Partnering for Greater Universality

OPC UA forms a universal application interface through its address space, whereas TSN add real-time capabilities to standard Ethernet and enable gigabit data speeds. Thus, it makes sense to combine the two technologies via a publish/subscribe (pub/sub) model, but there are also other possibilities for industrial communications in the context of Industry 4.0. In this interview, Volker Goller, systems applications engineer in the Deterministic Ethernet Technology Group at Analog Devices, provides some background information.

Q: Which Tasks and Functions Are Assumed by OPC UA and Which Ones by TSN in OPC UA TSN Systems?

A: To clarify the role of OPC UA, I'd like to quote Stefan Hoppe, vice president of the OPC Foundation: “OPC UA is not a protocol; it is an information model.” By that, he means that OPC UA is first and foremost an information model. Of course, there is also a protocol for connecting clients and servers, but OPC UA's strength lies in the address space, and this is what makes OPC UA a universal application interface. The flexibility of OPC UA allows existing user interfaces—the profiles of the industrial Ethernet protocols—to be mapped to OPC UA. Hence, now nearly every profile in an industrial Ethernet protocol is either already represented in the OPC UA address space or work is underway to accomplish this. OPC UA has not yet specified these profiles (I/O, drive, safety, etc.), but this will probably change. In the framework of Industry 4.0, OPC UA is being viewed as a lingua franca that holds great promise for the future.

In contrast, TSN is an extension of IEEE-802.1 Ethernet with an entire series of new possibilities aimed at making the Ethernet more deterministic and real-time capable. Because TSN-capable hardware will be expected from numerous manufacturers in the future, it can also be viewed as the democratization of real-time communications. Nearly every protocol could gain real-time capabilities with TSN.

Q: Which Tasks and Functions Could Classic Industrial Ethernet Systems Fulfill in OPC UA TSN Systems Above OPC UA TSN at the Profile Level?

A: To state it clearly once again, TSN does not automatically imply OPC UA. They are two completely independent technologies. OPC UA can play a major role in networking of controllers (controller-to-controller). Pub/sub with TSN is advantageous here; if it can also play a role at the field-level has yet to be proven, because OPC UA isn’t a small stack, at least not if you want to make use of all the advantages.

Q: How Are the User Organizations for Classic Industrial Ethernet Systems Responding to the TSN Challenge?

A: I'd say that all user organizations are responding to the TSN opportunity. TSN promises a greater selection of hardware, especially infrastructure components, as well as a way of achieving higher speeds—that is, 1 Gbps and higher. Ultimately, we will see Profinet® TSN, as well as EtherNet/IP® over TSN and OPC UA Pub/Sub.

Q: Will TSN be Capable of Real-Time with Cycle Times Down to 31.25 µs, and Maybe Even Lower in the Future?

A: To get below a cycle time of 250 µs at 100 Mbps, the established industrial Ethernet protocols are going to have to make significant modifications to standard Ethernet. The IEEE is not well disposed towards nonstandard approaches such as the summation frame protocols on which, for example, EtherCAT® and even Sercos are based. It is not likely that these extensions will be incorporated into the TSN standard.
In response to your question, TSN will reach the limit defined by the IEEE for 250 μs at 100 Mbps—at least as long as true parallel operation with standard TCP/IP applications has to work. For shorter cycle times, the road to 1 Gbps is open.

Q: How Is the Topic of Safety Solved or How Is It Expected to Be Solved by TSN?
A: Safety normally makes use of the black channel principle. Safety is defined above the actual communications protocols. However, reliability of the communications channel is a factor in safety calculations. TSN is not going to become less reliable than today’s systems are.

Q: The OPC UA Protocol Can Also Be Transmitted Via Classic Industrial Ethernet Systems Such As Time Slots or Tunneling. Why Does It Even Need TSN Then?
A: TSN adds deterministic real time to standard Ethernet. In many cases, different protocols coexist in one and the same cable. TSN enables robust parallel existence of real-time and best-effort TCP/IP in one cable.

Q: What Advantages Does TSN Then Even Have Over Classic Industrial Ethernet Systems?
A: TSN is not a new industrial Ethernet protocol. It is a unified extension that adds real-time capabilities to standard Ethernet. The advantages have already been laid out: hardware availability, unified infrastructure, and speed-independent definition.

Q: What Role Do Costs Play Here?
A: Scalable, standardized hardware and infrastructure promise cost reductions and unified know-how.

Q: To What Extent Does the Desire to Implement Data Rates of 1 Gbps and Higher Play a Role?
A: 1 Gbps (and above) is a logical progression of today’s networking. Will it take the place of 100 Mbps? Not everywhere, but 1 Gbps allows for new applications and enables the performance bottlenecks that occur today with data-intensive applications to be overcome.

TSN is not a new Industrial Ethernet protocol, but rather a unified extension that adds real-time capabilities to standard Ethernet.

The interview was conducted by Andreas Knoll, Markt&Technik, Germany. The original German version you could find here.

About the Author
Volker E. Goller is a systems applications engineer with Analog Devices and has over 30 years of experience with a diverse set of industrial application ranging from complex motion control and embedded sensors to time-sensitive networking technology. A software-developer by trade, Volker has developed a wide variety of communication protocols and stacks for wireless and wired applications, while actively engaging in fielding new communications standards through his involvement in industry-leading organizations. He can be reached at volker.goller@analog.com.