Presentation Notes: ISA Philadelphia Section, January 2018 Meeting
http://isa-philly.org/januarys-meeting-on-the-industrial-internet-of-things/

Date: 01/25/2018
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On January 17th 2018, I had the privilege to present to the ISA Philadelphia Section. I had given a similar presentation on the Industrial Internet of Things (IIoT), Analytics, and the impact to industrial automation with the Wilmington Section in 2017. The previous presentation was received well and quickly became more of an interactive dialog about the topics based on how the audience could relate from their professional experience. The Philadelphia meeting followed a similar path.

The terms edge computing and mobility are key concepts associated with IIoT and understanding how they support the creation of analytics and ultimately enable outcomes. I like to use examples we can all relate to as consumers to make sense of the terms in the context of the industrial automation space. One of the easiest analogies to help move from buzzwords to practical industrial application is the smart phone. The smart phone in your pocket has more computing power than what was used to start the US space program. It's the perfect example of an "edge" device where distributed computing at the edge of a network occurs (data collection, aggregation, optimized transmission) occurs. Smart phones produce a variety of analytics – think about the notification you receive when you're about to exceed your monthly plan?

> **Analytics**: *"Analytics* often involves studying past historical data to research potential trends, to analyze the effects of certain decisions or events, or to evaluate the performance of a given tool or scenario. The goal of *analytics* is to improve the business by gaining knowledge which can be used to make improvements or changes." Source: BusinessDictonary.com
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> **Edge Computing:** *"Edge computing* pushes applications, data and *computing* power (services) away from centralized points to the logical extremes of a network" Source: Wikipedia
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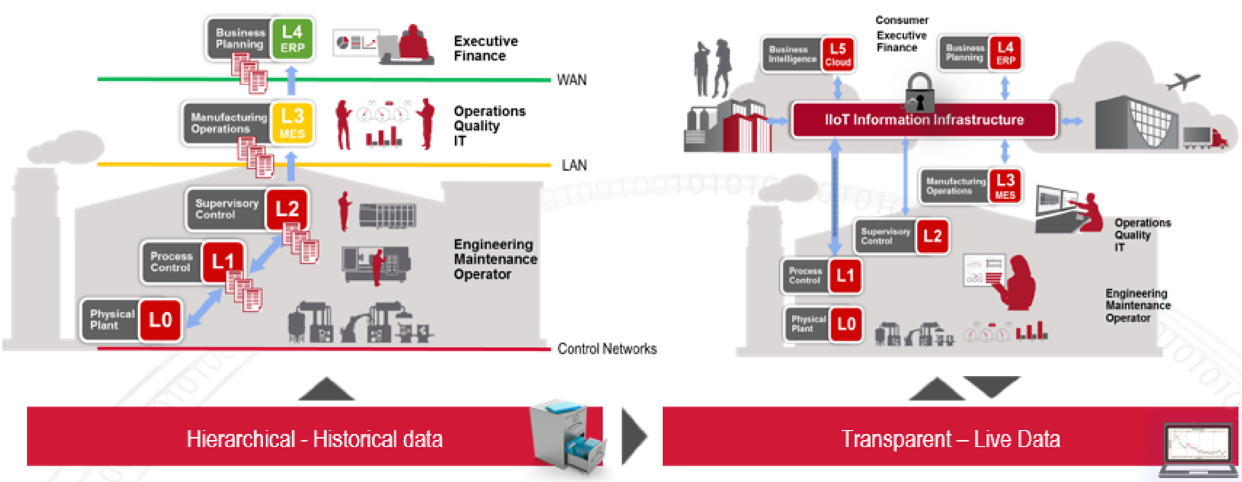
> **Mobility**: "the ability to move or be moved freely and easily" Source: OxfordDictonaries.com

As a consumer the benefits beyond the initial purpose of making a phone call include: managing contacts, calendar, navigation, pictures, music, payments, games, and more. You're accessing the device and data with more advanced security authentication with biometrics like facial recognition and finger imprint authorizing electronic payments. So when you think of the phone do you benefit from buying the device itself based on capabilities? The reality is the smart phone is part of systems where the location of data processing and corresponding results are spread across networks, while maintaining a seamless user experience. Do you really care where your photos, videos, and music reside if your data is both secure and accessible?

Relating the consumer experience of a smart phone to industrial automation is pretty easy. Traditional automation suppliers like my employer, Rockwell Automation, have long been manufacturers of “things” but it’s becoming increasingly important for the smart industrial devices (examples: instruments, overload relays, power monitors, drives, controllers) to have value beyond the initial intended purpose. When I asked the Philadelphia attendees for a definition of analytics someone volunteered the concept of a process instrument. This was a great example to highlight changes we are seeing in the capabilities of traditional industrial “things.”

