Open Process Automation Update

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Summary

This text is from an address given to the Information and Communication working group of the International Business Congress (IBC) by ARC Research Director Harry Forbes, who spoke to the IBC on 26 May 2017.

I thank the IBC and the organizers of this meeting for the opportunity to speak with you today. Roughly one year ago I spoke to you about a new program to develop new systems for process automation. This program is noteworthy for several reasons: First because it is being done for ExxonMobil, a leading international oil company with a long reputation for operational excellence. Second, because the products of this program will be technologically quite different from the process automation systems used today. Third, because the value chain envisioned this program is also quite different from the way the process automation market works today.

Now a year has passed and I would like to update you on how this program is progressing. The short answer is that it has made progress, but quite slowly. However, for reasons I will explain here, I expect the rate of progress to pick up during the next year or so. This will be driven by the program itself, and also by several factors external to the program that will also have a big influence on the technology that will be used in manufacturing automation.
Here is my agenda for this talk:

To begin, let’s review what this program consists of:

- First, why ExxonMobil started it, and their own corporate objectives
- Second I’ll review the system architecture envisioned by ExxonMobil
- Third I’ll review the current activities of the program, which break into 3 tracks:
  - A prototype development program
  - A new standards development initiative
  - A plan for development of commercial products based on the above

Then I’ll point out five factors that are external to this program that will, I believe, likely smooth the road and improve the outcome. Some of these factors are technological and some are economic/political. It is important to keep in mind that any such multi-year development program does not occur in isolation. Rather, it is helped or hindered by changes in the technical/business climate during its life.

Finally, and very briefly I will provide my personal assessment and opinion.

**ExxonMobil Situation and Drivers**

The business driver of the program from ExxonMobil’s perspective is the need to replace large numbers of Distributed Control System (DCS) installations that could no longer be supported economically. Historically ExxonMobil has gone to great lengths to support these systems, but even their best efforts could not provide effective system support indefinitely. The number of such DCS installations is measured in hundreds, not tens. This retrofit is a huge task. This is why ExxonMobil is setting aggressive dates for the program.

The functional scope of this program is also very large. It covers all process automation functions now performed by DCS, programmable logic controllers (PLCs), advanced process control (APC), as well as all human-machine interfaces (HMI) and the engineering tools that support these functions. However, process safety systems are excluded.
ExxonMobil wants to break the typical pattern of DCS retrofits. Even when the migration to new process I/O equipment is performed effectively and well, the migration (and management) of the vast amount of intellectual property (IP) that is contained within a DCS configuration is much more difficult and thus requires duplication or even re-discovery of past automation system engineering work.

Next let’s look at the broad outline of ExxonMobil’s automation vision. Here is a chart of the envisioned architecture. The new components are colored yellow, while the existing systems are light blue. The new capabilities break into 3 major areas:

**ExxonMobil Overall System Architecture**

A new Operations Platform - We have all heard of IT and OT. This is a new type of OT platform, dubbed “RTAC” for Real-time Advanced Computing. The RTAC will be implemented using highly standardized IT-like software and industrial-grade COTS hardware. In my view this likely will be implemented using on-premise cloud platform that includes additional real-time capabilities, and will make extensive use of virtualization and of open source software.

A real-time data services “bus” - This is this set of data services that ties the system together and enables incremental expansion and change. This is the industrial equivalent of an Enterprise Service Bus (ESB). This also may be implemented using open source software, but regardless of implementation the definitions of the services provided will certainly be public and probably already standardized.
A **small form factor module** - This is a dedicated single loop controller module, given the acronym DCN, for distributed control node. This is highly distributed edge module, and there may be a great many of them in each system. In many cases a DCN may regulate just a single control loop. This has the advantage of limiting the impact of any single module failure. By contrast, today’s DCS controllers may manage up to several hundred control loops rather than just one, and are therefore are much more critical system components. Over time existing functions of the installed DCS migrate either to the DCNs or to the real-time operations platform. Both will have their own computation and storage resources, albeit resources of very different magnitudes.

**Program Activities and Schedule**

Regarding the execution plan, ExxonMobil has spoken of this program as consisting of three tracks. Two of these are active now and the third will begin in roughly one year. I find that the two activities going on now are often confused in the minds of many people, so I wish to make clear the difference between these activities.

