Toward geopolitical-context-enabled interoperability in precision agriculture: AgGateway’s SPADE, PAIL, WAVE, CART and ADAPT

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Seeking a metaphor for field operations data...

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4 Things we want to agree on

- Can we agree on **what things mean**? (Semantics)
  - For humans: Ag Glossary
  - For computers: Reference Data
- Can we agree on **how things happen** (Processes)?
  - Stories, Process Models, Use Cases
- Can we agree on **what we need to know** (Data Requirements)?
  - Core Documents
  - Irrigation (PAIL)
  - Telematics (WAVE)
  - Grain handling (CART)
  - ContextItems
- Can we agree on **how things can talk to each other** (Interoperability)?
  - ADAPT object model, ADAPT plug-in framework
  - SPADE Reference Data APIs
  - Upcoming SPADE /PAIL work on data exchange

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## Projects’ Scope

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**KEY - S1: SPADE1; S2: SPADE2; S3: SPADE3; A: ADAPT; P1: PAIL1; P2: PAIL2.**
Topics in the Paper

- Introduction
- First steps and a vision
- The Development Process
- Business Processes
- AgGateway’s Core Documents for Field Operations
- PAIL: Standards for Irrigation Data Exchange
- Existing standards
- CART
- WAVE
- OK to Spray
- ADAPT
- Geopolitical context dependent data
- Discussion

Get the paper here: http://bit.ly/2aQVT5d
Agreeing on *what things mean*

- **Identity:**
  - Need common identifiers to convey common meaning

- **Sourcing:**
  - How can we source those common identifiers?

- **Access:**
  - How can we find those sources?

- **Ag Glossary:** [www.agglossary.org](http://www.agglossary.org)
  - Teaching and discussion-support tool
  - Currently on MediaWiki; moving to a semantically-richer platform
  - Contains terms from many sources; identifies origin

- **Reference Data:**
  - Standardized, distributed system for delivering identifiers.
Agreeing on *how things happen*

- Development process
  - User Stories
  - Process models using BPMN
  - Use cases
Agreeing on *what we need to know*

Data Requirements

- Core Documents
- Irrigation (PAIL)
- Telematics (WAVE)
- Grain handling (CART)
- Geopolitical Context-Dependent Data: ContextItems
The Core Documents (to date)

• Plan
  • "This is how we are going to grow this crop this season"

• Observations and Measurements:
  • “This is happening out in the field"

• Recommendation
  • "This is what I recommend we do about it"

• Work Order
  • "This is what we are going to do“

• Work Record
  • "This is what we actually did"
Core Documents and their Relationships

- Observations and Measurements
  - Motivates
  - Informs
  - Provides context for Reference, Setup and Configuration Data

- Plan
  - Informs
  - Provides context for Reference, Setup and Configuration Data
  - Motivates

- Recommendation
  - Provides context for Reference, Setup and Configuration Data
  - Informs
  - Motivates

- Work Record
  - Provides context for Reference, Setup and Configuration Data
  - Is represented by Field operation
  - Motivates

- Work Order
  - Provides context for Reference, Setup and Configuration Data
  - Informs
**Motivation:**

- Enabling principled decision-making in the context of increasing resource scarcity.

**Deliverables:**

- User stories
- Process models
- Use cases
- Data exchange schema
- Reference data (in progress)
- Data exchange API (in progress)
- A standard (X632, in progress)
Geopolitical-Context-Dependent Data

• Accommodating geopolitical-context-dependent data (e.g., EPA, FSA numbers) is critical for this work to be relevant to a grower, but conflicting requirements must be reconciled:
  • Standards favor universality (i.e., staying free of regionally-specific clutter.)
  • Local business processes involve local data.
• Additionally,
  • We want controlled vocabularies. (To enforce shared meanings among actors), but,
  • the dynamic nature of business / regulation requires the vocabulary to be easily extensible.
The ContextItem

• We reconciled the contradictions by defining an object class, the ContextItem, that can be attached to various objects in an object model.
  • A ContextItem is a key/value structure where the “key” code references a ContextItemDefinition that defines what each ContextItem means.
  • The “value” is composed of a string value along with data needed to interpret it (such as a unit of measure) or a nested list of other ContextItems (e.g. PLSS cadastral information.)

• The SPADE Reference Data API Product Team implemented a RESTful API to provide a machine-readable vocabulary of ContextItemDefinitions;

• AgGateway’s Standards & Guidelines Committee created an ad-hoc group to manage the vocabulary.

• Get ASABE paper on this topic at: http://bit.ly/2aAWpmH
Agreeing on how things talk to each other

• Ag Data Application Programming Toolkit (ADAPT):
  • A common object model for field operations.
  • A set of data conversion plug-ins (both open source and proprietary).
  • A plug-in management framework.

• ADAPT’s goals:
  • To enable communications between Machine / Implement Control Systems (MICS) and Farm Management Information Systems (FMIS) as well as among different FMIS.
  • To be geo-political-context-independent (strong emphasis on enabling international use).

• Open-source implementation:
  • Eclipse public license
  • Learn more at www.adaptframework.org
Discussion Points

- Expediency vs Consensus
- The Critical Role of Modeling Tools
- The Value of the ContextItem System’s Data-Driven Approach
- Impact on Standards Processes
- Infrastructure-Building
- Future Direction: Implementation

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Summary I

• Strong market forces are demanding the rapid deployment of standard data formats for precision agriculture.
• The sheer need to feed an ever-increasing global population with limited resources in the context of an ever-increasing regulatory burden requires **principled decision-making** regarding crop input usage.
• This includes the capture and sharing of a variety of data points across multiple hardware and software platforms; i.e., greater **interoperability**.
Summary II

• AgGateway created its Precision Ag Council and subsequently chartered the SPADE (including CART and WAVE) and PAIL projects to address the need for greater interoperability.

• These teams followed a development process that fostered collaboration among a large group of domain and technical experts, including the capture of user stories, use cases, process models, data requirements;

• This was followed by the gap-checking (and proposal of extensions thereof, or new solutions, where appropriate) of existing data standards.
A lot of work went into the development of infrastructure to support the desired outcomes:

- the ADAPT framework (www.adaptframework.org),
- the AgGateway standing committee created to house it for the future, and
- the SPADE Reference Data API Team’s work on implementing proof-of-concept application programming interfaces.
Summary IV

Future direction includes further **infrastructure development**, adopting **industry standard best practices** for data exchange authorization, authentication and supporting data services, to be followed by implementation of

- Reference Data APIs and
- Core Document exchange.
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Questions?

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