A central challenge posed by Industrie 4.0 and the Industrial Internet of Things (IIoT) is the secure, standardized exchange of data and information between devices, machines and services across different industries. As early as April 2015, the Reference Architecture Model for Industrie 4.0 (RAMI 4.0) recommended only IEC standard 62541 OPC Unified Architecture (OPC UA) for implementing the communication layer. In November 2016, the Industrie 4.0 Platform published a checklist for classifying and advertising products as Industrie 4.0 “Basic”, “Ready” or “Full”. To comply with the “Industrie 4.0 communication” criterion, even the lowest category requires the product to be addressable over the network via TCP/UDP or IP and to integrate at least the OPC UA information model. As a result, any product being advertised as “Industrie 4.0-enabled” must be OPC UA-capable (either integrated or via a gateway). The checklist also stresses the information modeling property of OPC UA.

**OPC UA is not just protocol – it’s a whole lot more**

When it comes to information modeling is often when many small and medium-sized companies tune out, because they compare OPC UA with other protocols like MQTT and assume that it has limitations. We often hear questions like, “OPC UA can’t communicate directly with the cloud, can it?”

First of all, every equipment and machine manufacturer already provides an implicit information model with data interfaces (via various protocols). Humans have learned to adapt to the computer’s way of ‘thinking’ – documenting what the bits, bytes and hex codes mean. This new world full of devices capable of a service-oriented architecture (SoA) helps humans understand the “things” more quickly and easily, because they offer “services” and describe their underlying meaning. The subject of SoA is nothing new in the world of IT. Now, however, it extends all the way to the “things” themselves. This is where OPC UA comes...
into play, providing the framework for industrial interoperability. Machine and
device manufacturers describe the object-oriented information of their systems
and define the access rights along with integrated security features. Germany’s
BSI (Bundesamt für Sicherheit in der Informationstechnik, or Federal Office for
Information Security) published the results of its security analysis of OPC UA
in April 2016 in highly positive terms. This was because machine builders keep
full control of the data, i.e. they can distribute it in a targeted and controlled
manner, which enables them to participate monetarily in big data applications
and data analytics.

To exchange the data, OPC UA combines two mechanisms to implement various
scenarios:
- A client-server model, in which OPC UA clients use the dedicated services of
the OPC UA server. This peer-to-peer approach provides a secure and con-
firmed exchange of information, but with limitations regarding the number
of connections.
- A publisher-subscriber model where an OPC UA server makes configurable
subsets of information available to any number of subscribers. This kind of
broadcasting mechanism provides an unconfirmed “fire and forget”-style
exchange of information.

OPC UA offers both mechanisms, but the more important benefit is that they
are decoupled from the actual protocol. TCP and HTTPS are available for the
client-server model, while UDP, AMQP and MQTT are available for the
publisher-subscriber model. As a result, the question of “OPC UA or AMQP
or MQTT” doesn’t matter from the OPC Foundation’s perspective. Since the
smallest microcontrollers may not have enough resources to implement full-
fledged OPC UA, the device can offer its data over MQTT or AMQP in an “OPC
UA-compliant” manner, making it easier to integrate it on the other end. After
all, agreeing on an information model and what the data means is the key to
achieving the concepts of Industrie 4.0.

Trend: Information models
OPC UA provides secure transport of data via diverse and expandable protocols.
But who defines the data’s meaning? Other associations like AIM for the auto
ID industry (RFID readers, scanners, etc.), VDMA technical groups for injection
molding machines, robotics or machine vision and 35 other VDMA industries
already define their information in OPC UA servers in the form of so-called OPC
UA companion specifications. For an equipment supplier, meeting this type of
industry standard does not automatically mean they become exchangeable, as
each manufacturer can offer their own special services on top of the standard.
Intelligent devices should definitely be able to support multiple information
models simultaneously – for example, the dedicated functionalities of an
injection molding machine, in addition to the models for energy data or MES
interfaces. To reduce the engineering effort, the importance and availability
of such industry-specific and multi-industry information models will increase
rapidly in the future. OPC UA may not directly increase an industrial device
vendor’s sales, but not supporting the OPC UA standard will definitely decrease
them considerably.

Trend: SoA
Most of the industry-specific information models developed so far are no
longer based on the exchange of bit/byte properties, but rather on SoA
services with complex parameters. An OPC UA client that does not support
any methods for this purpose or complex parameters will be increasingly
hampered in its communication with OPC UA servers. An RFID reader offers
no bits to activate a read/write command, but instead uses methods that can
be read by humans: ReadTag, WriteTag, and KillTag, among others. OPC UA
is ideal for SoA implementation, which is why the German Commission for
Electrical, Electronic & Information Technologies (DKE) lists OPC UA as the
only SoA solution.

Trend: Service-to-Service
OPC UA provides consistent scalability from the sensor to the enterprise IT level,
making a significant impact on the automation pyramid. While this pyramid will
continue to exist for the factory’s organizational structure, OPC UA bypasses
the communication pyramid entirely. The devices can deliver data, either directly
or in parallel, to the PLC, MES, the ERP system or to the cloud level. This is where
suppliers see opportunities for new business models. For example, manufactur-
ers can bill for their barcode or RFID reader on a per scan basis while the data
being read or scanned never leaves the factory.

Trend: Chip-based OPC UA
OPC UA will continue to be integrated into ever-smaller devices and sensors.
Today’s smallest OPC UA software solutions for industry with limited (but read-
able) functionality require just 35 KB of RAM and 240 KB of flash memory. Now
that the first chips with integrated OPC UA have hit the market, OPC UA can
make further in-roads into the world of sensors. As a result, OPC UA applications
are already extending from the core area of automation into other areas like
industrial kitchen appliances.

Summary
OPC UA has already become the de-facto standard for the automation market
and Industrie 4.0. In combination with TSN communication, OPC UA will also
be real-time-capable. This is not to propagate another fieldbus, but to create a
predictable time basis for the exchange of SoA services. Some challenges, such
as the configuration of complex TSN networks, have yet to be resolved. This is
why the OPC Foundation is not actively promoting OPC UA and TSN at this time.
However, OPC UA is covering a growing range of communication scenarios,
which makes it increasingly difficult for suppliers to justify proprietary solutions.
Products will increasingly differentiate themselves based on the features of the
device itself or of external services, not the interface. In the future we will see
rapid growth in the information models of additional industries, as OPC UA is
the preferred platform of the world’s largest ecosystem for interoperability.