**Current plan and schedule “Three tracks”**

**Track 1 is a “prototype development program”.** This is a contracted activity performed by US defense contractor Lockheed Martin under a January 2016 contract from ExxonMobil. In my opinion Lockheed Martin was chosen because they were familiar with the role of a pure systems integrator rather than an equipment or system supplier. This made it likely they would have greater concern about the program’s goal of fostering standards-based interoperability.
Track 2 is a standardization activity that is now being led by The Open Group. ExxonMobil supported the creation of this activity as well, but it is a separate and distinct activity, and The Open Group is managing it using their own standards development processes.

Track 3 is not yet active, and represents the activities that will occur between prototype development and commercial product availability.

I’ll take a moment to discuss each one of these tracks, since these constitute the core activities in this program.

Prototype Development

First the prototype development. The announcement of this contract between ExxonMobil and Lockheed Martin kicked off this program, and with a bang. It captured significant attention within the process automation market. Process automation suppliers were already well aware of ExxonMobil’s huge installed base of older DCS and they coveted the rare business opportunity to retrofit part or all of these many units and plants.

Track 1 of the 3 tracks is this prototype development program. Progress on this track was very limited in 2016. Lockheed Martin’s Request for Information (RFI) was issued in April 2106, but the Request for Quotations (RFQ) was not issued until the very end of 2016. ExxonMobil has taken the responsibility for this delay, but the delay has greatly compressed the time available for development.

The prototype integration will use the FACE Consortium standard for interoperability. Lockheed Martin has permitted 4 different methods for integrating with FACE as a “transition” method. This enables bidders to propose existing products with the relatively small addition of new interfaces for FACE.

As the program progressed, ExxonMobil announced its intention to share the findings from the prototype program with members of the Open Pro-
cess Automation Forum (Track 2). This should help the Open Process Automation Forum’s work as well as “level the playing field” for suppliers who may wish to participate in future projects using Open Process Automation Forum technologies.

**Standards Development Track**
Track 2 of 3 is the Open Process Automation Forum. This is an effort managed by The Open Group, an industry standards development group that is primarily focused on standards for enterprise software. The Open Group brings a collaborative standards development methodology to the work. Their model for this program is the FACE standard, an interoperability standard for avionics systems, which The Open Group also developed and manages.

Eleven end user companies have joined the Open Process Automation Forum. ExxonMobil would like broader participation and is recruiting additional Open Process Automation members from among other end user companies.

Their work should be thought of as development of a detailed reference architecture rather than standards development. The Open Group philosophy of operation is to do this rather than to create new standards. Open Process Automation Forum participants generally agree with this approach to process automation standardization.

The Open Process Automation Forum has organized into three working groups focused on Business models, technology, and Enterprise architecture. Each Working Group has 2 co-chairs for continuity reasons, one is from an end user firm and one from a supplier firm. The Open Process Automation overall leadership acts as project managers for this program and have recently recruited additional volunteer help to track and measure progress toward completion of the overall Open Process Automation scope.
of work. This should help to deal with “analysis paralysis” that too often occurs in development and standards work.

This “Forum” (an Open Group term for a standards task team) was formed in late 2016 but began functioning in early 2017. It held its first member meetings at the Orlando ARC World Industry Forum in February, 2017. Each working group now holds weekly conference calls and quarterly face-to-face meetings.

**Commercial System Development**

Track 3 of 3 is called “Commercial System Development” by ExxonMobil. This track of work has not begun yet and has not been specified or mapped out in detail at this point. This track will begin in approximately the first quarter of 2018 and will execute the activities required to develop and demonstrate commercial products based on the new Open Process Automation architecture. It is presumed that these efforts will begin work using the first revision of the Open Process Automation reference architecture, that will be largely in place (it is hoped) by the time this phase begins.

ExxonMobil envisions that Track 3 will consist of several demonstration projects, each undertaken by an end user with participation of system integrators and suppliers. The idea is to provide multiple proof points for the technology as well as multiple field sites where new products can be “alpha” tested in actual service conditions.

This pace may sound very optimistic, but you should be aware that another major end user (Saudi Aramco) has already conducted a field trial of a similar automation system (albeit not a standards-compliant one), and ARC believes that several process automation suppliers have ongoing development programs that closely mirror the RTAC functionality in this program. The timing of this phase, however, is dependent upon completion of both the standards work by the Open Process Automation Forum and completion of the prototype program by Lockheed Martin and its suppliers.

