Avoiding Vendor Lock-in with Open Source and Open Standards

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Land O’Lakes, Inc. Key Stats

#216
Fortune 500

290
U.S. facilities

$15 billion
2018 net sales

50 STATES
60+ COUNTRIES

Presence in

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1,851 DAIRY PRODUCERS
Herds range from 50 to 10,000+

749 AG PRODUCERS

1,116 RETAIL OWNERS
Serving a producer network of 300,000+

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We operate four diversified agribusinesses, driven by insights and innovation

Dairy Foods
Milk-based products and ingredients

Animal Nutrition
Solutions that enhance performance and well-being

Crop Inputs & Insights
Agricultural products, data, technology tools and services

Sustainability
Environmental sustainability solutions
Land O’Lakes, Inc.

A Farm to Fork View
Operational Processes – growing need for IIoT insights

- Process Manufacturing Operations
- Process Manufacturing Operations
- Crop Protection - Chemical Process Manufacturing
- Crop Nutrition – Blending Operations
- Seed / Genetics
  - AgTech: Farm Operations
    - Precision Ag

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Growth through acquisition

Inherit Dirty Laundry

Tech help is hard to find in rural areas
DON’T

BOIL THE

OCEAN
Background
The IoT Hype Cycle helps enterprises assess the building blocks and the levels of risk, maturity and hype associated with this transformative trend.

**IoT Hype Cycle, 2016 Focus**
The Hype Cycle focuses on the critical issues for enterprises implementing IoT projects. The challenges for enterprises remain formidable, because no one just "buys" a commercial off-the-shelf (COTS) IoT project. Enterprises need to prepare for custom IoT projects that leverage immature ecosystems, technology stacks and standards, and therefore require consulting and professional services (see "Hype Cycle for the Internet of Things, 2016").

**Related Research**
- "Hype Cycle for the Internet of Things, 2016"
- "Hype Cycle for Enterprise Architecture, 2016"
Stuck in the Chasm

- Core technology is not new
  - MQTT is celebrating its 17th year of existence, and now v3.1.1 is an OASIS standard
  - IEEE 1451 celebrating its 20th year of existence, defined the connected device and the ‘Smart’ Transducer

- ‘IoT’ emerged out of mobility; i.e., consumer-accessible Mobile apps and use of the Cloud

- Gartner Hype diagram still shows mainstream adoption 2-10 years out; suggests we are ‘stuck in the chasm’

- New sensor/actuator vendors are now starting to implement IEEE 1451 capabilities

- Putting IoT raw data in proper context is the real challenge
Recommended Land O’Lakes IoT Methodology

**Educate**
- Manufacturing Engineering, form closer partnership
- IT Leadership
- Business related to opportunities that can lead to projects

**Inventory**
- Assets in each Plant; including sensors, actuators, PLCs, other tools
- Opportunities areas outside manufacturing; Point-of-sale, etc.

**Assess**
- Problem Assets
- IoT Platforms
- Standards (formats, connectivity)
- Sensor vendors
- Low Cost Alternatives; e.g., Raspberry Pi 3, open source, microservice to EDL
- What can be integrated, what requires ‘rip/replace’

**Pilot**
- Pick one or two opportunities
- **Pick a low cost option == low risk**
- Evaluate IoT asset management tools

**Replicate**
- Engage infrastructure for rollout, risk assessment
- Pick a strategy vendor for IoT asset management

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Pick an problem, focus on it, and work through process
Use a Continuous Improvement approach

IoT is a journey that involves innovation, ability to crash and burn quickly, and learn and recover.
Apply to other areas of the business

- IoT
- Retail/Supply Chain
- Industry 4.0
- Farm Operations
- Co-op Grain Operations
- Mobile
- Testing Labs
- PLC
Compared IoT Architecture Layers…

IoT Business Solution

IoT Platform

IoT Endpoints

IoT Endpoints = Things + Agent

IoT Localized Device/Data Management, Apps/Analytics, Communications, Security

APIs = APIs

* "Best Practices in Exploring and Understanding the Full Scope of IoT Solutions"
...to that of ISA-95

- 21 - ANSI/ISA-95.00.01-2010 (IEC 62264-1 Mod)

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<th>Level 4</th>
<th>Business Planning &amp; Logistics</th>
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<td>Months, weeks, days</td>
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<td>4 - Establishing the basic plant schedule - production, material use, delivery, and shipping. Determining inventory levels.</td>
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<td>Time Frame</td>
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<td>2 - Monitoring, supervisory control and automated control of the production process</td>
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<th>Sensors, manipulating the production process</th>
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<td>1 - Sensing the production process, manipulating the production process</td>
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| Level 0 | 0 - The actual production process |

International Society of Automation

ERP, Logistics, QMS

MES, LIMS

SCADA, SPC, ML, Dashboard

Sensors/Actuators
Involves People, Process and Technology

Each stage is an iteration through the process (p4)

IoT is a maturity progression as an industrial organization’s business goals evolve. This maturity model illustrates the stages of IoT maturity and a snapshot of benefits gained along the way. Starting with a sound IoT strategy, companies can achieve maximum value upon completion of all five steps.

