AgGateway's Path to Traceability
Linked Data in the Ag Lifecycle

July 19, 2018
InfoAg, St. Louis

Joe Tevis, Vis Consulting
Scott Nieman; Land O’Lakes
Speaker Introductions

• Joe Tevis, PhD – President, Vis Consulting  
  • 20+ years experience in precision ag technology: Texas A&M, AgChem, AGCO, Topcon  
  • 2014 Awards Of Excellence Winners: Champions Of Precision Ag by PrecisionAg Magazine  
  • AgGateway Project Chair, SPADE1 and SPADE2  
  • AEF (Agricultural Electronics Equipment Foundation) PT9 Vice Chair

• Scott Nieman, Enterprise Integration Architect – Land O’Lakes  
  • Over 32 years of integration experience and 20+ years standards development experience  
  • Enable advanced business capabilities through integration and technology  
  • 8.5+ Years at Land O’Lakes; mentor IT teams on integration best practices and solution delivery  
  • Support all Lines of Business: Dairy Foods, Purina Animal Nutrition, and WinField United (AgTech, Retail ASCs, Croplan Seed, Crop Protection, Nutrition, SureTech/Solum labs)
Agenda

• Bios
• Intro to AgGateway
• Intro to Traceability Work Group
• Relevant Standards
• Background – AEF / 2014 Proof of Concept
• Background – 2017 CART Proof of Concept
• 2018 CART Proof of Concept – in progress
• Direction of Traceability Work Group
• Interoperability
• Q&A
AgGateway North America Key Facts

- Non-profit consortium founded in 2005
- Steady growth -- currently over 200+ member companies
- Non-competitive, transparent environment for collaboration
- Our **mission** is to promote and enable the industry's transition to digital agriculture, and expand the use of information to maximize efficiency and productivity.
- Scope of standards is international – http://aggatewayglobal.net/
- **We are NOT a gateway service** – we are an API standards and implementation consortium, not a VAN managing transactional data.
AgGateway Organization Structure

Councils
- Ag Retail
- Allied Providers
- Crop Nutrition
- Crop Protection
- Grain & Feed
- Precision Agriculture
- Seed
- Specialty Chemical

Committees
- ADAPT Oversight
- Architecture
- Communications
- Conference
- Data Privacy & Security
- AGIIS Directory Oversight
- Membership
- Standards & Guidelines

Working Group
- Traceability

Sampling of Members
- Farm Equipment Vendors: John Deere, AGCO, CNH, Claas...
- Farm Management Information Systems: AgConnections, RedWing Software...
- Rural Farm Co-operative information ERPs: SSI/AgVance, AgVantage, AgVision, Cultura...
- Technology Vendors: TopCon, Raven, Trimble, AgLeader...
- Process Control Vendors: Kahler, Murray Equipment...
INTRO TO TRACEABILITY WORKING GROUP
Traceability Working Group

- Initiated by interested generated by the 2017 Grain Traceability Proof of Concept and call for participation March 2018
- Approximately 32 participants
- Cross Council Membership
  - Precision Ag Council
  - Seed
  - Grain & Feed
  - Ag Retail
  - Allied Providers
- First meeting was held April 19 2018
Sub-Groups

- Grain Traceability (Currently under CART)
- Seeding (6)
  - Integration of GS1-128 bar coding standards at refill
  - Documentation of seed treatments
- Crop Protection (7)
  - Documentation and tracking of in-field mixtures
- Food/Feed Safety (8)
  - Processing Center (ethanol) to Feed Manufacturer
  - Grower to Feed Manufacturer
  - Veterinarian Feed Directive (VPD)
  - FISMA
- Provenance (13)
  - Produce (lettuce) Recall
  - Protocol Compliance
Growing – we started small

<table>
<thead>
<tr>
<th>Traceability Work Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Tests</td>
</tr>
<tr>
<td>Manure Management</td>
</tr>
<tr>
<td>As-Planted</td>
</tr>
<tr>
<td>As-Applied Crop</td>
</tr>
<tr>
<td>Nutrition</td>
</tr>
<tr>
<td>Protection</td>
</tr>
<tr>
<td>Tissue Testing</td>
</tr>
<tr>
<td>Weather Data</td>
</tr>
<tr>
<td>As-Harvested</td>
</tr>
<tr>
<td>Crop Reporting</td>
</tr>
<tr>
<td>Supply Chain</td>
</tr>
</tbody>
</table>

- AEF 2012: Load / Unload
- SPADE 2014 PoC: Combine to Cart
- CART 2017 PoC: Combine to Cart IoT (BlueCats BLE)
- CART 2018 PoC: Combine to Cart IoT RPi3/Arduino

IoT (BlueCats BLE) CART 2017 PoC
What is AgGateway trying to achieve?

- Correlation of all the data for **predictive analytics**, **optimize margin** and product quality
- Address **Food Safety** (FDA’s Food Safety Modernization Act - FSMA)
- Process efficiencies; elimination of paper, receiving, outbound scale tickets, settlements
- Increase sources of data including more sensors – put ‘smarts’ closer to the edge
- Inter-operability / leverage and offer enhancements to standards as necessary
- Regulatory: USDA / Farm Services Agency – efficient crop planning and reporting; other regulatory
- Crop Insurance: USDA/ Risk Management Agency – crop damage
- Quality Testing: USDA / Federal Grain Inspection Service under GIPSA
- Satisfy consumer demand for food transparency
- Reduce cost in cases of **product recall and root cause determination**
Guideline Principle

Enhance mature business processes by collecting data using modern technology and associated data standards that also enable traceability

- Non-intrusive that it does not add more work to collect information
- Leverage prior work efforts and standards already in place (supply chain, data standards, data transport)
- Data standards provide lower total cost of ownership, even if vendors suggest they can ‘take data format’
- Ultimately we aim make the business processes easier; e.g., reporting; logistics
- Better insights from the data that is collected (semantic reasoning)
- We will not dictate a single solution or technology provider, but define a reference model for an interoperable, distributed (federated) system
Supply Chain / Traceability Value Chain

