From Research to the Global Network

The possibilities offered by PROFIBUS and PROFINET in the age of IoT and Industry 4.0

The past three decades have been an exciting time for fieldbus technology. What began as a research project is today the basis for forward-looking Industry 4.0 concepts. And despite the sophisticated technology from PROFIBUS and PROFINET, the future continues to offer a wealth of exciting tasks – such as the integration of TSN.

Today, users can depend on fieldbus devices to reliably communicate with one another, regardless of the manufacturer. This has not always been the case – 30 years ago, the cost of installation, configuration and operation was enormous. Today's simplicity for the user is no coincidence. In the first stages of the development of PROFIBUS, two courses were set, which from today's perspective were almost visionary. The one was the promotion of a development-related standardization process. The other was that the newly-developed fieldbus should be able to be used by all companies. Even with further developments, the user organization – which is now internationally active – has not deviated from these two principles. However, until the point of practical maturity, numerous detail tasks were on the agenda. In addition to the actual technology, a unique quality assurance system – with interface tests, interoperability tests and certification – is also part of the fieldbus world. In order to take into account the application-specific features, the technical committees developed standardized profiles right from the start. This means that the PROFIdrive application profile meets the special requirements of drive technology in combination with the PROFIBUS and PROFINET communication systems. A little later, the PA devices profile for the process industry followed. In 1999, PROFIsafe was presented at the Hannover Messe. The development of PROFIenergy, the vendor-neutral, energy saving profile – which permits the targeted shutdown and restart of components such as lasers, robots or drives during production breaks – also met with great interest a few years ago. In the meantime, the first applications, among others in the automotive industry, are in operation.

Communication of the Future

Very early, PROFIBUS & PROFINET International (PI) relied on Ethernet-based communication. As early as 2001, the first pilot application with PROFINET was introduced. Shortly thereafter, a certification system was established, and the first PROFINET Competence Centers and test laboratories began operations. In 2004, PROFINET achieved a large-scale breakthrough in the automotive industry. Since then, PI has continued to further develop the open Industrial Ethernet standard.

Through Fast Forwarding, Dynamic Frame Packing and Fragmentation, cycle times of up to 31.25 µs – along with high-precision isochrone mode – is possible. And even before Industry 4.0 was a mainstream topic in the industrial world, the lifecycle management of plants and machines was high on the priority list for the operators. For this reason, PROFINET has integrated appropriate diagnostics mechanisms to support standardized preventive maintenance. PROFINET stands out with its unique range of functions. The device diagnostics PROFIBUS is known for don't just enable fast troubleshooting – for example, in the event of a short circuit or cable break. The integrated network diagnostics also ensures short downtimes for many other incidents and helps to optimize the performance of the network.

Seamless integration of new technologies

Increasingly, issues from the IoT and Industry 4.0 worlds are being brought to PI, driven not by the automation industry, but by information technology or basic Ethernet technology. PI sees it as its very own task to integrate new functions and features into proven PI technologies so that they work seamlessly with existing and proven systems. A current example is the integration of TSN: In Industry 4.0 applications, converged networks are real added value. They are characterized by the fact that the IT systems can easily be connected with the OT side. Data from production can be used in software applications without difficulty – for example, for process optimization. It's also easier to integrate cloud platforms – be it on-site or anywhere in the world. The reporting is simplified with regards to plant or machine performance. Of particular interest is that, through the continued evolution of the Ethernet in IEEE 802.1, future devices with standard Ethernet controllers will be developed that will meet all the robustness and deterministic requirements of industrial automation. However, an important finding of the work so far is that the simple configuration of the TSN network parameters will be decisive for user acceptance. For this reason, PI is primarily pursuing the decentralized configuration model of the IEEE – currently being tested in the testbed at Labs Network Industrie 4.0 e.V., for instance – which can be used to create flexible and powerful plant networks.

Simultaneous continuity and progress

Tasks and technologies are constantly changing, but the principles of PI – standardization and openness – will remain as constants. PI is committed to identifying the most important communication requirements for Industry 4.0 and standardizing them as PI technologies are further developed. The key is: users can continue to depend on the fact that the technology they're already using will last and the transition to new technologies will happen easily.

What you should know about TSN

Karsten Schneider, PI Chairman, gives you the answers!

What can TSN do better than previous Ethernet solutions?

Karsten Schneider: Ethernet TSN essentially extends the existing mechanisms of Ethernet to include “Quality of Service“ (e.g., bandwidth reservation), synchronization, as well as low latency and even bumpless redundancy. In practice, it looks like this: The applications report their communication needs to the network and get the respective requested QoS guaranteed by the network. The respective connections then run in so-called streams, which then enjoy bandwidth protection via resource allocation in the memory of the switches. In principle, each of these streams can be given a real-time capability. Due to the encapsulated streams, it is also possible with TSN that several real-time capable protocols can be operated in parallel in a single network. This is also known as network convergence.

Is TSN sufficient to transition systems into the age of Industry 4.0?

Karsten Schneider: TSN is just one building block on the way to Industry 4.0-capable systems. PI is currently working on using TSN for PROFINET, but TSN has only layer 2 mechanisms – that is, pure data transport. While this helps break down barriers to communication, IT systems do not understand the meaning of individual data from the machine. So, something must be said about the content. With a suitable semantic description, such as that already stored in the PROFINET application profiles, a quality management system without additional configuration knows that the value received is the torque from a screwdriver control unit. Only then can pure data be used profitably. Apart from that, other topics – such as security, safety or OPC UA – have to be considered for Industry 4.0.

What will happen to the previous PROFINET profiles when using TSN?

Karsten Schneider: For years, PI has been working on corresponding profile definitions in which information from devices is described and standardized across manufacturers. With TSN, these profiles can continue to be used, along with the complete PROFINET know-how. The vision for PROFINET applications does not change due to TSN. In addition, PI is now incorporating these profiles into the joint working group with the OPC Foundation to create open information models. These can easily be made available to IT systems via OPC UA. Companion specifications for OPC UA arise here with the usage of PI know-how. This will make it even easier to implement Industry 4.0 applications in the future.

Are there already chips for TSN?

Karsten Schneider: TSN requires a “TSN-capable“ chip. The chips used today cannot usually be upgraded through software on TSN. However, it is foreseeable that, in the future, the standard Ethernet chip will be a TSN-capable chip. Well-known chip manufacturers have already started, or at least announced, the development of chips with TSN mechanisms. Likewise, well-known PROFINET chip manufacturers will develop modules with RT/IRT and TSN, so that the hardware does not have to be changed during the transition to TSN.

What is the time frame for the developments?

Karsten Schneider: You should expect it to take up to ten years until a new technology is really assimilated into practice. This is at least the experience we had with the introduction of PROFIBUS and PROFINET. There may be industries where implementation is faster. But one should not forget that it is not only about the creation of the specification – which should be completed in 2019 – but also about topics such as certification, documentation, training and seminars. These things also require time.