**Context: Outside Influences on the Program**

Now I will “shift gears” a bit and discuss some closely related developments. The work of the Open Process Automation Forum does not occur in a vacuum. Indeed, during the past few years we seem to have entered a period of very active technology development for manufacturing – for both process manufacturing and discrete manufacturing. Within an environment
of so much technological innovation and change, I will touch on five areas of development that will certainly have impact on the efforts to develop Open Process Automation. There are others as well, but for the moment let’s look at these five programs, which are quite certain to have impact.

**Industrie 4.0**

In the areas of high value-added manufacturing there is growing global competition. Countries with developed economies want to maintain and grow their existing competitive advantages and support their exporting industries. Countries with developing economies want to improve their competitiveness as well. This competition is, in part, taking the form of national initiatives to improve manufacturing competitiveness. These initiatives are found in Germany, the USA, Japan, Korea, and China. Platform Industrie 4.0 is the influential German initiative. The “4.0” referring to a 4th industrial revolution (following steam, mass production, and IT). The Fourth Industrial Revolution can be described as a set of new technologies that are fusing the physical, digital, and biological worlds, and impacting all disciplines, economies and industries. Here is how I4.0 describes itself (emphasis mine):

“Platform Industrie 4.0’s primary objective is to secure and develop Germany’s top international position in industrial manufacturing. The platform aims to promote digital structural change and to provide the consistent and reliable framework necessary for this. The more networked the economy becomes, the more cooperation, participation and coordination of all stakeholders is needed. The platform’s goal is therefore to develop a consistent overall understanding of Industrie 4.0 through dialogue with businesses, trade unions, science and government. To draw up relevant recommendations for action and demonstrate with example applications how industrial manufacturing can be digitized successfully in practice.”

The model shown here is the I4.0 reference model, known as “RAMI”. This model has much in common with ARC’s older Collaborate Manufacturing Reference Architecture Model.
Model. But note that manufacturing automation is represented by a whole axis in the model and is critical to the vision.

**NAMUR NOA**

Another initiative, named “NAMUR Open Architecture” or “NOA” was announced in 2016. NAMUR is a group consisting entirely of end users, mainly German chemical manufacturers. NAMUR makes only “recommendations”, but given their source these have influence on automation and equipment suppliers.

What is NOA? In my opinion the best way to think of NOA is that it’s a vision for how to apply the Industrie 4.0 initiative to the process-oriented industries of NAMUR members. But many of these companies have no intention or need of wholesale replacement of their existing automation systems. This is an important difference in the situations of NAMUR members vs. that of ExxonMobil.

NOA architecture envisions a set of additional services that would be added to the installed automation systems using multi-vendor open protocols such as OPC UA. While there is some overlap with the ExxonMobil objectives, NOA does not require or envision the wholesale replacement of existing systems. Instead it envisions that the greater visibility for installed systems will also enable development of new and more common monitoring and optimization applications based on the common, multi-vendor interfaces.

**OPC UA**

I mentioned OPC UA in the context of NOA, but OPC UA is also a part of the Industrie 4.0 RAMI reference model. Because of this, during the years 2015-16 there has been a major effort to add new capabilities to OPC UA (which stands for Open Platform Communications Unified Architecture). OPC will serve as the lingua franca – the common language – of production machinery. To do this, significant enhancements to OPC UA were needed.

First, OPC UA communications had to be expanded from a client/server architecture to add a publish-and-subscribe capability as well. This provides upward scalability and variable quality-of-service. This publish-and-
subscribe model is being implemented for machine-to-cloud and for machine-to-machine services. The machine-to-machine service will be provided with real-time guarantees so that it is usable in automation applications.

OPC UA Publish-and-Subscribe Enhancements
Source: OPC Foundation

To provide real-time, OPC UA will use a new network technology called TSN (more about that below). Note, please, that this “PubSub” capability represents a major enhancement to OPC UA and that it is still in development. Also note that it uses TSN, which is also still in development. That is to say, I would assign a fair amount of risk to the ability of this technology to perform optimally in its earliest versions.

