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FOUNDATION

The Industrial Interoperablity Standard

OPC UA USERS AND EXPERTS – CONVEYING KNOWLEDGE AND EXPERIENCE

The OPC Foundation publishes a series of interviews with experts, market leaders and think tanks in communication, automation and industrial IT to highlight the benefits and the potential of the OPC UA technology for end users, system integrators, operators in the world of industrial IoT.

OPC SUCCESS-STORY HERE!

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MIELE OPTIMIZES APPLIANCE PRODUCTION WITH OPC UA

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For any further questions please send an email to office@opcfoundation.org and let's stay in touch.

OPC FOUNDATION – REPORT OF THE AMERICAS

In this article about the regional activities of the OPC Foundation in the North American area, read about in-person events and some of the remarkable outcomes from the first half of 2022.

MICHAEL CLARK,
OPC Foundation
Director OPC Foundation North America
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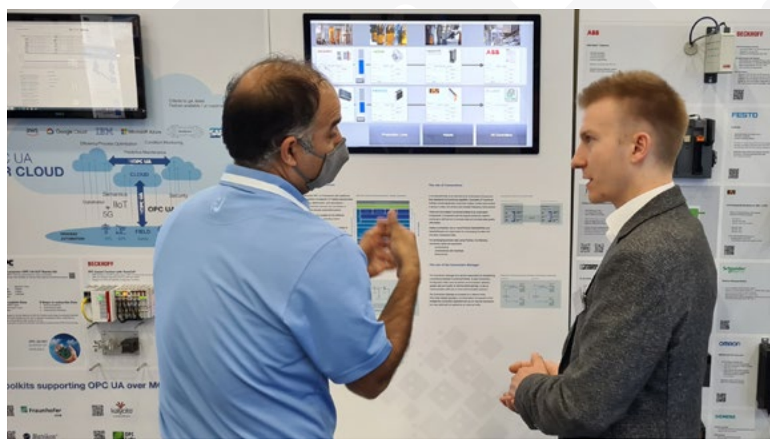
The OPC Foundation has been extremely active at numerous symposia and conferences thus far in 2022, all across North America. This is in dramatic contrast to the COVID years, wherein travel was an impossibility and most everything had transitioned to a two-dimensional, virtual screen. As effective as the virtual domain is, there's nothing that can surpass the value of 3-D, in-person interaction. It has been highly rewarding to reconnect, in person, with past associates but to also make new acquaintances, especially in situations where simply "being within listening distance" has created new opportunities that would otherwise have been impossible within the virtual sphere.

Some highlights of the first half of 2022 include attending an invitation-only event, co-located with both CYMANII and the FBI at their Industry Day in San Antonio, Texas, held in early March. This event proved to be very engaging for attendees as the FBI brought real-world examples of cyber-threats to everyone's attention. OPC UA has a significant role in defending critical-infrastructure through secure data modelling across all industrial sectors. It's rewarding to receive this acknowledgment and participate in further events tailored to these strengths.

Two weeks later, Industry of Things World (USA) was held in San Diego, California where participants were treated to excellent panel discussions from top-tier industry advisors, including Lockheed Martin, Procter & Gamble, and Airbus, just to name a few. Once again, OPC technologies were front and center during these discussions. Please stay tuned for really exciting news resulting from some of these interactions.

Only a week after the San Diego event, OPC Foundation attended the CERIAS Symposium at Purdue University in West Lafayette, Indiana. The Center for Education and Research in Information Assurance and Security was privileged to host experts from a variety of cybersecurity domains, including US Department of Homeland Security's Cybersecurity and Infrastructure Security Agency (CISA), CISCO, Idaho National Labs, Sandia National Labs, and Boeing, among many others. Securing industrial control systems was a prevalent theme, with OPC UA clearly occupying much of the discussion.



The Houston Offshore Technology Conference (OTC), ATX West in Anaheim, California, were expositions that OPC attended. Once again, rubbing shoulders with attendees proved to be far more advantageous than the virtual sphere could ever offer.

OPC Foundation embraced the opportunity to be a Gold Sponsor at this year's ARC Forum in Orlando. This event is normally in February; however, the pandemic pushed it to early June. Several OPC Foundation personnel contributed to this event with a compliment of talent staying for the Open Process Automation Forum, co-located with ARC Forum.

It bears mentioning that the O-PAS™ Specification has integrated OPC UA into the O-PAS Communication Framework (OCF), which serves as the backbone of the control system network, providing communication infrastructure across all nodes, controllers, and advanced computing platforms.

During the same week, OPC Foundation demonstrated the latest in Field Level Communication (FLC) capabilities at Automate, Detroit. At this event, booth visitors were provided with examples of OPC UA Over MQTT capabilities as well as Controller-to-Controller (C2C) demonstrations between physical hardware from myriad vendor sponsors. This demonstration is one that very prominently creates a buzz in industry – never before have controllers, from disparate vendors, been shown to communicate over a flat architecture with no gateways, converters, or translators in the middle. This is a unique testament to the fantastic work that the FLC Initiative, under the auspices of OPC Foundation, has done to further the interoperability standard. This work is now transitioning to standardize Controller-to-Device (C2D) communications in order to fully integrate field devices into the OPC FLC data modelling framework.

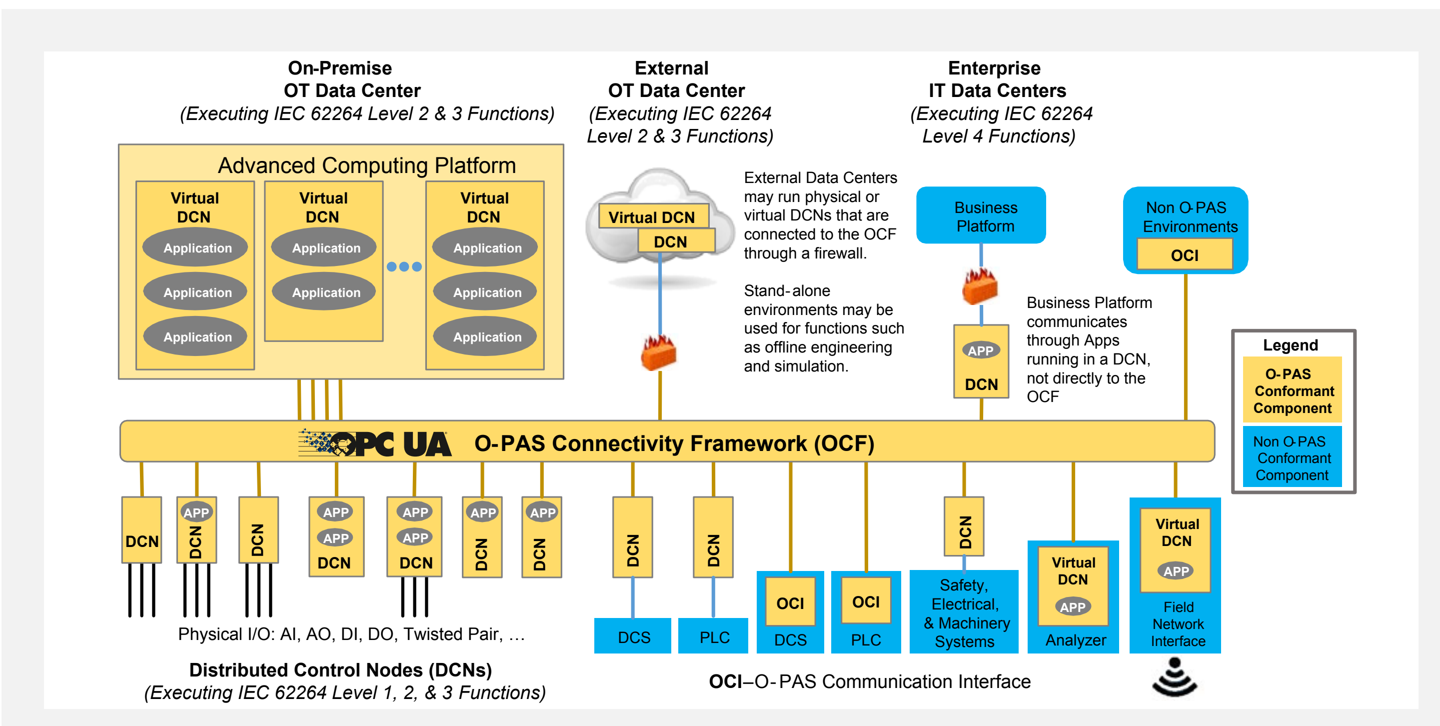
As for the balance of 2022, OPC Foundation North America will be prominent at IMTS and Pack Expo, both in Chicago, where OPC Foundation will, once again, demonstrate OPC UA Over MQTT communications as well as exhibit the Controller-to-Controller (C2C) demonstrations. OPC Foundation will also exhibit at the Industrial Transformation Expo in Leon, Mexico in October.

It's evident that OPC UA technology is playing a pivotal role in secure data exchange from sensor-to-cloud, and the North American market is hungry for more. Please visit the Foundation at any of our events or reach out to us for a one-on-one discussion. We are here to help.

ABOUT THE AUTHOR:
MICHAEL CLARK.

With over 30 years of experience, Michael Clark is internationally recognized in the process automation sector for his expertise in Industrial Control System (ICS) fieldbus protocols. Mr. Clark is also recognized for his contributions to the Open Process Automation Standard (O-PAS™) since its inception. As a vendor-neutral advocate for the end-user community, Mr. Clark became the Founding Director of BusCorp Inc., a Canadian-based consulting firm dedicated to design, implementation, commissioning, and training in the competencies of ICS networks and fieldbus systems. He has supported industrial sectors across the globe including, refining & upgrading, chemicals, food & beverage, gas exploration, off-shore production, water & waste water treatment, power generation, and nuclear remediation. As the Director of OPC Foundation North America, Michael continues his advocacy on behalf of the automation industry as it transforms itself through IT/OT convergence into the digital era.

See first Controller-to-Controller multi-vendor demo including 17 controllers like PLCs, Motion Controllers, Robot Controllers and DCS systems used in Process Industry:
https://youtu.be/Oe63qM5EnuE



Replenishment control with OPC UA. The Business Unit Laundry at Miele drives digitalization forward.

OPC UA

MIELE'S BUSINESS UNIT LAUNDRY OPTIMIZES THE PRODUCTION OF WASHING MACHINES WITH **OPC UA**

6.3 Million
home and commercial appliances were sold by Miele in 2020.

700
domestic appliances and more than 100 commercial appliances from Miele were network-enabled in 2020.

70,000
spare parts are stocked for up to 15 years after a series is discontinued

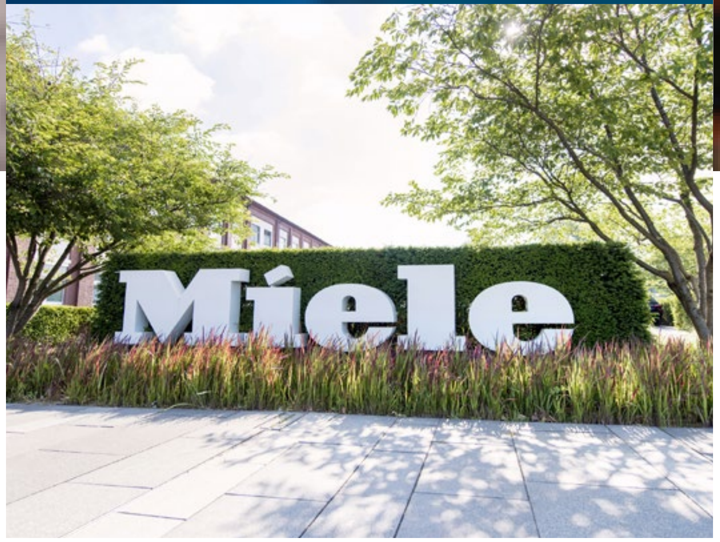
84 %
of supplies to Miele plants are in Europe.

CO_2 NEUTRALITY
Miele has been operating on a CO_2-neutral basis across all its sites since 2021.

5.5 %
of total sales are invested in research and development.

Miele is the world's leading supplier of premium domestic appliances. These include the product segments cooking, baking, steam cooking, refrigeration and freezing, coffee preparation, dishwashing, laundry and floorcare. In addition, there are dishwashers, washing machines and tumble dryers for commercial use, as well as cleaning, disinfection and sterilization equipment for medical facilities and laboratories.

Founded in 1899, the company operates eight production sites in Germany and one plant each in Austria, the Czech Republic, Poland, Romania and China. Sales in the financial year 2020 amounted to around EUR 4.5 billion. Miele is represented in almost 100 countries by its own sales subsidiaries or through importers. The fourth-generation family run company employs around 21,000 people worldwide. The company's headquarters are in Gütersloh, Westphalia, Germany.



BENEFITS **OF OPC UA**

WHY DOES MIELE'S BU LAUNDRY RELY ON PRODUCTION COMMUNICATION WITH OPC UA?
"OPC UA is the communication protocol for Industry 4.0 with cross-manufacturer and cross-platform use. The communication standard is based on a uniform and encryptable data model to ensure secure communication. Required transformers can be integrated into existing systems in an easy manner, without the need of time-consuming programming from the client. OPC UA has the crucial advantage that communication follows a uniform format and is robust and secure with the use of OPC UA interfaces," says Christian Stickling, Information Technology in Appliance, Miele, summarizing the main features.

