AgGateway-ASABE Work toward an Irrigation Data Exchange Standard

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STATING THE PROBLEM

The Need

- Increasing need for principled decision-making in agriculture.
  - Translates to farmers' need for actionable information to plan and manage their field operations (including irrigation.)
- The process must be **scalable**!

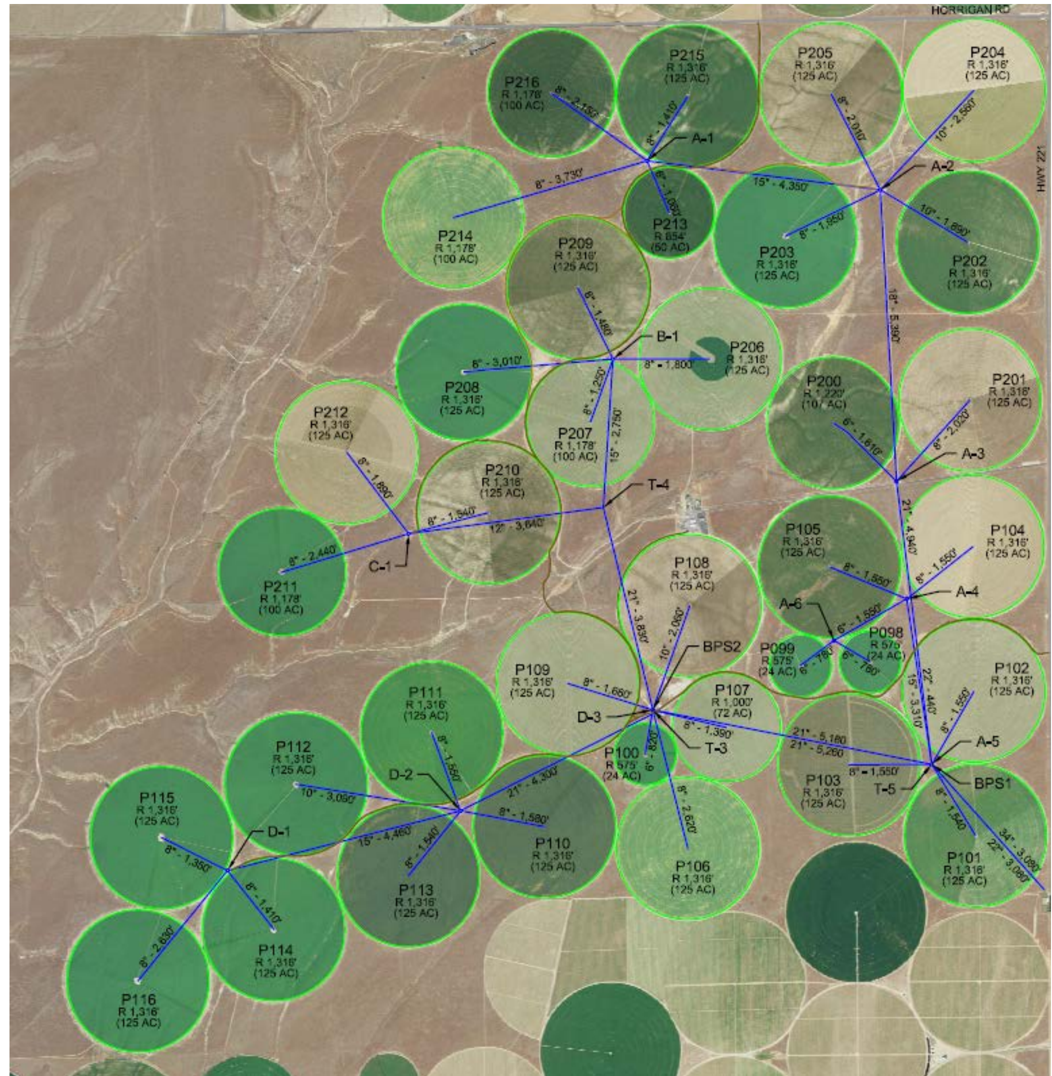
Challenges

- Different brands of equipment rarely talk to one another.
- Complexity is compounded when the farmer has a mixed fleet of equipment.
- Farmers and their advisors spend valuable extra time trying to analyze data and interpret it to derive actionable information.

Farmer Example: The Equipment

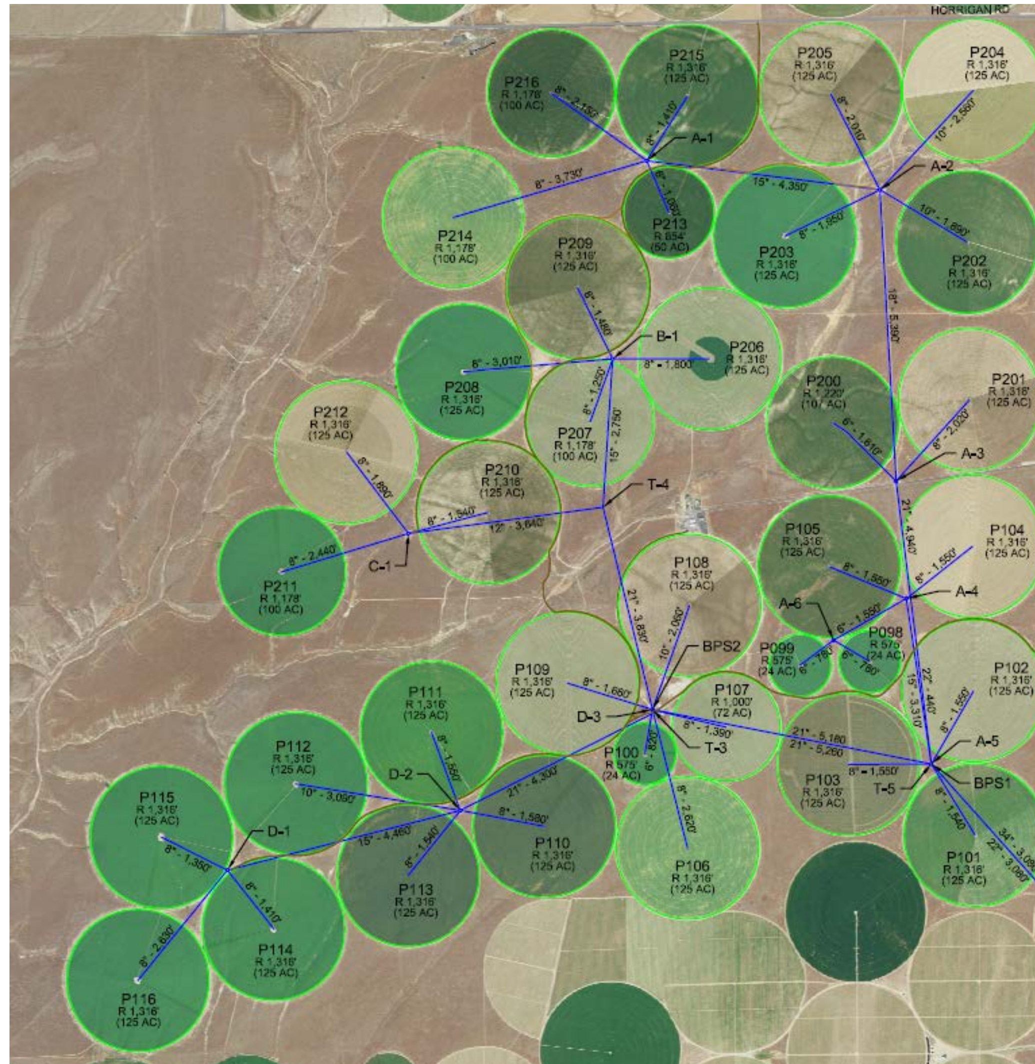
This example is representative of farmers attempting to use technology to make principled irrigation scheduling decisions in various parts of North America.

