

# Industry Trends

## Ethernet in Machine Construction

Part 4: How companies can master the conversion safely and systematically

One should love all things old, recommends Theodore Fontane in his book “Der Stechlin”, whereas the new has to be lived. This is generally easier said than done, however, since switching to a new technology involves numerous hurdles. Opportunities, risks and costs have to be weighed up. And there is also an emotional component, as no one ever likes to say goodbye to something which they have got used to.

Companies therefore face a correspondingly difficult choice when it comes to new projects where a decision has to be made as to whether to stick to a service-proven field bus or switch to an innovative Industrial Ethernet solution. On the one hand there are clear arguments in favour of making the switch. Anyone looking for more flexibility in production has to improve intelligence and communication at the field level. This is only possible with fast, high-performance networks which are capable of transcending barriers between different systems. Industrial Ethernet represents the symbiosis of real-time requirements under the often rugged conditions encountered in a factory building and the TCP/IP protocol of the Internet and office systems. On the other hand a lot of plants and machinery do not require the performance offered by Industrial Ethernet. Is it worthwhile making the switch nevertheless?

### Development with suitable judgement

In most cases the answer to the question can only be yes. This is because TCP/IP networks already extend into the control level today, where they are used, for example, for connecting HMI solutions (Human Machine Interface) and for engineering. There they find a media or protocol break which is more or less well bridged. Increasing vertical data consistency is a worthwhile goal because any investment in the infrastructure generally pays off twice over. Firstly, within the framework of the concrete planned project. Secondly, in the form of the critical mass achieved if the same technology is used in different areas. This can be compared to a railway line which allows both freight and passengers to be transported from A to B. The more railway lines there are, the greater the utility for each one because the resultant network and opportunities for changing trains creates advantages that the single line did not have. Users therefore gain additional advantages from a networked infrastructure without having to pay anything extra for it.

Hence machine manufacturers are faced with the question as to which network technology brings the greatest benefit, both in individual cases and in systems,

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## Industry Trends

and the question of whether the capital investment will pay for itself both in the short-term and the long-term. SERCOS is based, for example, on innovations which unite both tried-and-tested solutions and pioneering further developments. The communication system on which it is based operates with complete transparency – and is simple in terms of operation – both for the service-proven SERCOS II and the real-time Ethernet solution SERCOS III. Service-proven mechanisms such as hardware synchronization ensure that the network organizes itself independently, with no additional expert knowledge required for the network technology. In contrast to other Industrial Ethernet solutions the user does not have to invest any additional capital for the network and plan any additional expensive routers and switches for the communication system. This results in a noticeable reduction in hardware and development costs.

“The switch to SERCOS III went without the slightest hitch,” confirms Josef Stehmann at Standard Metallwerke in Werl. The company specializes in pipes with a wide range of profiles made of aluminium, brass or copper, which are precision-made to customer specifications. To this end the company develops its own machines. “In one project we had to ensure that drives were exactly coordinated with one another,” advised Stehmann, “and in analysing all the factors involved, SERCOS proved to be very advantageous. Thanks to better connections and higher data throughputs compared to conventional field buses, the job of evaluating data has become much easier. Remote servicing via the existing company network has also been made much simpler.”

### **Reliability through continuity**

Since its market launch in the early 1990s the SERCOS interface has become established as an open, real-time-compatible interface for Motion Control applications. It allows the high-precision control of drives and the guaranteed transfer of control commands. Over two million SERCOS nodes around the world speak the same language, which greatly simplifies the job of developing control systems.

The third generation of SERCOS also uses standard parameters, ones which were already an interaction of controllers and drives in the earlier versions. The SERCOS drive profile has been standardized in IEC standard 61491 since 1995. With the development of Industrial Ethernet, IEC 61800-7 (Drive profiles and communication) is now gaining in importance. Here, too, the service-proven drive profile which provides the basis for all three SERCOS generations is specified.

The manufacturer-independent semantics provide the continuity required. At the same time, advanced technologies bring pioneering networks to production. SERCOS III uses the TCP/IP protocol in a real-time Ethernet environment. This

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means that all devices communicate using the same protocol, from the planning to the field level. The real-time-based exchange of data between controllers, drives and sensors is guaranteed. SERCOS III also offers minimal cycle times of as low as 31.25 microseconds, so future increases in performance are also no problem.