CAN EXISTING SYSTEMS BE UPGRADED TO OPC UA?
"The uniform interfaces can be used for different systems. This is a great advantage for an existing production. As a result: the time required for adaptations or the integration of devices and systems is significantly reduced. The effort of communication technology in complex 4.0 manufacturing processes is reduced as well. Further advantages are in the use of virtual hardware. The "hardware in the loop" principle already checks processes during the construction and planning phase. Furthermore, a major advantage is that 100 percent of Miele's suppliers now supply OPC UA-compliant products with OPC UA interfaces in machines and controllers."

KEYWORD 'DATA SECURITY'?
"The high security level of OPC UA is a main factor for Miele. Communication with OPC UA works according to the principle "secure by default". All data is encrypted and transmitted securely. Under these security standards, the BU Laundry's assets and production data are transferred to Microsoft's Azure Cloud."

CHRISTIAN STICKLING,
Information Technology in Appliance, Miele,
at the OPC UA Foundation Press Conference in 2018
(SPS Nuremberg).

"In simple terms, the conversion to OPC UA is the modernization of data communication according to the latest findings."

"The development of the washing machines, the production of the components and the final assembly take place almost entirely in-house. The vertical range of manufacture at Miele is enormous. This gives us a firm grip on quality."

MARKUS FRIELINGHAUS,
Miele, Head of Press Shop,
Gütersloh

OPC UA
AT THE PRESS SHOP

MANUFACTURING WASHING MACHINE AGGREGATES WITH OPC UA
In May 2017, the first working group began operations with the objective of reviewing the OPC UA standard. In November 2017, the company officially joined the OPC Foundation. In 2018, Miele decided to rely on OPC UA in the press shop and body shop for the production of washing machines. Sheet steel components are produced at the Gütersloh press shop. In subsequent production steps, these individual parts are assembled into a washing machine unit and washing machine housing in the body shop. This requires welding processes, clinching processes or even bolting processes. In the final assembly, the washing unit, washing machine housing, and other individual parts are combined to form the finished washing machine. The goal of the OPC UA integration was to modernize and simplify data communication in the press shop and in body-in-white production. Since 2018, the utilization of OPC UA for production communication has continuously increased in the BU Laundry. Today, OPC UA standards are also implemented when existing plants are remodeled, wherever possible. New plants are already equipped with OPC UA at the factory. Only in rare exceptional cases can OPC UA not be implemented, for example when purchased equipment is delivered with proprietary systems. In this case, a change would result in a breach of warranty.

Production of approx. 860,000 Washing Machines per Year
Compared to the rest of the industry, Miele achieves a very high level of vertical integration. The company can therefore comprehensively influence the quality of its products and increase product safety. Miele washing machines are tested to last 20 years. For the fourth year in a row, washing machines from Miele are also series winners of the 2021 Stiftung Warentest.

The Gütersloh site was built in 1907 and is now Miele's headquarters as well as the competence center for laundry care. Here, Miele develops and produces washing machines and washer-dryers. Additionally, the company manufactures pressings, cast-iron components and enameled casing sections for other Miele plants, as well as product and process development for Miele's Uničov (Czech Republic) and Ksawerów (Poland) plants. The development and production of electronic components for nearly all Miele appliances also takes place in Gütersloh.

Miele converted communication in the press shop at its main plant in Gütersloh to OPC UA in three weeks.

A TIGHT **SCHEDULE**

CONVERSION TO OPC UA IN JUST THREE WEEKS

The integration of the new communication level could only take place during the three-week plant vacation period, which means that the individual test series had to take place under real conditions of the running press plant in Gütersloh. It was therefore necessary to stay within an extremely tight schedule and coordinate with the press shop. The conversion itself took place during ongoing operations. Within three weeks, the old system had to be dismantled, the new communication levels, including the OPC UA interfaces, had to be integrated, and the upgrade of the existing machinery with adapters had to be completed and tested. The connection of the control station also took place during the company vacation period. The control station ensures optimal control strategies by, for example, linking the status of the systems and machine availability with statistical data and generating analyses from it.

PLAN B FOR EMERGENCIES

Failure would have resulted in immense licensing costs for the previous software, as well as rebuilding and redundancies. There was a plan B, but no going back. "When production started without errors on Monday morning after the plant vacation period, we knew every stage of production had been successfully converted to the OPC UA communication standard. We had good experiences with OPC UA, a concept for the conversion, and were very sure that we could accomplish it in three weeks," explains Christian Stickling in retrospect. "However, being very sure doesn't mean being completely sure. The OPC UA integration was an immense challenge, because a press plant, unlike a laboratory experiment, cannot simply be converted. It was a wonderful moment when everything worked and we achieved improvements with the successful conversion to OPC UA. We now have a simpler and more future-proof operation of production-related communications and achieved monetary savings by not having to purchase licenses for special software. This also results in faster troubleshooting and ensures a smooth operation of the plant."

JAN BRINKJANS,
Miele, Production Engineering
Business Unit Laundry

“Our goal is to use simulation not only for strategic planning analyses, but also in the long term to support operations. To this end, the models are to be initialized with the ‘actual and live state’ of current production. Predictions can then be determined from this state.”

In Miele’s washing machine production – here the belt end test – numerous production scenarios can be tested with the data transmitted via OPC UA in the material flow simulator. The real data from the factory provides the basis for optimising production.

1.PRODUCTION DATA COMMUNICATION

In the first step, the production plan data from SAP was linked to the actual data from the plants. This included, for example, setup times and setup costs, data on plant capacities and work shifts, and material numbers. For this purpose, data format standards were defined and interfaces integrated so that the data could be accessed via OPC UA. Through the use of OPC UA, data can now not only be generated, processed or evaluated, but also transferred to other systems in any form and without additional effort.

2. MATERIAL FLOW SIMULATOR

A material flow simulator uses OPC UA interfaces to retrieve live data from the data sources. Production signals, for example from the press shop, are transferred to the material flow simulator in a matter of seconds. The actual data of the plant status is recorded and visualized in the material flow simulator. The main advantage is that the plants are already mapped in virtual 3D models in the material flow simulator and only need to be enriched with actual data in order to turn the simulation models into digital twins.

OPC EXPERTS INTERVIEWS: OPC UA AND THE PA-DIM SPECIFICATION.

In this interview, Frank Fengler, of ABB, will provide an overview and the rationale behind creating the Process Automation – Device Information Model (PA-DIM) Specification and the role OPC UA plays in this initiative. He will also share insights and the vision of how this specification was developed, what problems it solves, who benefits, and why OPC UA was selected as the base architecture.

BY MICHAEL CLARK

FRANK FENGLER,
ABB Measurement & Analytics
Head of Cyber Security and Connectivity
frank.fengler@de.abb.com

CLARK: Frank, please introduce yourself to our readers by sharing where you are from, what is your role at ABB, and tell us about ABB's involvement with OPC technology and the OPC Foundation.
FENGLER: As you've mentioned, I work for ABB and I am the head of cybersecurity for measurement and analytics. Prior to this, I was the head of device integration and have had a lot of experience with Fieldbus protocols and device integration technologies.
I became involved in OPC technologies at the time of the FDI project launch in 2007. Today, I'm active within the FieldComm Group but also the OPC Foundation in the Field Level Communication (FLC) working group, focusing on information modelling.

CLARK: Let's discuss the main theme of our topic, which is the Process Automation – Device Information Model or PA-DIM. Please give us a brief overview of this specification.
FENGLER: From your question, it's obvious that it's an information model for process automation devices like the name explains. It's designed for pressure, temperature, flow, and level devices as well as valve positioners. For these devices, we have developed an information model with nested and hierarchical description of an asset, or a device, which includes identification, diagnostics information, as well as the process signals and their configuration.

CLARK: Since the information model is a hierarchical description, it means that, if I need a very specific value, I can search for it but it also works the other way around; if I receive a certain value, I can go into the information model, rather quickly, to find out what it stands for, right?
FENGLER: Exactly; and that's the purpose for which we have standardized. It is so you know exactly where to look and how to find the device information we are seeking.

CLARK: So, tell us when the development was started and why?

FENGLER: We started development in 2017, when the FieldComm Group and the OPC Foundation formed a Joint Working Group. One of the first tasks was to analyze what already existed in the market space, including: Industrie 4.0, NAMUR Open Architecture, Semantic Identifier, NAMUR Core Parameter, etc.; all of which were concepts on the market. Then the task for the Joint Working Group was to define a reference model for the integration of process devices into IoT and the Industrie 4.0 framework.

We had a team of highly engaged participants from key process automation vendors, like ABB, Emerson, Siemens, Endress+Hauser, and Yokogawa, all working in close collaboration with end user organizations but, especially, NAMUR. We also included very good OPC experts, who helped us with deeper knowledge concerning OPC UA technology.

CLARK: You just mentioned the FieldComm Group and also NAMUR. Can you give a brief overview of what they both do and their role in industry?

FENGLER: So, both are based in the field of process automation.

NAMUR is an end user organization, concentrating on automation technologies in order to standardize and to formulate requirements from end users. They are mainly driven by chemical and petrochemical industries but are acting worldwide.

The FieldComm Group is also a worldwide organization, active in the area of process automation. They were formed out of the former organizations for the Hart Communication Foundation, the Fieldbus Foundation and the FDI initiative.

CLARK: What problem does PA-DIM solve?

FENGLER: PA-DIM solves a number of problems. Data is often lost in translation within vertical communication between device and cloud. Information does not move through the various communication layers, losing semantic information due to misinterpretation. Also, PA-DIM removes barriers to information access that advances operational effectiveness between process and IT teams. By doing so, the convergence to IT connectivity is one goal wherein PA-DIM provides an information model, which speaks one language plantwide.

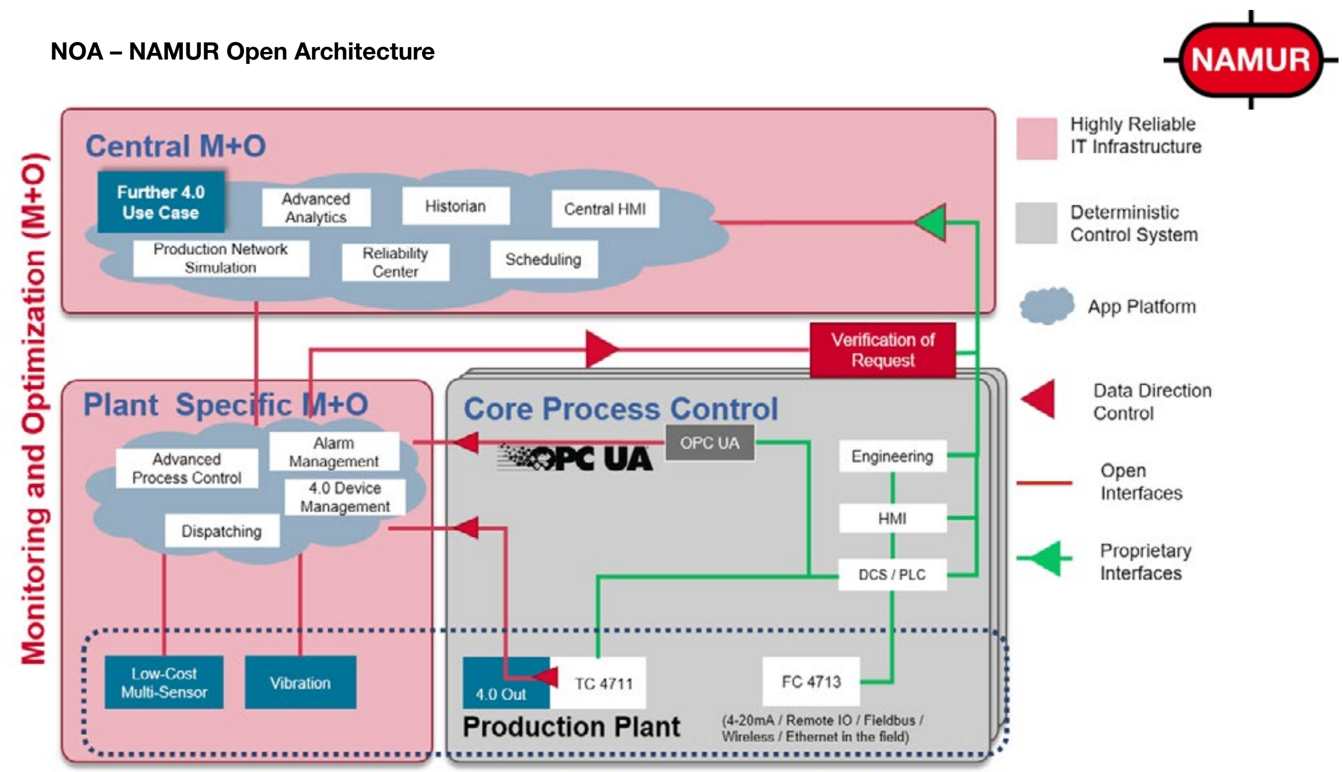
CLARK: So, who will most benefit from the PA-DIM specification?

FENGLER: Of course, the end user… having seamless access to all device data – that is a common problem today wherein end users would like to have more information coming from devices – PA-DIM provides access to this information so that the end users know what information is available and the meaning behind it.