- 32 x 400-meter Pivots
- Pivot control system
- Soil Moisture Monitoring
- Weather Station
- Pump Controls
- Remote telemetry for all systems



Farmer Example: The Data

- Trying to support principled irrigation scheduling decisions
  - a.k.a. Scientific Irrigation Scheduling
- Decision-making inputs:
  - Weather (ET & Precip)
  - Recent irrigation history
  - Soil moisture measurements
  - Energy and water availability constraints
  - Other regulatory constraints
- A typical current management system requires multiple Copy/Paste steps among different pieces of software, **for each pivot.**
- 3-4 minutes/pivot by a specialized (expensive) user **= 96-128 minutes**
- Time consuming x expensive = **NOT SCALABLE!!!**



PAIL: THE AGGATEWAY-ASABE IRRIGATION DATA FORMAT STANDARDS PROJECT

NEEA, AgGateway, PAIL

- The Northwestern Energy Efficiency Aliance (NEEA), an organization funded by a group of electrical utilities in the Northwest USA to save energy through increased efficiency, brought together a group of companies to develop common data exchange standards.
- This work was later moved into AgGateway for development, to leverage the AgGateway collaborative mechanisms and anti-trust and intellectual property framework.
  - AgGateway chartered the PAIL project in early 2013 to provide a home for this.

AgGateway and ASABE

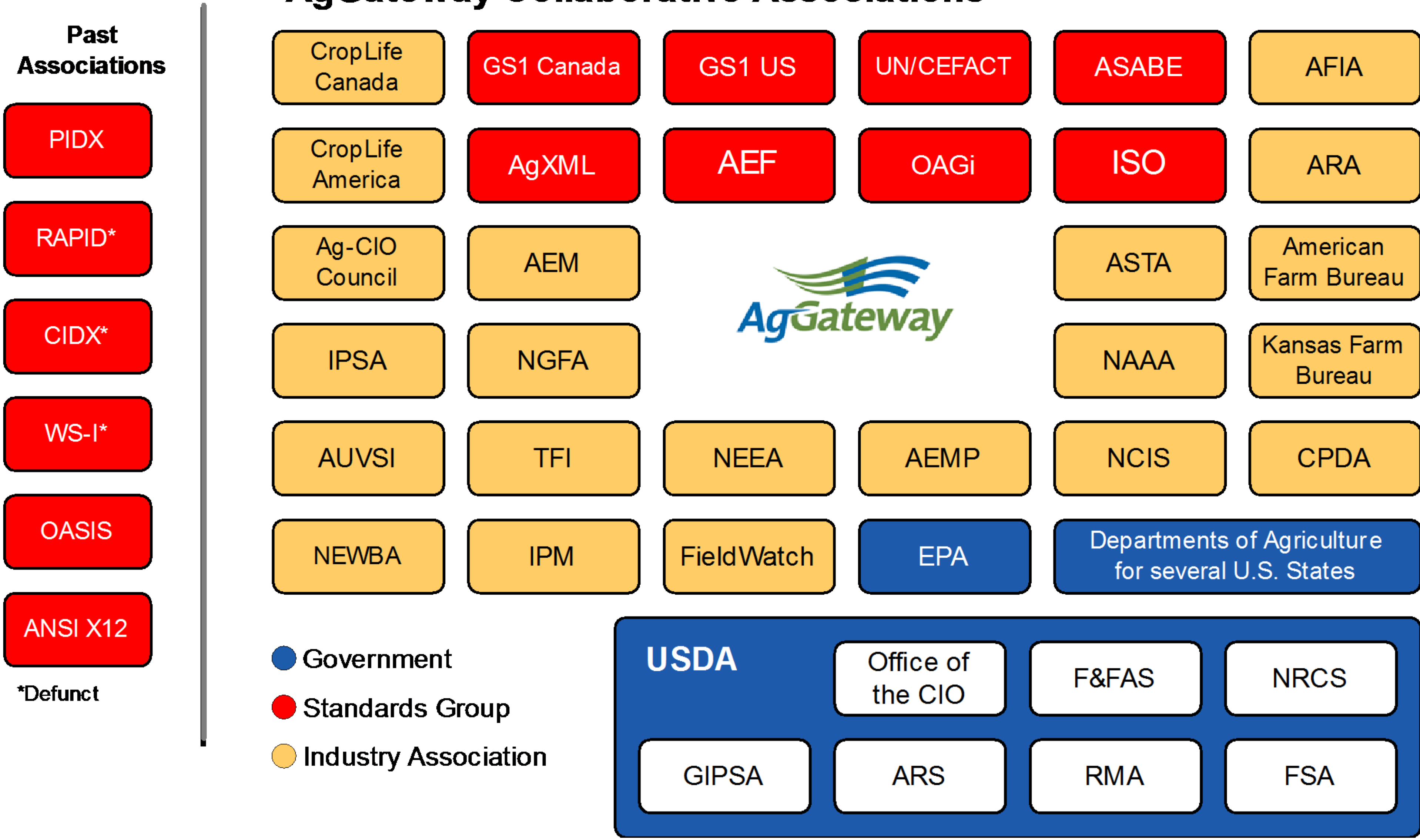
- AgGateway does not usually develop standards. Its focus is on implementation (or enhancement, when necessary) of existing standards.
  - AgGateway's SPADE / ADAPT projects' ongoing involvement with ISO11783 is an example of this.
- There was not an existing irrigation data standard focused on the farmer's business processes
  - ISO11783 provides some of what is needed for operations, but presents some fundamental incompatibilities,
  - ISO19156 provides an elegant abstract framework, but not the necessary domain-specific material for observations
  - Stakeholders had specific needs regarding bandwidth, and the team discovered a variety of patterns in observations data that required special treatment.
- It was decided to propose a US National Standard, partnering with the American Society of Agricultural and Biological Engineers (ASABE)
  - The intent is to subsequently present this to TC23/SC18

AgGateway

- Non-profit consortium of approximately 240 companies
- Mission is to promote, enable, and expand eBusiness in agriculture
- AgGateway's Precision Ag Council chartered the PAIL Project in early 2013
- Chartered the SPADE project for other field operations in precision agriculture (e.g., planting, harvest, etc.)
- Developing the ADAPT toolkit: an open-source common object model for field operations, and an open-source plug-in framework for conversion to/from proprietary formats and the common object model.

AgGateway Collaborative Associations

Updated 2016-02-22



AgGateway / PAIL Stakeholders

AgGateway: About 240 companies

Precision Ag Council: About 120 companies

PAIL Project: 20+ companies (See below)

AGRIAN

LINDSAY CORPORATION

CropMetrics YIELD OPTIMIZATION TECHNOLOGY

NDT

CROP IMS Information Management Services

ONFARM GROW INFORMED

Ranch Systems LLC

IRROMETER

Simplot

CAMPBELL SCIENTIFIC WHEN MEASUREMENTS MATTER

VALLEY

MapShots

AgConnections

DECAGON DEVICES

AgSense

OBSERVANT

ITERIS

MONSANTO

RPE

Zed XXV 1987 - 2012 25 YEARS STRONG

JOHN DEERE

ASABE Standards Project Proposal X632

A standard that enables the transmission and collection of weather, soil moisture, and other relevant data, currently stored in a variety of proprietary original equipment manufacturer (OEM) formats, in an industry-wide format that can be used by irrigation data analysis and prescription programs.

The goal is to standardize data formats for irrigation equipment, including, but not limited to, weather stations, soil-moisture sensors and irrigation control systems, soils data and other agricultural irrigation-related information impacting irrigation methods and applications.

Farm-Centric Scope of X632

- **Operations:** The creation and execution of a field task (e.g., planting, irrigation, crop protection, crop nutrition, harvest) associated with growing a crop. It includes *core documents* (crop plan, recommendations, work orders, and work records. (“What needs to happen or will happen in the field?”)
- **Observations:** The collection of data (including measurements) from crop scouting, moisture sensors, weather stations, and other data sources. ("What are the conditions in the field?")

