



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

R. Andres Ferreyra, Ph.D. (Ag Connections, LLC)
13th International Conference on Precision Agriculture
St. Louis, August 3, 2016

Papaer available here: <http://bit.ly/2aQVT5d>

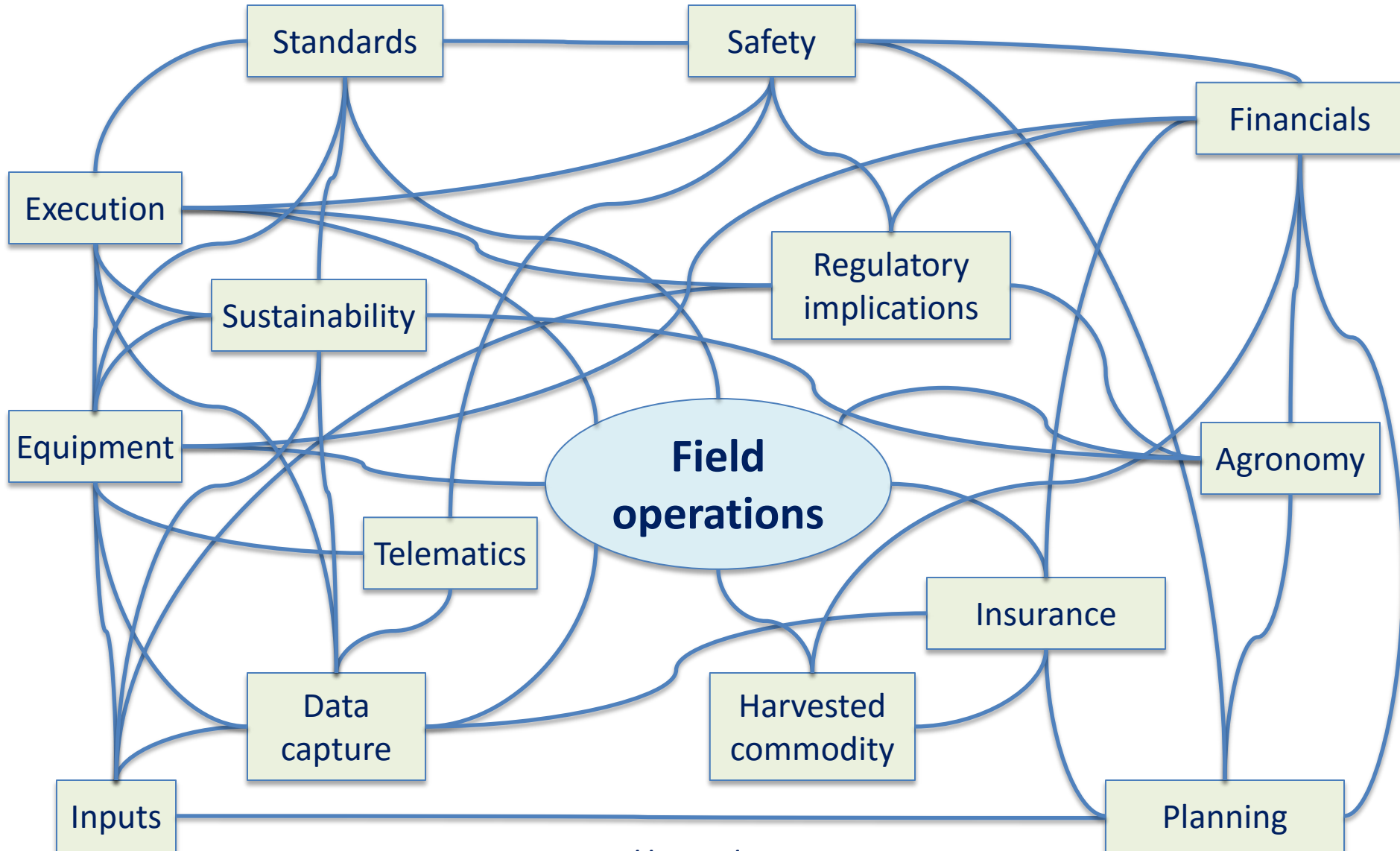
Authors

Applegate, Doug B. (Praxidyn); Berger, Aaron W. (AgSense);
Berne, Daniel T. (NEEA); Bullock, Rob (SSI);
Craker, Ben E. (AGCO); Daggett, Dennis G. (ProAg);
Ferreya, R. Andres* (Ag Connections); Gowler, Andrea (SSI);
Haringx, Shannon C. (Syngenta); Hillyer, Charles (TAMU AgriLife);
Howatt, Todd (AGCO); Nef, Bart (Campbell Scientific);
Nieman, Scott T. (Land O'Lakes); Reddy, Linga T. (John Deere);
Rhea, Stuart T. (Ag Connections); Russo, Joseph M. (ZedX);
Sanders, Patrick (SST); Schultz, Eric D. (Schultz Consulting);
Shearouse, Timothy W. (John Deere);
Stelford, Mark W. (Premier Crop) Tevis, Joe W. (TOPCON);
Wilson, Jeremy W. (CropIMS); Wilson, James A. (AgGateway)

