**Agenda and Content**

» **Process Control and Automation:** the other Information Technology system
   - Process Control and Automation 101
   - Operational Technology (OT) 101
   - The OT marketplace and the problem
   - Changing an industry-wide supply chain to open standards?
   - What is the Open Process Automation Forum?

» **The Open OT Architecture**
   - The Open Process Automation “Ecosystem” Business Model for Open OT
   - The “as-is” Technical Architecture
   - The Conceptual Technical Architecture Target for Open OT

» **Example Data Models for OT**
   - Automation processes
   - OT topology and applications
   - OT communications
   - OT management

» **Q&A**
Process Control and Automation 101 - Industries

Automation Types by Industry

- Mining and Metals
- Fine Chemicals
- Bulk Chemicals
- BioPharmaceutical
- Oil and Gas
- Exploration and Production
Process Control and Automation 101 - Processes

- Facility demand, raw material input, and product output orchestration
- Resource orchestration / scheduling at the facility to produce product
- Manual and automated control of the production process
- Production process sensing and adjustment actuation
- The physical production at the facility
ISA 95® was designed for production plants, but can describe material movement facilities as well (pipelines, trucks, etc.)
Operational Technology (OT) 101

- OT use cases and the underlying information technology has several unique characteristics, including:
  - **Deterministic control of compute/comms latency** (real-time OS and network stack required to support typical automation applications)
  - **Expectation of always available systems**, limiting number of change windows and rate of change (difficult to keep patching levels up-to-date)
  - **Moving app logic into production has higher stakes** – OT engineers have to be more conservative as errors have higher consequences
  - **A separate, parallel, safety control system** is used to prevent loss of plant control and limit damage (fail safe for facility failures, automation logic failures)
  - Compute, comms, sensors, and actuators can be in **harsh and dangerous environments**
  - **End point count can be very high** (1000’s) at a single facility, typically much larger than the IT landscape (OT is “the other IT” in an organization)
The problem with the current OT market

Limited supply / non-competitive supply drives up costs substantially compared to open systems.

Obvious solution to this problem: Require open standards from the system integrator.

Easier said than done. Which standards? The current System Integrator business model partially relies on single supplier margins. So the supply chain ecosystem value chain will have to change.
Changing an industry supply-chain to open standards

- US DoD created the **Future Airborne Capability Environment (FACE)** consortium working with the Open Group in 2009
- The consortium included the end user’s and suppliers
- They co-developed a set of open standard interface specifications to support loosely coupled hardware and software components for their aircraft
- Suppliers now go through FACE conformance testing to supply any aircraft control components to the DoD
- The market has changed substantially, with new suppliers and changed business model for the system integrators.
- Application portability achieved with FACE conformant systems
- This was one of the inspirations to the Open Process Automation Forum (OPAF)

Figure 2: FACE Reference Architecture
What is the Open Process Automation Forum?

» A consortium of process control and automation end users and suppliers, developing a “standard of standards” that mirrors what FACE developed

Total Open Process Automation™ Forum memberships = 116 (as of 2-7-2018)
Target Open Process Automation™ Ecosystem

**New Ecosystem improvements**
- More flexible execution model
- Lower barriers to entry and increased innovation
- “Best-in-class” solutions
- Emerging business models and opportunities
- Reduced customization
- Software and configuration leveraged across platforms
- Faster introduction and adoption of new technologies

Loosely Coupled through:
- Open standard components/systems
- New marketplace player
- Larger number of service providers with skills on OPAF systems
- Increased supply for support including internal to end user
- Multiple vendor for all adds/changes, best of breed selection
As-is Technical Architecture

L4 and L3 function apps and platforms
- On standard OS/Network (usually not real-time)
- Generally run on modern IT platforms with IT lifecycles
- Most functions moving to cloud platforms
- Security/patching up to date with few limitations
- L3 apps can be proprietary

L2 and L1 function apps and platforms
- Automated control apps (DCS, PLC) on real-time platforms
- Specialized and proprietary platforms and apps
- Located at production facility (latency control, etc.)
- Usually older technology (change rate constraints)
- Security/patching delayed (change rate constraints)
- Networking latency controlled, can be proprietary
- Highly segmented zoning, limited/no trust
Conceptual Technical Architecture for Open OT

Distributed Control Framework (DCF): The software environment executing distributed control, distributed applications, and distributed I/O access.