Others who benefit, include:

- Application vendors, those who program applications for various customers, are given the advantage of standardized interfaces.
- Maintenance personnel now have standardized device core parameters, so they know what data exists within devices that support PA-DIM.
- System integrators have reduced integration effort.
- Device suppliers can concentrate on commonly defined semantics so they don't have different semantic meanings across different protocols.

NOA – NAMUR Open Architecture



CLARK: It seems like all parties involved in process automation benefit by the new standard. Can you please describe the solution?

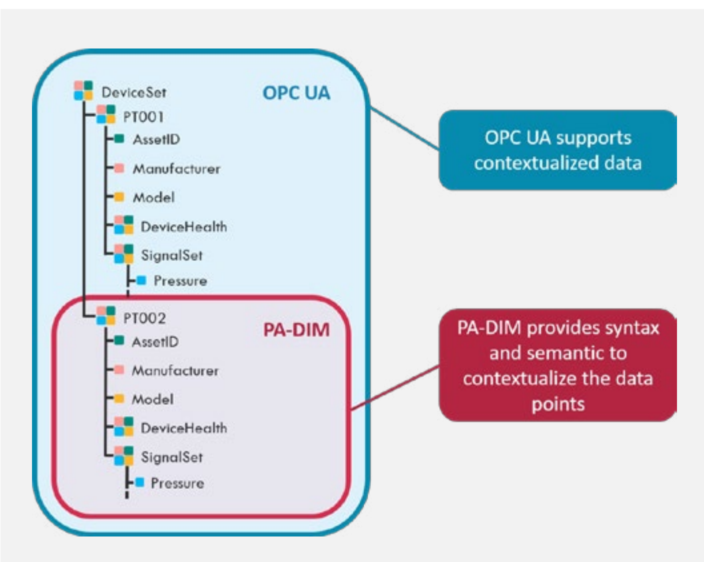
FENGLER: Yes, it's a signal-centric model, which is different from the functional-centric model of the past. Signal-centric means that a device or an asset, has a set of signals and the signals represent a function. For example, process variables from a temperature transmitter may include two Signals, Temperature 1 and Temperature 2, with the transmitter being an Asset. The two signals, including all the accompanying parameters, describe the semantic meaning by using the IEC 61987 Common Data Dictionary.

The Joint Working Group developed the PA-DIM specification based on OPC UA Part 100 for Devices, by reusing what was already defined in Part 100, including the interfaces for identification and diagnostics. Additionally, we invented two new interfaces, one for administration, where you find things like device reset, and one for the signals. These are interfaces which can be reused from other information models. So, in the first release of PA-DIM, the specification fulfils the needs of the NAMUR Open Architecture (NOA) for monitoring and optimization.

CLARK: Can you go into further detail and clarify what you mean by device and asset and signal?

FENGLER: Sure.

So, the device is a globally-unique, physical component, defined by the manufacturer and is identified with the product instance URI, formerly called the Serial Number. This product instance is often stamped on the outside of a device as a QR code. Next, an asset ID is something the user can write. It's an alpha-numeric character sequence uniquely identifying the device within the plant. So, the user is able to provide identification for the device or the asset. Additionally, we need identification for each of the signals, which is called a signal tag. The signal tag is also a user writable alphanumeric character sequence to uniquely identify a measurement or control point.



CLARK: So, why did you select OPC UA as the underlying architecture?

FENGLER: From FieldComm Group's market research of process automation protocols, there was limited reach across automation layers. FieldComm Group discovered that OPC UA is used in IT applications and is the model for process automation devises. It reaches across the IT/OT integration barrier. Additionally, OPC UA's modeling capabilities has integrated security by design.

CLARK: Just to clarify, when you talk about IT, those would be the systems in the control room; and when you talk, in this case, about OT, those are the systems that are actually in the plant, right?

FENGLER: Yes. There is also the broader business management systems, like SAP and others. PA-DIM provides seamless integration with all of them.

CLARK: Let's look at this from the Client side of the model. What would a PA-DIM client need to support?

FENGLER: In general, a client would need to support OPC UA functionality – that would be enough. And as we use new features of OPC UA functionality, like alarms and conditions, or multi state discrete type, or new variable types, those will also need to be supported by an OPC UA Client.

CLARK: How can users know that the PA-DIM specification is actually implemented correctly? Was there some kind of proving?

FENGLER: Yes, one of the tenets of these kinds of standards is that they cannot be released without implementing prototypes. Prototypes of the PA-DIM specification were introduced at the NAMUR General Assembly in 2019.

CLARK: What about future activities? Can you support additional device types and functions and, if so, which ones?

FENGLER: There are additional activities ongoing to develop use cases and requirements for analyzers, as an example. If additional functions or parameters are required, it's important to have a meaningful use case to explain which parameters are needed and why. These use cases should come from the user community and then these use cases or this new functionality can be added.

CLARK: How do you ensure that the information models will not deviate from the basics that have been defined in PA-DIM?

FENGLER: That's a good question. Both the FieldComm Group and the OPC Foundation, the two owners of the PA-DIM specification, are working to organize a joint PA-DIM initiative that includes other relevant organizations, like NAMUR, ZVEI, PNO, ODVA, and ISA 100 to ensure that we all work toward a common goal; that none of these peer organizations feel that they need to do the same thing, but a little bit differently. Therefore, it makes a lot of sense to work together on one harmonized standard.

CLARK: So, brownfield installations, as they're being called, play a big role in industry. How can brownfield plants then benefit from PA-DIM?

FENGLER: Data from existing fieldbus devices, like Wireless HART or PROFIBUS, used today in many plants, can be mapped to PA-DIM. One possibility is to use FDI, Field Device Integration, since it already supports an OPC UA Client/Server architecture for installed devices. In parallel to the PA-DIM specification, FieldComm Group developed the FDI Mapping Specification, which enables existing devices to provide the PA-DIM information model via Edge devices.

CLARK: As we conclude our interview, do you wish to share any final thoughts with our readers?

FENGLER: Yes, so there are a lot of things happening currently, one of which is Ethernet-APL (Advanced Physical Layer), which is an Ethernet-based, two-wire, intrinsically safe network, upon which the PA-DIM information model is transported.

Another activity I would like to mention, that's relevant to the process automation industry, is that we are working on the next generation of field devices. These field devices incorporate OPC UA as the modeling and security layer; OPC UA also provides the information model basis for these instruments. I invite everybody to join and bring your valuable expertise.

ABOUT THE INTERVIEW PARTNER – FRANK FENGLER:

Frank Fengler is the Head of Cyber Security and Connectivity at ABB Measurement & Analytics. He started as Product Manager Application for Pressure Transmitter in 1993. Frank had leading positions within Fieldbus & Tools and has experience with process field devices and automation systems. These systems include communication protocols, such as HART, Profibus, FF, OPC UA, as well as integration technologies, like EDD, FDT/DTM, FDI, PA-DIM and Common Data Dictionaries, like IEC CDD and ECLASS.

See first Controller-to-Controller multi-vendor demo including 17 controllers like PLCs, Motion Controllers, Robot Controllers and DCS systems used in Process Industry:
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OPC EXPERTS INTERVIEWS: OPC UA AND ETHERNET-APL

This interview is with Andreas Hennecke of Pepperl+Fuchs. Andreas will provide an introduction into process plants going digital. He will talk about robust communication and its implications for technicians and he'll introduce the Ethernet-APL Standard and how it relates to OPC UA.

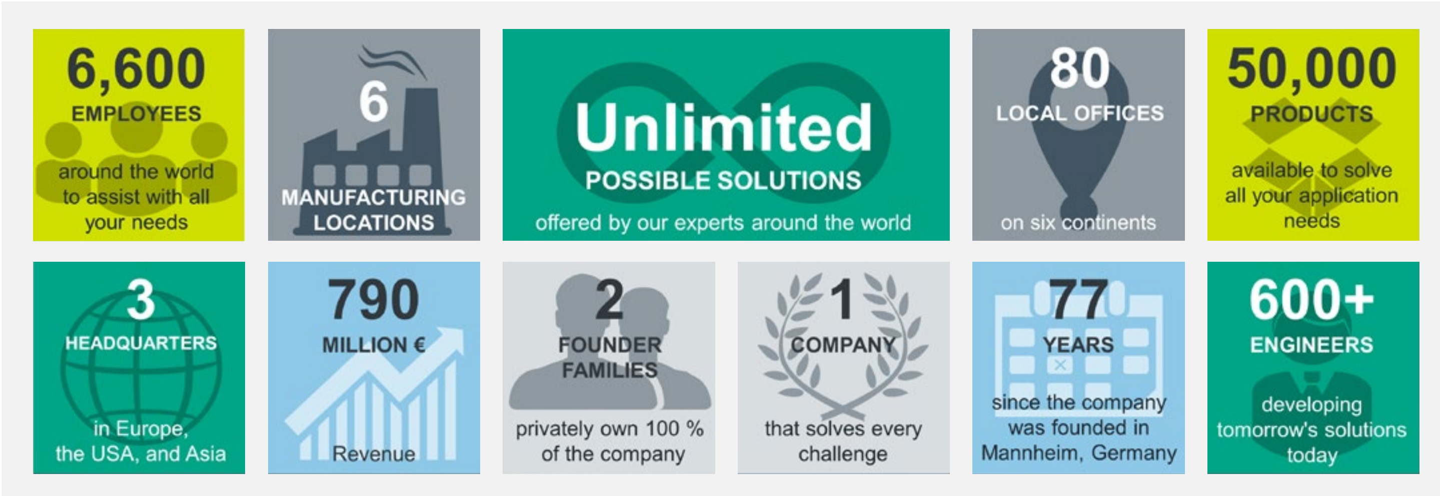
BY MICHAEL CLARK

ANDREAS HENNECKE,
PEPPERL+FUCHS AG
Product Marketing Manager
ahennecke@de.pepperl-fuchs.com

Field Junction Box with Ethernet-APL Switch provides easy access to the instrument wiring.

CLARK: Andreas, please introduce yourself to our readers and tell us a bit about your employer, Pepperl+Fuchs, but also your personal involvement with OPC technology and the OPC Foundation.

HENNECKE: I'm a product marketing manager for digital communications infrastructure at Pepperl+Fuchs. The infrastructure to which I'm referring is for the instrumentation in the field of process plants. Pepperl+Fuchs is one of the major global vendors for the process and factory industries, providing infrastructure and sensors. I've specialized in serving process industries for about 15 years now. The company provides industry solutions for more than three quarters of a century. It is owner operated and specializes in the explosion hazards industry, so we know about these types of challenges. We've been working with almost all of today's major operators of process plants where we provide equipment specializing in explosion protection. To serve our customers, a very large, dedicated group of standards experts help develop and design products that conform to international standards and specifications. This means we're going from cradle to grave, through the entire lifecycle of our own products, making sure that they are always conforming to standards and are thus safe to operate.



Pepperl+Fuchs - One Company, Unlimited Solutions

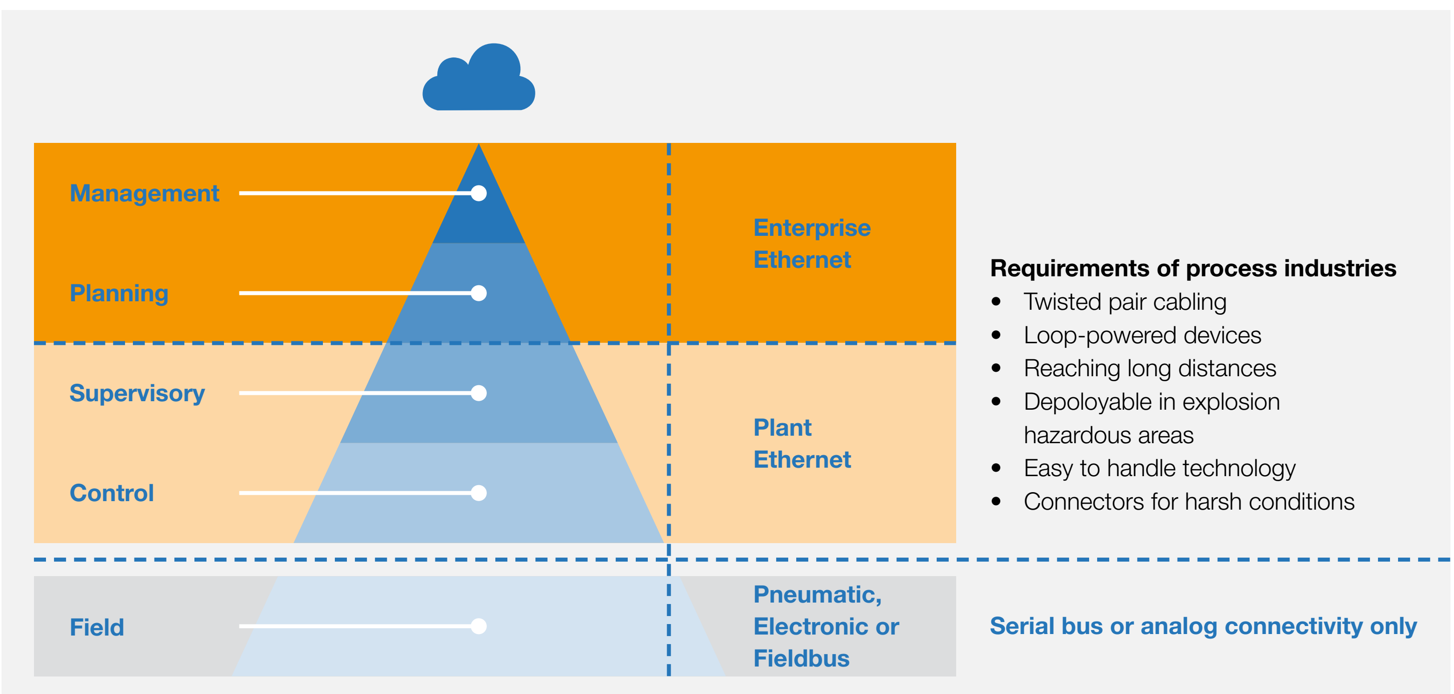
CLARK: So, Andreas, process plants are going digital these days. Can you please share with our readers the challenges in doing so?

