OPC UA PubSub over TSN: A high-performance combination for the industrial automation

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Open Platform Communication Unified Architecture (OPC UA) has been a communication standard in the research field for many years and is still considered an important technology and enabler for Industry 4.0 applications. Properties like platform independence, scalability and secure communication are meeting the necessary requirements for ever-growing connectivity in the industry. In this environment of growing connectivity, the integration of systems in the operational technology (OT) into the enterprise systems of information technology (IT) is converging and is enabling entirely new opportunities. The convergence of IT and OT is an indispensable step for Industry 4.0 but creates new challenges for the current industries. In this convergence, the additional real-time requirements of OT systems are essential, and classic IT communication technologies do not meet the requirements. OPC UA and Time Sensitive Networking (TSN) is a promising combination to fulfill the real-time requirements and successfully perform the convergence of IT and OT systems to achieve continuous networking through all levels of the automation pyramid.

The PubSub specification is one of the newest parts of OPC UA and complements the existing Client/Server communication model. A PubSub communication model stands out, especially in flexible and modular networks and in transmitting extensive data from one to an arbitrary number of hosts. The specification defines the Transport Protocol Mappings MQTT, AMQP, UDP and Ethernet. The first two are a broker-based approach and rely on existing PubSub technologies. On the other hand, the network can be configured to send messages without a broker by transmitting UDP messages or directly on layer two Ethernet using MAC addresses to address a destination. Especially the broker-less approach can send traffic with low latency.

However, OPC UA PubSub alone cannot reliably deliver messages with low jitter. Low jitter is essential for industrial applications such as motion control and must be considered in large networks created in an Industry 4.0 environment. A solution to this is TSN. TSN is a set of specifications that defines technical mechanisms for prioritizing traffic. By prioritizing specific traffic in the network over others, time-critical applications are able to fulfill real-time requirements. TSN defines several features for the reliable and precise transmission of network traffic over Ethernet. One of these features is IEEE802.1qbu Preemption. Prioritized messages are tagged and as soon as these messages arrive at a TSN-capable switch, the switch can forward this message sooner by stopping and cutting the current non-prioritized message. This effect

is more noticeable if many non-prioritized and large messages are transmitted, as they would create a bottleneck for the transit devices and block other messages from passing through.

The combination of the technologies OPC UA PubSub and TSN is a promising approach to fulfill the necessary requirements of time-critical OT systems and add the advantages of the data-focused communication of IT systems, thus resulting in a converged industrial network. This new network form allows data transmission based on standardized models of OPC UA, hence allowing secure and reliable communication in a multi-vendor environment from the sensor to the cloud with bounded low latency provided by TSN.

The advantages of OPC UA and TSN, each and in combination are undeniable. They become even more noticeable the larger, more complex and modular an industrial network becomes. However, such complex, multi-vendor and modular networks must be configured in a standardized way to keep the configuration effort in an acceptable and practical range. The topic of configuration will be subject of research in the coming years. Furthermore, the available devices are currently limited in selection, early in development and mainly focused on the switches. For deterministic communication, end devices and the application must be considered. Overall, it can be concluded that the benefits of these technologies have been recognized and that the research in this field and the development of the appropriate devices will continue over the following years.