Real-Time Ethernet in Mobile Automation

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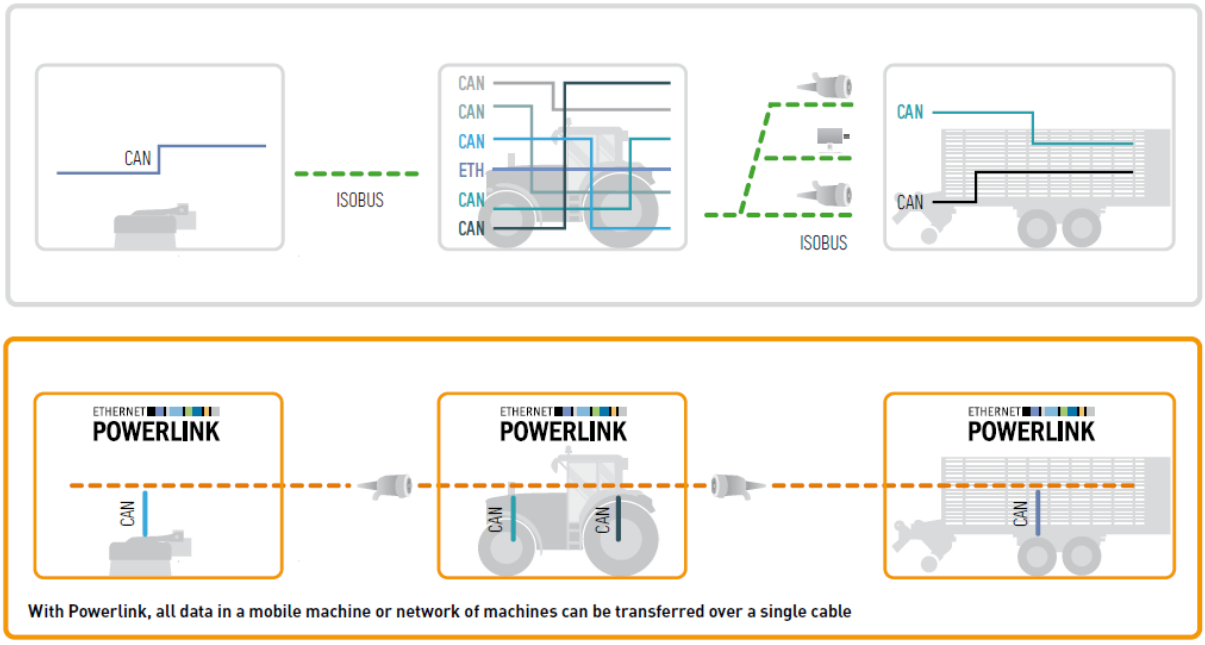
Increasing demands have pushed the bus systems used in mobile machinery to their limits. As a result, Mobile Machine builders are looking for an additional backbone bus next to CAN, that will be able to meet the demands for high performance in future automation solutions.



Demands on a high-speed backbone bus

- Future-proof with economic independence
- Standardized hardware layer
- Readily identifiable working and protocol structure
- Selection of any topology, multi-master capabilities
- High bandwidth
- Hard real-time characteristics
- Functional Safety
- Diagnostics and service

Existing Situation:

The foundation for the automation systems used in today's mobile machinery is undoubtedly the CAN bus. Driven by the automotive industry, this technology was introduced in the 1990s as a backbone bus system and has delivered adequate performance and bandwidth for quite some time. Nevertheless, the demands placed on construction, agricultural and municipal vehicles have risen sharply in recent years. New functionalities are also increasing rapidly, as are the demands for more efficiency and higher expectations regarding the quality of the work processes themselves.

Trying to take all of this into account quickly uses up the available bandwidth of a CAN interface in complex machinery. In the past, it was necessary to generate additional bandwidth by adding more CAN interfaces. This is why current mobile automation systems frequently consist of

several interlinked CAN interfaces and protocols as well as other proprietary interfaces.

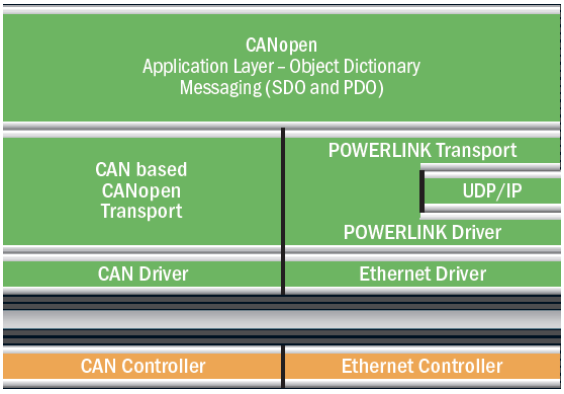
Decentralized software administration costs money

An approach to automation where hardware is distributed decentrally on mobile machinery is definitely economical. Due to the performance of the CAN bus, however, manufacturers are being forced to not only implement decentralized hardware, but the software as well. Frequently, the tools used for programming and maintenance are different, which results in drastically increased expenditures. The industry is therefore on the search for a higher-level backbone bus system in order to make it easier to design automation systems for mobile machinery.