Source: https://www.bsquare.com/blog/the-five-stage-iot-maturity-model/
Response to IoT Roadmap

Pick a vendor and move forward!!
A vendor is not standard.

Using a single vendor using proprietary protocols leads to lock-in and risk if the vendor is bought or goes under.
Epic Fail!

Cloud-based Historian and processing latency too slow to support operation’s needs

No Edge Compute

Opened plant network ports

Long story short
Involves People, Process and Technology

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IT Security is Building a Wall (DMZ) for each Plant
Some vendors want to give us the Fog

Fog is a system-level horizontal architecture that distributes computing, storage, and networking closer to users, and anywhere along the cloud-to-things continuum.

- Blurs the lines from cloud to “things”
- Requires a huge network infrastructure spend
- Rural Plant Networks and regional infrastructure not ready
Meanwhile

On the Farm Operations/AgTech side...

Grain Traceability
While we were getting pretty good at using GPS and sensors for field operations...
…as Grain entered the Supply Chain we had problems

IoT Platform
MQTT Endpoint

AgXML TransferEvent

AgXML TransferEvent

AgXML TransferEvent

AgXML TransferEvent
Grain Movement within the Elevator

Need: Ag Industry Recommendation Report

Address Key Elevator Processes:

- Bin to Bin Transfers
- Blend Operations (multiple TransferEvents at variable flow rate)
- Bin to Dryer, etc.

Opportunities

- ERP-> Process Control WorkOrder integration
- Potential Mobile application capabilities
- IoT for bin monitor, grain flow, facility safety
- Capture of PLC event into Historian (work order completions)
Needed an Open Source Historian

• Retail Co-operatives (Land O’Lakes members) could not afford commercial historians
• Many co-ops didn’t even have process control systems at all
• Process Control vendors supporting co-ops found them to expensive and they would not scale
Enter New Land O’Lakes Leadership
New Leadership announced amidst a very tough year (2018)

Beth Ford, new CEO

“Much like we do in our families, we must know what is a "nice to have" and what is a "must have" for our business to progress.”

“Teddy Bekele has been promoted to Chief Technology Officer and will report directly to me. As we look to our future, there is perhaps no one thing that will make more of an impact on our business and our members than technology.”
Main message:

Make use of what you have
Translate:

• No more big vendor platform purchases
• Innovate
• Use Standards
Historically every time we would go into a plant for a project, it would end up at $1 million each plant.

For 60 Feed plants, 12 Dairy plants, that adds up.

We are DONE with that pricing model.
Pendulum has swung once again
Back to the ‘get it done’ ‘less-is-more’ mentality, with caution
Use Standards
No Money but for resource time
Not throwing the baby out with the bath water
Can we find Edge Computing architecture in Open Source?

The IoT is helping to blur the physical and digital worlds, as well as transform industries and the way we live and work.

* Not all architectural elements (e.g., IoT edge platform, digital twin, visualization) are offered by all vendors, nor are they always required for a particular IoT project.

**IoT Defined**
The Internet of Things is helping to blur the physical and digital worlds, as well as transform industries and the way we live and work.

**IoT Platform Defined**
Software that facilitates operations involving IoT endpoints and enterprise resources. The platform provisions and controls IoT endpoints, monitors event streams, and enables analytics and integration capabilities. See expanded definition in "Hype Cycle for the Internet of Things, 2016."

**Related Research**
- "How to Address the Top Five IoT Challenges With Enterprise Architecture"
- "Build Your Blueprint for the Internet of Things, Based on Five Architectural Components"
- "Hype Cycle for the Internet of Things, 2016"
Close: But still no local historian
Challenges

• We need to look for open source tools and standards that enabled ‘what we had’, especially on the PLC side
• Many Purina plants were built in the 1960’s and 1970’s
• System Integrators were typically local to the plant
• 60 plants in remote areas with poor broadband; no plant Wi-Fi in most cases (dirty laundry)
• Engineering had focused on process control systems that had REST integration capabilities, however,
  • middleware needed to call the *its endpoints*
• And the even bigger challenge… *we still needed to address the IT/OT Partnership Challenges*
Our Goal: enable OT resources to be self-sufficient

Recommendations and Training on Open Source tools, and Data Standards

IT/ Top Floor

Plant Floor Information

Data Analytics Tools

OT/ Shop Floor
IT needs to help OT articulate the business value to their leadership

$$ savings $$
So we could focus on key areas of concern

- Plant Safety
- Plant Reliability
- Plant Efficiency
- Product Quality
- Regulatory
Standard Semantics

Let’s talk Standards
Connectivity vs. Content

Once connected, content can be passed

Reliable connections historically challenging in rural areas and developing countries

Source: www.postscapes.com
The core principles to establish Data Standards

• ‘Wrappers’ or ‘façade’ aim to front-end a more complex and/ or a proprietary system (business application or Thing) and provide consistency so others can communicate the same way

• Developers often implement a façade using proprietary semantics as a hiding mechanism

• The ‘façade’ Design Pattern appears in the quintessential Gang of Four design patterns book

• The canonical model provides an agreed upon set of semantics in addition to the façade