Technology Providers → Seed Manufacturer → Seed Retailer → Grain Producers → Grain Elevator → Ingredient Manufacturer → Food Manufacturer → Food Retailer → Consumer

Traceability
Agricultural Lifecycle

Soil Health → Weather → As-Planted → As- Applied → As-Harvested

Supply Chain

Exploded view

Equipment Manufacturers → Technology Providers → Agronomy Services → Testing Services → Crop Nutrient Manufacturers → Seed Manufacturers → Crop Protection Manufacturers → Co-op Retail / Elevators → Food Processors → Animal Nutrition Services → Consumer Retail
Exploded View

- Equipment Manufacturers
- Technology Providers
- Agronomy Services
- Testing Services
- Co-op Retail / Elevators
- Crop Protection Manufacturers
- Seed Manufacturers
- Crop Nutrient Manufacturers
- Food Processors
- Animal Nutrition Services
- Consumer Retail
Define and Address Key Use Cases – Product Recall

FSMA: One step forward, One step back
Define and Address Key Use Cases – Consumer Demand


SHoppers want to go beyond the label
Actionable Benefits of collecting Data

• Agronomists: better insights into the field, match of crop to field based on various factors (soil, weather, history, outcome based data)

• Crop Protection/ Seed Manufacturers: track and correlate product information usage and effectiveness

• Growers: Improved crop reporting to USDA/RMA (leverage new NIEM Agriculture domain)

• Growers: better on-ramp into the Supply Chain

• Co-ops and Feed Manufacturer: improve receiving and load out processes

• Feed/ Food Manufacturer: lot track and trace on incoming ingredients
AgGateway Precision Ag Project Deliverables

<table>
<thead>
<tr>
<th>Reference data APIs</th>
<th>Requirements</th>
<th>Process definitions</th>
<th>Data requirements</th>
<th>Standards</th>
<th>Gap-Checking</th>
<th>Infrastructure</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seeding operations</td>
<td>S1</td>
<td>S2</td>
<td>S2</td>
<td>-</td>
<td>S3</td>
<td>S3</td>
<td></td>
</tr>
<tr>
<td>Harvest operations</td>
<td>S2</td>
<td>S2</td>
<td>S2</td>
<td>S2</td>
<td>A</td>
<td>S3</td>
<td></td>
</tr>
<tr>
<td>Crop protection operations</td>
<td>S2</td>
<td>S2</td>
<td>S2</td>
<td>S2</td>
<td>A</td>
<td>S3</td>
<td></td>
</tr>
<tr>
<td>Crop nutrition operations</td>
<td>S3</td>
<td>S3</td>
<td>S3</td>
<td>S3</td>
<td>A</td>
<td>S3</td>
<td></td>
</tr>
<tr>
<td>Grain handling (CART)</td>
<td>S3</td>
<td>S3</td>
<td>S3</td>
<td>S3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop scouting operations</td>
<td>S3</td>
<td>S3</td>
<td>S3</td>
<td>S3</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telematics (WAVE)</td>
<td>S3</td>
<td>S3</td>
<td>S3</td>
<td>S3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensor and weather data</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P2</td>
<td>P2</td>
<td></td>
</tr>
<tr>
<td>Irrigation Operations</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P1</td>
<td>P2</td>
<td>P2</td>
<td></td>
</tr>
</tbody>
</table>

KEY - S1: SPADE1; S2: SPADE2; S3: SPADE3; A: ADAPT; P1: PAIL1; P2: PAIL2.

We are here!
# ISO 11783

<table>
<thead>
<tr>
<th>Primary Objectives</th>
<th>Enable interoperability of equipment to perform field operations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tasks which define instructions to complete field operations</td>
</tr>
<tr>
<td></td>
<td>Document the execution of the task</td>
</tr>
<tr>
<td>Administration</td>
<td>ISO - Phase Gate process used to change/enhance the standard</td>
</tr>
<tr>
<td></td>
<td>AEF – Promotion and manages committee work and conformance testing</td>
</tr>
<tr>
<td>Access</td>
<td>Requires AEF membership to participate in committees and working groups</td>
</tr>
<tr>
<td></td>
<td>Standards documents are available for purchase to the public</td>
</tr>
<tr>
<td><strong>Primary Objectives</strong></td>
<td>Track the movement of commodity grain from destination A to destination B (Field to elevator, Field to processor, etc.)</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Document grain quality certificates</td>
</tr>
<tr>
<td></td>
<td>Document the fulfillment of grain contracts</td>
</tr>
<tr>
<td><strong>Administration</strong></td>
<td>Managed and promoted by AgGateway</td>
</tr>
<tr>
<td></td>
<td>Process controlled by AgGateway Staff</td>
</tr>
<tr>
<td><strong>Access</strong></td>
<td>Requires AgGateway membership to participate in committees and governance</td>
</tr>
<tr>
<td></td>
<td>Standard is available for free download to the public</td>
</tr>
</tbody>
</table>
## Primary Objectives

- Enable interoperability between OEM tractor-implement control systems (MICS)
- FMIS to FMIS data transfers
- Provide a standard for field operations not covered by ISO 11783 such as irrigation

## Administration

- Promotion and governance provided by AgGateway
- Cooperation with AEF

## Access

- AgGateway membership required to participate in governance
- Code contribution is open to the public
- All code available for download free to the public @ [www.adaptframework.org](http://www.adaptframework.org)
## Bar Code 128 (w/lot number)

<table>
<thead>
<tr>
<th>Primary Objectives</th>
<th>Administration</th>
<th>Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide unique identifier for crop input products</td>
<td>GS1</td>
<td>Free to public</td>
</tr>
<tr>
<td>Facilitate efficient tracking of products for supply chain</td>
<td>AgGateway AIDC Working Group</td>
<td></td>
</tr>
<tr>
<td>Inventory management</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# OAGIS

## Primary Objectives
- Enterprise level messaging standards for supply chain and operational business processes
- Based on ISO 15000 core components standard; these are building blocks into messages
- Adaptable to many industries

## Administration
- Managed and promoted by Open Applications Group Inc (OAGi)
- OAGi also manages the Chem E – Standard used heavily by AgGateway in supply chain transactions