HENNECKE: Yes. While the back-office environment has been digital for the longest time – deploying ERP systems that communicate digitally, E-Mail even Voice over IP – digitalization has not, until now, reached the field side of the process plant. The business and production environments in field locations are extremely tough and, thus, have very special needs. Plants are required to be operational 24/7, sometimes spanning large outdoor environments. With 24/7 operations, comes equipment that is robust and provides a long service life, because it's intolerable and impractical to interrupt a running industrial process at any given time. And, let's not forget the potential for explosion hazards, where it's imperative to be safe.

CLARK: You've said that technology must be extremely robust. Can you give us some examples of what robustness means with respect to communications?

HENNECKE: Well, this is pretty much having to do with everything in an outside environment; we're not talking about clean manufacturing floors or warehouses. We're talking about temperatures that range from 50 °C when exploring oil and gas in Arctic climates to extremely high-temperature, humid environments in equatorial zones. Not to mention the possibility of wildlife in these plant environments.

So, what we want to see is that process equipment, and the associated communications to the instruments, are well protected. Notwithstanding the length of cable, communications must be stable, even though we often see requirements for cable lengths of 400 to 600 meters.



The automation pyramid illustrates the barrier for networks in the field of process plants

With consideration to mechanical protection; most of the communication equipment resides in marshalling cabinets or field junction boxes, where wiring is then extended out to the actual instruments, with cable distances ranging from some 10 meters to 100 meters or more.

Maintenance personnel may sometimes want access to instrument communication wiring so it's feasible to design installations where the junction box in the field is easy to access, even when hazardous media might be present; there's different techniques for solving these issues. For example, in many plants, a hot work permit may be necessary when accessing field junction boxes or process instrumentation. These permits are to be signed by supervisory staff, granting approval to journey out into the process areas, where gas detection testing may be required to ensure the safety of both the people in the field as well as the process equipment.

CLARK: So, a very specific, not so easy, hazardous environment. What does all of this mean for the technician?

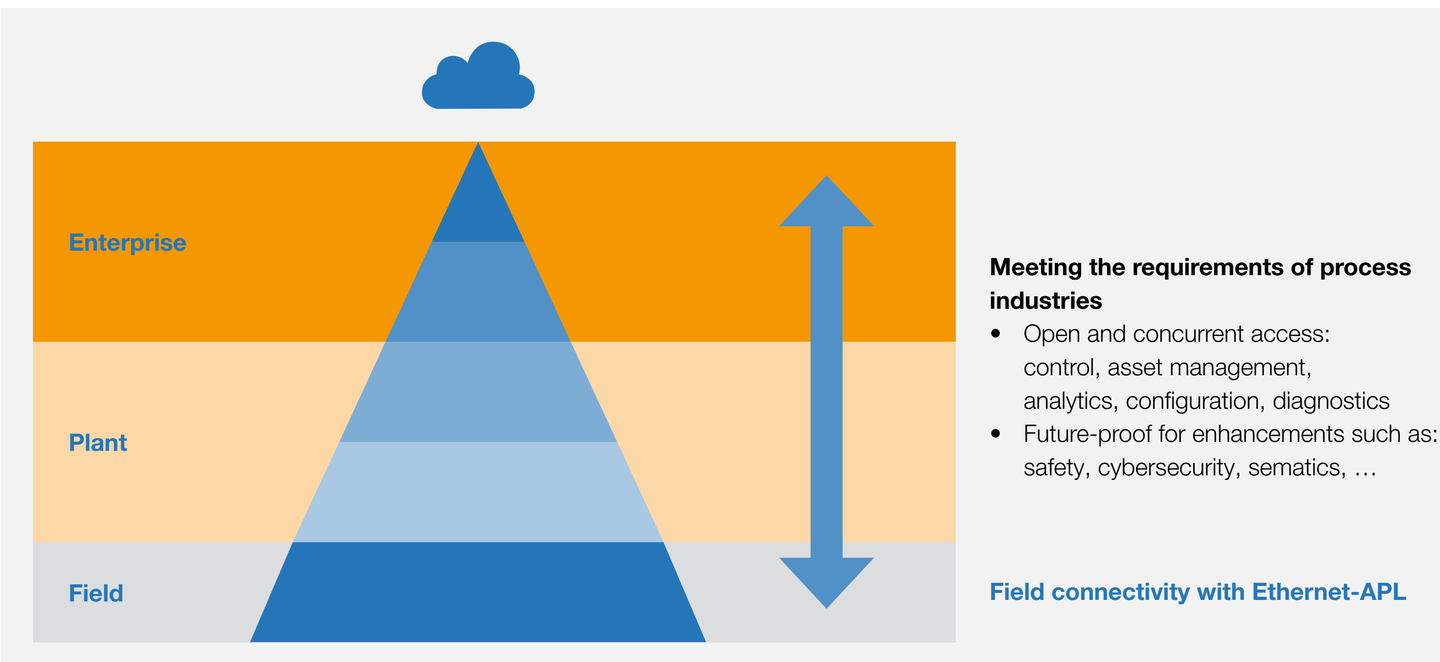
HENNECKE: For technicians that maintain a plant that has a designed lifecycle of 40 years or more, it's conceivable to expect the potential for two or three generations of technology to be deployed in the same plant. So, technicians appreciate conditions better when they can work very easily with the installed equipment and not have too much complexity in the field, with regard to installation techniques. In the late 1950s, we've seen the transition from air pressure control (pneumatics) to electronic sensors, which are still predominant today because these sensors are simple and they work just fine. These automation components and sensors communicate and receive power via a simple two wire cable.

It's really just two wires that power from the instrument, and the load current of the instrument communicates the actual, sensed value back to the system.

Also, consider the fact that this architecture is comprised of point-to-point wiring from the marshalling panels. So, you're looking at long, long cable distances with a lot of copper, where each wire connects to exactly one instrument. So, users today, when receiving values from an instrument, they're getting one value via an analog current that they can measure.

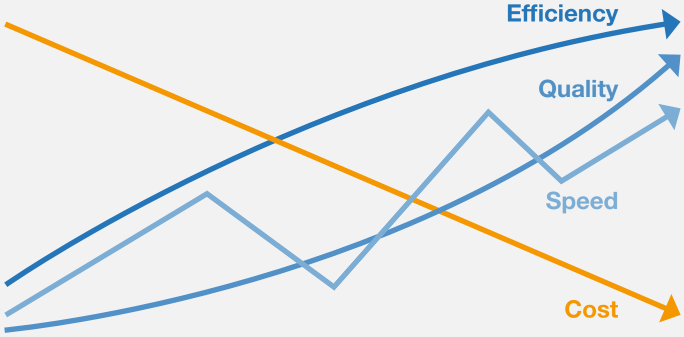
… That's it.
… There's no digital communication.
… There's no Ethernet... nothing.

However, the type of Ethernet that we're launching with Ethernet-APL is a version of Ethernet that meets the demands of simplicity for the field-side of the process plant.



Network Connectivity to the Field with Ethernet-APL

**Enabling you to … Reduce risk … Simplify design … Accelerate deployment …
Reduce total cost of ownship … Increase asset optimization**



The Ethernet Advanced Physical Layer is the enabling technology for the digitalization of the field within process plants.

CLARK: Are you saying that plant operations do not have some kind of network infrastructure in the field? Shouldn't there be some kind of requirement for harnessing the benefits of digital transformation but also running technologies like OPC UA?
HENNECKE: Yes, to both of your questions.
This is exactly what we're missing in the field.
Some users have deployed fieldbus systems, which is basically a bus system that communicates digitally. The infrastructure for fieldbus is also similar to what I described with two-wire communication and actually one of my main areas of responsibility with my employer. This bus is as reliable as the analog technology but, for various reasons, only about 20 percent of the industry have actually adopted fieldbus technology today. So, we're seeing some degree of digital communication, but it certainly isn't networked yet.
In the last 15 years, we've seen some development in the direction of wireless process instrumentation. That too, has its challenges in critical infrastructure, as these devices have to be maintained by changing out batteries on a regular maintenance cycle. This is a contributing factor why wireless has not really been adopted for critical control but, rather, is more likely used in measurement-only applications.
The APL project, on the other hand, has now combined technologies in such a way that we can provide a flat Ethernet network infrastructure that will work across the challenging environments within process facilities. This is what we call the Advanced Physical Layer for Ethernet.

CLARK: Good, so that's how we arrive at our main discussion topic for today. You mentioned Advanced Physical Layer for Ethernet. This may be new to our readers; frequently referred to as Ethernet-APL, please fill us in on more details.
HENNECKE: It took a long while to get here because, I think it's important for our readers to understand, process industries are very conservative in adopting new technologies; they need the assurance of reliability.
They not only balance many requirements and risks relating to protecting humans, they also have responsibilities to the environment and their businesses.
Ethernet-APL really is a combination of two technologies that operators in process industries already know very well:

1. Ethernet, which we know from our office environments
2. And two-wire technology, which we discussed a little bit earlier

Ethernet-APL is the standardization of these two things. The physical layer represents the field communications infrastructure – the physical layer being the lowest layer in the automation architecture – where we specify electrical signals, signaling rates, the wire (or transmission media), the connectors, power supplies, and so on. All of these attributes have been designed, specified, and now released in public standards, assuring that they conform to the rigorous applications within process field locations.
Going further, Ethernet-APL supports network cable distances per segment of up to 1000 meters in length; it is designed and specified in such a way that it allows for myriad topology types. And it specifies point-to-point connections only between switches and instruments for a very high degree of robustness; it has provisions for hazardous area protection, such as intrinsic safety, which specifies a very low level of power on the two-wire network. This means that if you open an intrinsically-safe circuit, the spark that is caused by the disconnect cannot cause an ignition. That is why this technique is called intrinsic safety.

CLARK: Could you share more of the historical beginnings of APL and tell us where we're standing today?
HENNECKE: The team with whom I work at Pepperl+Fuchs had been going to the drawing board as early as 2009, thinking about what could be done differently that would improve installation technologies and usability in the field, where fieldbus had only captured about 20 percent market share. We immediately thought that Ethernet with as an established technology with many convenience functions ready and defined would be the network also for process field locations.
In 2015, there was a big breakthrough for multiple organizations; we discovered that we weren't the only ones looking at this idea. At that

time, there were multiple solutions proposed that demonstrated an Ethernet network in the field.

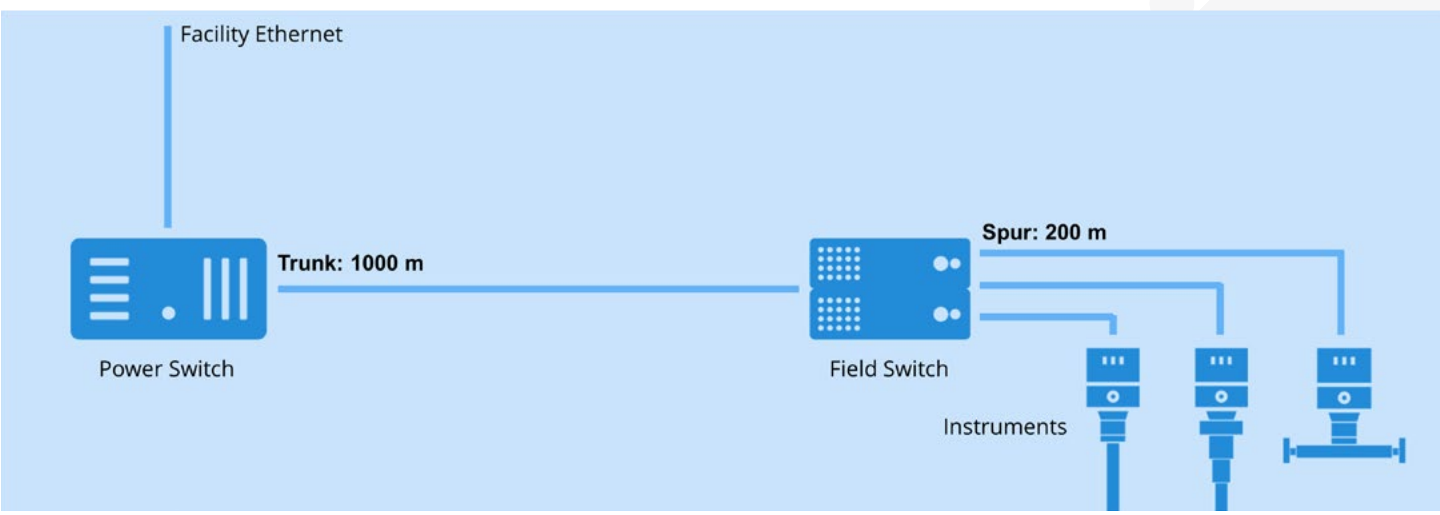
Let me explain why this idea needed careful consideration. When proposing to produce a signal that could transmit 10 megabits or 100 megabits per second (mbps), the higher the speed, the greater necessity for signal strength (or amplitude). Propagating the Ethernet signal through a two-wire network requires a balance between cable length and communication speed. That's how, in 2015, we arrived at a working model that specified 10 megabits per second over a 1000 meter twisted-pair wire.