* Corresponding author

<http://bit.ly/2aQVT5d>

Seeking a metaphor for field operations data...





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

Projects' Scope

Requirements
 Process definitions
 Data requirements
 Standards Gap-Checking
 Infrastructure
 Implementation

Reference data APIs	S1	S2	S2	-	S3	S3
Seeding operations	S1	S1	S1	S1	A	S3
Harvest operations	S2	S2	S2	S2	A	S3
Crop protection operations	S2	S2	S2	S2	A	S3
Crop nutrition operations	S3	S3	S3	S3	A	
Grain handling (CART)	S3	S3	S3	S3		
Crop scouting operations	S3	S3	S3	S3	A	
Telematics (WAVE)	S3	S3	S3	S3		
Sensor and weather data	P1	P1	P1	P1	P2	P2
Irrigation Operations	P1	P1	P1	P1	P2	P2

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*

- Ag Glossary: 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.

Identity

Need common identifiers to convey common meaning

Sourcing

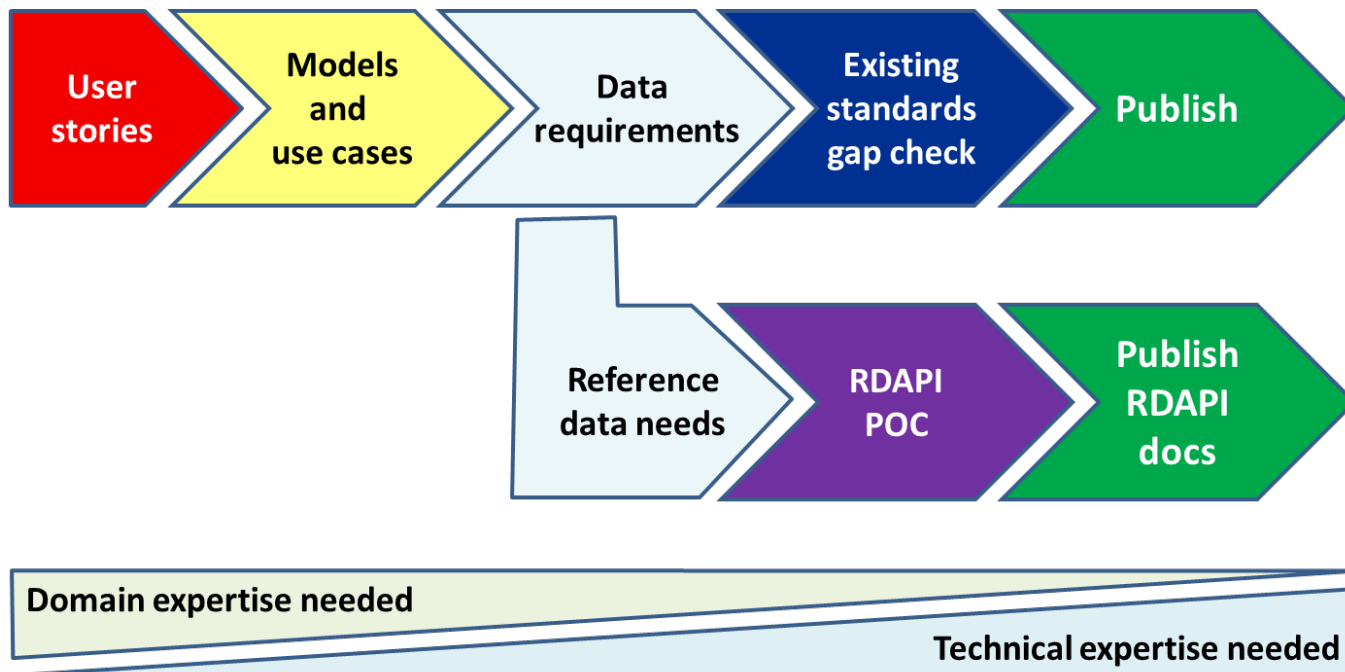
How can we source those common identifiers?