## Access
- Requires OAGi membership to participate in committees and governance
- Standard edition is free downloaded
- Enterprise edition and other tools require OAGi membership
HOW WE GOT HERE
AEF Load/Unload Working Group

- Initial work ~2012
- Added load & unload event DDI elements to ISO 11783
  - Harvest - Grain mass transferred from combine to cart
  - Planting – Seed count transferred from tender to planter
  - Crop Protection – Chemical mass/vol transferred from mixing station to sprayer
- Transfer partner IDs
2014 Harvested Grain Traceability
A Transfer Event is the movement or transfer of a product or commodity from one container to another container. Any transfer event can be specified by:

- A timestamp or data/time range that the transfer occurred
- Source container ID
- Target container ID

IoT Opportunity

Harvest Transfer Events

- Field -> Combine
- Combine -> Cart
- Cart -> Semi
- Semi -> Elevator
- Truck -> Bin
2017 POC

• Scope: Extend the 2014 PoC from cart to On Farm Storage
• Improved field operations to CART with BLE
• Amazon Web Service IoT platform
• Commercial Beacons cannot withstand weather elements
• Need Smart Edge Devices — commercial gateway very limited, not well suited to Agricultural environment, fine for retail
Harvested Grain Traceability

ISO 11783 - 10 ➔ SPADE ➔ CART/AgXML

1st Transport Vehicle ➔ Secondary Transport Vehicle(s) ➔ Storage Facilities ➔ Grain Processors

MCP

AgGateway

ADM

The InfoAg Conference
2017 POC Container Detection and Identification

IoT Beacon Hardware + Harvest Containers/Vehicles + AWS IoT Platform

IoT Beacon Hardware

Harvest Containers/Vehicles

AWS IoT Platform

Control Lambda ➔ DynamoDB

IoT Control Topic ➔ Device Shadow

Sensor Lambda ➔ SQS
2017 POC Recorded ~529 Transfer Events

- Field -> Combine: ~182
- Combine -> Cart: ~182
- Cart -> Semi/Truck: ~85
- Semi -> Elevator: ~10
- Truck -> Bin: ~70
Observations & Measurements During Transfer

<table>
<thead>
<tr>
<th>Field -&gt; Combine</th>
<th>Combine -&gt; Cart</th>
<th>Cart -&gt; Semi/Truck</th>
<th>Semi -&gt; Elevator</th>
<th>Truck -&gt; Bin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass flow</td>
<td>Unload time</td>
<td>Unload time</td>
<td>Semi ID</td>
<td>Transfer type</td>
</tr>
<tr>
<td>Moisture</td>
<td>Combine ID</td>
<td>Moisture</td>
<td>Pit ID</td>
<td>Transfer device ID</td>
</tr>
<tr>
<td>Protein</td>
<td>Cart ID</td>
<td>Cart ID</td>
<td>Truck ID</td>
<td></td>
</tr>
<tr>
<td>Geo-location</td>
<td>Geo-location</td>
<td>Semi/Truck ID</td>
<td>Bin ID</td>
<td></td>
</tr>
</tbody>
</table>
## Observations & Measurements per Load

<table>
<thead>
<tr>
<th>Field</th>
<th>Combine Tank</th>
<th>Cart</th>
<th>Semi</th>
<th>Truck</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>?</th>
<th>Container ID</th>
<th>Total Mass</th>
<th>Total Mass</th>
<th>Total Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Container ID</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Grain Quality Certs*    | Moisture     | Grain Quality Certs* |
|------------------------|--------------|----------------------|

---

ISO 11783

AgXML
### Raw Beacon Data -> Beacon Events

**Raw Data extracted from AWS dynamo db**

<table>
<thead>
<tr>
<th>timestamp</th>
<th>edgeMAC</th>
<th>beaconMAC</th>
<th>rssi</th>
<th>mPow</th>
</tr>
</thead>
<tbody>
<tr>
<td>43003.00098</td>
<td>E4956E4CC16A</td>
<td>59C9E0F9BFFFF</td>
<td>-64</td>
<td>-67</td>
</tr>
<tr>
<td>43000.49834</td>
<td>E4956E4CC16A</td>
<td>71981AA9BA1C</td>
<td>-38</td>
<td>-67</td>
</tr>
<tr>
<td>42997.94153</td>
<td>E4956E4CC16A</td>
<td>5FADB15AA011</td>
<td>-64</td>
<td>-67</td>
</tr>
<tr>
<td>43002.75758</td>
<td>E4956E4CC16A</td>
<td>79284910D025</td>
<td>-58</td>
<td>-67</td>
</tr>
<tr>
<td>43003.72983</td>
<td>E4956E4E41EC</td>
<td>4DE820EF5631</td>
<td>-59</td>
<td>-71</td>
</tr>
<tr>
<td>43002.75063</td>
<td>E4956E4CC16A</td>
<td>79284910D025</td>
<td>-60</td>
<td>-67</td>
</tr>
<tr>
<td>42997.53826</td>
<td>E4956E4CC16A</td>
<td>5F2B33C85E19</td>
<td>-35</td>
<td>-67</td>
</tr>
<tr>
<td>43003.72108</td>
<td>E4956E4CC083</td>
<td>4DE820EF5311</td>
<td>190</td>
<td>-71</td>
</tr>
<tr>
<td>43003.78318</td>
<td>E4956E4CC083</td>
<td>5A08D0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43002.8097</td>
<td>E4956E4CC16A</td>
<td>59C9E0F9BFFFF</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**AWS Lambda Function**

- Time sort
- Filter redundant entries
- Identify “Start – End” pairs

**Beacon Events**

- Relay
- Beacon
- Start
- End
- HMS
- Avg. RSSI
- Max RSSI
Beacon Events -> Transfer Events