Think about process instrumentation – the primary intended purpose in most cases is to provide accurate measurement and feedback into a control system. The devices have evolved and now have onboard configuration, diagnostics, data collection/processing, alarming, with varying degrees of historization capabilities. Some devices communicate with Ethernet/IP and are web browser accessible while others are accessed through communications gateways. This is one area where the “internet” aspect of IIoT becomes a bit gray, but let’s stick with this example. These smart device capabilities combined with modern networks challenge the ideas around established standards such [ISA95](ISA95) which exist to define the interfaces between control system functions and enterprise/business functions using the Purdue Reference Model.



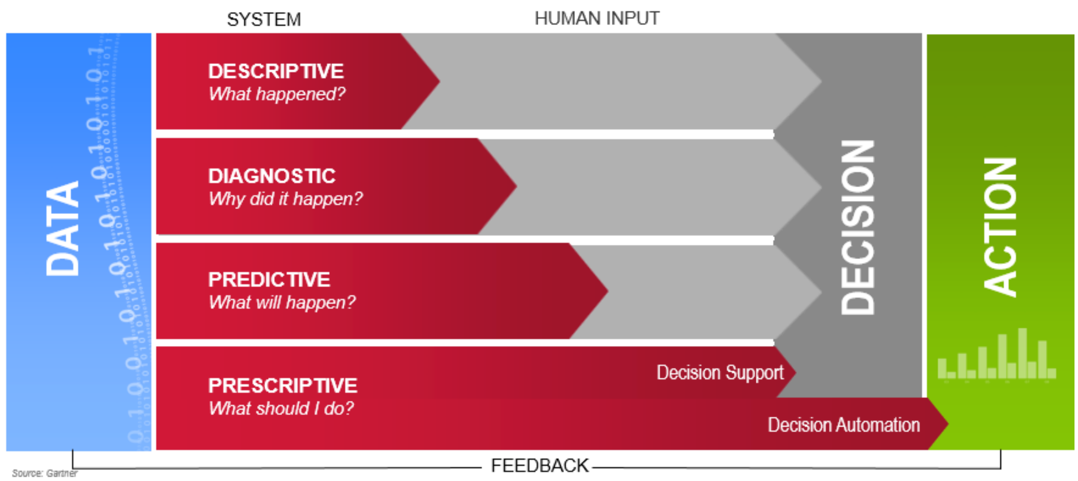
I often distinguish control functions as requiring “data in transit”, where deterministic behavior is important, verses “data in storage” where timing is still important but is not the same criticality as starting/stopping a process, acknowledging an alarm, writing a setpoint, or sampling for closed-loop control. This is particularly of concern when information held in “cloud-based” environments needs to be transacted with automation systems.

The group discussed protocols like MQTT and gateway devices that make cloud/hosted system integration scenarios feasible but immediately commented on the security and safety concerns created by the distribution of “things” over service provider networks. Performance is another obvious concern as the round-trip time from control system to remote database, back to control system, can impact cycle times of equipment. Another concern was the additional complexities associated with life cycle management - registration, verification, and replacement of devices should something in the field fail. Modern automation platforms have optional configuration settings to support automatic device replacement and configuration. IIoT devices and gateways create other variables beyond device match and physical connection. Additional steps are required to ensure secure connectivity and replacement between device and hosted systems on the other side of a network connection (see procedural instructions for device registration in Microsoft Azure IoT Hub as a reference).

As the Philadelphia Section noted in discussion – there are lots of implications for the expanded computing capabilities in traditional SCADA applications which monitor and control distributed remote assets and provide critical infrastructure: water, sewer, bridges, tunnels, air quality monitoring, traffic systems, power distribution, and pipelines were just a few examples. The group briefly discussed the implications of cyber security with applications like oil and gas pipelines and terminals where there is a combination of remote monitoring, remote control, and a need for local autonomy when a remote terminal is disconnected. These security related topics were beyond the scope of the discussion but standards do exist for control and information systems that are critical infrastructure and one of the best illustrative reference examples is NERC.

If devices or "things" keep getting more localized capabilities, what are the future possibilities for industrial control systems and where does "IIoT" stop and "IoT" start? Smart Cities, Connected Campuses, Building Automation Systems (BAS) were briefly discussed – do you consider these applications "IoT" or "IIoT?" There are lots of examples from companies like Comcast (MachineQ) with focused offerings in the space – platforms consisting of cloud-based services connecting low powered devices that can transmit signals below grade. Honeywell has continued to positon Tridium and its Niagra platform as a standalone business but it clearly markets itself as a broader IoT platform beyond BAS.

One of the best analogies for what's possible when smart "things" are accessible in a system is the onboard diagnostic system (OBD2) adopted in the automotive industry which provided standard codes for check-engine lights. The codes alert you of a problem via the light and provide some common diagnostics of the root cause (example is the check engine light is a result of an O2 sensor reading). Where these systems stop is the specific step-by-step confirmation of the diagnosis and corrective action. You still need a combination of technical know-how and mechanical aptitude to fix the underlying issue.



