CANopen FD use cases

CANopen FD allows efficient and simplified embedded networking. It comes with interesting features added to classic CANopen networking by keeping the robustness and scalability. This article examines why and when choosing CANopen FD.

Modern applications demand network design flexibility. Even the end user shall have the option to modify the application or network setup. Thus, a dynamic handling of communication coherences between the devices in the network is needed. Additionally, increased requirements for safety-relevant or secure communication demand a high data throughput; not only during configuration and maintenance, but also during system runtime. Furthermore, requirements derived from condition monitoring or IoT (Internet of Things) applications, demand an increased communication bandwidth on embedded level. The new features, added to CANopen FD, allow very efficient embedded networking, today and tomorrow; as illustrated by means of the following examples.

Control of multi-axis systems

In several applications the synchronization of various tasks is requested. For example, in multi-axis systems some axis shall start with their movements at the very same time. In Classical CAN-based networking, this task can be solved. For starting synchronized movements, the axis that shall operate synchronously for example can use a synchronized time base or a specific global event as trigger. In CANopen FD, extended PDOs provide a simplified solution. A single CAN FD data frame is utilized to transfer the drive commands in the embedded network, to all drives, at the very same time. CiA 402-6 has already specified merging several control words for several axis, in one PDO. Thus, the addressed axis are getting the commands at the very same moment and start operating simultaneously. An additional effort for synchronization is just not needed.

Security and authentication

Distributed applications that handle sensor values, on which an invoice is generated for example, have to proof that the invoice is based on the correctly-measured value. They have to assure not to use some manipulated values. Typically, in such applications, system designers have opted the classic CANopen SDO transfer. This confirmed point-to-point connection, makes sure that the right sensor value is collected from the intended sensor, that is currently in an error-free operating state. To provide all this information in a single, Classical PDO, the size of 8 byte is not sufficient. Transferring the information in several segments, may causes run-time conditions, which have to be detected. The CANopen FD PDO, with a size of up to 64-byte payload, overcomes these limitations and eases the setup of such applications. ▷

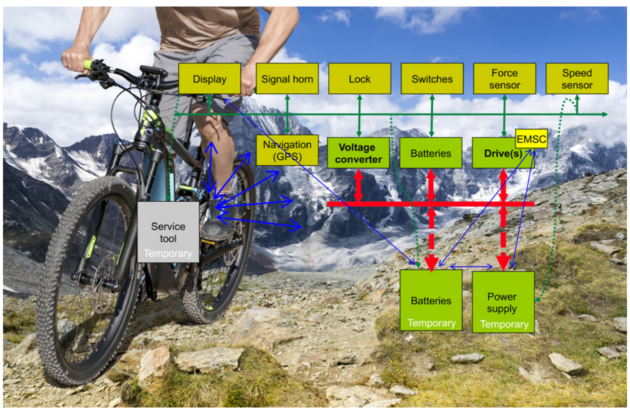


Figure 1: Pedelecs are typically based on CAN and can be modified by the end user (Source: Adobe Stock/CiA)

End-of-line production

Device manufacturers want to download the very same software, to many devices of the very same type. In classic CANopen, this requires a single SDO access to any device that shall get the latest firmware. With the enhanced functionality of the CANopen FD USDO broadcast service, up to 126 devices can be updated, with a single USDO access. For downloading 16-KiB firmware to a single device, the classic SDO would require about 9 300 CAN data frames for transmitting. Taking into account that every segment is confirmed with an 8-byte Classical CAN data frame. The number of exchanged Classical CAN data frames is even doubled. Additionally, the same effort is required for any device that shall be updated. Consequently, the time that is needed for updating the firmware on the devices is increased, proportional to the number of devices that shall be updated.

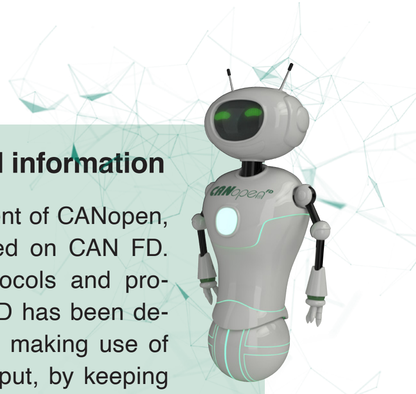
The CANopen FD USDO accelerates this use case significantly. For downloading a 16-KiB firmware to a single device, about 1 200 CAN FD data frames are required. With special regard to the segmented USDO protocol, the number of used frames is also doubled for confirming the reception of every segment. But in contrast to classic SDOs, the USDOs utilize a CAN FD frame for confirmation, which is about half of the size of the Classical CAN data frame, used by the classic SDO. In CANopen FD, the protocols use a CAN FD data field, that has been adapted to the real required payload.