TSN
Now, what is TSN? It is the next technology on my list of external factors. Time Sensitive Networks or TSN is an effort to bring much higher and more adjustable quality of service to standardized networks. TSN is a task group of IEEE 802, the technical standards organization that standardizes networks for the US-based IEEE. These IEEE 802 networks go by various popular names include Ethernet, Wi-Fi, ZigBee, WiMAX, and others.

TSN is needed for “network convergence”; when a single physical network replaces multiple dedicated-function networks. In such cases, network traffic needs to be managed so that the applications using the single converged
network continue to experience their normal quality of service. Where are the biggest cases for network convergence today? In my opinion the largest unit volume opportunity is for converged networks in automotive on-car applications for future smart and autonomous cars.

The big advantage of standardizing TSN is that it can be implemented in (silicon) hardware and incorporated on many different Ethernet physical layers (such as copper, fiber optic, plastic fiber, etc.). The difficulty is that TSN involves addition/modification to multiple IEEE 802 standards (roughly 5 of them). IEEE 802 has experience managing tasks of this complexity, but TSN is certainly not the simplest thing to standardize.

TSN carries big implications for existing industrial Ethernet protocols as well as for OPC UA and for all types of middleware. The formation of the Avnu Alliance organization is intended to manage the certification and branding of TSN capabilities, analogous to what the Wi-Fi Alliance does for the IEEE 802.11 standard consumers know as Wi-Fi.

Please note that both Industrie 4.0 and TSN are driving changes in OPC and these will impact all types of industrial automation products, including those developed for the Open Process Automation Forum specifications. There is no single “driver on this bus” regarding progress in industrial automation!
**Virtualization and NFV**

Finally, I want to note the technical progress in system virtualization. Virtualization is a critical technology that underlies and enables all the cloud computing services we now take for granted. But applications for virtualization are expanding. In the telecommunication industry, suppliers are now proposing that the dedicated function appliances located at the base of every cellular tower be virtualized. The appliances would thus be replaced by an on-premise cloud system that delivers real-time application services to serve these telecom applications. This strategy is called NFV or Network Function Virtualization, and NFV is a very hot topic now in cellular telecommunications.

The equipment used for NFV, for virtualization of real-time functions in telecommunications, could also be used in industrial automation. Such equipment could virtualize, perhaps, many of the applications now running in PLCs or even in redundant DCS controllers.

![Virtualization Diagram](image)

**Virtualization of Both Automation System HMI and Controllers**

In the DCS market, virtualization has been applied at the server and HMI level but not at the controller level. This is new and promising ground. I expect automation suppliers to explore it with great interest. It may offer important new benefits to DCS end users and suppliers alike. This may or may not be a good thing for the Open Process Automation Forum, since adoption of such virtualization by existing DCS products would somewhat narrow the gap between the proprietary DCS and the products following the Open Process Automation architecture. Real-time system virtualization
is certain to be an important technology for automation, regardless of other developments.

**ARC’s Assessment**

Finally, speaking as an industry analyst let me provide a brief and current assessment of this new automation program.

There are several positive factors:

- The program is now moving forward with an acceptable development methodology and wide participation, though wider participation would be better.
- With the development of NFV in telecom and autonomous/smart automobiles, other industries are also advancing the technology for networked industrial automation applications
- Industrie 4.0 and similar national initiatives are driving large investments in manufacturing automation research and development
- Many more end users recognize the limits of present-day DCS

There are also several negative factors that may delay or inhibit the success of this program:

- It greatly disrupts the existing and long-standing DCS supplier business model, though the Open Process Automation Forum recognizes this challenge and is trying to address it
- There remains uncertainty about the suitability of FACE technology/business for process automation markets and applications, though the prototype development program should provide insight into this question
- Open Process Automation Forum schedule remains likely to slip further, although the Forum has taken steps to gain visibility and (sooner or later) control of its own schedule
- As I have discussed there are many other large and related development programs are taking place at the same time, and this is both an opportunity and a risk

The outlook, in my view is that while this program is on target in addressing end user “pain points” with existing automation technology, it still carries significant schedule risk. A second risk is that of being overtaken by a different technical solution such as real-time system virtualization.
I thank the IBC for this opportunity to share with you, and thank you for your time and attention. Now we have time for your questions and some discussion.

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