Design Principles

- Simple Beats Clever
- Small payloads
- Make It useful for the consumer of the data
- JSON - friendly
- Use Compound Identifiers
- Transmit content that stakeholders are comfortable with

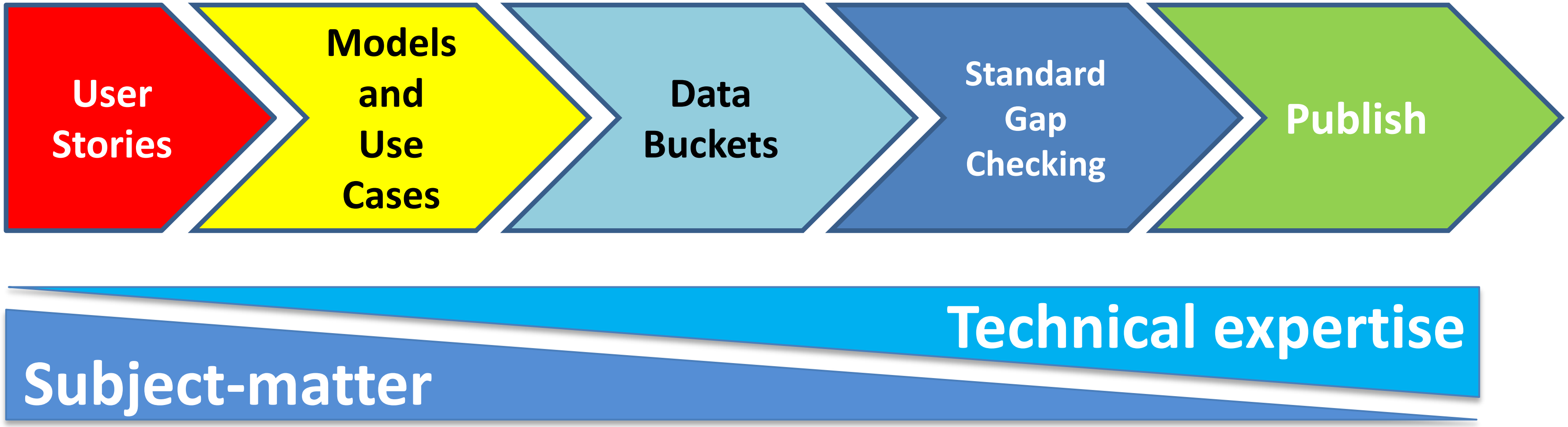
Technical Specifications

- XSD Schema to define document/message structure
- Use XML for first generation
- Use existing standards wherever possible
- RESTful API - friendly

How the standard is structured

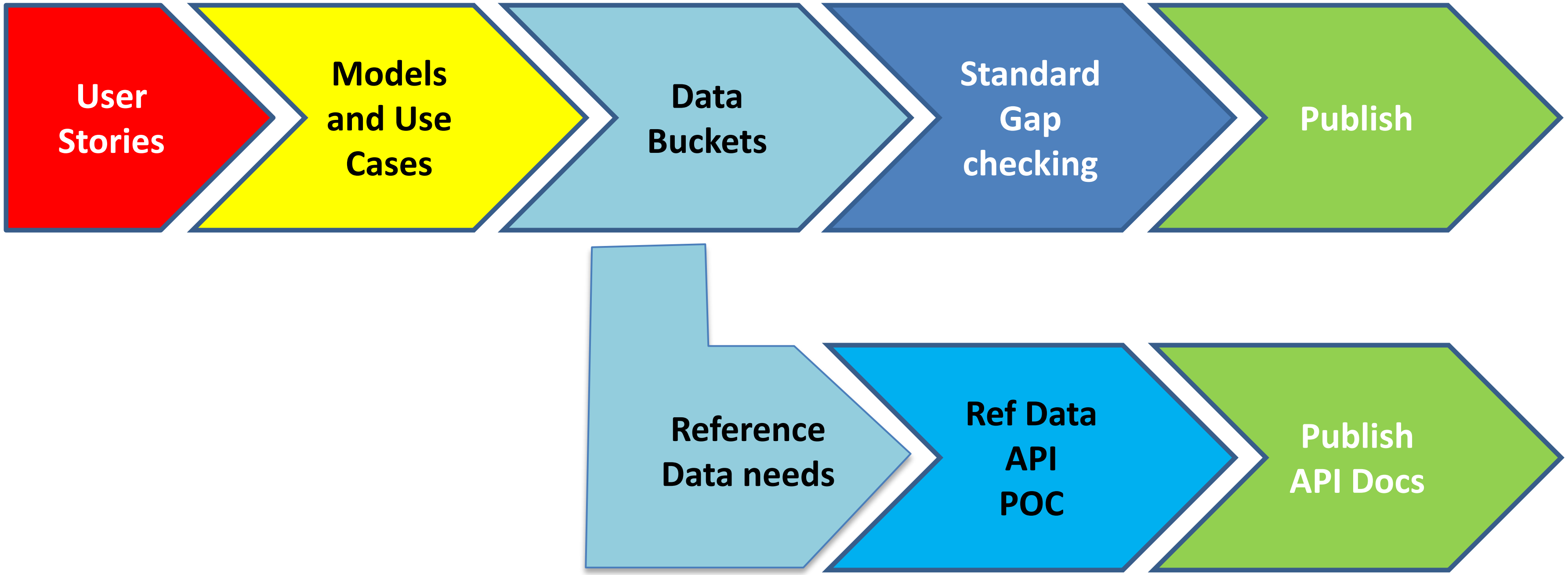
- Part 1: Fundamental Concepts, Processes, and Objects
- Part 2: Irrigation System Operations
- Part 3: Observations and Measurements in Field Operations
- Part 4: Pump Systems

➢ Other Parts To Be Determined...



PAIL has generally followed the process shown above:

- User stories were obtained from growers and other SMEs.
- The processes described by the stories were modeled with BPMN and translated into use cases usable by developers.
- Data requirements or "Data Buckets" were identified by the SMEs and technical experts working together.
- The technical experts looked for, and proposed solutions to, translating these requirements into an efficient data format.
- The last step is publication.