<table>
<thead>
<tr>
<th>Relay</th>
<th>Beacon</th>
<th>Start</th>
<th>End</th>
<th>H/M/S</th>
<th>Avg. RSSI</th>
<th>Max RSSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>C083/Sensi</td>
<td>FDA50693A4E2F5B1AC5F0E6D71F8CB8</td>
<td>2017-10-31 18:14:00</td>
<td>2017-10-31 19:01:00</td>
<td>00:47:00</td>
<td>-76</td>
<td>-73</td>
</tr>
<tr>
<td>C083/Sensi</td>
<td>24a5/Kinze Grain Cart</td>
<td>2017-10-31 18:35:20</td>
<td>2017-10-31 19:40:20</td>
<td>00:05:00</td>
<td>-72</td>
<td>-66</td>
</tr>
<tr>
<td>C083/Sensi</td>
<td>24A5/Wade West</td>
<td>2017-10-31 18:35:20</td>
<td>2017-10-31 19:00:14</td>
<td>00:25:12</td>
<td>-74</td>
<td>-73</td>
</tr>
<tr>
<td>C10f/Combine</td>
<td>24a5/Kinze Grain Cart</td>
<td>2017-10-31 17:31:15</td>
<td>2017-10-31 17:31:13</td>
<td>00:00:00</td>
<td>-76</td>
<td>-76</td>
</tr>
<tr>
<td>C10f/Combine</td>
<td>24a5/Kinze Grain Cart</td>
<td>2017-10-31 17:18:12</td>
<td>2017-10-31 17:18:12</td>
<td>00:01:02</td>
<td>-72</td>
<td>-68</td>
</tr>
<tr>
<td>C083/Sensi</td>
<td>24a5/Kinze Grain Cart</td>
<td>2017-10-31 17:10:24</td>
<td>2017-10-31 17:33:24</td>
<td>00:03:00</td>
<td>-70</td>
<td>-67</td>
</tr>
<tr>
<td>C139/Red Grain Truck</td>
<td>24A5/Kinze Grain Cart</td>
<td>2017-10-31 17:10:24</td>
<td>2017-10-31 17:10:24</td>
<td>00:03:00</td>
<td>-70</td>
<td>-67</td>
</tr>
</tbody>
</table>

Server Code

- Apply ContainerType Rules
- Apply Business Rules
- Fill State Analysis
- "Ask Jeremy"

Transfer Events

<table>
<thead>
<tr>
<th>Relay</th>
<th>Direction</th>
<th>Beacon</th>
<th>Start</th>
<th>Status</th>
<th>Violation</th>
</tr>
</thead>
<tbody>
<tr>
<td>C10f/Combine</td>
<td>-&gt;</td>
<td>24a5/Kinze Grain Cart</td>
<td>10/21/2017 7:50</td>
<td>TRUE</td>
<td></td>
</tr>
<tr>
<td>C139/Red Grain Truck</td>
<td>-&gt;</td>
<td>24A5/Wade West</td>
<td>10/21/2017 8:18</td>
<td>FALSE</td>
<td>Truck is empty</td>
</tr>
<tr>
<td>C139/Red Grain Truck</td>
<td>&lt;</td>
<td>24a5/Kinze Grain Cart</td>
<td>10/21/2017 8:25</td>
<td>FALSE</td>
<td>Cart is not full</td>
</tr>
<tr>
<td>C10f/Combine</td>
<td>&lt;</td>
<td>24a5/Kinze Grain Cart</td>
<td>10/21/2017 8:44</td>
<td>FALSE</td>
<td>Cart is not full</td>
</tr>
<tr>
<td>C139/Red Grain Truck</td>
<td>BRV</td>
<td>4CB9/Bill's Corn Bin</td>
<td>10/21/2017 9:37</td>
<td>FALSE</td>
<td>BRV</td>
</tr>
<tr>
<td>C139/Red Grain Truck</td>
<td>&lt;</td>
<td>24a5/Kinze Grain Cart</td>
<td>10/21/2017 9:40</td>
<td>FALSE</td>
<td>Cart is not full</td>
</tr>
<tr>
<td>C139/Red Grain Truck</td>
<td>&lt;</td>
<td>24a5/Kinze Grain Cart</td>
<td>10/21/2017 9:48</td>
<td>FALSE</td>
<td>Cart is not full</td>
</tr>
<tr>
<td>C10f/Combine</td>
<td>&lt;</td>
<td>24a5/Kinze Grain Cart</td>
<td>10/21/2017 9:57</td>
<td>TRUE</td>
<td></td>
</tr>
<tr>
<td>C139/Red Grain Truck</td>
<td>&lt;</td>
<td>24a5/Kinze Grain Cart</td>
<td>10/21/2017 10:01</td>
<td>TRUE</td>
<td></td>
</tr>
<tr>
<td>C1EC/White Grain Truck</td>
<td>&lt;</td>
<td>USB1/Combine</td>
<td>10/21/2017 10:23</td>
<td>TRUE</td>
<td></td>
</tr>
<tr>
<td>C139/Red Grain Truck</td>
<td>-&gt;</td>
<td>4CB9/CGB Elevator</td>
<td>10/21/2017 11:02</td>
<td>TRUE</td>
<td></td>
</tr>
<tr>
<td>C10f/Combine</td>
<td>-&gt;</td>
<td>24a5/Kinze Grain Cart</td>
<td>10/21/2017 11:06</td>
<td>TRUE</td>
<td></td>
</tr>
</tbody>
</table>
Transfer Events -> Traceability Data Elements