SERCOS III is based on Fast Ethernet and therefore offers data throughput of 100 MBit per second. Thanks to the full-duplex mode, every node can call on the full range for both target and actual values. A so-called NRT channel makes it possible to send not just real-time data (RT) via the network but non-time-critical non-real-time data (NRT) in parallel. In a SERCOS III network it is therefore possible for a technician to connect his notebook to any SERCOS III port which operates as a gateway and which complies with the Ethernet standard. This connects the user to the company network without any danger of compromising the real-time communication of the plant or machine.

All SERCOS generations are based on the same principle, namely identical profiles, the same telegram structure and secure hardware synchronization. Even if they work with different technologies and speeds they offer the required continuity in the important area of the control system. This is highly valued by users such as JTEKT Corporation in Japan. The company, part of the CNC Group, is a specialist in steering systems and was one of the first suppliers of components to the automotive industry to make power steering affordable for the mass market. This requires considerable know-how and ultra-efficient production. The machines at JTEKT Corporation communicate using SERCOS. "SERCOS has been meeting all our requirements for over 12 years now," says Toshihiro Yonezu at JTEKT Corporation. "This is because the open structure offers full control over the technology. Comprehensive diagnostic options and service-proven functions are essential for our core business of high-performance process solutions for global customers. SERCOS provides the basis for efficient, easy-to-handle and failsafe production systems."

### **A plus for flexibility**

Consistent communication and a high data throughput enable machines to be planned quite differently. Tasks which previously could only be controlled by reliable but inflexible hardware are now handled by flexible machine software which monitors the process with the help of sensors and precisely controls the actuators. This opens up wholly new dimensions for manufacturers of machinery, because it means that automation is no longer a finished process. The more creativity that goes into the control system, the more can be got out of investments which have been installed, and this means retroactively as well. Parts can be combined anew and interconnected intelligently. The better the interaction between hardware and software, the less that has to be invested in

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## Industry Trends

mechanical elements compared to the past, which also puts the question of the costs of switching into perspective.

When it comes to selecting an Industrial Ethernet solution, therefore, users have to take care not to buy into the flexibility of the TCP/IP world only at the cost of other restrictions. There are 25 solutions offering the promise of real-time-compatible Ethernet. However, there are enormous differences in some cases. Some systems may offer real-time functions but with only limited synchronicity, which guarantees that several modules work in the same system cycle. Others are based on a close connection between the control and network functionality, which means that the user is restricted in his choice of automation systems. Others again might be open but demand rigid network planning with numerous control units which make modifications difficult and also make simple standard communication very slow.

Simplicity, robustness and openness are the key features of effective networks. Which is why manufacturer 3S-Smart Software Solutions from Kempten also supports SERCOS. CoDeSys (Controller Development System) programming software is a system of software used for programming high-performance control systems in accordance with IEC Standard 61131-3. "At 3S there were no doubts about implementing SERCOS III in our CoDeSys system," says Manfred Werner of the management board at 3S. "We had already had excellent experience with SERCOS II and the outstanding level of standardization of the drive profile, which made it possible for to operate devices from a range of different manufacturers without the need for complex driver developments or adaptations."

That the investment in SERCOS III is a secure investment for the future is also demonstrated by the inclusion of the real-time Ethernet solution in the binding standards IEC 61784-2 (Digital data communication for measurement and control) and IEC 61158 (Field buses for industrial control systems). They give users and developers the planning certainty they require. And as a general representative body, SERCOS International ensures that the interests of all suppliers and users are protected.

### Preparing for the switch

The path to the Industrial Ethernet should not be confused with switching to a faster field bus. Although it also revolves around the automation of machines by means of control and monitoring, this alone would not justify the expense and effort. Far more than this, it is concerned with using intelligent modules to achieve greater freedom and to be able to react to changes more quickly and flexibly. This only works if communication throughout the entire network is simple and consistent. In combination with the greater range, totally new

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solutions are made possible which would be too complex and expensive in purely mechanical systems or would simply be impossible to solve in functional terms.

In order to secure these advantages long term it is worthwhile entering the new production world now. Ideally with a solution such as SERCOS III, which has fewer entry hurdles and does not restrict the user. And which is also future-proof and includes all key functions at the outset. Requiring little additional network planning and providing the user with support in every aspect of automation and mechanical engineering. Then the new can be lived, even if one continues to love the old.

Note: this Ethernet series has four parts which address different aspects of the technology. (The publication date publication is shown in parentheses).  
The parts that have already been published are available at [www.boschrexroth.de/press](http://www.boschrexroth.de/press)

- Part 1 More flexibility in machine construction through Industrial Ethernet (31.10.2007)
- Part 2 Trends and challenges in industrial automation (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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