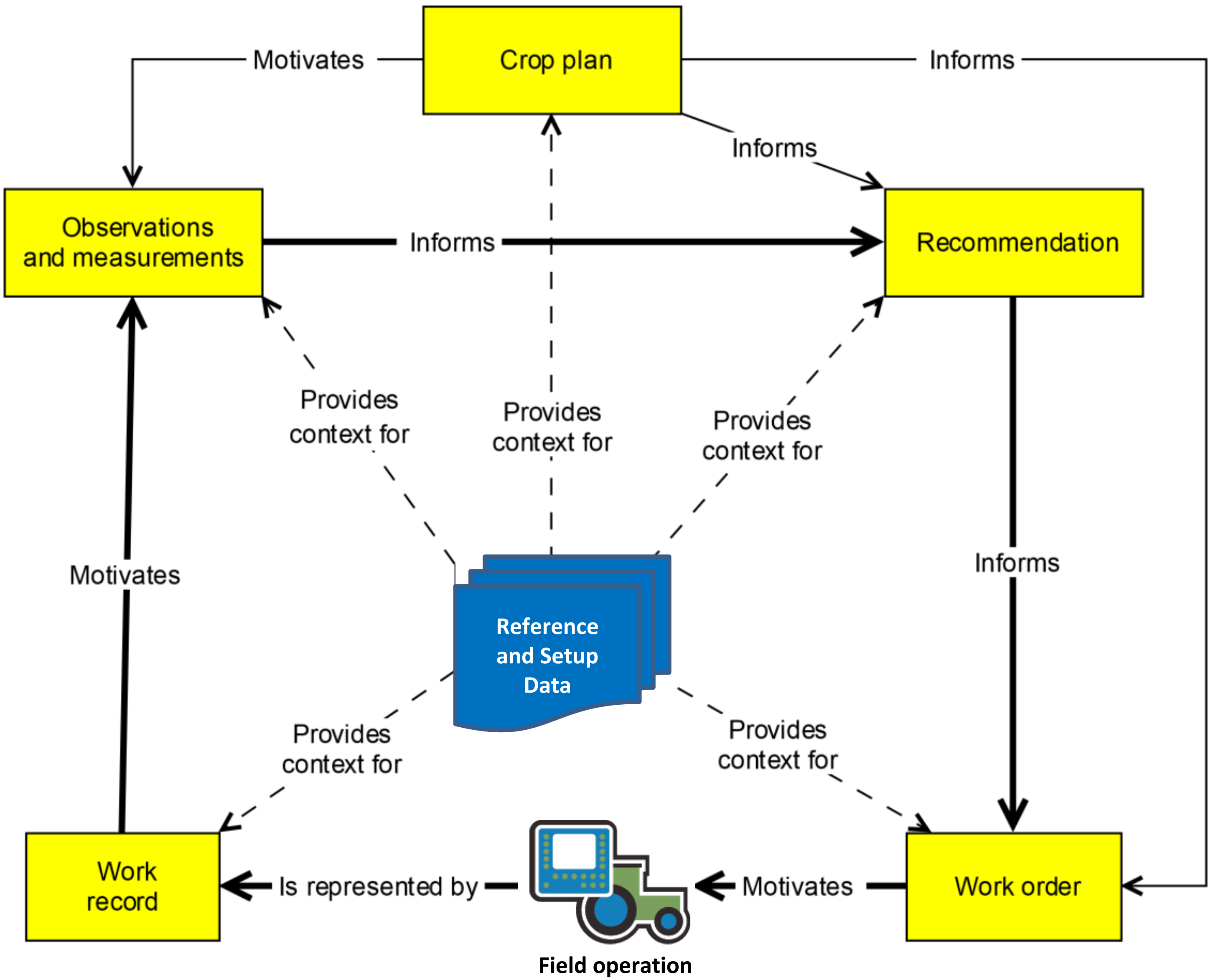


- There are additional aspects to the workflow, such as identifying the Reference Data (e.g., product identifiers) that is needed to support the process.
- Reference Data APIs
  - Equipment
  - Seed
  - Crop Protection
  - “Other” (e.g., Context Items)

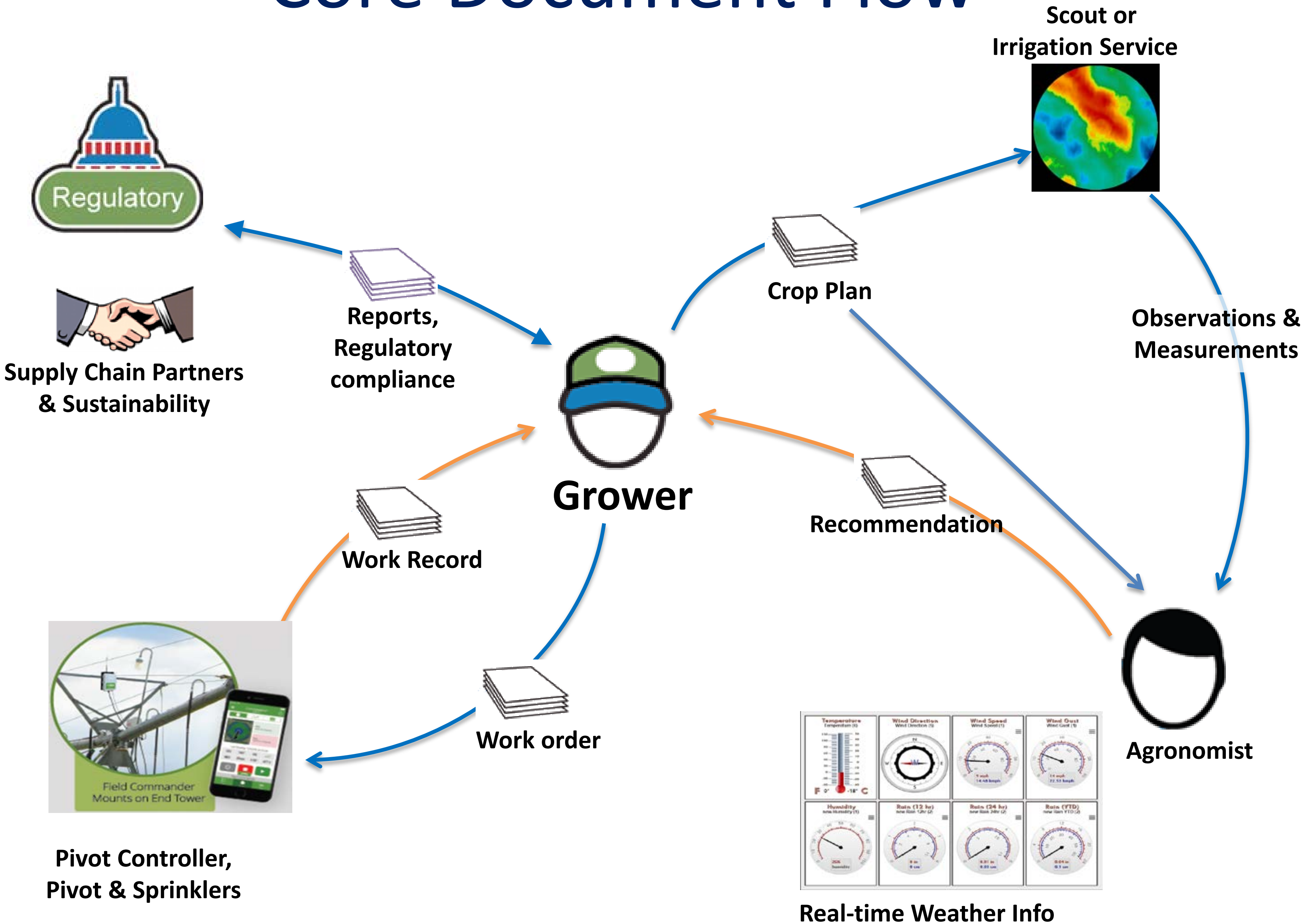
The Core Documents

Document	Description
Plan	A high-level document describing how a crop will be grown on a given piece of land during a crop season. ***"This is how we're going to grow this crop this season."***
Observations and Measurements	A document containing data measured/observed in the field. ***"This is what's happening in the field right now."***
Recommendation	A document where an actor with expertise (e.g., a Consultant) suggests a course of action to follow on a given piece of land. ***"This is what I think we should do about it."***
Work Order	A document where an actor with authority (e.g., the Grower) indicates a course of action to follow (e.g., a field operation) ***"This is what we're going to do about it."***
Work Record	A document that describes what was done out on the field during the field operation. ***"This is what we actually did."***