Access

How can we find those sources?

Agreeing on *how things happen*

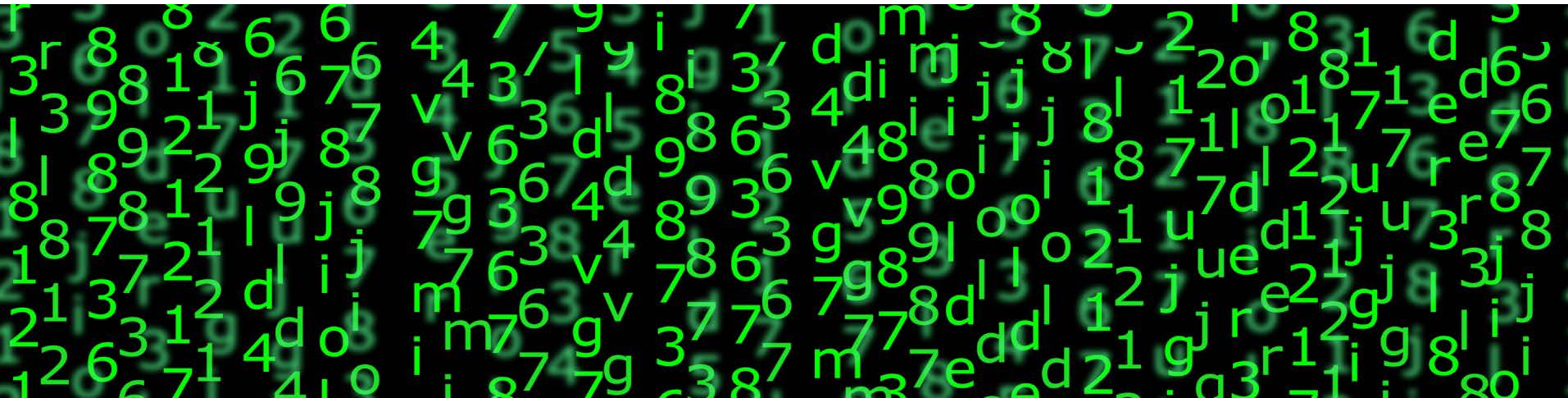
- Development process
 - User Stories
 - Process models using BPMN
 - Use cases



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"