Transfer Events

<table>
<thead>
<tr>
<th>Relay</th>
<th>Direction</th>
<th>Beacon</th>
<th>Start</th>
<th>Status</th>
<th>Violation</th>
</tr>
</thead>
<tbody>
<tr>
<td>C10f/Combine</td>
<td>-&gt;</td>
<td>24a5/Kinze Grain Cart</td>
<td>10/21/2017 7:50</td>
<td>TRUE</td>
<td></td>
</tr>
<tr>
<td>C139/Red Grain Truck</td>
<td>-&gt;</td>
<td>24A3/Wade West</td>
<td>10/21/2017 8:18</td>
<td>FALSE</td>
<td>Cart is not full</td>
</tr>
<tr>
<td>C139/Red Grain Truck</td>
<td>&lt;-</td>
<td>24a5/Kinze Grain Cart</td>
<td>10/21/2017 8:25</td>
<td>FALSE</td>
<td>Cart is not full</td>
</tr>
<tr>
<td>C10f/Combine</td>
<td>BRV</td>
<td>4CB9/Bill's Corn Bin</td>
<td>10/21/2017 9:37</td>
<td>FALSE</td>
<td>BRV</td>
</tr>
<tr>
<td>C139/Red Grain Truck</td>
<td>&lt;-</td>
<td>24a5/Kinze Grain Cart</td>
<td>10/21/2017 9:40</td>
<td>FALSE</td>
<td>Cart is not full</td>
</tr>
<tr>
<td>C139/Red Grain Truck</td>
<td>&lt;-</td>
<td>24a5/Kinze Grain Cart</td>
<td>10/21/2017 9:48</td>
<td>FALSE</td>
<td>Cart is not full</td>
</tr>
<tr>
<td>C10f/Combine</td>
<td>-&gt;</td>
<td>24a5/Kinze Grain Cart</td>
<td>10/21/2017 9:57</td>
<td>TRUE</td>
<td></td>
</tr>
<tr>
<td>C139/Red Grain Truck</td>
<td>&lt;-</td>
<td>24a5/Kinze Grain Cart</td>
<td>10/21/2017 10:01</td>
<td>TRUE</td>
<td></td>
</tr>
<tr>
<td>C1EC/White Grain Truck</td>
<td>&lt;-</td>
<td>USB1/Combine</td>
<td>10/21/2017 10:23</td>
<td>TRUE</td>
<td></td>
</tr>
<tr>
<td>C139/Red Grain Truck</td>
<td>-&gt;</td>
<td>4CB9/CGB Elevator</td>
<td>10/21/2017 11:02</td>
<td>TRUE</td>
<td></td>
</tr>
<tr>
<td>C10f/Combine</td>
<td>-&gt;</td>
<td>24a5/Kinze Grain Cart</td>
<td>10/21/2017 11:06</td>
<td>TRUE</td>
<td></td>
</tr>
</tbody>
</table>

Server Code

- Loads
- Transfer Events
- Unload Events
- Load Events

Adapt Traceability Data Elements ERD
Transfer Events -> Traceability Data Elements

ADAPT Traceability Data Elements ERD

Trace Algorithm
- Load -> Target
- Load -> Source(s)

Traceability Questions:
- Where did the grain in this storage bin come from?
- Where did the grain harvested from this field go to?
- FSMA (One Step Forward – One Step Back)
  - What other containers did a contaminated load come in contact with?
  - What other grain did the container with the contaminated load hold?
2017 Grain Traceability POC – Lessons Learned

- Agricultural environment is very challenging for commercial retail devices
- Constant connectivity is very hard to maintain in agriculture
- Transfer event validation would benefit from the “fusion” of other data sources
  - Grain cart CAN messages,
  - Harvest data and combine CAN messages
  - GPS tracking
- “Ask Jeremy” transfer event validation function needs to be in “real time”
- Data is of little value without context
- TSL required by AWS IoT platform may not be justified
2018 CART PROOF OF CONCEPT
CART 2018 Scope

• Continue container focus; one source of contamination
• Expand on 2017 efforts with smarter edge devices (another harvest season)
  • Determine the Beacon of Interest via Proximity APIs
  • Filter superfluous events
  • Add more context to data (asset and operation metadata, and instance identifiers)
• New: On-farm storage to Grain Elevators process
• New: Grain Elevator to Food Processor process
• New: Recommendation report for grain movement within an Elevator (sensors, process control integration, historians)
Objective: Use Cloud for Completed TransferEvents

IoT Platform
MQTT Endpoint

TransferEvent
TransferEvent
TransferEvent
TransferEvent

On-Farm Storage
Semi Trailer
Grain Elevator Receiving Dump Pit
Grain Elevator Load Out Bin
Semi Trailer
Feed Manufacturer Receiving Dump Pit

On-Farm Storage Load Out
TransferEvent

Co-op Grain Elevator
TransferEvent

CommodityMovement
ERP
CommodityMovement
ERP

FMIS

AgGateway

The InfoAg Conference
Deliverables

Storage to Elevator
- ✓ DRAFT TransferEvent Implementation Guidelines (2)
- DRAFT CommodityMovement Implementation Guideline
- CommodityMovement Integration from Elevator ERP

Elevator to Feed Manufacturer
- ✓ DRAFT TransferEvent Implementation Guidelines (2)
- DRAFT CommodityMovement Implementation Guideline
- CommodityMovement Integration to Feed Manufacturer ERP (in-progress)

Foundational
- RPi3 BLE/MQTT Java Code; “Beacon of Interest” generate TransferEvent
- Cloud API Service (POST/GET)
- Grain Movement within Elevator Recommendation Report
Participants mapped to Process Areas

- Purdue OATS/OADA
- F4F/Proagrica
- Farmers Mutual Hail
- Syngenta; Visualization

AgXML CommodityMovement

FMIS

Redwing Software
AgConnections

On-Farm Storage
Load Out

AgXML TransferEvent

On-Farm Storage

AgXML CommodityMovement

Semi Trailer

AgXML TransferEvent

Semi Trailer

AgXML TransferEvent

AgXML CommodityMovement

WEM Automation

Kahler Automation

SSI

AgVision

John Deere

AgXML TransferEvent

EFC Systems

Kahler Automation

ChargFarms

Key Cooperative

National Institute of Standards and Technology

Land O Lakes
CHS

Google contribution
Timeline

- **Plan/ Spec**
  - Feb 2018

- **Execute**
  - March-May

- **Recalibrate Plan**
  - June MYM 2018

- **Harvest Season**

- **Final Review Annual Meeting**
  - Nov 2018
Grain Movement within the Elevator

• Key Planned 2018 Deliverable: 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)
Grain Movement is most challenging

- Co-mingling of grain is most common
- Segregation is expensive
- Survey of facilities with a wide spectrum of capabilities
- Need use of historians to automatically record conveyance movements; open source NoSQL historians are available
- Goal is to minimize exposure -- if there is a need to recall, narrow it down to a small number of grain deliveries
Futuristic Techniques to Aid Process - Brainstorming

- DNA testing
- RFID mixed with grain; recyclable
- Increased use of camera technology

More innovation needed
Extensive use of Business Process Modeling
Key Discoveries using BPMN

• Comparison of as-is and to-be process models
• Identified where TransferEvents occur
• Identified where data exchange automation is needed between Parties (CommodityMovement)
• Carrier integration is also needed to provide last load information; what commodity (BoL), cleaning info (maintenance records – who, what, when, where, how)
• Key question to answer -- What’s in it for me?
  • Receiving and Load-out Efficiencies
  • Shorter wait times
  • Process control automation; work order completion
  • Ability to count number of trucks waiting for weigh-in, and dump
Data Analysis -> AgXML Updates

BETA v5.0
Why update XML based Data Standards?