When looking to compare other solutions, even today, a 100 Mbps, or Gigabit Ethernet, for that matter, is limited to cable lengths of 100 meters. So, after careful calculations and pushing the boundaries of physical limits today, we're getting into the area where 1000 meter cable lengths are plausible.

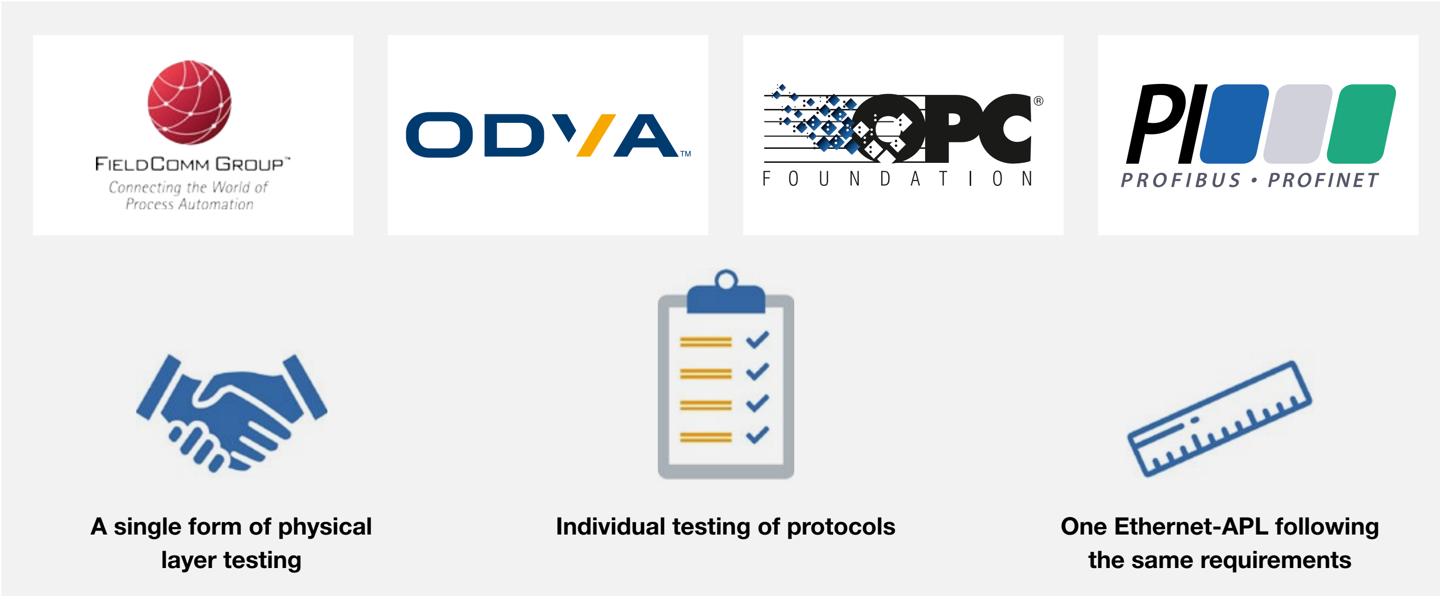
In 2018, 12 suppliers and four user organizations signed on to commonly develop this technology to a single, jointly-developed standardized technology. Completing this development entails much more than just defining the physical layer, but it entails two very important elements for the end users, which is, on the one hand, an engineering guideline that details how to deploy the technology and be successful with it right from the start, and, secondly, to ensure reliability wherein this definition of standards also includes compatibility checking and conformance testing, assuring that all products are tested for compliance to the standard.

In the summer of 2021, we were ready to go and we released these standards in one big celebration at ACHEMA Pulse.

Standards organizations and companies joining and supporting the standardization of Ethernet-APL



Elements of an Ethernet-APL topology



Mutually defined mandatory conformance testing ensures interoperability for vendors and users

CLARK: Please tell our readers what you announced and what you showed at ACHEMA Pulse?

HENNECKE: Sure. We released the standard and all the documentation that goes with it. These standards are now included as chapters of the IEEE 802.3 standard, which is the standard that defines Ethernet as a whole. Additionally, there's an accompanying package of standards that are now part of the IEC standards, which define all the other aspects that I mentioned earlier, such as cables, connectors, and the power supply.

We arrived at this approach so that we could actually have an entire market adopt one common technology; because the members of the APL project realized that, only based on standards, can you achieve a marketplace and a widespread global adoption of a technology.

Consequently, this is where the OPC Foundation got involved.

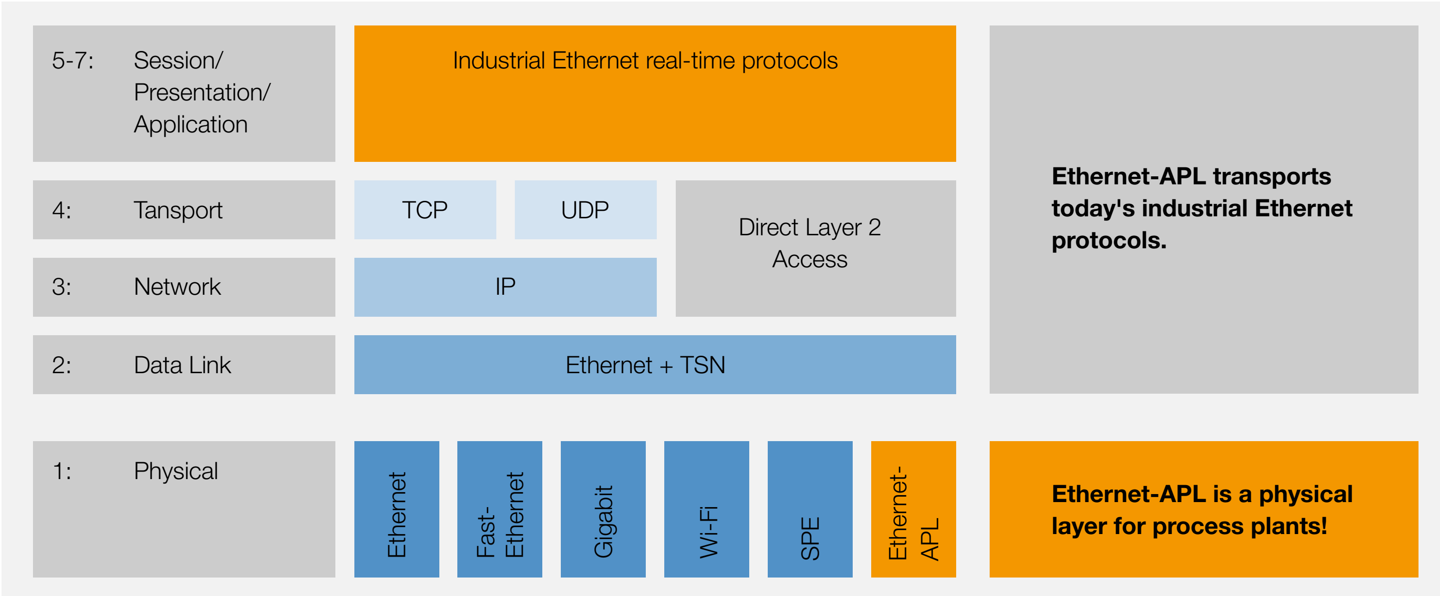
Suddenly, there was a solution that had the potential of changing process field device communication technology that is used for instrumentation, namely, the analog 4 to 20 milliamp technology, to then replace it with a flat network infrastructure that enables concurrent access to the instrumentation.

It's much easier than fieldbus, where you were potentially confined to restrictions due to gateways or proprietary interfaces. Instead, with Ethernet-APL, there can be multiple connections, concurrently, to an instrument. Consequently, an instrument could now be developed with its own embedded server – and that's why OPC Foundation got involved in 2019.

Admittedly, one of the reasons we're probably only just now getting to a point of deploying Ethernet in field locations is because of the improvements in computing power and speed. This has helped a lot along the way. Now users, and even vendors, can get insights into the performance of their assets because of Ethernet in the field.

Parameter	Attribute
Power supply output (Ethernet-APL power switch)	Up to 92 W
Switched network	Yes
Reference cable type	IEC 61158-2, Type A
Maximum trunk length	Up to 1000 m, into Zone 1/Div. 2
Maximum spur length	Up to 200 m, into Zone 0/Div. 1
Speed	10 Mbit/s, full-duplex
Hazardous area protection: Inspired by fieldbus	2-WISE for all zones and divisions. With optional instrinsic safety at the device
Standards	IEE Std. 802.3cg-2019 (10BASE-T1L) IEC TS 60079-47 ED1 (2-WISE)

Technical data and standards for Ethernet-APL

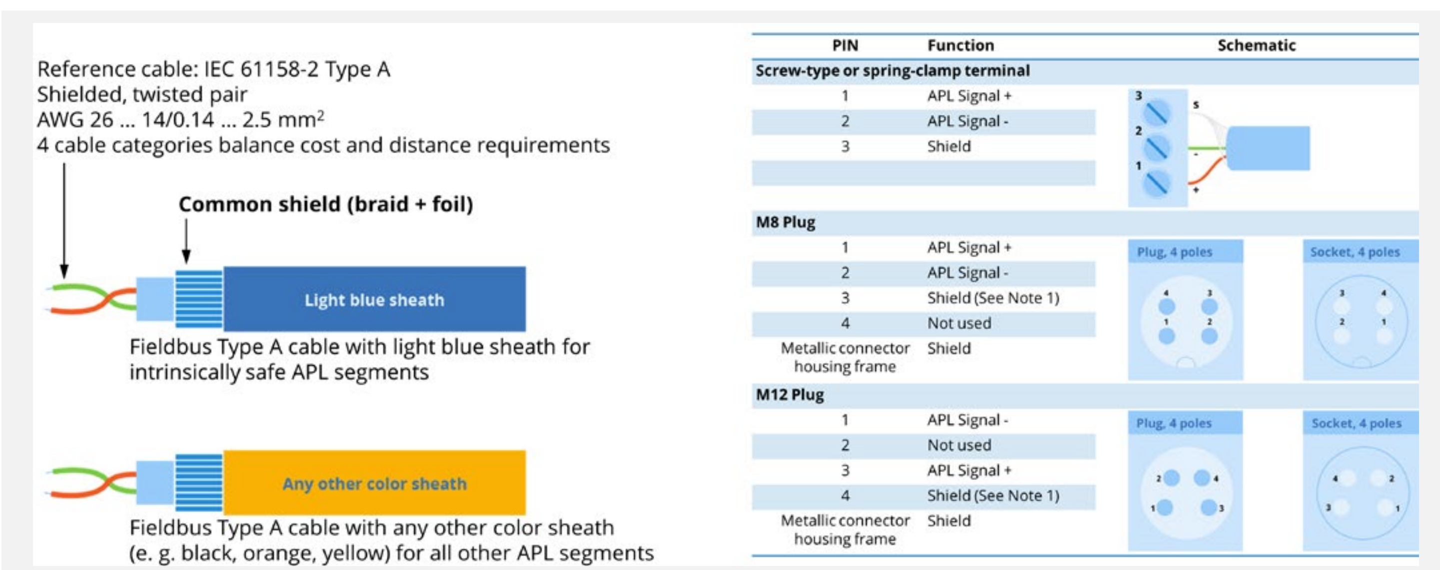


Ethernet-APL shown in the OSI model - The physical layer for the field of process plants and compatible to any industrial protocol

CLARK: So, from your perspective, what do users in the process automation industry get out of Ethernet-APL?

HENNECKE: Well, now that the technology removes the bottleneck of bandwidth, we now have access to all the data of the field instruments, which have become quite sophisticated. They provide device diagnostics and some of these instruments have configuration parameters ranging from 100 to even 600 different parameters that can be configured to optimize the instrument. Additionally, these instruments can do calculations and alarm value detection. So, we're no longer just looking at the process variable. It's clear, then, that we can fill a large data lake with the information that used to be stranded in the instrument.

And Ethernet-APL provides an infrastructure with long-term stability, I mean for decades to come as it is "just" a physical layer. This is essentially possible because Ethernet physical transmission media and data protocol are engineered independently. As a physical layer, any future protocol or function can utilize it. The same network management tools apply, and Ethernet-APL will be compatible with any future enhancements and developments in protocols.



Ethernet-APL shown in the OSI model - The physical layer for the field of process plants and compatible to any industrial protocol

CLARK: You told us earlier about the long service life that instruments and infrastructure provide. Does this mean that Ethernet-APL technology is only available for new installations, or can brownfield installations also profit from Ethernet-APL?

