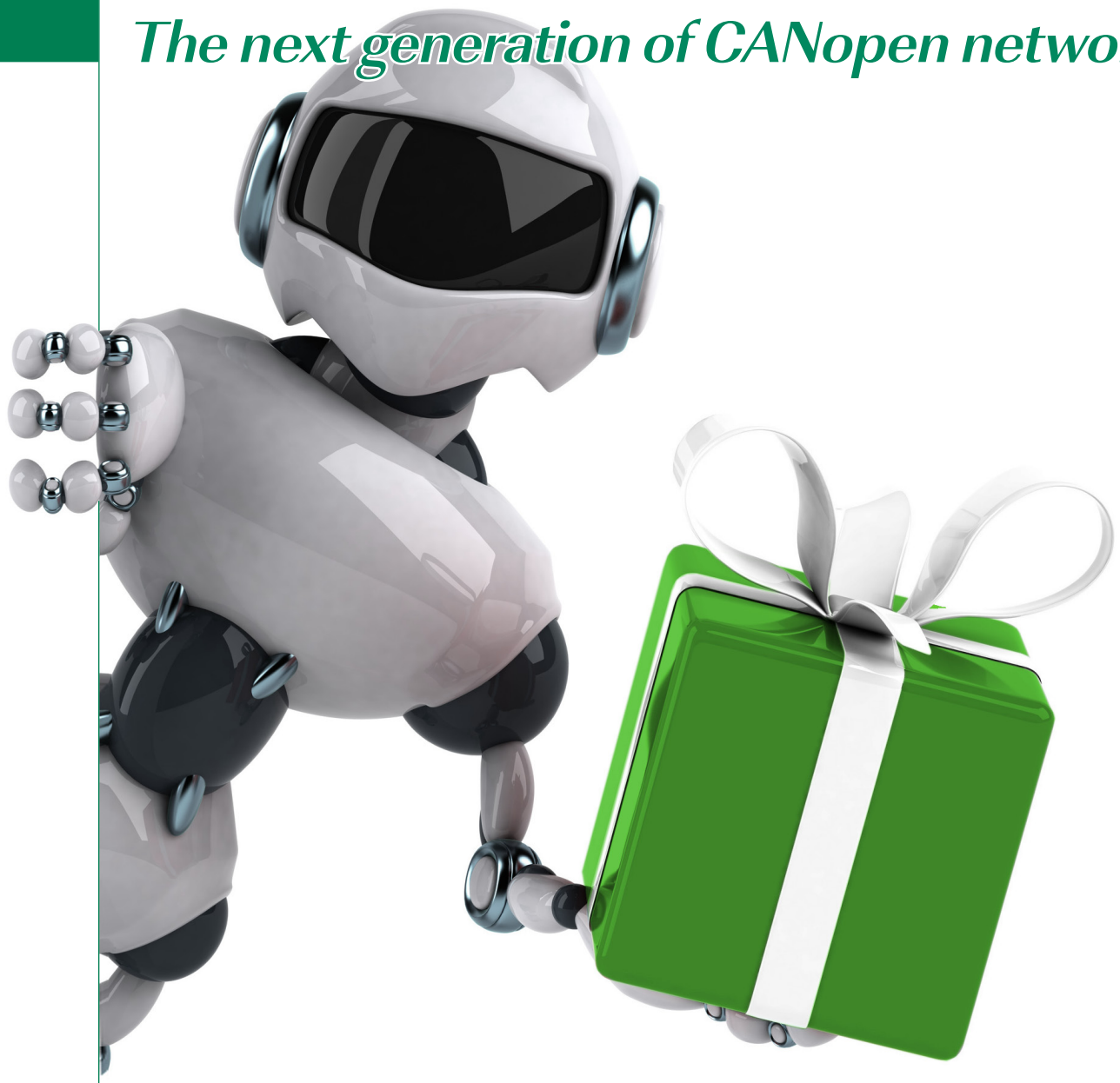
November 2016

CANopen FD

The next generation of CANopen networking



Higher data throughput

Network-wide cross communication

Simple integration into the Internet of Things

Enabler for safety and security

Benefits

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CANopen FD – CANopen at its best