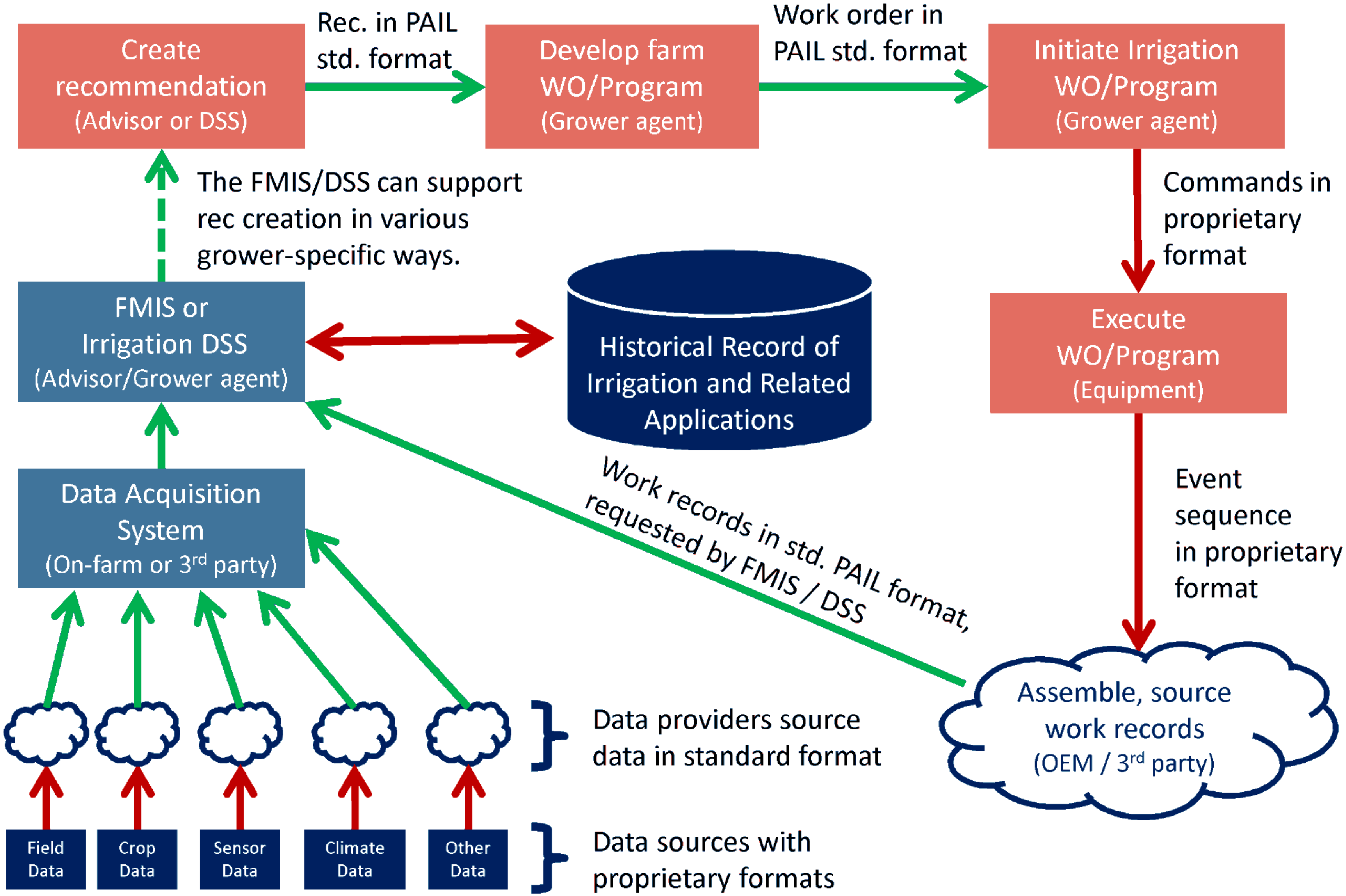
Core Documents



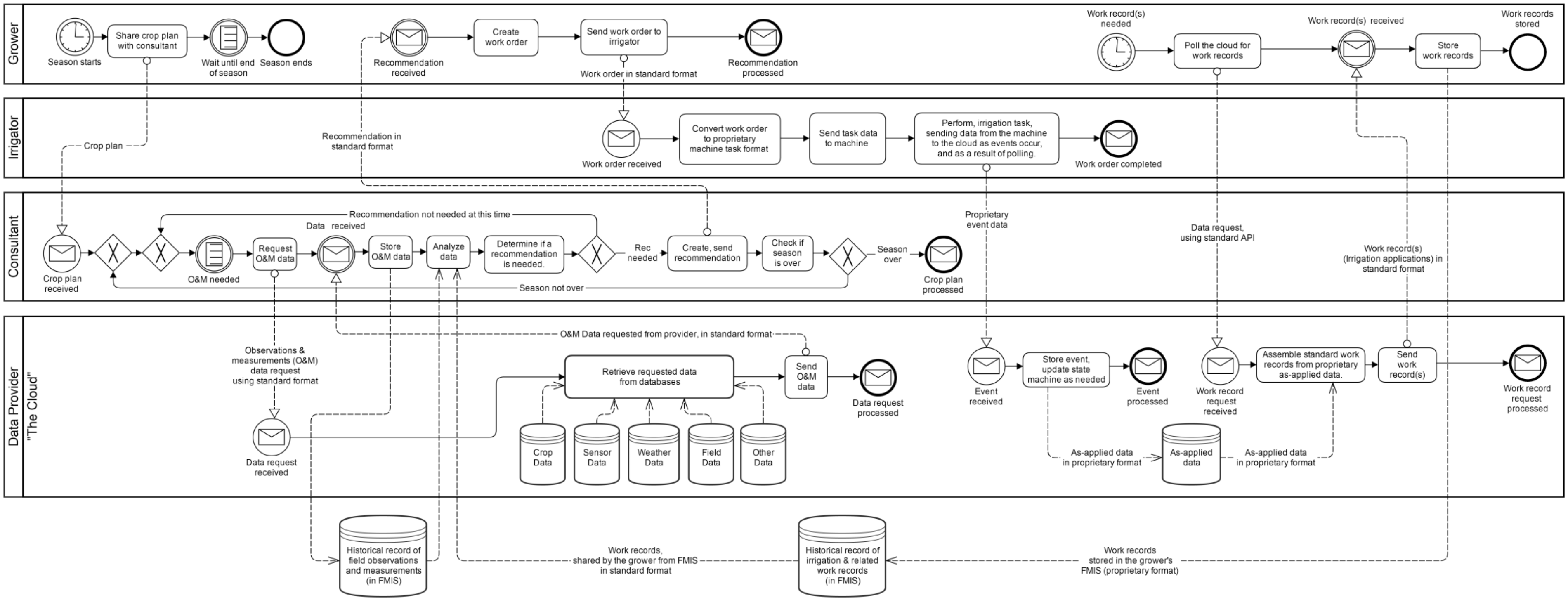
Core Document Flow



PAIL Irrigation Data Flow



The PAIL Business Process Model



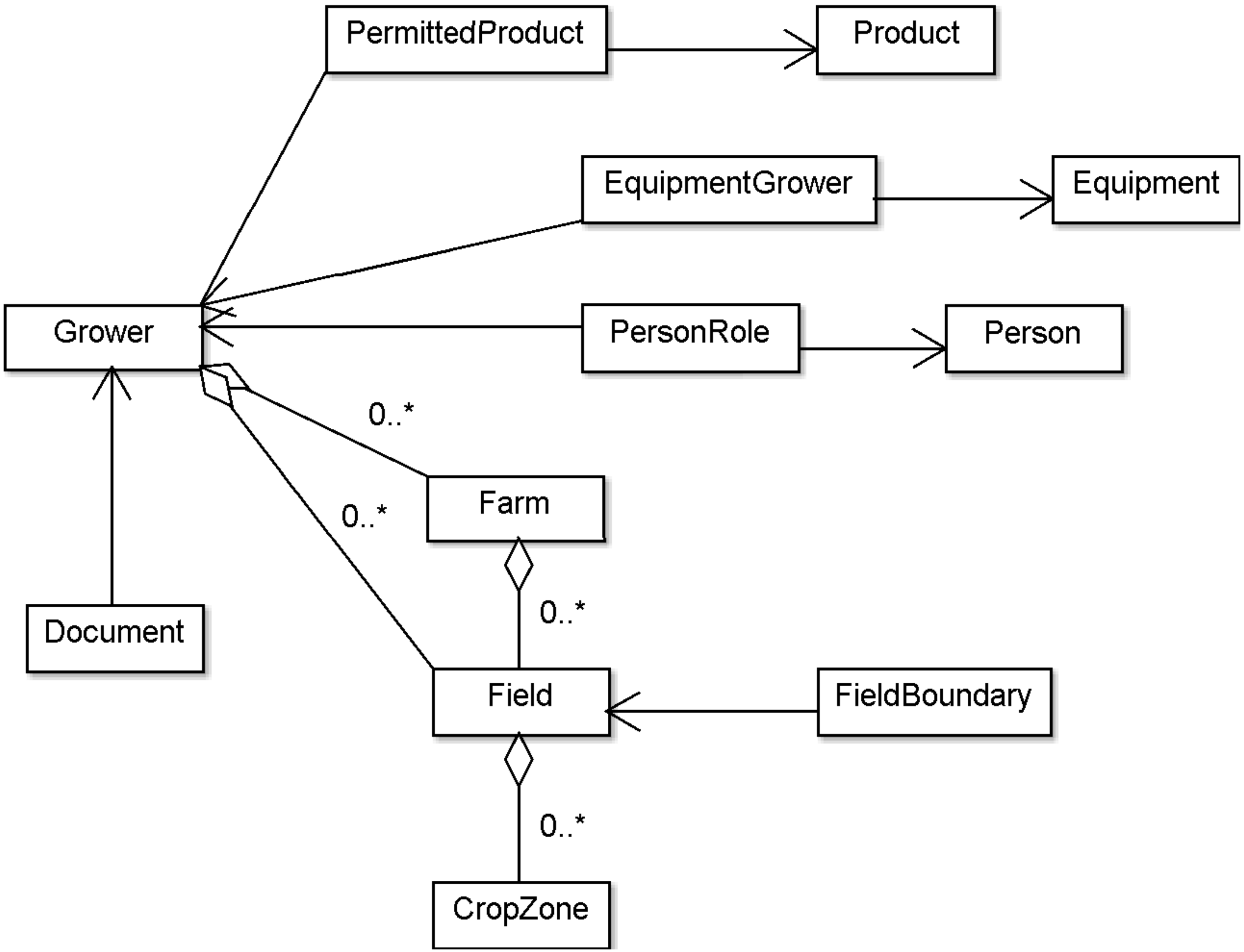
The Actors

Stakeholder	Description
Farmer / Grower	Has authority. Uses that authority to create Work Orders out of Recommendations received from the Consultant.
Irrigator	Uses Work Order received from the Grower to initiate a FIeld Operation
Consultant	Has expertise. Uses that expertise to translate data into a document called a Recommendation. The data is received from the Grower (Crop Plan) and procured from a Data Provider (Observations & Measurements.)