HENNECKE: Those users that deployed fieldbus, probably have the best pathway of deploying Ethernet-APL in their brownfield plants. And that's the first time in history that actually a new technology has not rendered the old equipment worthless; because APL is designed to utilize the Fieldbus Type A cable, which is well known in this industry, particularly by fieldbus users. So, in many cases, this cable can stay in place.

Unfortunately, I can't give a free pass to our readers to simply utilize any type of two-wire cable in the plant. It is required that the installed cables are checked because many of the very old two wire cables do not have proper shielding that would support the frequency range that Ethernet-APL utilizes.

CLARK: As we close our discussion today, are there any final thoughts you'd like to share?

HENNECKE: Ethernet-APL opens so many possibilities for data management. Imagine how applications and systems can now synchronize data between instrumentation and a central database. Solutions, based on OPC technologies, can help users keep all their data up to date. They can automate their working procedures for plant commissioning, startup, operations, and even simplify instrument exchange when performing maintenance.

We hosted a two-day virtual Ethernet-APL workshop in October, 2021, across all time zones and the response was really great. We had hundreds of listeners with very good questions and dialogue. So, we're seeing that Ethernet-APL is generating interest in the marketplace because of its simplicity and I think users in process industries are starting to understand this.

I encourage your readers to get in touch with the vendors that helped standardize Ethernet-APL. Request a demo from them or, maybe, examine Ethernet-APL in your own testbed or pilot. Now is the time to engage with this new and exciting technology that provides an evolutionary path for the installation and definitely opens revolutionary capabilities for the digital transformation in the field of process plants.

ABOUT THE INTERVIEW PARTNER – DIPL.-ING. ANDREAS HENNECKE:

Dipl.-Ing. Andreas Hennecke, MBA is Product Marketing Manager at Pepperl+Fuchs and responsible for digital communications technology in process industries. Prior to his engagement with Pepperl+Fuchs he held positions in development, technical support, engineering and marketing in Germany and abroad. He serves as member of the advisory board of Profibus and Profinet International user organization. Andreas is an ambassador for Ethernet-APL, the physical layer that brings the benefits of open communications to the field of process plants.

Information

Further information can be downloaded from the OPCF's website:
www.opcfoundation.org/flcwww.opcfoundation.org/apl

BRAD BIDDLE,
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OPC EXPERTS INTERVIEWS: OPC LEGAL TOPICS

In this interview with Brad Biddle, Outside General Counsel to the OPC Foundation, we learn about some of the rules behind the development of standards while adhering to antitrust or competition law. Brad expounds on patent licensing, intellectual property rights, the differences between open-source and open standards, and gives guidance on how contributors are best governed during and after these development phases.

BY MICHAEL CLARK

CLARK: Brad Biddle is OPC Foundation Legal Counsel and, as a fun-fact, we've never interviewed a lawyer for our articles before. Brad, can you please explain to engineers and business planners, those who are typically our readership, why they should care about legal issues.

BIDDLE: Sure. Thanks for inviting me.

One thing that I find particularly fascinating about standards is that there are certainly cutting edge and, sometimes, quite complex technical issues; some very complex, high-stakes business strategy issues; but also, all of that becomes intertwined with some fairly complicated and high-stakes legal issues.

For example, antitrust issues, or competition law, can be a very serious consideration for standards developers. Standards are, fundamentally, about promoting cooperation between companies but antitrust law, or competition law, is really focused on policing cooperation between companies. So, there's always some tension there, which is, I think, quite interesting.

There's also, now, some very high-stakes patent licensing questions. There are business models out in the world focused on Standards Essential Patents (SEP) Licensing that can be high-stakes, from a financial point of view. I think there's some intriguing issues there, particularly in the industrial automation world.

Also, open standards and open-source software are two worlds that are related, yet distinct, and increasingly colliding. I think under-standing some of the differences between open standards and open-source software can be helpful for technologists or business strategists who are trying to figure out the right tool to enable interoperability.

CLARK: Please give us a sense of your background and your current role the OPC Foundation.

BIDDLE: My current role is that I serve as Outside General Counsel to OPC Foundation. This is in the context of a small legal practice. Our team focuses on supporting standards development organizations, other tech consortia, open-source software foundations, and the like. So, OPC Foundation is one of several clients we support.

I previously worked at Intel and ran a group there up until about 2014 called the SIGs and Standards Practice Group (SIGs are “special interest groups”). Intel was a fascinating place to learn about standards. Back in the day, Intel led some pretty important industry standards, like USB, Bluetooth, PCI Express, and so they kind of established a playbook for how companies work together to create industry standards.

I also study standards; I have a role at Arizona State University in the US. Notwithstanding that I reside in Portland, Oregon, I am affiliated with Arizona State University School of Law, where I do some research and writing, focused on standards setting.

CLARK: So, you mentioned that antitrust is a hot topic. Can you say more about that?

BIDDLE: Sure, I should just also make a terminology point that, in the US and in some other countries, we call it antitrust law; however, in the EU and a number of other places, it's called competition law. They're really synonyms.

I alluded, earlier, to this very interesting tension between this idea of companies cooperating in connection with standards, contrasted with antitrust or competition law enforcers being quite suspicious about the cooperation between competitors.

This, certainly, isn't a new issue but we see this in our current political environment, where tech companies are facing increased scrutiny about their behavior on a number of different fronts.

I think this tension is as prominent or as concerning as ever; and the lines between what's appropriate in terms of cooperation, and what's inappropriate in terms of potential collusion, aren't always perfectly clear.

CLARK: In certain consortia, where I've had the privilege to assist in the authoring or reviewing of standards, I've always been given a list of rules by which the participants were to govern themselves – rules about what you could and couldn't share amongst the team, and so forth. I'm sure you'll say more on this later but can you share any examples of organizations that have gotten themselves into trouble?

BIDDLE: Certainly, yes, and it does happen; this is not just a theoretical issue.

There are examples in many different countries, although, as a US lawyer, it's easiest for me to pick US examples. There are a couple of examples that went all the way to the US Supreme Court – the highest court in the US.

One example is a case called Allied Tube, wherein that an organization was held liable because they allowed one industry segment to pack a key vote with several hundred additional voters, who had never shown up before within the organization. These voters suddenly showed up to defeat a proposal that was favored by a different industry segment, allowing these parties to misbehave in an unfair way, which created some liability for the organization itself.

There's another example, in a case called Hydrolevel, where a committee chair had falsely declared that a competitor's product was non-compliant, which had significant marketplace impacts for that competitor. Consequently, the standards organization was held liable in that case.

Often when these issues come up, in the context of standards, it's because a party is claiming that their technology is wrongfully excluded from a standard in which the party wants their technology to be included. Historically, the standards development organizations would typically win those cases when they arose, but, back in 2013, there was a case involving ETSI, the European Telecommunications Standards Institute, that I think really rattled the standard development organizations because ETSI was unable to dismiss that case. They were stuck in complex, expensive litigation, and they ultimately settled the case.

We also saw, during the Trump administration here in the US, some unusual cases focused on trying to protect the interests of patent owners. The theory, in those cases, was that if parties were trying to limit what patent owners could charge, it would be deemed as some kind of buyer's cartel, which is a violation of antitrust law; however, I think we're going to see less of that in connection with the Biden Administration and, furthermore, we don't see that same theory arising elsewhere.

CLARK: So, what do standards organizations do to mitigate antitrust risks?

BIDDLE: There's something of a standard playbook for Standards Development Organizations (SDOs). Typically, organizations will have an antitrust policy; hold regular antitrust training sessions; remind participants at the beginning of meetings about what group behavior is appropriate and what's not appropriate; and all of that really should be in the context of a broader and antitrust compliance program.

For participants, this really can be a super-high-stakes issue. There are risks for the SDO, itself, but there's also, in many ways, greater risks for those parties participating in standards development. Their own company could, potentially, be held liable for antitrust violation, which can be very expensive or even bring criminal penalties.

I think it's really key for the participants to understand, at least generally, the kinds of risks they're trying to avoid, like avoiding any perception of illegal collusion; things like price fixing, market allocation, a buyer's cartel, or allowing some dominant player to monopolize the market.

If someone participating in an organization sees anything that even hints at those kinds of issues, it's worth escalating to both their internal counsel and to the organization's counsel.

CLARK: When producing standards, isn't it important to find some sort of middle ground? I mean, OPC Foundation has hundreds of member companies and it's okay to come together to help develop standards but only on the basis of certain rules, right?

BIDDLE: Yes. Clearly there are social benefits associated with standardization, and antitrust enforcers definitely recognize these benefits. So, playing by the rules, and facilitating cooperation, in the context of standard setting, is definitely allowed. Just be aware that there's, potentially, a sort of slippery slope, – from permissible cooperation to impermissible collusion – and it's critical for participants to stay on the right side of that line.

CLARK: So intellectual property rights have come up a few times and you mentioned earlier that patent licensing is a hot topic right now. Can you tell us more about this?

BIDDLE: Sure, it's a complicated topic, so bear with me if it takes a moment to walk through it.

There are other kinds of intellectual property beyond patents: there's copyright, there's trademarks, trade secrets… so, sometimes, even the term intellectual property can be a little confusing. However, focusing specifically on patents, the key idea here, or where the complexity arises, is that implementations of standards are likely to implicate patented technology. That could be because, perhaps, a participant owns a patent on some technology that they intentionally contributed to the standard. Alternatively, it could be the case that participants are collaborating, coming up with ideas, and they inadvertently come up with an idea that actually reads on some patent owned by some participant or by a third party. And we are potentially talking about lots of patents. For example, there's been studies about mobile phones and how they implicate 10s of thousands of patents. So, almost certainly, in any given implementation, the odds of it reading on some patents, somewhere, are fairly high.

Different industry segments have dealt with this in very different ways. Reflecting on the kind of traditional computer hardware space, which I was exposed to back in my Intel days, one way that they dealt with patents was to say that anybody who owns a patent that's relevant for the standard, is going to make it available royalty-free. So, they would simply contribute their patented technology and there's no royalties associated with it. There are some important, historical examples of that model; both USB and Bluetooth are two big instances.

There's another approach that's used, which is sometimes called RAND or FRAND – reasonable and non-discriminatory licensing or fair, reasonable and nondiscriminatory licensing. Remarkably, in the traditional hardware space, there was a kind of phenomenon that appeared to be ostensibly RAND, where, theoretically, someone could have asserted patent royalties, but it almost never happened; PCI Express being an example of that.

Then, we see in other industry segments – generally, in the Internet space – there's been a kind of either explicit or de facto royalty-free environment. So, similar to what we saw in some of the computer hardware stuff, or just where there's ostensibly an opportunity to collect royalties, it turns out that it's very rare.

We see other examples, like in the consumer electronics industry, where they had a very different approach. Looking at the CD and the DVD as an example, where companies in the consumer electronics space would get together and create these little mini-patent-pools, where parties would contribute technology that's patented but they would all decide, upfront, on some maximum royalty rate so that, if you wanted to license the DVD, for example, there's at least a predictable royalty associated with implementing that technology.

Telecom is the world that's quite interesting. Within that model, there has been this RAND or FRAND model but there, in fact, have been many, many patent royalty assertions. So, what we typically see is that companies contribute technology into a standard and then, once that standard is employed, they'll go and collect royalties based on products that implement those standards.

That model seems to have worked reasonably effectively in the telecom world but it's spreading to other spaces. We see some controversies arising. I mean, it's one thing when it's 2% of the price of a $300 old-school mobile handset; but it's altogether another when we see the same patent-owners claiming 2% of the price of a $70,000 automobile. That's a high-stakes dispute over what the appropriate price is for the technology in that context.

I think a key message for us in the industrial automation world that, perhaps, this model – the previous example – which has not been prominent in the industrial automation world yet, may be coming for this sector, just because it is such an attractive business model for patent owners.

CLARK: After sharing a variety of models with us, dealing with intellectual property rights, are there any models that are better than others?

BIDDLE: It's hard to say. I don't think that there's a one-size-fits-all answer. I mean, it does seem like the FRAND model has worked well for the telecom space, but that could be partly due to their unique circumstances. In that space, it's really important to get cutting-edge, technical contributions way up front, before the market is developed and, really, before there's even a product business. Let's say their goal is to make a transition from 4G to 5G, for example. So, at least the theory is – and perhaps it's accurate – that creating incentives that reward innovative contributions with royalties is the right way to get parties to contribute that kind of innovative technology.

But in a lot of other contexts of standards setting, the standards are more like, "do we drive on the right side of the road or on the left side of the road?" It doesn't really matter which we choose; it just matters that everybody is doing the same thing. And, in that context, it's not clear that creating a windfall for the party who just happens to have the patent for driving on the left side of the road would really make sense. If there is a patent associated with driving on the left side, we could just choose to make driving on the right side the standard.

In those cases, it seems that the royalty-bearing model, the FRAND or RAND model, is ambiguous and uncertain as to what an implementer is going to have to pay. There's real cost associated with that, and it's not clear that there's relevant benefits.

So, yeah, I think that we definitely see contexts where we understand that people are going to make innovative contributions without the incentives of SEP royalties. There are plenty of examples where we see that we're getting these "good enough" contributions, without the downside of that risk and uncertainty.