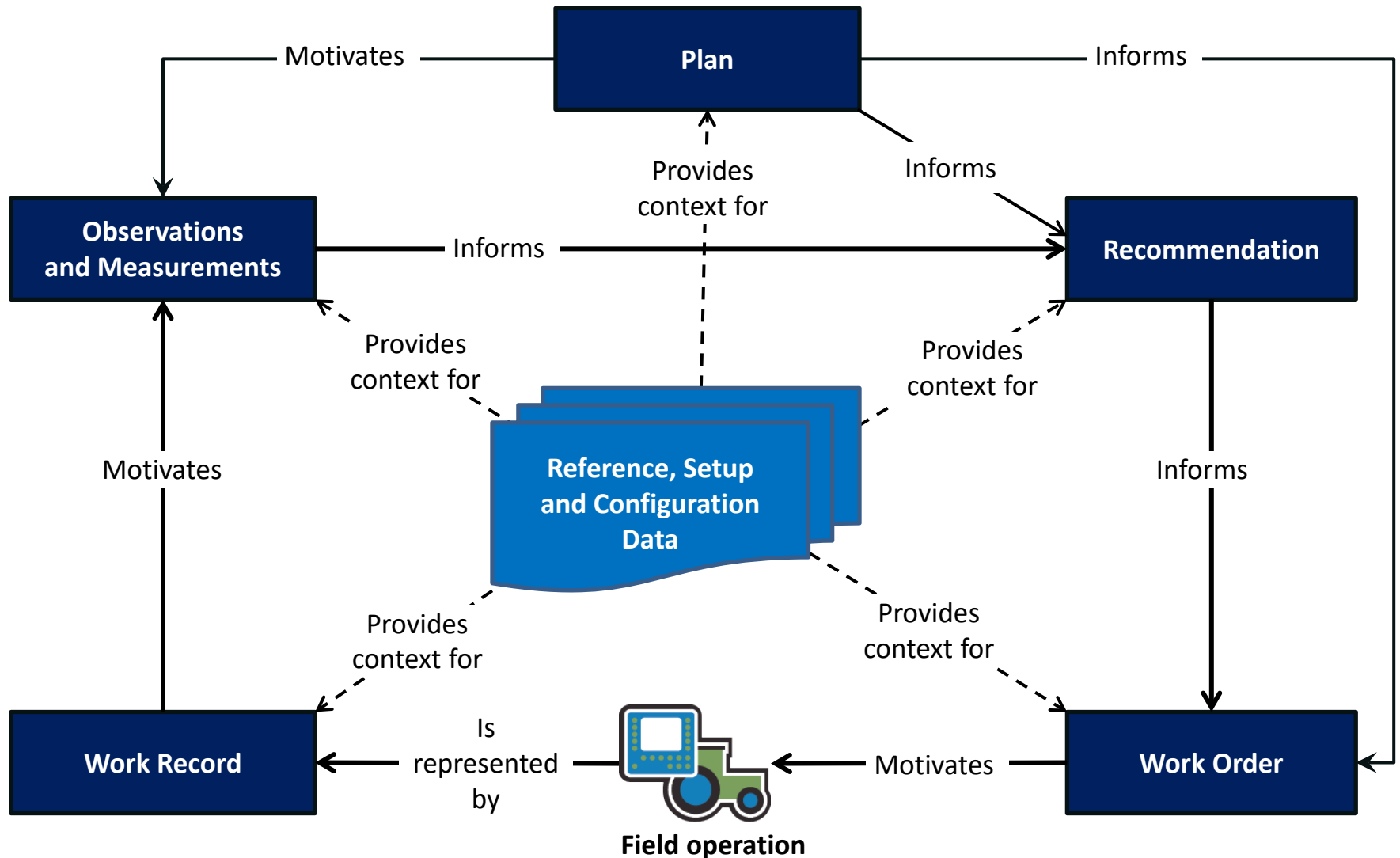
- **Work Order**

- "This is what we are going to do"

