

There are also micro-controllers with pre-programmed CiA 401 compliant software available, for example by Frenzel and Berg.

Figure 1: The recently introduced XN300 device family with a CiA 401 compliant interface (Photo: Eaton)

Figure 2: The Smartio CiA 401 compliant device dedicated for rail-vehicle applications by Selectron comes still in a purple colored housing as in 1996 (Photo: Selectron)
These I/O chips simplify the device design of CANopen I/O modules. Besides I/O devices available for many years, there are new CiA 401 implementations. At the SPS IPC Drives 2015 exhibition, Eaton launched the XN300 family and Weidmuller introduced CANopen support for its u-remote series (take a look at the insert “CAN Newsletter Online”).

Although CiA 401 is twenty years old, there are some new enhancements under development. Especially, the PDO mapping is going to be updated due to the longer data frames (up to 64 byte) provided by the CAN FD data link layer. There is also the demand to improve the interoperability between host controllers and CiA 401 modules. This could be achieved by means of device classes using dedicated mappings as specified in CiA 852 for example.

Control system
Suitable for mobile machines
The increasing complexity of mobile machinery results in growing demands of I/O controllers. In accordance with those market requirements B-Plus (Germany) developed the b-CAN-Cube-Mini.

CiA 401
Q&A with Beckhoff
Ralf Vienken from Beckhoff (Germany) answered five questions on the CiA 401 profile, CANopen I/O modules, and more.

Three-phase power meter
With CANopen interface
The PM-3133-CPS power meter by ICP DAS provides a CANopen interface for users to gather real-time power consumption information in connected devices. The meter complies with CiA 401.

Q&A with Frenzel + Berg
New versions of CANopen chips
Erich Frenzel from Frenzel + Berg (Germany) answered questions about the CANopen I/O chip used in many different applications.