Data Provider	• Collects and stores various forms of Observations and Measurements (O&M) data. • Makes the O&M data available to the Consultant. • Collects and stores proprietary irrigation operations event data. • Derives Work Records from the irrigation operations event data • Makes the Work Records available to the Grower.

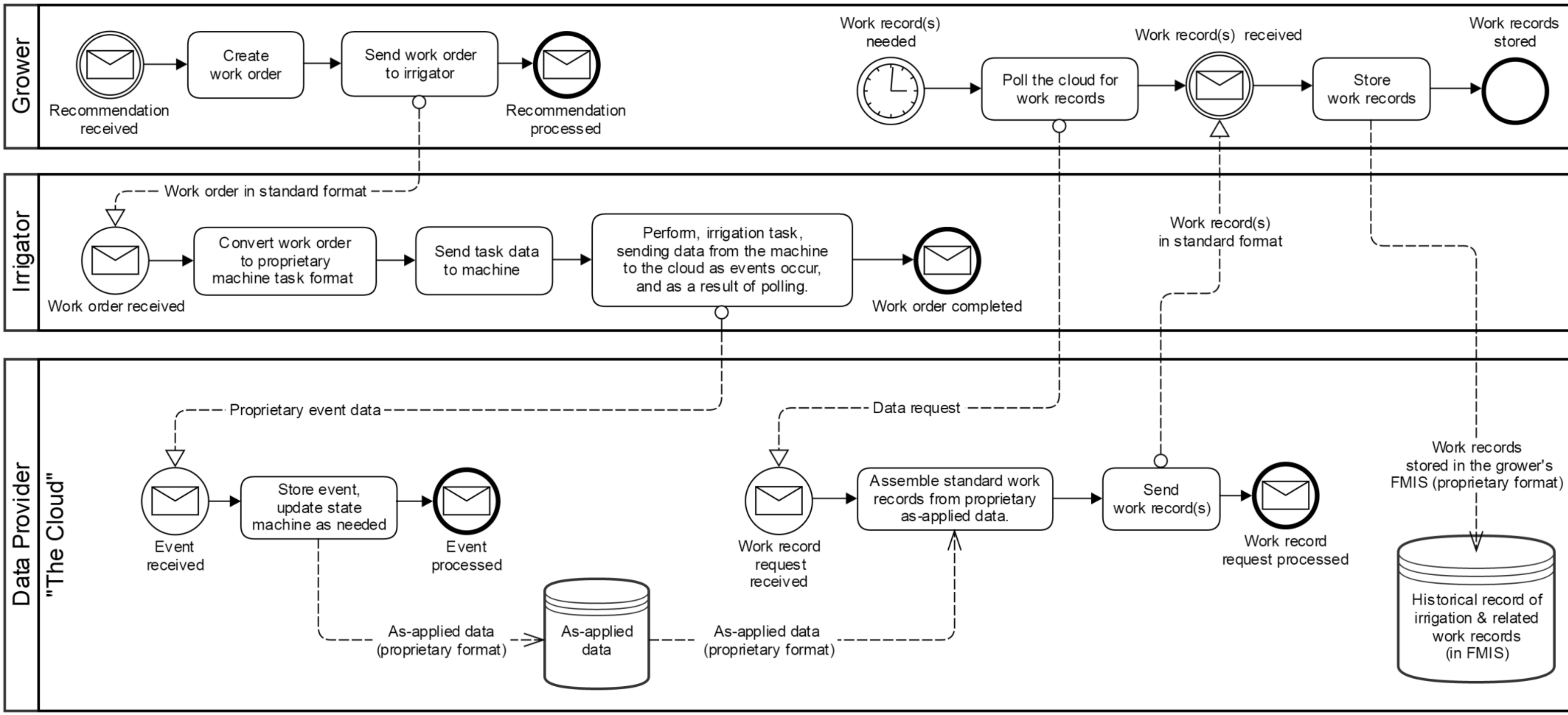
Different Kinds of Supporting Data

Reference Data	**All instances of a thing (“The ACME MaxSuperTron 200”)**	GENERAL
Grower (Setup) Data	**One particular instance of a thing, INDEPENDENT of its state: (“The MST200, serial #12345”)**	↓
Configuration (Setup) Data	**One particular instance of a thing, in the context of its current state: (“MST200, #12345, now installed at Lat,Lon X,Y, using Widget Z”)**	SPECIFIC

