Industry Trends

Ethernet in Machine Construction

Part 1: More flexibility in Machine Construction thanks to Industrial Ethernet

Industrial Ethernet – Communication without artificial boundaries

The dream of an intelligent factory is almost as old as industrial engineering itself. The higher the number of employees and workstations working in parallel for the production of a product, the more communication and control is required. What was once defined by a strict working cycle is now done by information channels constituting the nervous system of a company.
Upon closer inspection, production companies today use not just one, but several networks. The development of specialised solutions was driven by different requirements as to speed, robustness and expandability. What works well in an office may only be of limited use under the harsh conditions of an industrial environment, where field busses have become the prevailing communication systems. In the 1980s they brought digital data transmission to production. The processes were optimised for the control of machines, which meant that it was not a high priority to have high data throughput, or simple data transfer between machines over larger distances.
That is why many companies have several networks running in parallel, making it impossible or unprofitable to communicate with each other. This makes cooperation more difficult and results in functional losses. Yet it would be helpful if a die-casting machine were able to report a fault, not just to the staff on site, but also to the production planning systems, material management as well as the manufacturer. A direct connection between the PC of a developer located at headquarters and the control of an assembly line of a subsidiary factory could make updates much faster and more cost-efficient.
Therefore companies are increasingly coming to use a unified protocol to transfer information from A to B. Here Ethernet and TCP/IP, the basis of the Internet and office communication, have become dominant. Ethernet offers a uniform infrastructure which helps information find its right recipient within a building or around the globe. It enables a vertical integration between different applications, thus providing communication without boundaries.

Ethernet in the factory

As factory automation has much higher requirements as to the robustness, reliability and safety of the information networks, Ethernet in the industrial environment looks somewhat different from Ethernet in the office. The most important requirement Industrial Ethernet has to meet is real-time communication, i.e. the assurance that important information will be transferred immediately or within a guaranteed time frame. This is the only way to

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Industry Trends

coordinate complex processes. Common Ethernet allows a unit to block the line for all other participants for as a long as it takes to transmit its data completely. This leads to the typical "freezing" of the network, for instance when someone is sending an e-mail with a volume of several megabytes to many recipients. Two seconds of delay may not be a problem in the office, but in a machine, which has to coordinate 80 work cycles per minute, it would be disastrous.
The second important feature is reliability. Heat, dust and vibration can never be prevented at a workplace. Strong magnetic fields may induce currents in cables that are insufficiently protected. And a cable failure is always possible where many parts are moving. None of these factors may be allowed to jeopardise the work capabilities, and the same applies to the safety from external access. However desirable it is to make communication easy, unauthorised access must be prevented in every case.

Competing solutions

The term of Industrial Ethernet actually covers various different practical solutions to utilise the advantages of Ethernet for the harsh requirements of a factory site. Around a dozen solutions are offered, six of which – systems such as SERCOS III, PROFINET RT or EtherNet/IP, can be seen as the relevant market participants with enough international support and a sufficient number of clients. The differences between the various Industrial Ethernet solutions stem from their individual history as well as the specific requirements and target applications for which they were developed. Some of these approaches can be traced back to old field busses which have been made ready for the open and digital world in several steps.
Thus, although the individual solutions all use TCP/IP as a standardised protocol ensuring the safe transmission of data packets from one device to another, this does not mean that identical connections and control mechanisms are used. There are significant differences, in particular with regard to unrestricted real-time capabilities, transfer rate and network administration.
This results in a dilemma for controls engineers. Currently a unified standard is not in sight and many systems and components of specific manufacturers can be bought only for one single solution. Developers may therefore have to decide between the best Industrial Ethernet concept and the best components available for solving a task, or the engineers may be constrained to create costly gateways between the different protocols.

Open for all applications

Rexroth can offer a way out of this dilemma. Instead of just extending the power of SERCOS III, Rexroth has integrated multiprotocol-capable connections in the components of its “Automation House”. The “Open Connectivity Platform” (OPC) offers not just the classic field busses PROFIBUS and DeviceNet, but

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also the master and slave interfaces for SERCOS III, PROFINET RT and EtherNet/IP. This means that the embedded control platform IndraControl can be integrated directly into the most important system worlds. Multiprotocol-capable interface connections reduce the development effort and simplify the system design.
Furthermore, the IndraDrive drive family has slave interface connections for further Ethernet-based derivatives and field busses. They allow addressing the high-precision servo drives via SERCOS III, Profinet RT, EtherNet/IP and EtherCAT. IndraDrive supports nine communication interfaces in total, fitting seamlessly into the system world preferred by the user, so that developers are no longer forced to decide between network and components - they can simply select the best modules for their application.

Reliability at high speed

Today's field busses and Industrial Ethernet systems offer some basic functions which allow carrying out typical control tasks. As the complexity of the application increases, the requirements for the network increase as well. For instance, real-time applications that require the precise interaction of several electric drives or need fast processing of sensor data depend on a network with a guaranteed high performance. This is exactly the domain of SERCOS III. Thanks to Fast Ethernet with a throughput of 100 megabits per second and possible minimum cycle times of only 31.25 µs (the blink of an eye takes approx. 330,000 µs), the fast transfer of the information is guaranteed. Also, the architecture enables direct communication between the executing units (slaves) so as to keep reaction times down to a minimum. To optimise the network, SERCOS III does not require expensive additional network components, such as switches or hubs. The integrated network functions ensure that TCP/IP packets can also be transmitted next to the real-time data.
The safety is increased by a robust design, a ring structure of the lines against the consequences of a cable break, as well as the secured data transmission via a certified safety protocol. The data is secured by automatic backups, which require no additional hardware.

Note: The subject-related service Ethernet consists of four parts, each of which focuses on a different aspect.

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Industry Trends

Part 1 More flexibility in machine construction through Industrial Ethernet (31.10.2007)
Part 2 Trends and challenges in industrial engineering (19.11.2007)
Part 3 Data traffic with high performance and tested reliability (07.12.2007)
Part 4 How companies can master the conversion safely and systematically (14.12.2007)

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