• AgXML is currently used in Ethanol industry
• Some Co-op ERPs have v4.0 capabilities

Changes
• V5.0 adds new message called TransferEvent; generated by Smart Device
• Modified CommodityMovement message to embeds RelatedTransferEvents
• Identified additional previous load fields to add to CommodityMovement
• PLAN: Encode TransferEvent and CommodityMovement as JSON Schema
Embeds the IoT data in a B2B message ‘Data Fusion’
Long Term: Cloud to Cloud Interoperability

- On-Farm Storage
- Load Out Bin
- Grain Elevator
- Receiving Dump Pit
- Semi Trailer
- Co-op Grain Elevator
- FMIS
- Commodity Movement
- ERP
- AgFlow
- RDF
- OADA
- Google
- Cloud IoT Core
- AWS
- Internet of Things
- Feed Manufacturer
- Receiving Dump Pit
- ERP
Use of Raspberry Pi3 for TransferEvent
Proximity Challenges during Transfer

RPi3 at each loadout bin; each will detect beacon on a semi-trailer
Use of Raspberry Pi3 at Receiving
Proximity Challenges during Receiving

Multiple trucks lined up waiting for scale; RPi3 will detect beacons on all semi-trailers
Proximity Calculation
AndroidThings for Raspberry Pi3


Raspberry Pi 3

Raspberry Pi 3 Model B is the latest iteration of the world’s most popular single board computer. It provides a quad-core 64-bit ARM Cortex-A53 CPU running at 1.2GHz, four USB 2.0 ports, wired and wireless networking, HDMI and composite video output, and a 40-pin GPIO connector for physical interfacing projects.
How AndroidThings fits with Google’s Cloud IoT Core
Tools for PoC

- Google Beacon Registry – Proximity API
- Cloud IoT Core – Google’s MQTT Endpoint
- BigQuery – serverless SQL DB – free up to 1TB (initial PoC)
- Eclipse Paho MQTT client
- Moquette MQTT Broker (embeddable)

Getting Started

- https://www.protechtraining.com/blog/post/887
- https://github.com/google/beacon-platform
Key AndroidThings APIs for RPi3 – beyond Android

• Proximity API - https://developers.google.com/beacons/proximity/get-started
• Time Sync to Network Time Protocol (NTP) server -

• Other User drivers:
  • Location - https://developer.android.com/things/sdk/drivers/location
  • Low-Power Wireless Personal Area Networks (LoWPAN) API
Closing note for AndroidThings

• AndroidThings is now Generally Available (GA) - v1.0.2
• First-class project in AndroidStudio
• First code was beta; still breaks
• There is no Android Virtual Device (AVD) simulated device for AndroidThings in AndroidStudio
• If you try to use an existing AVD such as a phone, the phone will try to install AndroidThings libraries and will fail
• You will need to test on the Raspberry Pi3
• AndroidStudio is NOT supported on Raspberry Pi3 Model B+ at this time
Harvest Simulation Efforts
Evaluation of Blockchain for Grain Traceability

Initial thinking: Grain mixing/blend/transfer makes Previous Hash hard to re-calculate and correlate

Grain Settlements using Smart Contracts is our focus.
More to come! Blockchain vendors have joined as members!
Blockchain

- 2018 MYM had Blockchain presentations from Purdue University and ChronicleD
- Technical overview – Prof Jim Krogmeier and Aaron Ault
- Business Cases – ChronicleD CTO Maurizio Greco and Abhishek Gutgutia, VP of Product and Client Solutions

Summary:
- Be very selective of your use cases
- The cost and performance is not ready for prime-time
- Key use cases could be ledger-based (Smart Contract), logistics (CommodityMovement)
- Still requires the data standards
TRACEABILITY WORK GROUP – LINKED DATA
Define how to Link Data

- Product Recall
- Consumer Demand

Fits Resource Description Framework (RDF)

RDF Graph represented as ‘triples’:
- RDF/XML
- Turtle
- JSON-LD

Subject → Predicate → Object
Resource Description Framework

• Syntax Neutral
• Data referenced by URLs; can reside in distributed repositories
• Usually an RDF HTTP endpoint has a triple store behind it
• Security protocols not prescribed but required
• We will look to our NIST friends for guidance as this also touches on their Industry Ontology Foundry work
Provenance

Information provenance is a mechanism for tracing and verifying sources of information. In software development, provenance can be seen in two dimensions:

- (a) traceability among different versions of the same artifact and
- (b) traceability among various artifacts across system lifecycle.

Link Information from current and prior work efforts

**Soil Health**
- Lab Inspection Orders
- Lab Test Results
- Soil moisture (IoT)
- IoT Soil elements
- IoT pH
- Compaction
- Manure Management

**Weather**
- Weather stations; Quantitative measures wind, rain, clouds
- Events
- Insurance Claims
- Imaging of Crop Damage
- Rain gauges

**As-Planted**
- Seed /Product identification (AutoID)
- Seed Treatment
- Planned vs Actual Seeding
- Variable rate seeding Applications
- Geo-polygon boundary; planned vs Actual; rendering from seeding operations

**As-Applied**
- Water management (PAIL); irrigations
- Tissue testing; Nutrients absorbed by plants
- Pest scouting
- Variable Rate application data
- Crop Protection (Product and BOM)
- Crop Nutrients (Product and BOM)
- Imaging for pests, crop damage
- MixTicket work orders, actual BOM of blends
- On-field mixing
- Sensor data
- Container Maintenance