The CANopen SIG application layer is currently finalizing the adaptation of CANopen to CAN FD. CANopen FD combines todays CANopen attributes such as design-flexibility, scalability, and robustness with the attributes of CAN FD such as a 64 byte data field, a high data throughput and an increased reliability. CANopen FD enriches CANopen by an enhanced Error history and the Universal Service Data Object (USDO). By adding a time stamp to each recorded error, the error history enables sophisticated diagnostics. The USDO adds a highly flexible and powerful communication object to CANopen. Transferring any amount of data in a confirmed uni-, multi-, or broadcast communication, establishing dynamically cross-communication between two CANopen devices by absence of any SDO manager functionality or communicating over network borders by using the inherent USDO routing capabilities summarizes just a subset of the possibilities, contributed by the USDO to CANopen FD. CANopen FD is provided in the updated CiA 301 version 5.0. Its attributes allow to meet todays and future requirements with regard to embedded networking.

Join the working group SIG application layer:

- Make sure that your company-specific requirements are covered in CANopen FD
- Get a comprehensive understanding of the new CANopen FD features
- Be an early bird on the market, with regard to CANopen FD products and services
- Setup and maintain relations to other companies active in the CAN business
- Support CAN FD and CANopen FD in general

The Universal Service Data Object (USDO)

The USDO is intended to become the multi-function knife of embedded CANopen FD networking. The USDO is not just making use of the increased data throughput offered by CAN FD but adds a lot of useful functionality to CANopen FD.

In contrast to the classical SDO, the CAN-IDs used by the USDO do no longer determine the accessed (U) SDO server but the originator of an USDO request or response. To address a specific USDO server, the USDO client therefore has the task to code the intended USDO server in the data field of the request. Hence, the USDO client has the option to access one, several or all USDO servers available in the network at the same time. Furthermore the USDO client may have several sessions with the very same USDO server in parallel, e.g. to monitor the progress of a simultaneously running software download. As connectivity gets more and more important in times of the Internet of Things (IoT), the USDO provides an inherent routing capability. In heterogeneous network architectures, CANopen users just need knowledge about the topology (network- and node number) and they are enabled to access any CANopen device, connected to this network architecture. Additionally the USDO enables users to read and write multiple CANopen sub-indices by a single USDO access. The demonstrator provided at the CiA booth on occasion of the SPS/IPC/Drives 2016 provides an insight to the CANopen FD design flexibility, added by the new USDO communication object.

