

CANopen application layer for Safelynet p

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In order to provide a common application layer Safelynet p uses CANopen. The CANopen standard describes the exchange of data in a CAN-based network. Since it is not limited to CAN it can be used for Safelynet p. CANopen is standardized in the European standard EN 50325-4 and is looked after by the CiA (CAN in Automation). The core elements of CANopen are the device profiles, which define the uniform functions and standardized parameters and objects for the various applications and devices. With these profiles as a base it is possible to achieve a high degree of uniformity, even among devices from different manufacturers and device classes. Corresponding profiles are available for all common device types found in automation. These are for example:

- ◆ Digital and analogue I/O modules
- ◆ Drives
- ◆ Valve terminals
- ◆ Controllers
- ◆ Rotary encoders

The decision to use CANopen in the Ethernet based automation network Safelynet p was due to its widespread use and the wide range of device profiles. From the user's perspective, with Safelynet p he can fall back on familiar interfaces, while manufacturers are largely able to

OSI	Layer	Internet	File Transfer	E-Mail	Precision Time Protocol	Domain Name System	SafelyNET p RTFN	SafelyNET p RTFL	
7	Application								
6	Presentation	HTTP	FTP	SMTP	PTP	DNS			
5	Session								
4	Transport	TCP			UDP				
3	Network	IP							
2	Data Link	MAC							
1	Physical	PHY							

Fig. 2: Safelynet p in the ISO/OSI reference model

adopt the CANopen implementation on existing devices.

The basic element of a Safelynet p CANopen device is the object dictionary that acts as linking element between the application and the communication system. Essentially the object dictionary is a grouping of objects and specifies standardized communication, device parameters, data and functions that are stored and retrieved by use of objects. For communication of the objects CANopen distinguishes between PDO (process data objects) and SDO (service data objects). Whereas for the cyclical communication of process data PDOs are used and for

the non-cyclical communication of parameterization data the SDOs are applied. For certain devices the CiA has specified profiles that provide a standardized object dictionary. To make these device profiles applicable in Safelynet p it provides a communication stack that is conform to the CiA 301 communication profile. The previous 8-byte limit of CANopen certainly doesn't exist in Safelynet p anymore. This means that a larger amount of data does not have to be transferred segmented. The implemented CANopen services are basically the PDO and the SDO communication, the object dictionary, the network management functions

(NMT) and the emergency object (EMCY). The general object dictionary format matches that of the CiA CANopen specification and can be described using 6 fields/columns.

The EMCY objects are used for transferring error codes like current, voltage or temperature. The error codes use the same codes as specified in CiA 301. For cyclic process data that normally have to be updated in

short cycles in real time, the PDOs are used. Non-cyclical, less time critical data as parameter data for device configuration or diagnostic data are communicated on demand, event driven by use of SDOs. The CANopen application layer is available in Safelynet p comparably for the fast RTFL (real-time frame line) communication cycle times of down to 62,5 µs and a jitter of smaller than 1 µs in a line structure and also for the UDP/IP (user datagram protocol/internet protocol) based variant RTFN (real-time frame network). Safelynet p utilizes a specific publisher/subscriber technology for cyclic data transfer. Each Safelynet p device can publish its data and subscribe to any data provided by other devices. For the communication of the objects Safelynet p offers different data channels.

Index (hex)	Object type (Symbolic name)	Name/description	Data type	Attributes	Category
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Fig. 1: Used object dictionary format

PDOs are mapped to the cyclic data channel (CDC). The non-cyclical SDOs are mapped to the message channel (MSC). The interaction between application and application layer is done by the CANopen typical service primitives: request, indication, response and confirmation. Emergency objects are sent as broadcasts over the MSC. A further CANopen service is Heartbeat. Heartbeats are cyclical send messages from a producer that can be used by a consumer for life sign monitoring. The Safelynet p state machine for the network management is the same as it is known from CANopen, that means it has the four states initialization, pre-operational, operational and stopped. So the adaptation of existing CANopen implementations will be easy.