After extensive discussions with many manufacturers of mobile machinery, B&R has compiled the requirements for a new bus system from the agricultural, construction and municipal sectors. B&R is extremely keen to determine the suitability of POWERLINK for use as a high-speed backbone bus in these industries and applications.

POWERLINK – The logical addition to CAN

Many manufacturers prefer a solution based on CAN in order to facilitate a smooth changeover. POWERLINK integrates the full range of CANopen mechanisms and conforms entirely to the IEEE 802.3 Ethernet standard so that all standard Ethernet features – including cross-communication, hot-plugging capabilities and the selection of any network topology – are retained. POWERLINK is a completely patent-free, vendor-independent and purely software-based communication system for hard real-time requirements that is available free of charge as a license-free open-source solution.



[1] Ethernet POWERLINK Facts

The POWERLINK cycle consists of an isochronous and asynchronous phase. In the isochronous phase, data is transferred through a mixture of time slot and polling procedures. In the subsequent asynchronous phase, non-time-critical data packets are transferred in standard Ethernet frames. This includes, for example, service data objects (SDOs) for device configuration and diagnostics, application data such as surveillance camera recordings and even protocols like TCP/IP for configuring or maintaining devices using a web browser.

Future-proof with economic independence

Choosing a bus system is a long-term decision. It's not just the technical facts that must be convincing. The most important thing is guaranteeing availability. In order to ensure a company's economic independence, it is necessary that the technology being used can be shaped as needed in order to respond to future demands on the bus system.

[2] BSD Wikipedia

POWERLINK is the perfect technology for this task. As POWERLINK is distributed under the BSD licensing framework, this protocol is available free of charge as open-source code for masters and slaves without licensing restrictions. In addition, anyone interested in POWERLINK technology has the opportunity to actively help structure its continued development as part of the EPSG. This exceptional degree of openness has allowed POWERLINK to establish itself very quickly in fast-growing markets such as China and India. The specification for the POWERLINK communication profile was even declared a national standard in China in 2011.

Because POWERLINK is a pure software solution, there are different possibilities available to implement the hardware. In the simplest scenario, it is set up on existing hardware with a conventional Ethernet interface. To meet higher jitter and cycle time requirements, manufacturers of controllers or sensors have access to a wide range of hardware components from many different suppliers.

Single twisted pair technology

There is also a changeover from CAN to Ethernet-based protocols taking place in the automotive industry. Work is currently underway on a new hardware layer that enables the transfer of data in the GHz range over a single twisted pair cable. This should make sufficient bandwidth available for the transmission of audio and video data, for example. The advantages of CAN with regard two wiring and connection technology are still maintained. Therefore, it is extremely likely that this technology will not just enter series production over the coming years but will find its way into mobile automation as well. POWERLINK has already been successfully tested on BroadR-Reach single twisted pair technology from Broadcom.

With regard to the bus protocol, however, the demands of the automotive industry and mobile automation diverge. While the automotive industry requires high bandwidth for audio or video data, in mobile automation it's more about the deterministic communication between ECUs, HMI systems, drives and sensors. POWERLINK was developed for exactly these requirements.

Choice of any topology

All Ethernet-based bus systems allow any topology to be selected, although the path to get there may differ quite considerably. For protocols that work with the token ring concept, a logical ring is generated using special switches. POWERLINK is based on polling mechanism, which is why it is possible to generate star connections with standard switches or hubs.

With POWERLINK, all data in a mobile machine or network of machines (mowers, tractors and forage wagons, for example) can be transferred over a single cable. And because of the multi-master capabilities of POWERLINK technology, self-propelled machinery can be controlled

on its own or through the use of a towing vehicle.

Hard real-time characteristics

There is a clear trend towards electrifying individual or groups of assemblies. POWERLINK is the perfect solution for guaranteeing the synchronous control of multiple drives. Because high-performance data transfer is combined with real-time behavior, it's not necessary to specifically program the remote I/O. Since time-critical, closed-loop control processes can run on a central controller when necessary, it is possible to do away with expensive system maintenance that makes use of different tools and software versions while also reducing hardware costs at the same time. As a result, decentralized software is only implemented where it really makes sense to do so.

Functional Safety

As an extremely future-proof open-source solution characterized by its high degree of flexibility, openSAFETY is the perfect safety protocol for mobile automation. This technology makes it possible to implement a safety solution quickly and easily thanks to its pre-certification for applications up to SIL 3 / PL e. A separate safety network is no longer necessary.

POWERLINK is the ideal network for openSAFETY. Using the "black channel" principle, safety applications are completely independent from the rest of the data traffic on the POWERLINK network. openSAFETY can be implemented in systems to ensure that data packets with safety-related data are transmitted securely between safe ECUs. This can take place either inside an excavator or together in a machine network with tractors and other accessory equipment, for example. In this way, it is possible for an electrified drive shaft being controlled on a forage wagon to be safely controlled from the tractor.

Diagnostics and service

As complexity increases, so too does the need for high-performance service and diagnostic tools. POWERLINK offers users numerous advantages, for example by using the single telegram procedure when transferring data.

Unique node addresses and the availability of all data across the entire network guarantees transparent diagnostics in POWERLINK networks, especially it this allows the use any troubleshooting tool that is compatible with Ethernet.

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