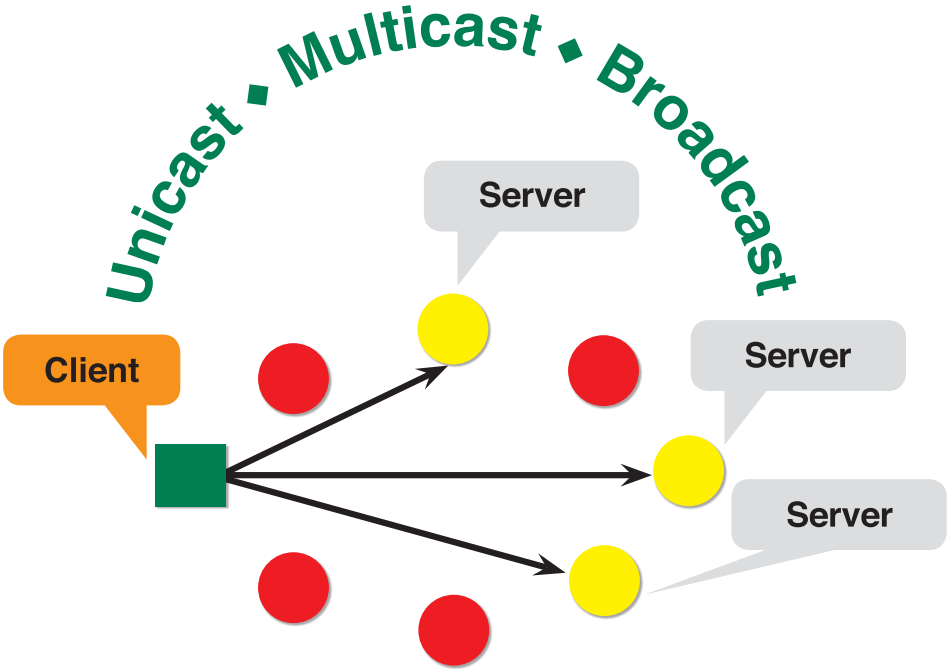

Figure 1: Design flexibility by means of user

USDO attributes:

- Dynamic access to any CANopen device by absence of a SDO manager
- Accelerated, confirmed data transfer in uni-, multi-, and broadcast communication
- Simultaneous USDO sessions between the very same USDO client and server
- Access of several CANopen sub-indices by a single USDO access
- Routing capability

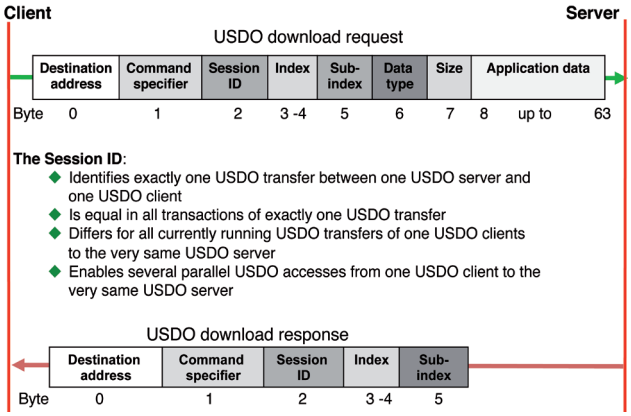

Figure 2: USDO in principle

CANopen FD demonstrator

A major task during updating the CANopen specification with regard to CAN FD has been the specification of the new communication object USDO. As most relevant aspects of the USDO communication object have already been specified, attendees of the SIG application layer offered their resources to setup a CANopen FD demonstrator for the SPS/IPC/Drives 2016 to illustrate the design flexibility of this new, powerful communication object.

The CANopen FD demonstrator integrates CANopen FD prototype implementations from the companies Emtas, ESD, HMS, and Microcontrol in a CAN FD system, using 500 kbit/s in the arbitration phase and 2 Mbit/s in the data phase. In parallel a second network based on classical CANopen integrates the nodes of the aforementioned companies as well.

Depending on the user interaction one node is triggering a request to the requested CANopen (FD) node either via pre-configured SDO communication or dynamically established USDO communication. Immediately after the successful completion of the request, the requested CANopen (FD) implementation starts to upload an illustration to the server, offered by the requesting node. The transfer of the data from the client to the server is running via that network, which provided the request, so either via CANopen or CANopen FD.

As the server starts immediately presenting the illustration on a display, the observer of the CANopen FD demonstrator can experience the rapid and flexible data transfer via CANopen FD's USDO in comparison to the classical CANopen SDO. In case the data received via USDO, the data is much earlier available and can therefore much earlier be displayed in contrast to the data received via classical SDO.

Future CANopen FD application fields:

- Applications dealing with increased security requirements, e.g. billing systems
- Applications dealing with high amount of safety-relevant data, e.g. construction machineries
- Applications that require robust and highly reliable communication, e.g. commercial vehicles
- Applications with low energy consumption service, e.g. light-electric vehicles, service robots
- All existing CANopen application fields suffering from a limited bandwidth or payload