All CANopen profiles as for example the drive profile CiA 402 and CiA 406 can be used completely with little adaptations. Devices, which have implemented CANopen profiles can be simple transformed to Safelynet p devices. Ex-

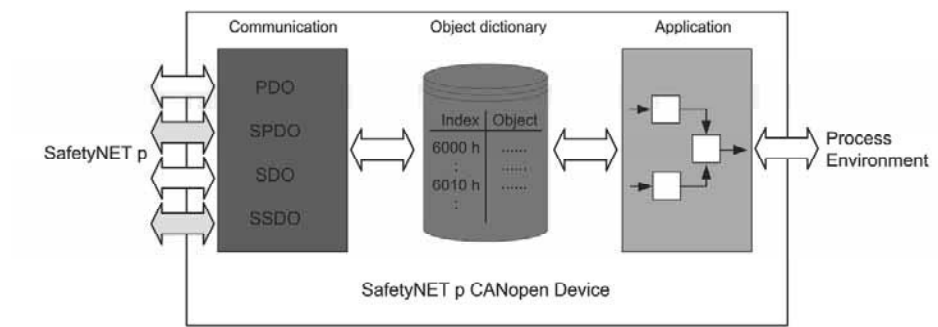


Fig. 3: CANopen in Safelynet p

isting applications are reusable in Safelynet p.

Safe communication

In Safelynet p the CANopen communication mechanisms like PDOs and SDOs are also used for safety relevant data. Therefore SPDOs (safe PDOs) and SSDOs (safe SDOs) have been defined. SSDOs and SPDOs are enhanced by a checksum and additional safety measures to make them usable for safe communication. The safe objects also have to be processed in a redundant fashion. All safe devices have integrated a safe object dictionary. Safe Safelynet p devices can have read and write ac-

cess to the object dictionary. Non-safe devices are allowed to read the safe objects. So the standard system can have uncomplicated access to the failsafe system for example for diagnostics. The application, this means the firmware, of a safe device uses the service primitives safe process data write.request for sending an SPDO and the application layer of Safelynet p indicates the receiving of an SPDO with a safe process data write.indication to the application. The sending and receiving of SSDOs is done in the same way. The sequences are the same as for the non-safe CANopen communication. Consequently the handling of the

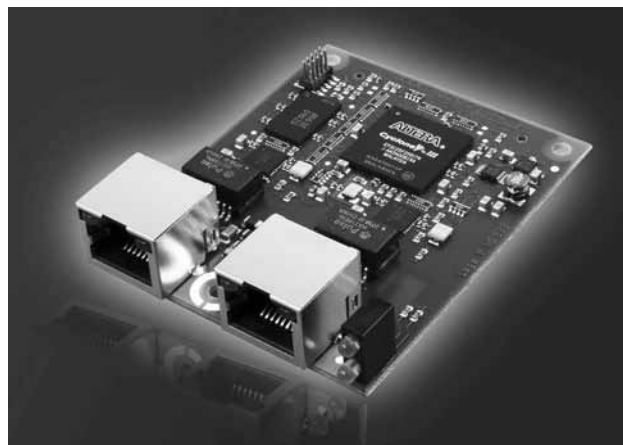
failsafe Safelynet p communication is done in the same way as the standard communication. Per network are up to 512 SPDOs permitted. One SPDO can have 254 safe application objects. Safe application objects are stored in the object dictionary in the range from 8000_h to 9FFF_h.

With the use of the CANopen application layer a widespread and well-known application layer is available for Safelynet p. Users and device manufacturers can use their existing implementations and know how. The change from a CANopen network to an Ethernet based network is simplified.

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Industrial Ethernet module

Ixxat provides an Industrial Ethernet module, which enables to connect devices to networks based on an Industrial Ethernet standard. The device was designed to support various protocol standards and will be offered for Powerlink and Ethercat as well as some other Ethernet-based solutions not supporting the CANopen profiles. In the module the Altera Cyclone III FPGA is used. The device is delivered with a protocol independent host API (application programming interface). The supported evaluation kit includes, besides software and documentation, a carrier board and an adapter board for the connection of various



CPU modules. The company offers also design-in solutions and customized solutions on a project base.

The version 1.04.05 of the Powerlink stack allows for node monitoring on controlled nodes (CNs) via ob-

ject 1016_h. It supports all priority levels on managing nodes (MNs) and all mandatory and many optional objects according to the Powerlink specification DS 1.0.0. Modification of the node-ID via the object dictionary and

switching between MN and CN functionality by changing the node-ID at run-time is possible. A tool for the stack configuration with GUI (graphical user interface) for scaling and generation of the company's Powerlink software is also available.

The stack is prepared for the integration of various Ethernet controllers including hardware support. It is also available as IP core version and will be ported soon for such company's hardware products as Industrial Ethernet module, Powerlink PCI board PL-IB 300/PCI and PL/CANopen gateway. (of)

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