Distributed Control Platform (DCP): The hardware and system software platform that a DCF may be applied within.

Distributed Control Node (DCN): A component that can participate in a distributed control execution environment. A DCN = DCP + one or more DCFs.

OPA Connectivity Framework (OCF): A connectivity framework that provides a logical data exchange service between endpoints.
Core Interface Standard Targets for OPAF

- Application framework and OS services standard
- Standard network data bus between applications
- Standard security control interfaces
- Standard electro-mechanical interface for DCN

**Major Implications**

- DCN’s could potentially be 1000’s of single loop devices replacing DCS and PLC
- Standardized I/O for all vendors
- Real-time compute / networking L1 through L3 function on any DCN
- DCN replacement is a simple maintenance routine (plug and play DCN deployment)
- Security upkeep is non-disruptive and up to date
Reference Information Model

Facility Topology ISA 95©

- ENTERPRISE
  - SITE
  - AREA

  PROCESS CELL
  - PRODUCTION UNIT
  - PRODUCTION LINE
  - STORAGE ZONE

  UNIT
  - UNIT
  - WORK CELL
  - STORAGE UNIT

WORK CENTERS
WORK UNITS

Equipment used in batch production
Equipment used in continuous production
Equipment used in repetitive or discrete production
Equipment used for storage or movement

Role based and physical hierarchy

ISA 95© information exchange during automated production

- Work Schedule / Demand info (What to produce?)
- Work Performance Response info (What did we?)
- Actual Performance Response info (What did we?)
- Definition of work to perform info (How?)

Segmented down the topology into:
- Process segment (resource types needed)
- Operation Segment (Resource requirements, sequence)
Process segment defines the view of resources (personnel, equipment, and materials) required to produce the product for a specific segment of the facility.
Example Potential Standards

Automation Markup Language (AML)

Example Topology

Reference between the Topology (IEC 62424) and Segment Sequence (PLCopen XML)
Example Potential Standards

PLCopen

Configuration is a specific OT deployment

Specific compute capabilities

Tasks are sequence of program executions

A dataset and algorithm

A group or network of function blocks

PLCopen uses the IEC 61131 standard to define the process logic
Example Potential Standards – Communications

IIC Connectivity Standards

Well Construction, Healthcare, Robots, etc.

Manufacturing

Distributed Data Interoperability and Management

Framework

Transport

Network

Link

Physical

Energy & Utilities

Healthcare

Manufacturing

Transportation

DDS

oneM2M

Web Services

OPC-UA

DDS-RTSP

CoAP

MQTT

HTTP

OPC-UA Bin

TCP

UDP

Internet Protocol (IP)

TSN / Ethernet (802.1, 802.3)

Wireless PAN (802.15)

Wireless LAN (802.11, Wi-Fi)

Wireless 2G/3G/LTE (3GPP)

Wireless Wide Area (802.16)

Industrial Internet Consortium (IIC) © Connectivity Stack Alternatives
Example Potential Standards – Communications

OPC UA

OPC UA Client/Server or Pub/Sub connections

OPC UA Server Architecture

OPC UA Information Model can support data exchange for ISA 95, PLCopen, etc.

Basic Object Model in OPC UA

Example: OPC UA Objects map to ISA95 Classes/Object, OPC UA Variables map to ISA 95 properties
Example Potential Standards – OT Management

IT4IT Process / Data Context

OT systems generally use IT Management technologies and aligns to ITIL/IT4IT

OT Measured Service Levels Source

OT Topology Data Source

Open Group's IT4IT Data Model for Detect to Correct

OT Service Level Target (Policy) Source

OT systems generally use IT Management technologies and aligns to ITIL/IT4IT
Example **Potential Standards – OT Management**

**Distribute Management Task Force (DMTF)**

DMTF Profiles can capture data from any compute, storage, or network agent.
Example Potential Standards – OT Management

Topology and Orchestration Specification for Cloud Applications (TOSCA)

TOSCA YAML Template

Deployment Orchestrator

Configured Compute Instance

OASIS TOSCA can be extended to automate OT build of compute / network topology and service level policy.
Questions?