In case such a scenario is executed at a nominal bit rate of 500 kbit/s, by using the CANopen FD segmented USDO protocol without bit rate switching, the firmware update would be handled in less than half of the time, compared to the classic CANopen segmented SDO protocol. But up to now, the real power of the USDO has not been applied. Classic CANopen SDO protocol is only applicable in a unicast session. Therefore, any additional device that requires a new firmware, adds the full time for a single device firmware download to the entire procedure. In CANopen FD, it does just not care how many devices in the network need a firmware update. Even in the worst case that the maximum number of devices (126) need an update of the very same firmware, the time for updating this firmware remains unchanged. Thanks to the USDO broadcast services, the time for updating devices' firmware does not depend on the number of devices, in case the devices are of the same type and need the same firmware. Another booster for this scenario, utilizing the CAN FD bit rate switch, has not been considered, yet, and would reduce the time for this scenario additionally.

System maintenance

The new USDO (broadcast) service saves system maintainers a lot of effort and time. In case system maintainers intend to get familiar with an application; e.g. they like to verify whether the correct devices of the correct origin and configuration are installed, the USDO broadcast services accelerate this task enormously. A big share of this acceleration is achieved by omitting a lot of time-outs; e.g in case some devices have a slow reaction time or are simply not attached to the system. All these time-outs would be experienced in case a classic CANopen SDO would be used. But not only the USDO multicast or broadcast capability is beneficial in this scenario. Also, the fact that in contrast to classic CANopen SDOs, CANopen FD devices can handle multiple USDO transfers in parallel, simplifies and accelerates this task.

Diagnostic tasks are simplified by the extended CANopen FD EMCY write service. A listing of current device errors, is provided in any device. The error information provides details such as the type of error, the chronological order of the errors, or the location of the error within a more complex device. This may reduce the time for diagnostics, removing the errors, and thus down-times of the entire application, as well.



CANopen FD background information

CANopen FD is an advancement of CANopen, a communication system based on CAN FD. It comprises higher-layer protocols and profile specifications. CANopen FD has been developed with special regard to making use of CAN FD's higher data throughput, by keeping the key-attributes of CANopen. CANopen FD offers a high data throughput, advantageous for data demanding cloud applications. Embedded systems that can be modified by the end user during system run-time, benefit from the new USDO that allows a dynamical, simple establishment of cross-communication, in unicast and broadcast. Please find here more technical-related details regarding CANopen FD.

Applications, modified by the end user

An increasing number of applications have the requirement that the end user can change the setup of the application. Especially in energy management applications such kind of requirements are typical. The end user adds or removes batteries, power supplies (chargers), or further types of energy sinks and sources. Depending on the kind of connected devices, a lot of cross communication between the devices need to be established dynamically. Thus, all devices in the system get familiar with the current operation mode and setup of the system, and are enabled to provide their functionality to the application, in a correct and save way.

In principle, these kinds of requirements can be managed in a classic CANopen environment. But typically, comprehensive evaluations are needed such as, how potential network setups could look like and how they could be treated, by means of CANopen, which had been designed for rather static applications in mind. In an CANopen FD based environment, of course evaluations have to be done, but the solutions are much simpler to be realized by the possibilities of the USDO services.
By default, any CANopen FD device attached to the application has the ability to access any other, potentially available, network participant. Therefore, independently which devices are connected, any device can get familiar with the current network setup and learn by accessing all other network participants, which functionality shall be provided to the application. No human interaction is needed anymore, neither by a skilled technician, nor by a CANopen FD expert. With the CANopen FD devices, everything can be treated dynamically, by means of basic CANopen FD communication capabilities. Thus, a lot of resources in system design and maintenance can be saved.

Internet of Things applications

More and more applications need to submit data to web-based applications. This includes e.g. condition monitoring or system maintenance. In these kinds of applications, edge-gateways provide data, generated deeply in the embedded network of the application, to cloud-based applications. One tricky aspect in these applications is that it is not necessarily known at the time of the system design, which kind of embedded data will be needed in the cloud, in future.

CANopen FD USDO services own the ability to establish communication channels to any device in an embedded network, dynamically during system runtime. Thus, any data element in the embedded network level, is available in principle, on demand, just in time. An exhaustive assessment, which kind of data element could be needed now, or will be needed in future, can be omitted. CANopen FD simplifies therefore the integration of embedded networks, into the cloud.

Summary

CANopen FD comes with a lot of interesting features, added to the well-known classic CANopen. They simplify CAN-based embedded networking by keeping the robustness and scalability. CAN FD hardware has been made available in a broad range and also CANopen FD protocol stacks are offered by several companies. Thus, everything is available to start in the next generation of CANopen-based embedded networking. CAN in Automation offers a range of CANopen FD based webinars and explains how to migrate from classic CANopen to CANopen FD. ◀

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