So, I think it's not clear that the FRAND model is really "better", which I think some people argue. I think, in some contexts, "royalty-free" is better; but I really do think, ultimately, the choice is context specific.

CLARK: So, then, which model does the OPC Foundation use? I'm sure our readers would love to hear your answer.

BIDDLE: Yes, because it is a very important, high-stakes question for implementers.

The OPC Foundation is a royalty-free organization! So, participants make a promise to license their SEPs – their Standard Essential Patents – on what we call Royalty-free and Otherwise RAND terms, meaning that it's royalty-free and otherwise reasonable and nondiscriminatory if, and when, a contributor is requested to do so.

Our experience has been that the OPC Foundation gets lots of innovative contributions without the incentive of patent royalties. Then, the way this works pragmatically, implementers just go ahead and implement knowing that if they ever need to get a license, they can get one. Typically, implementers don't go and do formal patent clearance, so they'll just implement the specs knowing that they're available royalty-free.

This royalty-free model is largely consistent with the historical practices within the industrial automation world. Although, interestingly, there are many different industrial automation standard-setting organizations – really, a surprising number to me – compared to other industry segments; and not all of them have explicit, royalty-free policies… and that can create some tricky issues when we're trying to collaborate with other organizations.

CLARK: I wonder if the number of standards bodies has anything to do with the level of development within industrial automation. Perhaps you have more to say about that; but what are some of the tricky issues you talked about?

BIDDLE: On the business question, as to why there are so many standards organizations, it really fascinates me because it's quite different than other industry segments where I've been active. I think it is an interesting legacy of how the industrial automation world has evolved; but it's not always clear to me that there's current benefit in having so many different organizations, and it does create challenges as I mentioned. There are some small and some large organizations and, in this particular space, a lot of the standardization work is done by collaborations between organizations, as opposed to just collaboration between companies themselves.

When considering the companion specs that build upon the OPC UA foundational specifications, there's good reason for cooperating with these different organizations because they're often domain-experts in their particular area.

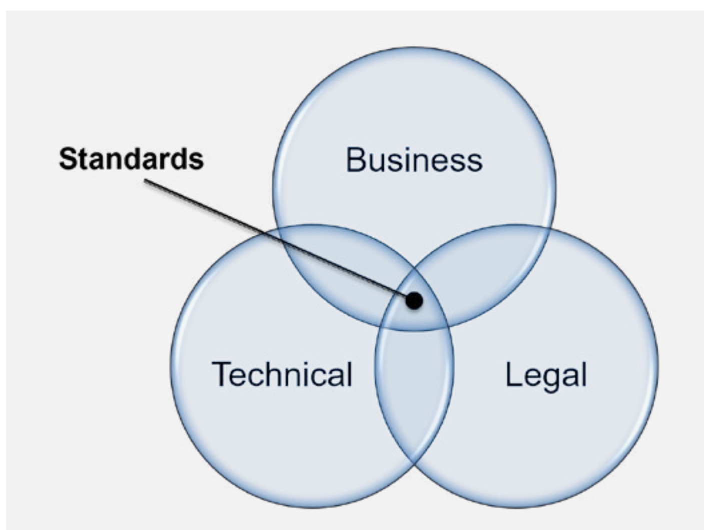
The tricky issue is that, sometimes, these organizations have incompatible IPR policies. So, as you recall from what I said a moment ago, the OPC Foundation's IPR rules state that everybody promises to license royalty-free; however, somebody else's policy might state that everybody promises to license only other members or only on FRAND terms.

The tricky thing for an implementer is that they are then left to ask: "Oh, if I'm picking up some technology that has some contributions that came in under the OPC terms, and some contributions that came in under some other organizations terms, what are my rights? Do I get this royalty-free? Do I owe somebody a royalty?" So, there's some high-stakes risks for the implementer.

What we've done to address this in the OPC context – which, by the way, I like to think that just as we see amazing technical innovations happening in the OPC context, we, likewise, try to bring some innovative legal solutions – we have created something called the MOCA, the Multi-organization Collaboration Agreement. This is an IPR framework that is designed to address this complexity by bringing all of our contributions under the OPC royalty-free terms; to make sure that all of the contributors, whether they're OPC members or not OPC members, abide by or are bound by those terms.

The goal, fundamentally, is to give implementers clarity, that if they implement an OPC foundation spec, including companion specs that we've done collaboratively with other organizations, that they will be able to get a royalty-free license and fundamentally create a royalty-free ecosystem.

We want all of the parties, who are benefiting from the implementation of the spec, to be obligated to grant royalty-free licenses to any patents they have or read on that spec to ultimately enable this royalty-free ecosystem.



CLARK: It sounds like you've found a solution to the tricky issues. I say that there's nothing wrong with you being proud, having brought in a creative legal solution. This means, in the end, for those parties involved, that they're going to achieve a royalty-free ecosystem.

You talked about open standards and open-source code. They play different roles. Can you talk about that a little more?

BIDDLE: Sure, and this is conceptually related to the IPR questions but there's a different set of issues here. Also, the patent questions are considerably so high-stakes, from a financial point of view, that this question about open standards or open-source, is, to me, more of a strategic question as to how best to facilitate interoperability.

By the way, what I think is so interesting about this world in which we live – the industrial automation, or more broadly, the information technology world – is that interoperability between products and services made by different parties is so fundamental to how technology works. Achieving interoperability is not easy, and it's a small miracle when we see that products from different parties can actually work together. So, open standards are an incredibly important tool for enabling interoperability.

Open-source code can also be an important tool for enabling interoperability – it's just kind of different. We see that a standard could be implemented any number of different ways: it could be implemented in hardware and software, or in some combination of that, or in Python or Java; whereas, open-source software is a particular implementation, in particular code, licensed under a particular open-source license. The open-source code can be very effective at enabling interoperability but it's often just for a moment in time. I say this because open-source software licenses all have this feature that anyone can change the code – it's baked into the whole definition of open-source. That's a freedom associated with open-source code.

But standards aren't designed to fork; they're designed to live in a way that is not easily changed, even though, sometimes, it's a long slog to get agreement between different parties. The standard needs to abide the complex governance processes controlled by the standard setting organization to manage changes, as opposed to giving everyone the freedoms to just go off and make their own version.

And so, for long term ecosystem interoperability, open standards are really important. We want everybody to be able to participate and we want to have something that can serve as a foundation for long term interoperability.

Open-source code can be complementary to standards. OPC Foundation does a lot of this, where they use code in a complementary way to help support our standards. For example, we can create reference implementations where we identify the specification and then provide one way – a sample solution – to implement that portion of the specification in open-source code. And when we do things like that, it can make it much easier, and faster, to speed up the adoption of those standards. Fundamentally, I think this practice builds on the open standard as opposed to replacing the open standard with open-source code.

ABOUT THE INTERVIEW PARTNER – BRAD BIDDLE:

Brad Biddle is the founder of Biddle Law PC, a legal practice focused on facilitating interoperability in technology ecosystems. He serves as outside general counsel for various leading global standards-setting organizations and other technology consortia. Brad formerly was Standards Counsel for Intel Corporation. Brad is also currently a Faculty Fellow with Arizona State's Center for Law, Science and Innovation and a Visiting Scholar at Lewis and Clark Law School. His research focuses on standards development methodologies.

OPC EXPERTS INTERVIEWS: OPC UA AND ARTIFICIAL INTELLIGENCE.

In this interview, Peter Seeberg, of asimovero.AI, will describe the correlation between Artificial Intelligence (AI), Machine Learning (ML), and Algorithms and balance the benefits, and even potential threats, posed by AI. Peter further explains how the information modelling of OPC UA is an accelerator to launching industrial applications of AI.

PETER SEEBERG,
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BY STEFAN HOPPE

HOPPE: Peter, please introduce yourself to our readers by sharing who you are and what you do. Also, tell us how you came to work with artificial intelligence.

SEEBERG: I'm happy to do so, Stefan. My name is Peter Seeberg. I was born in the Netherlands, and studied Computer Aided Design in Delft. I've worked 25 years in IT. My main stop was Intel in Europe, based in the Munich area and then almost 10 years of industrial automation. That was with Softing, where one very important activity that I was in charge of was introducing OPC UA.

For the last four years, I've been an AI consultant and moderator. I still live in the Munich area; I write books on AI, co-produce a number of podcasts – one of which I'm very happy and very proud to be doing for the OPC Foundation – but also a German language podcast on AI in industry.

HOPPE: Can you please define artificial intelligence and give us a little bit of history? How long has it existed and, frankly, does a real definition even exist?

SEEBERG: Very good questions.

So, the term artificial intelligence, or AI, was really first used in the 1950s by a guy named John McCarthy, when he sent an invitation for a study on artificial intelligence in the summer of 1956 at Dartmouth College in Hanover, New Hampshire. He wrote, "Every aspect of learning or any other feature of intelligence that can, in principle, be so precisely described that a machine can be made to simulate it." – so, let's call that the rules-based approach to AI, wherein you can describe learning or intelligence so precisely that you can create a piece of software that would have a machine do the same thing.

A couple of years later, there was another guy, in 1959, named Arthur Samuel, who defined the term "machine learning". Quoting again, he called it "the study that gives computers the ability to learn, without being explicitly programmed." – so, let's call that the probability-based approach to AI, which is the most important way of actually doing artificial intelligence today.

The third name I'm going to call out is that of Alan Turing, perhaps the most recognizable to our readers. In 1915, he poses the question, "Can machines think"? He goes on to develop a game, later called the Turing Test, for helping decide if algorithms show intelligence.

Now, my personal definition, if I may, without ever wanting to put myself on the same level as these three famous people, I say, “AI is an algorithm, as a tool in the hands of humans, that recognizes patterns in data that are too complex for humans to recognize, supporting us in our daily lives”.
Now, these algorithms can be used for good, which is of course what we would always like to strive for – autonomous driving, increasing the output of an industrial plant – that's what we'll talk about more today; however, they can also be used for bad – manipulating human opinion during elections – and that's, of course, what we do not want to have happen. For that reason, we're going to need to have AI regulated like any other critical infrastructure, whether it’s electricity, gas, water, or energy.
So, to conclude, there is not one single definition of AI, which, consequently, is no different than not having a definition of the term “intelligence”.

HOPPE: Soon, I’d like to come back to the discussion about the regulations you mentioned. But first, I've heard about a differentiation between weak AI versus strong AI. What is this all about?
SEEBERG: Yeah, it's an interesting approach.
Let's start with the first one – Strong AI – which is an approach that is really only used by a very small group of worldwide researchers. This refers to a stage, perhaps sometime in the future, where algorithms could reach the same level of intelligence as humans. So, it doesn't exist today.
We could cite parallels to scenes you might see in really good movies, you know, like “I, Robot”, or “AI”. All of these wonderful cinematic movies show algorithms, or artificial intelligence, as something bad that happens to human beings, right? They take humans hostage or whatever; and we love to look at these kinds of movies, but that kind of AI, Strong AI, doesn't exist today. If that's ever going to happen or not, we shall see; I don't think it ever will.
On the other hand, there's so-called weak AI, which is a little bit of a weird word. It just means that there are algorithms that can do all kinds of things for us today; and that is upon which 99+ percent of all researchers and parties, who are involved in AI, concentrate. That is really what we, today, do with algorithms.
Furthermore, where is the differentiation between what until today has been called software and AI?
Let's take the game of chess as an example. There were points in time, where people became very impressed by what was suddenly happening. That was the case, over 20 years ago, when the IBM Deep Blue computer won the World Chess Championship from Kasparov. He was devastated, right? He didn't believe that it was ever possible and, those people interested in chess, including me when I was at Intel, would say, “Oh, this is a very important milestone in the world of artificial intelligence.” Even though the chess software consisted of not really more than a search and algorithms-based approach. Now, people who play chess know that today it is not possible to win against a good AI-based chess algorithm. What seems revolutionary in today’s AI, five years later, becomes normal.

HOPPE: We touched briefly on regulations earlier – advocating that regulations would be necessary – and now, allow me to quote some inspiring people, like Bill Gates, Elon Musk, and Stephen Hawking. They’ve each made statements relating to AI. Stephen Hawking mentioned, “AI is likely to be either the best or the worst thing to happen to humanity.” Here’s an example or two from Elon Musk. He says, “With artificial intelligence, we are summoning the demon.” Then he said, “We need to be super-careful with AI; it’s potentially more dangerous than nukes.” And, finally, Bill Gates said, “Humans should be worried about the threat posed by artificial intelligence.”
So, should I become more worried that artificial intelligence is more of a threat; or is it becoming more normal?
SEEBERG: Let's pick up the quote from Elon here, where he says it's potentially more dangerous than nukes… I would agree!
It's important that we realize that these algorithms – call them artificial intelligence or call them machine learning; it doesn't matter – they have the potential to change the world; to perhaps solve climate change - the potential is there as a very wonderful, great, and good thing, as Stephen Hawking says. Not by itself; it's rather a tool in our hands, if we want to use it.
On the other hand, it's just as big in a potentially negative way. It can destroy democracies. We've seen examples of elections that have been influenced by means of algorithms. I think the comparison with nuclear technology is great. It is very important that we regulate artificial intelligence to make sure that, the same as with nuclear technology and the same as with electricity or gas, the worldwide community is trying to make sure that artificial intelligence is going to be used only for the good of humanity, not for destroying them.
On the question of the threat versus the opportunity, I believe most of your readers have heard researchers say that 50% of the jobs are going to be lost to AI, while, on the other hand, many new jobs are going to be created. The opportunity is huge, in all parts of the world; the USA, China, Europe, they all want to become major powerhouses in artificial intelligence. So, if we're then going to be talking about OPC UA and AI, I would say that we have a huge potential, as long as we make sure that we regulate AI.