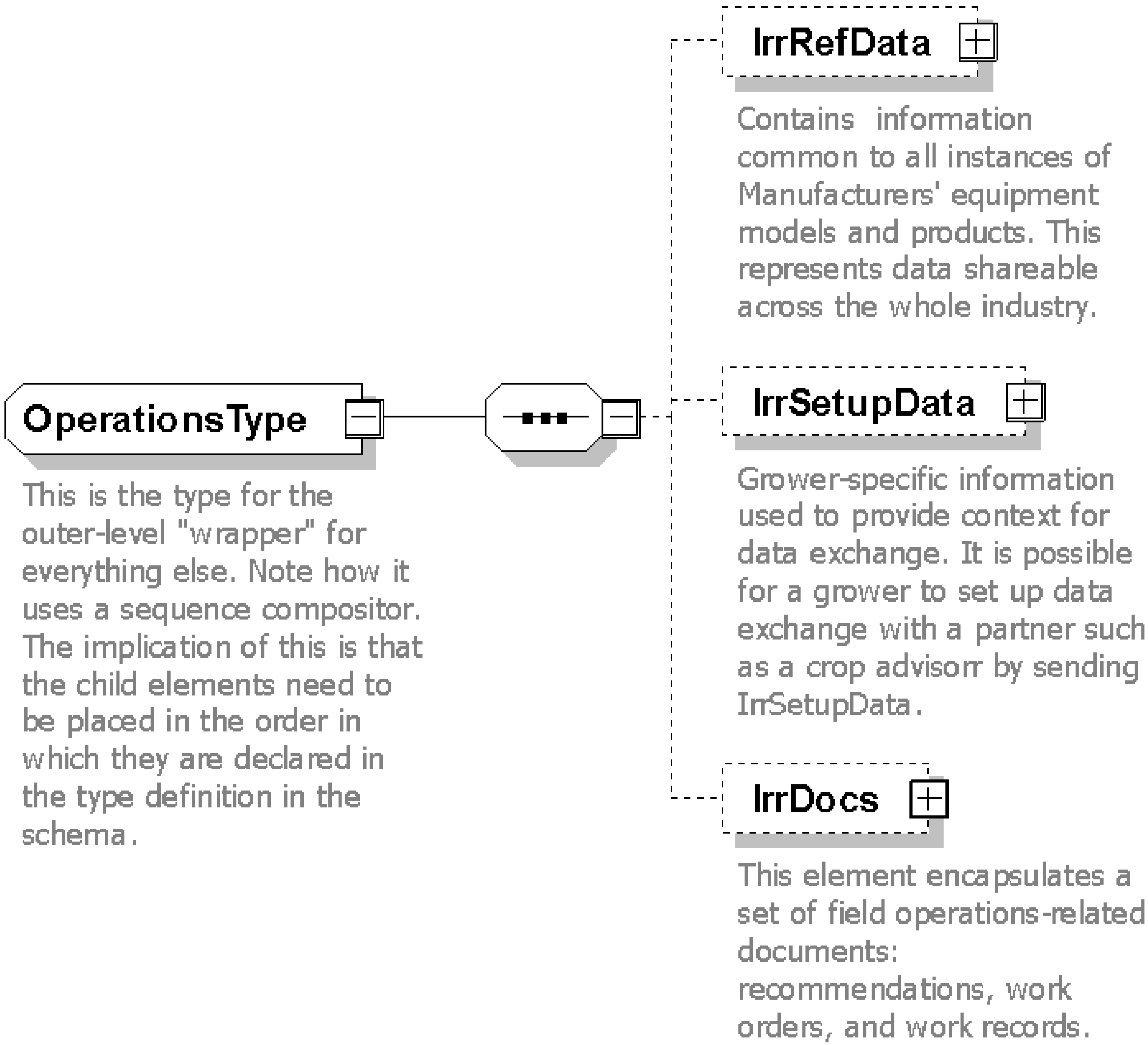
Grower Setup Data



Operations: The Processes



Operations

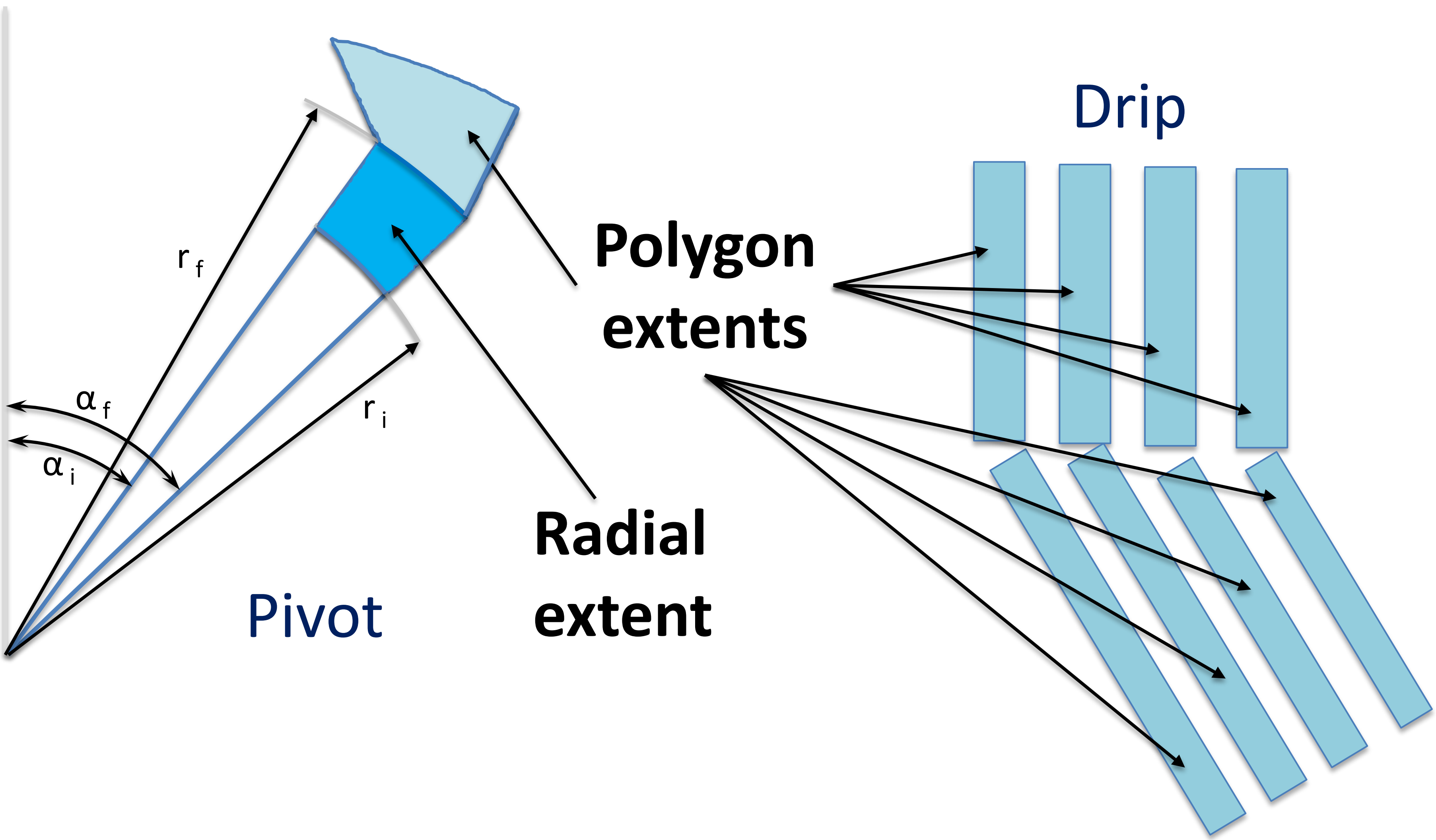


IrrRefData
Contains information common to all instances of Manufacturers' equipment models and products. This represents data shareable across the whole industry.
OperationsType
This is the type for the outer-level "wrapper" for everything else. Note how it uses a sequence compositor. The implication of this is that the child elements need to be placed in the order in which they are declared in the type definition in the schema.
IrrSetupData
Grower-specific information used to provide context for data exchange. It is possible for a grower to set up data exchange with a partner such as a crop advisorr by sending IrrSetupData.
IrrDocs
This element encapsulates a set of field operations-related documents: recommendations, work orders, and work records.

Fundamental Concepts

- **Identity**
  - Every object in the model can have a unique identifier associated with it, but can be represented by short, locally-scoped Ids to save bandwidth.
  - It is possible to specify the source of the unique identifier as well.
  - Follows ideas laid out in ISO11783 part 10 Annex E.
- **Time**
  - Time is bundled along with its *meaning*
  - Single moments and time intervals can be represented
- **Spatial Extent**
  - What region in space are we talking about?
- **Data Pedigree**
  - How did the location and time data arise?