• The canonical model fits very well in a ‘publish and subscribe’ paradigm

• The term canonical does not necessarily imply a standard, as it could be internal to an organization
Façade Pattern aiding ERP Replacement

Upgrading or replacing Appl2 only requires replacement of wrapper2
Data Standards

• When groups get together to agree upon a set of semantics for an industry or set of industries, that can be ‘standardized’ typically by an organization that provides governance around that collection

• ANSI ASC X12, UN/EDIFACT, OAGi, SWIFT, etc., are historically well established business-to-business standards

• MIMOSA and B2MML are established shop floor standards

• There are a lot of competing standards

• There are standards that are based on the same ‘building blocks’ of terms (i.e., core components) yet aim to solve completely different problems

• This is the intent of the Core Component Technical Specification (CCTS)
Open Applications Group (OAGi)

• The OAGIS standard produces by OAGi has been around for 20+ years
• OAGIS focus has primarily been in the area of “top-floor” transactions and business-to-business; i.e., at the ERP and complementary business capability level
• As of recent it has established itself to be syntax-neutral, producing JSON representation of the semantics
• NIST has performed extremely important work in the area of enabling the syntax neutral schema representation and contextual profiling with the tool ‘Score’ (formerly called Semantic Refinement Tool)
• Score is an implementation of CCTS
• Land O’Lakes has leveraged this tool and is in production with numerous OAGIS REST JSON middleware implementations
Embedding the OAGIS standard within Business Applications

• Land O’Lakes has successfully embedded several OAGIS standards inside vendor business applications

• This was typically done when the application’s proprietary interfaces were ‘chatty’ requiring numerous calls over the network to complete a single business transaction

• Each time, we communicated to the business application vendor 1) that it could be done and was the best practice, and 2) they should support OAGIS as a standard API in their core product

• Negative Response: the vendor did NOT implement and instead continued to shift customers to professional services for these implementations
Contract-First API

Single, Course-grain Web Service HTTP POST

Client

Separate code Deployment into WebLogic 12c

Approximately 100 Java API Calls

WebLogic Server 12c

LabVantage Application
MIMOSA

- The OAGi Smart Manufacturing Work Group identified scenarios where there is increasing need to add shop floor measurement data and IoT data in general to B2B messages
- Certificate of Analysis provided to customers requires test measurement and in-process control information
- Transported dairy products required proper refrigeration, and temperature may be sent with shipment status information with location updates
- The SM WG studied various payloads (Open Group, OSISoft Message Format, MIMOSA), and MIMOSA seemed most compatible
- MIMOSA’s focus on asset management and asset generated measurement, and that it is based on the OAGi BOD Architecture proves to be a natural fit
Let's talk Open Source

The start of our Journey
The value of open source is that they are based on communities of interest, and sharing of ideas and code. Free is good, too.

Can it work ‘with what we have’?
Open Source and Standards

Since this is supported by the open source community, incorporating it into the code-base is often quicker than waiting for a vendor to get functionality into their release cycles.

We find support for lower level programming API such as W3C’s Web of Things – very low level.
Kepware -> Apache NiFi

• We are customers of Hortonworks Hadoop for our Enterprise Data Lake, running on Azure
• Part of Hortonworks DataFlow leverages Apache NiFi
• Over the last several years, we have built intensive data ingestion flows to the EDL
• Current project: Kepware IoT Gateway publishes data to an HTTP endpoint exposed by NiFi for more EDL data ingestion
• Kepware brings OPC and PLC value to solution
• NiFi is NOT local to the plant floor
• Solution still does not address many rural plant floor needs
Innovation tracks:
Prototyping with the Raspberry Pi3

- Raspberry Pi3 Model B has the following connectivity options
  - Bluetooth LE
  - Cat 5
  - WiFi
  - USB (which allows RS-232, additional network for gateways, etc.)
  - General Purpose Input/Output (GPIO)
- Operating Systems
  - Linux/ Raspbian
  - AndroidThings – no longer supported
- Intended as single purpose computer
- Low cost replacement $35 if the hardware dies; remove SD card and place into a new one
- Hardened enclosures recommended in dusty, humid environments
Node-RED and GPIO prototyping
Docker on Raspberry Pi3 makes install easy

You can run Node-RED, Grafana, and InfluxDB all as Docker containers on the Pi.

Node-RED running pre-installed on Raspbian is recommended, as some nodes require system access.
Open Source enabling Context

Measurements need context; correlating by timestamps is very hard

Metadata Level

- Camunda BPMN offers the value of business process context
- More work needs to be done with flexible manufacturing models, smaller grained processes at work center levels that can be assembled on demand
- Process Task within the BPMN model should be captured
- BPMN model may name the measurement and relate other measurements

Instance Level (which specific asset is being used at a given point in time)

- Plant Identifier
- Asset Identifier (tag)
- Workcenter Identifier
- Work Order Identifier
- Etc.
Very large community

Kura is a set of libraries geared towards Java developers; Paho (MQTT), OPC-UA, etc.

Other projects built on top of Kura
Open Source and Open Standards will save an estimated 10x / plant.

Implementation Costs are people costs

This is a Journey…
To be continued…

Thank you