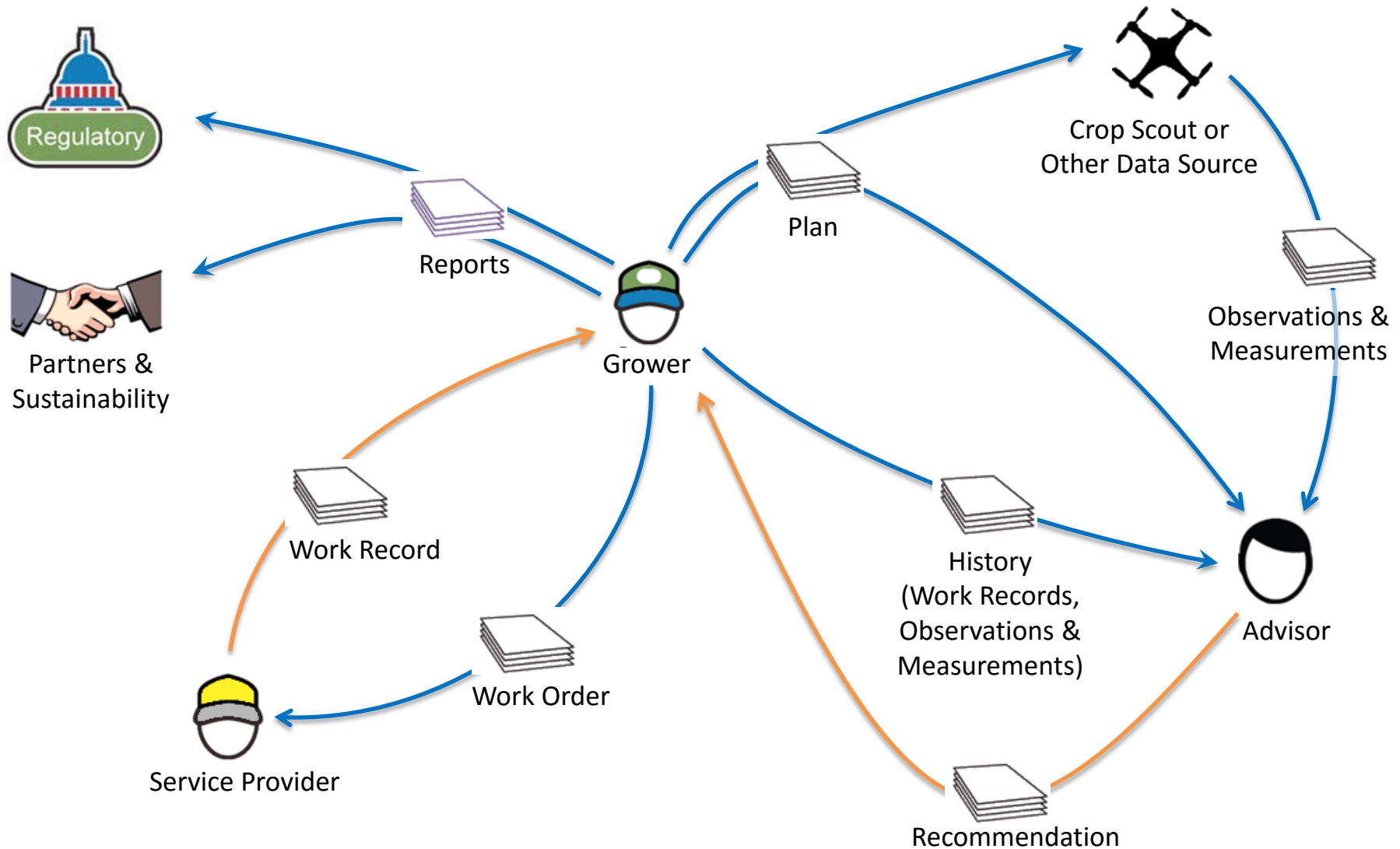
- **Work Record**

- "This is what we actually did"