**As-Harvested**
- Geo-polygon boundary rendering from harvest operations
- Real-time moisture readings
- Proteins tests
- Beacons / IoT
- Imaging for mold identification, crop damage
- Dust monitoring / Explosions
- TransferEvents

**Supply Chain**
- Reference Data; product identification
- Commodity Movement
- Testing of grains prior to send to elevators
- Financial Settlements
Innovations yield new sources of information

- Internet of Things (IoT) – Smart Sensors and Actuators
- Drones – Imaging, Sensors on Drones
- Outputs from new Algorithms driven by AI and Machine Learning; derivative works
Soil Sampling
Manure Management
Additional Nutrient Applications
Seed Planting
Crop Protection
Tissue Sampling
Harvest
Cart
Storage
Lab Request
Batch ID
Batch ID
Seed Lot ID
Seed Lot ID
Seed Treatment Batch ID
Seed Treatment Batch ID
Batch ID
Lab Request
Lab Request
Lab Request
Lab Request
Batch ID
Batch ID
Batch ID
Batch ID
BoM
BoM
BoM
BoM
Traits
Traits
Traits
Traits
Test Results
Test Results
Test Results
Test Results
Work Record
Work Record
Work Record
Work Record

Clearly raises questions of transparency ‘willingness’
Methods of Identification – No winners

• All open game
• Bluetooth LE beacons
• RFID
• Cameras
• DNA
• Biometrics
Challenges with Identifiers and Identification

• Typically identifiers can carry forward only from previous step
• Restated: we lose identifiers as you progress forward throughout the lifecycle
• Need to leverage key identifiers in a Linked Data approach, pulling these identifiers out of key business transactions
  • Orders (Purchase, Sales, Inspection, Work, etc.)
  • Shipment Notices (Commodity Movement, X12 856 ASN)
  • Work Records (Test Results, Work Order Completion)
  • Master / Reference Data (Items, Bill of Materials, etc.)
• Need more standards-based Identifiers – GS1 GTIN, GLN, and 128
• Compound Identifiers in ADAPT provide means to carry partner specific identifiers
Reminder - Key Use Case – Consumer Demand


SHoppers WANT TO GO BEYOND THE LABEL
We are looking for YOUR input

Please join us at AgGateway!

Thank you!!
Standards Interoperability: A New Challenge in Agricultural Documentation

Joe W. Tevis, PhD
Vis Consulting
Precision Ag Cycle

1990

Management is the KEY

- Fertilization
- Seeding
- Cultivation
- Data Collection
- Yield Monitoring
- Personal Computer
- Management Strategy
- Precision Maps
- Equipment

2014

- Planning & Documentation
- Planting
- Growing
- Harvesting

- GPS
- Specific Equipment
- Decision Support Systems
- Electronic Data Management
- Data Aggregation
- Yield Maps
People We Share Data With

- Local coop for VRA fertility Recommendations
- Seed dealer for VRA planting Recommendations
- Crop IMS for data analysis & water management enhancements
- Crop insurance agent for acreage & actual production history reporting
- Landlords wanting to keep production records on their fields
Ag Data Management – Today's Reality

- Grower
  - History (Work Records, Observations & Measurements)
  - Crop Plan
  - Observations & Measurements
  - Crop Scout or Other Data Source
  - Work Record
  - Work Order
  - Reports
  - Grain Marketers

- Service Provider
  - FMS
  - Work Order
  - Service Provider

- Crop Input Suppliers
  - Product Identifiers

- Regulatory

- Advisor
  - Recommendation

- Ag Gateway

- Crop Marketers

- Todays Reality

Product Identifiers
Grain Marketers
Common Scenarios

Data Collected Under Standard “A”

Data Collected Under Standard “B”

Reports Generated Under Standard “B”

Reports Generated Under Standard “C”
Possible Solutions

1. Ignore….let the growers struggle with the status quo
2. Lock the door and argue until one standards exists the winner!
3. “Create a canonical” …one standard that includes all possible
4. Pursue standards interoperability
   1. Changes and enhancements
   2. Guidelines for implementation
GRAIN TRACEABILITY
Harvested Commodity / Traceability Value Chain
AgGateway CART Project

**Commodity Automation for Rail and Truck**

- Jan 2017 CART Face to Face meeting at SSI offices, Shellbyville IL
- Identified “touch points” between ISO 11783 and AgXML
- Identified grain transfer use cases beyond ISO/AEF
  - Semi to on-farm storage
  - Cart to on-farm storage
  - Semi to elevator
  - Semi to food processor
  - Elevator to food processor
- Defined enhancements to AgXML
IDENTITY PRESERVATION - SEED
Seed Identity / Traceability Value Chain

GS1-128
- Genetics Providers
- Seed Manufacturer
- Seed Retailer
- Grower
- Transport Vehicle
- Seed Tender
- Planter

ISO 11783

Traceability
## Bar Code 128 (w/lot number)

<table>
<thead>
<tr>
<th>Primary Objectives</th>
<th>Provide unique identifier for crop input products</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Facilitate efficient tracking of products for supply chain</td>
</tr>
<tr>
<td></td>
<td>Inventory management</td>
</tr>
<tr>
<td>Administration</td>
<td>GS1</td>
</tr>
<tr>
<td></td>
<td>AgGateway AIDC Working Group</td>
</tr>
<tr>
<td>Access</td>
<td>Free to public</td>
</tr>
</tbody>
</table>
## Gap Analysis – Bar Code Content & Requirements

