We have really known it all along: there is no such thing as a single communication technology that is suitable for every purpose. Quasi-religious fundamentalism for a certain network is not in the industrial users best interest. Users are always spoilt for choice, even the introduction of Ethernet-based solutions to industrial automation has not changed this fact. By now more than 15 systems compete for users’ grace.

The criteria for choosing one network over another are not only technical ones. Also historical and economical, as well as personal (training, standard of knowledge) reasons play a role in the selection of a bus system or a network. It is therefore not remarkable that most complex machines and plants use more than just one communication technology.

To avoid having to use the diverse bus systems and networks as stand-alone solutions, users connect systems via bridges and gateways. Bridges are devices that translate the lower-layer protocol of a communication system, the higher-layer protocols stay identical. In the human communication this equals translating Latin characters into Chinese characters or vice versa. The language is not translated thereby. This would be done, to stay with the comparison, by a gateway. Gateways translate the higher-layer protocols.

There are many gateways and bridges made by even more manufacturers for a multitude of bus systems. However, it is here as it is in human communication: every translator/interpreter translates details a tiny bit differently. This means, gateways and bridges by one manufacturer may not necessarily be exchanged for those made by another manufacturer. Users, however, demand just this.

Two years ago, ModbusIDA and CAN in Automation (CiA) started standardizing a ModbusTCP/CANopen gateway. The CiA 309 specification has been available for a year and is being improved to correct minor mistakes and to define additional functions. The first part of the specification describes the communication services in the Ethernet-based network, with which the communication services in the sub-layered CANopen network are triggered. Thus it is possible to access any CANopen device via SDO (service data object) from a controller or a software tool from Ethernet and via the gateway.

Several CANopen networks may be connected to a gateway according to the CiA 309 specification. The second part of CiA 309 describes the ModbusTCP protocols that implement the services defined in the first part. The format of the protocols complies to the ModbusTCP rules. It has been developed in co-operation with experts from ModbusTCP. The third part of CiA 309 specifies ASCII protocols that can be used in any Ethernet-based network.

Networks that are based upon the CANopen application layer (e.g. EtherCat and Ethernet-Powerlink) do not need these protocols. For these a bridge specification would enable a direct conversion of the communication services. However, a standardized solution is not available yet. The standardization of a CANopen/ProfinetIO gateway is being discussed with PNO and CiA. This cooperation has just started, results will be available further down the line.

Holger Zeltwanger describes the work being done to standardize CANopen networks.
Some applications, e.g. cranes, require connecting CANopen networks to AS-I bus systems. Somespreaders (a crane add-on device that grabs containers) use AS-Interface for the internal communication, cranes are being standardized with a CANopen interface (CiA 444). Proprietary CANopen/AS-I gateways have existed for a long time, though they are not standardized with regards to their CANopen interface.

Interface profile
CiA members are currently working on an CANopen interface profile, which will not just map the AS-I process data but also make accessible the configuration parameters and diagnosis information of the CANopen object dictionary at specified addresses (16-bit index and 8-bit sub-index).

Gateways according to CiA 446 can serve two AS-I bus systems per logical CANopen device. Since a CANopen device can represent up to eight logical devices, altogether 16 AS-I bus systems are connectable to one gateway. It is interesting that CANopen networks can implement several controllers. Thus several controllers may share an AS-I bus system. While this cuts down on the number of gateways used, it may also do so with sensors and actuators, which can be shared by the networks.

Complex control systems increasingly use several CANopen networks. These are networkable via a standardized bridge (CiA 400) hierarchically and non-hierarchically. The CiA 400 specification even supports meshed network topologies, meaning every CANopen device is able to communicate with any other CANopen device via several gateways and via several network paths. This may be looked at as a CAN Internet. Ga 400 defines a Remote SDO service that enables forwarding an SDO service via one or several bridges with the aid of a unique network identification. Even Emergency messages may be transmitted to CANopen devices in different networks. Requests to the Network Management of another network may be transmitted with the help of the Remote SDO services. This functions is defined in detail in the Ga 302 specification (additional functions of the CANopen application layer).

Process data objects (PDO) – messages that transmit process data in real-time – will just be forwarded by the bridge if it has been specifically configured to do so. For this system variables were defined that are unique in a system with multiple CANopen networks. Bridges according to CiA 400 may implement up to 32 independent and equally ranked CANopen interfaces. The overall system may consist of up to 128 network segments. This should suffice even for very complex systems.

Outlook
Standardization of devices that connect CANopen networks with other bus systems and networks save investments users have made and allow swapping devices by different manufacturers and with different functions with small effort. Up to now, standardization has been mostly initiated by manufacturers of devices. However, also users must articulate their requirements in order that their point of view will be considered during standardization.

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Fig. 3: Remote SDO protocol according to CiA 400.

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