The car is the system in this analogy and the analytics provided by the sensors, network, and onboard computer is aligned conceptually with descriptive and diagnostic industrial analytics capabilities defined by Gartner.

Industrial Automation companies have been active in the analytics space for years with scenarios and offering that range from straightforward to more specialized – think about

- Alarming on an HMI that alerts an operator and triggers a notification (descriptive)
- Applications that focus on asset performance and capture time-in-state, production counts, and downtime with reason codes (diagnostic)
- Condition Monitoring systems that use vibration analysis to identify when expensive equipment might require service or be at risk of failure (predictive and possibly prescriptive)
- Model Predictive Control (MPC) used for process optimization and economic dispatch (predictive and prescriptive)

If we focus on the skills and expertise required for MPC, most complex applications need a cross functional and specialized team that understand both the physical process capabilities and control systems to translate variables into a mathematical model. Process Automation focused companies like AspenTech, Emerson Electric, Rockwell Automation, and Honeywell have had MPC offerings for years. So while predictive analytics aren't new in concept there are definitely contemporary approaches to these applications. If we take a step back from MPC specific discussion, GE Digital's platform is called Predix because its intended purpose is to enable scaled predictive analytics with many of the initial use-cases focused on historical GE businesses – water, energy, transportation.

For illustrative purposes of complexity and cost associated with other forms of "analytics", look at a traditional data warehousing implementation. These systems take data from various sources, cleanse, normalize, and then generate actionable information via a variety of visual outputs. Machine Learning (ML) algorithms can be applied to these datasets. Architecting and administering these systems also needs lots of specialized skills and computing resources which translate into cost. One of the greatest opportunities with industrial analytics and the distributed computing capabilities of IIoT is to minimize the cost and effort traditionally associated with these types of systems.

Use-Case examples of industrial analytics and IIoT don't need to start with detailed descriptions of advanced ML. Several companies like Verizon and IBM have ramped up marketing on how they use the assets they are best known for to address real-world issues with food safety. In the case of Verizon, they present how IoT sensors connected to the Verizon network track fish from boat to consumer. In the case of IBM, it's a combination of blockchain, IBM cloud, and Watson to enable traceability in the food supply. By tracking time in containers and environmental readings during transit these systems would reduce risks of food borne illness. This example is another gray area that is similar to Smart Cities – are these food safety examples a broader digital supply chain or part of the Industrial-IoT?

Edge computing, analytics, mobility span a lot of potential areas. Where do we see near-term applications that address challenges common in most industrial environments? One of the biggest challenges facing industrial organizations is the ability to attract, retain, and develop people. We continuously hear about the need for cultivating early interest in Science, Engineering, Technology, and Math (STEM) education to ensure we have the people. Many of the organizations I interact with have an aging workforce and struggle to find younger talent. At the same time most industrial environments present a hybrid of legacy and latest technology. Industrial organizations will need to modernize due to multiple reasons but will also need people capable of supporting their installed-base.

When you hear the term “productivity,” the context that most people think of relative to manufacturing operations is cost. Removing people equates to lowering cost. IIoT has the potential to disrupt the way in which industrial operations service their systems and equipment. If we go back to the ODB2 example in cars, these systems helped to identify the reason a check engine light was illuminated. There is a gap as-to what happens next to fix the underlying problem once a trouble code is identified. We are in a period of transition where the connectivity provided by IIoT will enable semi-skilled human resources with general mechanical and information technology aptitude to service and fix increasingly complex industrial systems.

Examples of industrial services disruption and productivity range from simple to complex. Rockwell Automation has a mobile application (TeamONE) that enables a team of users to collaborate and utilizes login credentials tied to knowledgebase accounts. A simple near-term use-case is a device in a cabinet with a red LED indicates there is a fault. The individual who needs to address the issue can collaborate with team members, access information in the knowledgebase, and capture the steps to resolve the issue. As industrial environments are modernized, Ethernet-based node count of smart things will increase – fewer people supporting systems consisting of interconnected things. This will create a need for management tools to assist with early issue identification and resolution (FactoryTalk Analytics for Devices).

PTC has made several acquisitions and have created a storyboard that ties traditional product design (Product Lifecycle Management Systems) to aftermarket services via IoT platforms (ThingWorx) and acquisition of Kepware. This is a more comprehensive approach where the combination of these technologies is intended to support IIoT connectivity to both new and existing systems. The vision enables a future state where a technician can connect, identify root cause from a smart device, and use job aides to guide through the service process. The aides may take the form of augmented reality (overlays of schematics) and instruction prompts on heads-up displays (Vuzix).

Given the current state of IIoT space, I have a very simple and obvious opinion. The use-case scenarios where there is greatest early user adoption will set the direction and influence standards. This is an interesting time to be in the industrial sector and I predict we will see an enormous amount of change caused by all these topics over the next several years.