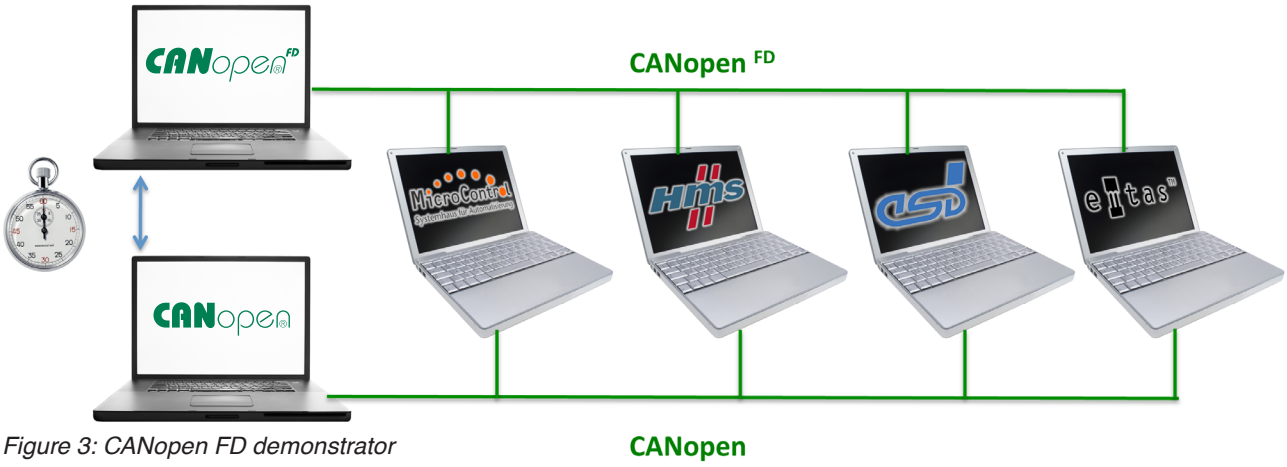

Figure 3: CANopen FD demonstrator

CANopen FD – Current status

The CANopen SIG application layer succeeded in finalizing many of the issues that occurred during the update of CANopen with regard to CAN FD. This covers the basic USDO functionality, the enhanced error history as well as enabling PDOs with a payload of 64 byte. In addition the SIG application layer removed detected ambiguities with regard to interpreting the existing definitions of the CANopen finite state automaton and removed RTR-based services because the CAN remote frame handling has already been detected as a well-known source for erroneous device and system behavior years ago. It is planned to release CANopen FD as version 5.0 of CiA 301. Prior to the release of the document, the involved parties are going to test the new specification by means of CiA plugfests. A first plugfest took place in October 2016 at the CiA office in Nuremberg. Representatives of Emtas, ES Academy, ESD, HMS, and Microcontrol interconnected their implementations via CANopen FD. The focus during this test was on the USDO protocol. All protocol tests were passed by the implementations of all attendees. The experts experienced that system designers have to setup the physical layer much more carefully than they might be used to do in current CAN-based systems. To allow in future a simple CANopen FD system design, the experts concluded to specify very detailed, the physical layer settings such as the bit timing. To be sure that these specifications meet the requirements of most of the CANopen FD users, todays CANopen users are requested to submit their requirements with regard to topology, bit rate, number of nodes, etc. to CiA and the related working groups.

The SIG drives and motion control has already adapted its CANopen device profile to CANopen FD. In CiA 402 part 6 of the specification, a new PDO mapping for CANopen FD PDOs is specified. This new mapping eases the transfer of entire sets of control data (such as set point, velocity, acceleration, etc.) to a single axle. In addition, interpolated movements are simplified by providing control data for several axles in one PDO and all CANopen drives get their data at the very same time.

Figure 4: Members of the SIG application layer verify the specification by means of a CiA plugfest

Standardization and availability

- Major part of the CANopen update to CAN FD finalized
- First CANopen FD stack prototype implementations exist
- First parts of the new CANopen FD specification have been tested successfully
- CAN FD is standardized in ISO 11898-1:2015 and ISO 11898-2:2016
- MCUs with CAN FD announced by several chipmakers
- First car manufacturers plan to use CAN FD in 2018

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