<table>
<thead>
<tr>
<th>Product GTIN View</th>
<th>Contact Us</th>
<th>Logout</th>
<th>R. FRY - CERES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Company/EBID:</strong> MONSANTO CO SEED ASDKDP</td>
<td><strong>Product Number:</strong> DK64-99RIB A6</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Company Prefix:</strong> 0883560</td>
<td><strong>Pkg ID:</strong> 78761</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GTIN:</strong> 00883560787611</td>
<td><strong>Pkg Level Code:</strong> 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Product Name:</strong> DK64-99RIB (VT2PRIB)</td>
<td><strong>Pkg ID Name:</strong> DK64-99RIB AF2 VT2P SP50 BAS250</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Acceleron 250</strong></td>
<td><strong>Pkg Status:</strong> Active</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Primary Category:</strong> Seed</td>
<td><strong>Additional Categories:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Product Status:</strong> Active</td>
<td><strong>Pkg ID Status:</strong> Active</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Qty/Value</strong></td>
<td><strong>Reporting Unit of Measure:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pkg ID Base Qty:</strong> 50</td>
<td><strong>Brand:</strong> DEKALB</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pkg ID Package Unit of Measure:</strong></td>
<td><strong>Crop:</strong> Corn</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pkg ID Package Unit of Measure:</strong></td>
<td><strong>Proprietary Code:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Reporting Unit of Measure:</strong></td>
<td><strong>Optional Fields:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Linked Agreements:</strong> (1 linked agreement)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**UOM/ANSI X12** | **UOM/REC 20**
---|---
UN - Unit | UN - Unit
BG - Bag | BG - Bag
BG - Bag | BG - Bag
UN - Unit | UN - Unit

**Variety/Hybrid:** DK64-99RIB
**Seed Size:** AF2

Notify Manufacturer: Back

[The InfoAg Conference Logo]
GOVERNMENT COMPLIANCE
USDA Reporting

As-planted Report → FSA Crop Plan
Harvest Report → RMA Insurance Claim
# USDA Commodity Validation Table (CVT)

<table>
<thead>
<tr>
<th>Commodity Name</th>
<th>Commodity Type Name</th>
<th>Actual Use Name</th>
<th>Production Unit of Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agave</td>
<td>N/A</td>
<td>Cover</td>
<td>N/A</td>
</tr>
<tr>
<td>Agave</td>
<td>N/A</td>
<td>Destroyed</td>
<td>Pounds</td>
</tr>
<tr>
<td>Agave</td>
<td>N/A</td>
<td>Fresh</td>
<td>N/A</td>
</tr>
<tr>
<td>Agave</td>
<td>N/A</td>
<td>Left Standing</td>
<td>Pounds</td>
</tr>
<tr>
<td>Agave</td>
<td>N/A</td>
<td>Processed</td>
<td>N/A</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>N/A</td>
<td>Cover</td>
<td>N/A</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>N/A</td>
<td>Destroyed</td>
<td>Pounds</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>N/A</td>
<td>Foraging</td>
<td>N/A</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>N/A</td>
<td>Grazing</td>
<td>Tons</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>N/A</td>
<td>Left Standing</td>
<td>AUD</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>N/A</td>
<td>Seed</td>
<td>N/A</td>
</tr>
<tr>
<td>Algae</td>
<td>Ogo (Red)</td>
<td>Biomass</td>
<td>Pounds</td>
</tr>
<tr>
<td>Algae</td>
<td>Ogo (Red)</td>
<td>Destroyed</td>
<td>N/A</td>
</tr>
<tr>
<td>Algae</td>
<td>Ogo (Red)</td>
<td>Fresh</td>
<td>Pounds</td>
</tr>
<tr>
<td>Algae</td>
<td>Ogo (Red)</td>
<td>Left Standing</td>
<td>N/A</td>
</tr>
<tr>
<td>Algae</td>
<td>Ogo (Red)</td>
<td>Processed</td>
<td>Pounds</td>
</tr>
<tr>
<td>Algae</td>
<td>Ogo (Red)</td>
<td>Destroyed</td>
<td>N/A</td>
</tr>
<tr>
<td>Algae</td>
<td>Ogo (Red)</td>
<td>Fresh</td>
<td>Pounds</td>
</tr>
<tr>
<td>Algae</td>
<td>Ogo (Red)</td>
<td>Processed</td>
<td>N/A</td>
</tr>
<tr>
<td>Alligators</td>
<td>N/A</td>
<td>N/A</td>
<td>Pounds</td>
</tr>
<tr>
<td>Alligators</td>
<td>N/A</td>
<td>N/A</td>
<td>Pieces</td>
</tr>
<tr>
<td>Alligators</td>
<td>N/A</td>
<td>N/A</td>
<td>Pieces</td>
</tr>
<tr>
<td>Almond Trees</td>
<td>N/A</td>
<td>N/A</td>
<td>Pieces</td>
</tr>
<tr>
<td>Almond Trees</td>
<td>N/A</td>
<td>N/A</td>
<td>Pieces</td>
</tr>
<tr>
<td>Almonds</td>
<td>N/A</td>
<td>N/A</td>
<td>Pieces</td>
</tr>
<tr>
<td>Almonds</td>
<td>N/A</td>
<td>N/A</td>
<td>Pieces</td>
</tr>
<tr>
<td>Almonds</td>
<td>N/A</td>
<td>N/A</td>
<td>Pounds</td>
</tr>
<tr>
<td>Almonds</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Almonds</td>
<td>N/A</td>
<td>N/A</td>
<td>Pounds</td>
</tr>
<tr>
<td>Almonds</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Almonds</td>
<td>N/A</td>
<td>N/A</td>
<td>Pounds</td>
</tr>
</tbody>
</table>

*Note: CVTPUM is a placeholder for the production unit of measure.*
TRANSFER & COMMUNICATION
AEF EFDI Wireless Project

- File Transfer
- Coverage maps
- Seed/chemical refill info
- Messages
  - Instructions
  - Confirmation
Road Map to Standards Interoperability

- Standards memberships recognize a mutual opportunity
- Upper management of both Standards groups reach an “understanding”
  - Publicly commit to pursue mutual benefits
  - Define a framework for cooperation
- Publish guideline for interfacing between standards
- Verify by a cooperative project from start to finish
The Geopolitical-Context Challenge

- We’d like for our solution to simultaneously:
  - Support US, EU,, etc. geopolitical-context-dependent data, yet
  - Not clutter the standard that seeks to remain generic.
  - Support controlled vocabularies, yet
  - Allow for simple extensibility thereof.

- Enter ADAPT (Open-source programming toolkit)
  - Common object model
  - Format conversion library
    - Manufacturer-specific “plug-ins” that convert to/from the common object model
Q&A / OPEN DISCUSSION
THANK YOU