Core Documents and their Relationships

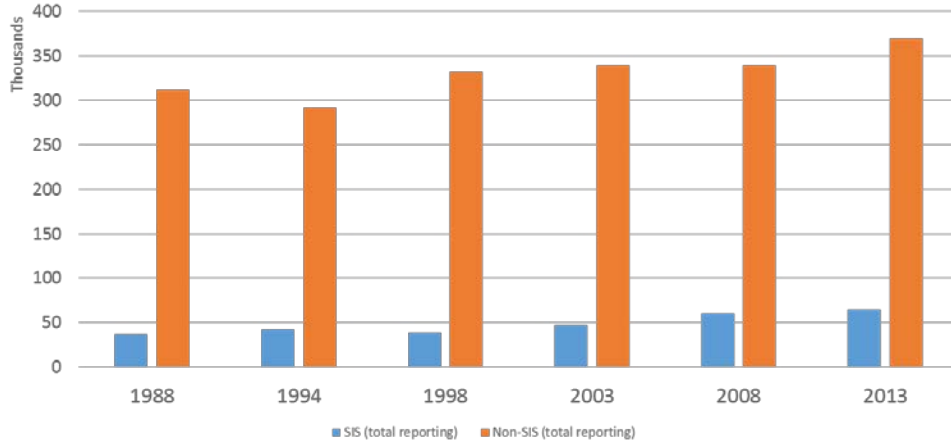


Core Document Flow



PAIL

SIS vs Non-SIS Methods Used
From the last six Farm And Ranch Irrigation Surveys

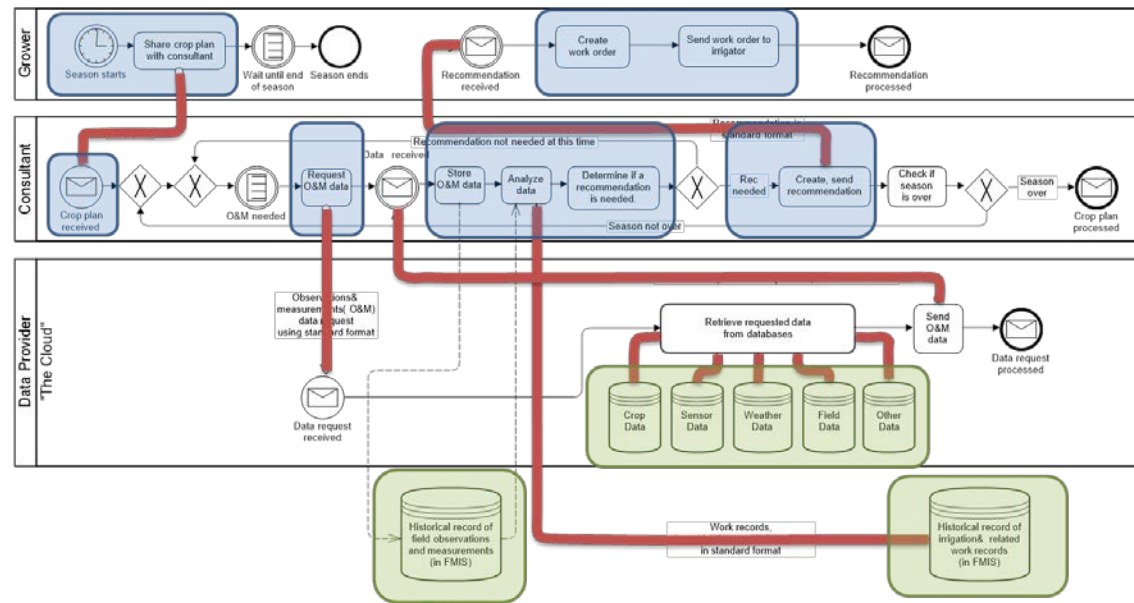


Motivation:

- 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

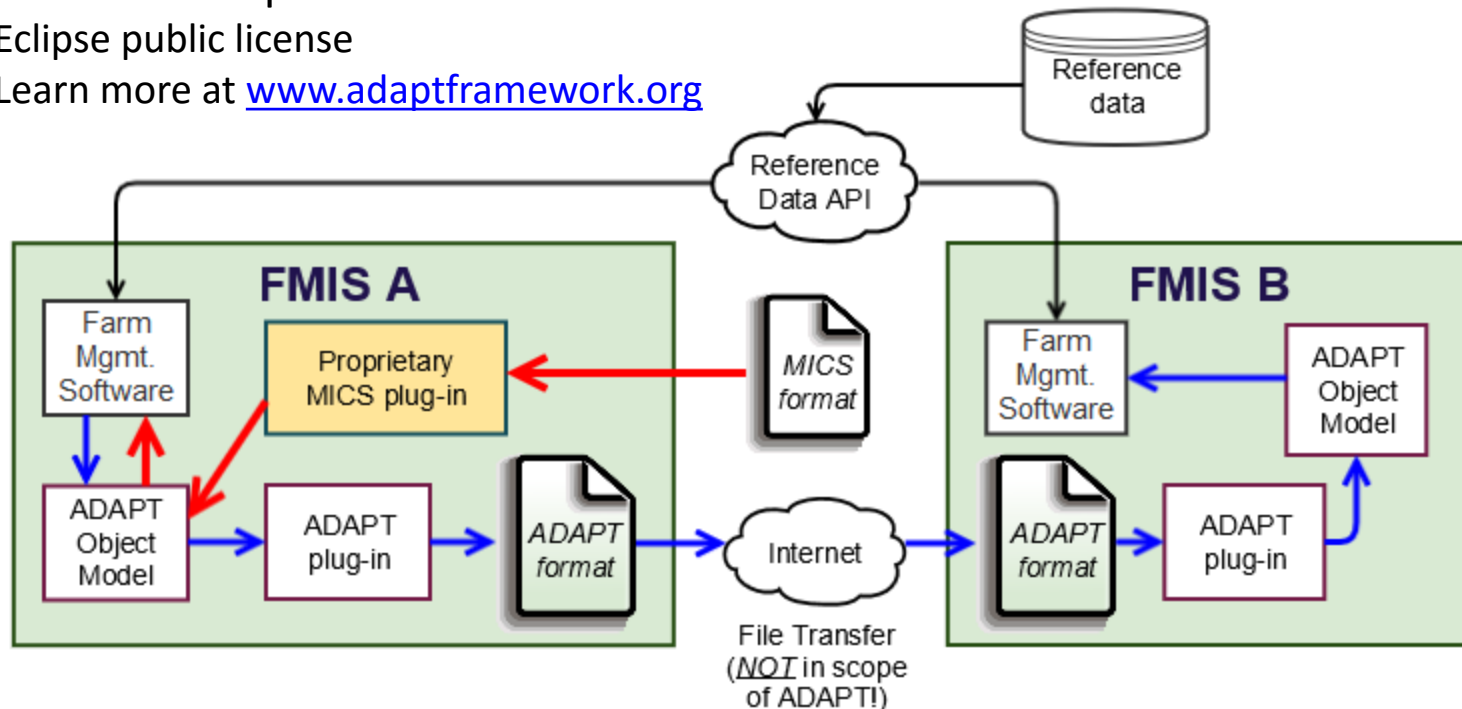
- Accommodating geopolitical-context-dependent data (e.g., EPA, FSA numbers) is critical for this work to be relevant to a grower, but conflicting requirements must be reconciled:
 - Standards favor universality (i.e., staying free of regionally-specific clutter.)
 - Local business processes involve 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

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.

Summary III

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.

Acknowledgements

The authors gratefully acknowledge the contributions of the dozens of other industry participants and AgGateway staff who participated in the work presented herein.

Special thanks go to AgGateway member companies for their huge contribution of resources necessary for making the idea of eAgriculture a reality.



Questions?

andres.ferreyra@agconnections.com

Get the paper here: [**http://bit.ly/2aQVT5d**](http://bit.ly/2aQVT5d)