HOPPE: Thank you for explaining the risks. Let's switch to the industries of industrial automation. Can you give us some examples of AI use cases in both the discrete manufacturing and process automation industries?
SEEBERG: Let's focus on product production, which is where OPC UA is really at home. I would say there's two major categories of AI in industry. The first is optimization, while the second is new product development. I'll comment a little bit about them both.
So, starting with the optimization, it's all about improving OEE, Overall Equipment Efficiency so…

HOPPE: …But let me interrupt you. I mean, haven't we been doing that forever? Like, when I started 26 years ago as a software engineer, it was to optimize efficiencies, right?

SEEBERG: Exactly, and, Stefan, I can tell you, I've been with colleagues in numerous companies and OEE is always a theoretical value of 100%, right?

So, you have to take into consideration the quality of your product, downtime, and your throughput numbers. The theoretical efficiency of 100%, is a number you can never achieve, right? In the discrete industry, OEEs of 80 - 90% are perhaps typical, or something like that, leaving the potential to improve by 15 - 20%. Whereas, in the process industry, my personal experience is that the OEE numbers are a lot lower, like, maybe 60 - 70%.

So, we come to an imaginary example where humans (engineers) do not understand why, once a month, there is a specific problem in the plant, where they have looked at this problem for over a year or so, and they just cannot solve it. They finally invite the people who are good at data science, who do AI, to gather the data, to derive the algorithms, to look at the data, and then go back with a theoretical solution.

Remembering my earlier definition, where I said that AI is an algorithm that looks into the data and recognizes patterns that are just too complex for us humans… well, in this example, we've built a complex production line; we might have 100 or 1000 sensors; and even though we humans built this line, we are not perfect. So, somewhere, somehow, we have installed something that doesn't work perfectly. Algorithms don't care if it's 10, 100, or 10,000 sensors, they're designed to recognize patterns.

Today we might have 85% OEE and, tomorrow, with the first project analyzed, we might increase OEE by 2%, to 87%; and then, you do a couple of other projects and you cross the 90% threshold, towards 95%. That's how you do it!

HOPPE: Got it.

SEEBERG: And, if I may, you can also use specific technologies like process mining, which helps you trace back to an originating condition. For example, you may observe a problem happening at a particular stage of production but, after performing careful process mining, you discover that the originating circumstance (the root cause) is occurring two minutes earlier on your production line.

If it turns out to be a small problem, you may be able to make a quick engineering change; however, if it turns out to be a bigger problem, what is typically done is that an algorithmic model of the production line is created so that, in the future, when the same situation occurs again, the algorithms, running for example on an edge device in the production line, can recognize it and alert operations to take early, corrective action.

HOPPE: So, we know that you are an expert in AI, and I don't want to ask you to tell our readers all of your business secrets, but how would you typically go about introducing AI, specifically machine learning, to your clients?

SEEBERG: I'm happy to share some thoughts.

The first step is to perform some kind of assessment; make yourself knowledgeable; be open to ideas. Clearly, your readers are open minded, wanting to learn, and have an interest in OPC UA technologies, especially since they have read this far into the article.

As part of the first step, it would be helpful to organize a workshop or a brainstorming session. This reveals what use cases you do have? What data? Where's the data? What's the quality? This information may not necessarily be new, but in the environment of OPC UA, those are the things you typically evaluate, anyway.

Secondly, it's very important to define goals or desired outcomes. When introducing AI, you can do a half-day or full-day workshop, having all your people present – all the stakeholders – making sure to identify who is the decision maker in the room. Throughout the workshop, you may present as many as ten use cases – two or three in the production area; one in the sales area, etc. – and then the team produces a criterion list, deciding upon which use case to focus… The TOP ONE with which you're going to do a Proof-of-Concept (POC). Do we have data? Where is the data? And, by the way, if you already have OPC UA, I can tell you, right now, that you're very, very lucky; but I'll come back to that later.

Let's say you run this small POC for maybe three months. By starting step by step, starting really small, and then evaluating after three months, whether the data that you have collected might prove to be helpful – let's say, for example, improve your OEE from 85% to 87% – if that's what you see with a small POC, then you go the next, bigger step and then maybe you go into other areas as well.

HOPPE: So, you've mentioned now, a couple of times, that OPC UA can be helpful here. What role can OPC technology play in the industry to help Artificial intelligence become successful.

SEEBERG: Yeah, you will not be surprised to hear that I strongly believe that AI and OPC UA are a real winning team. I must say that this has been my view from the beginning, and I'll be even more pleased when I see other people supporting this view. This observation comes from over ten years of experience with the OPC Foundation and six years of experience consulting in the field of Artificial Intelligence.

Let's go back to my earlier example of the short, three-month-long POC. By deciding to launch this small project for a three-month evaluation, the goal was to find out what can AI, or Machine Learning, do for the organization.

What you first need to know, and you can ask hundreds of data scientists and they will all confirm this, is that about 80% of the work done by data scientists involves cleansing the data. So, we start by finding the data, which may be found in different departments, silos, and repositories, and then we start to understand the data. This might require that people think back to a time, a while ago, to try and remember what "X23" stood for years ago. Maybe nobody knows anymore; that was 25 years ago; we don't have that written down anywhere. This is where the team needs to fill in the blanks of lacking information.

Once you have a clean data set, then comes the high expectation that algorithms are going to find patterns in them, that's the core of what AI is. So, of these three months, which is only 12 weeks, you may have already spent nine weeks cleansing before you can insert the data to the algorithms.

Now, here's where OPC UA shines. And, for those of you that already know, or for those of you learning about OPC UA, it's all about the information models.

The OPC UA information models precisely describe and represent each variable in the production area, including all the relationships between the different variables. If you are using OPC UA, you can almost immediately start applying the algorithms onto the variables. It's easy to then come in for your work on day one and start your three-month POC.

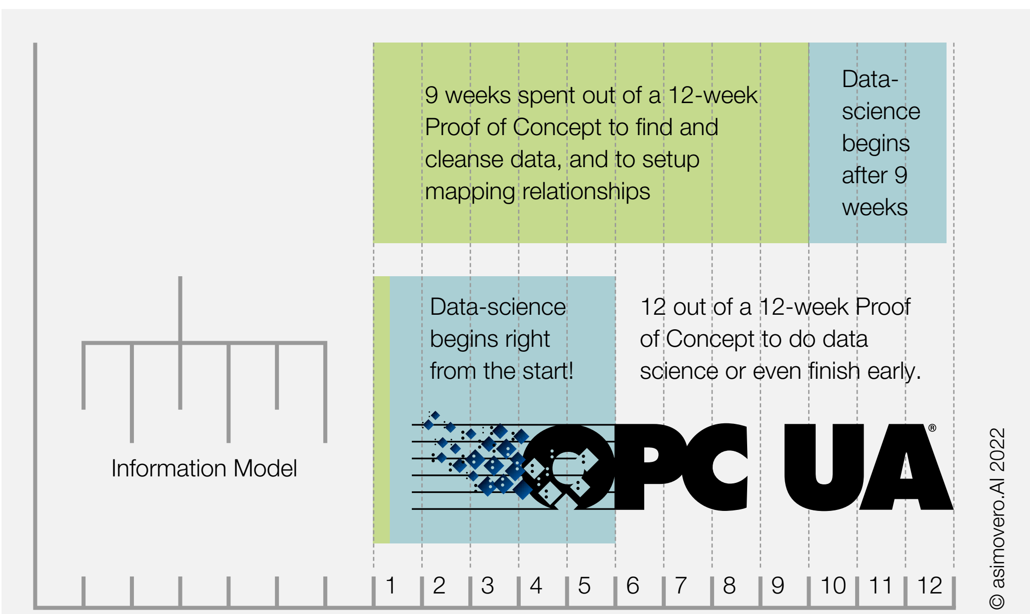
OPC UA information models may also include Companion Specifications for things like, Robotics, Machines, End of Arm Tools, or other standards (there's too many to mention) but, if OPC UA is running as an integrated structural element in my production area, I know that the relevant variables, out of the information model that I am using, are 100% real.

Now, to be clear, I'm not a technical guy, but I've seen many OPC UA information models – all the data points, the variables, their meaning, their relationships, and I've been able to play a little bit with them in the past – and the reason I say that is because I'm not the guy that goes into the technical detail. However, as a person that deals with machine learning, I can easily look into such an information model and, immediately, within the hour, I can start and I'm off and running. Instead of dealing with nine weeks of cleansing data and mapping relationships, I can immediately start my machine learning. That's why I say that it's the combination of OPC UA and Artificial Intelligence that make a winning companionship.

HOPPE: You mentioned earlier that 80% of a data scientist's work is cleansing data, which reminds me of a podcast from 2016 about artificial intelligence. During the podcast, an expert said, "Just having data, including big data, is not enough. We need a better understanding of the data."

This draws attention to work wherein the OPC Foundation is cooperating with many other associations on exactly the solution to understanding the data – specifying information models. I could name multiple examples but, here, for our readers, allow me to just mention the VDMA because, of the over 65 information models that the OPC Foundation is specifying with our partners, the VDMA is managing 31 of them. Furthermore, they oversee harmonization between these companion specifications, to avoid potential double-definition of data. This is really the Champions Class of defining data.

SEEBERG: Yeah, and if I may, for 10 years now, we've been dealing with Industry 4.0, right? It's all about digitization; it's about automation. The example that I just gave – wherein I talked about finding the data; the meaning of the data; what does the data represent – that's the world of digitizing information, also called Industry 4.0, the likes of which we have been implementing for over 10 years. And when I talk about this from the perspective of algorithms, machine learning, and artificial intelligence, that is not new. So, I emphasize that, if I then wish to augment this with artificial intelligence – which is really just a further extension of digitizing your industry – then I come to exactly the same conclusion, which is, if I already have OPC UA in my production facility, I can immediately start the work of analysis and AI, rather than starting again at the beginning.



OPC UA for Flying Start in Artificial Intelligence

HOPPE: So, if someone wishes to introduce higher-fidelity data intelligence, who are the people in charge within these industrial companies?

SEEBERG: I would say that it really depends on the size of the organization, right?

So, if you, our reader today, are part of a smaller organization, it might be you! Perhaps it's somebody in the IT department; somebody in the production environment that works closely with OPC UA; somebody from a different department who may have heard about AI/ML. However, my advice to the "decision-maker", within the organization, is to let the people run with it; and help by making yourself knowledgeable. Sit together with the person that is championing the idea, to see what you can do together.

On the other hand, if you're part of a larger organization, I would assume that your strategic team or your IT department has probably already brought you to this juncture. It's possible that, somewhere within your organization, people may have been implementing machine learning already.

In either case, you can always get external help. You can get consulting where needed; and today, there's so many solutions available: from IT; from cloud hyperscalers; from people in the IT department who write software; there are libraries; there are software environments available, and so on. Again, I would repeat the same message, go step by step, but sit together as a team. Find out who knows something about the topic and have them offer some internal courses. Perhaps your team needs to attend external courses. There are many available online and some also being provided face to face.

HOPPE: Perhaps you can offer suggestions here to our readers. What action would you suggest they take in relation to AI?

SEEBERG: I'm going to make a very bold statement here – whatever your role is today or whatever it was yesterday, it will change! I'm 100% certain. Whenever I do a presentation, I will always tell the attendees, "Your job is going to change; a little or a lot!"

Some of the jobs, of those reading this article, will not exist in a couple of years; but, on the other hand, there's going to be new jobs. Don't wait for AI to take away or change your job. Sit together with management and agree on what parts of your job could be taken over by AI in the next couple of years. Then, agree on which activities you will take charge of. Make sure that you deal with it proactively.

HOPPE: Peter, is there any question I have not asked you or is there anything else you'd like to mention?

SEEBERG: Yeah, it's nothing new, rather, I'll just confirm again what I said before. It's clear to me that OPC UA gives AI a flying start… I can't put it better. I believe OPC UA is the perfect match for making AI come true in industry. OPC UA has been growing now for 20 years. It implements a secure data exchange architecture and, within that, is the very important implicit metadata, which is really a dream come true for artificial intelligence.

So, let's put it the other way around. If you do not yet have OPC UA, consider introducing it into your factory. You're going to be so happy that you have it when you, later, want to introduce machine learning and artificial intelligence.

ABOUT THE INTERVIEW PARTNER – PETER SEEBERG:

Peter Seeberg studied Computer Aided Design in Delft, Netherlands. After 25 years in the IT industry (Intel, Infor, Seiko, Mentor), and almost 10 years in industrial automation (Softing), since 2019, he works as an independent AI consultant for asimovero.AI Peter has been actively involved in the introduction of Industry 4.0 at Bitkom, VDMA, OPC Foundation and Smart Factory and initiated and co-founded the internal start-up Industrial Data Intelligence. Peter moderates discussions, does public presentations, and advises companies on the introduction of AI.

He co-produces a weekly podcast on "AI in Industry" and is the host of the OPC Foundation podcast.

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