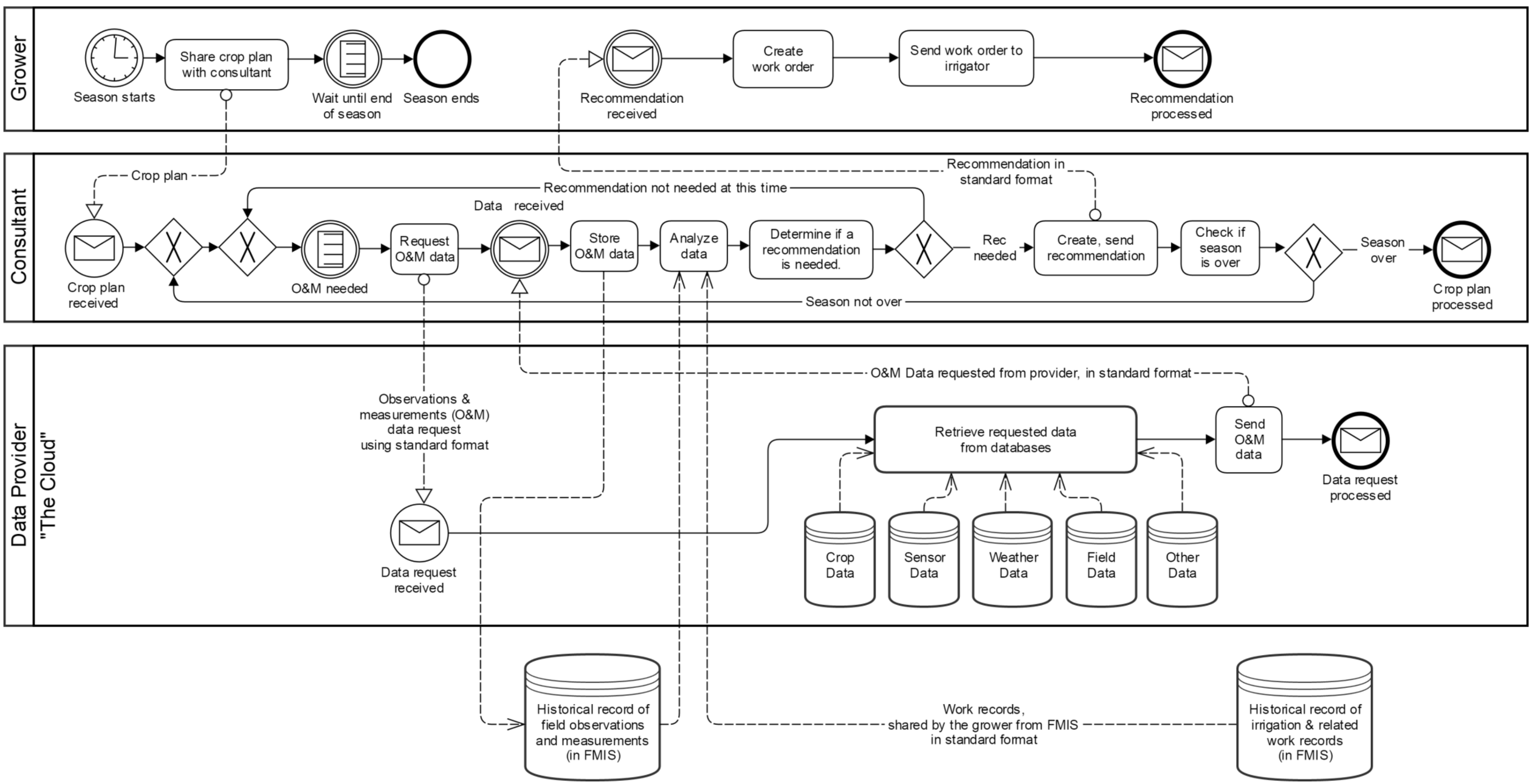
Spatial extents: Radial and Polygon



How Operations Work

- Stakeholders wanted to not report more detail than needed (agreeing on pre-competitive, non-proprietary space).
- We define abstract DeviceElements (e.g., booms, sections) and describe their **spatial extent** in one of three ways:
  - Static polygon (e.g., drip)
    - Extent defined once in setup.
    - Very efficient, but change requires new setup record.
  - Dynamic radial (space-efficient shorthand for pivot sections)
    - “Pie-slice” extent defined using 4 scalars (efficient)
    - One per time slice
  - Dynamic polygon (e.g., pivot swing-arm corners, laterals, traveling gun)
    - Whole polygon defined once per time slice
- Recommended, desired, and observed irrigation records:
  - Expressed as total water or depth applied to spatial extent of the corresponding type between a given start & end time.
  - Fertilizer and crop protection product rates can be expressed as totals, mass/volume per area, mass/volume per time, or concentration.

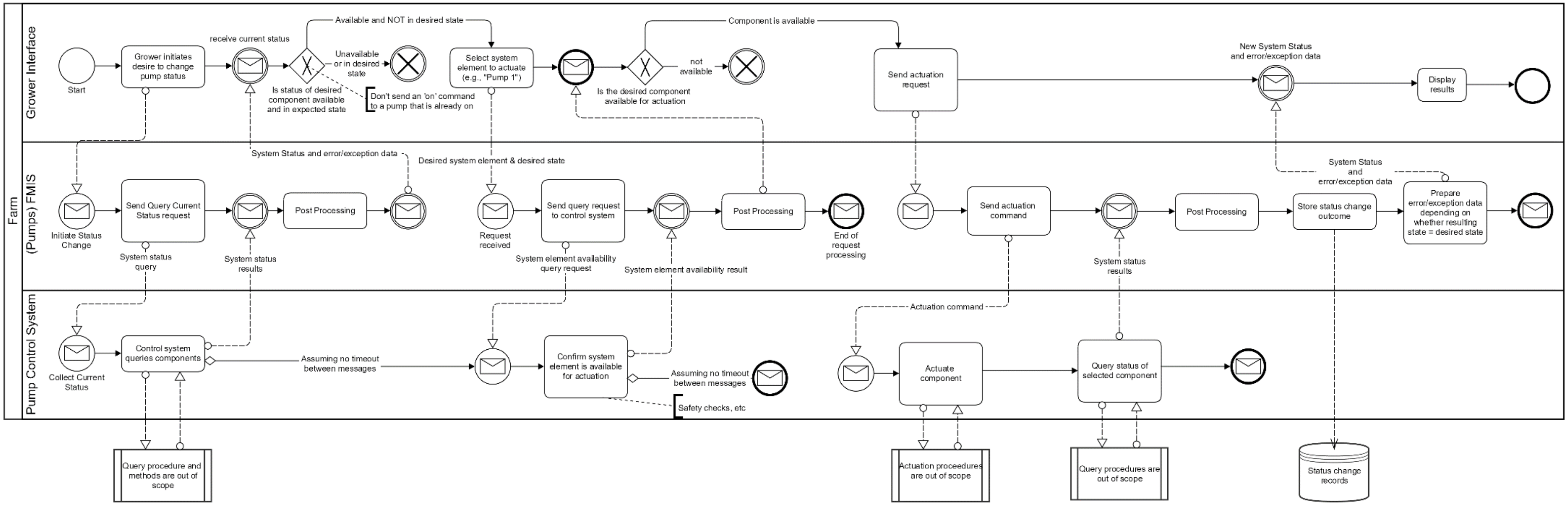
Observations: The Processes



How Observations Work

- Stakeholders wanted to minimize bandwidth
  - Schema accommodates a recursive structure that allows for organizing the reported data optimally
- Use controlled vocabulary of features of interest
- Define a “source” that encapsulates the feature of interest, observation procedure, and all relevant data.
- Intent is to reduce the payload to a name-value pair, where the name is the *source identifier* that references the complete source object, including the units of measure the value is expressed in.

Pumps



- Focused on operational aspects of on-farm pumping networks.
- Includes basic elements for energy analysis and pumping efficiency.
- Engineering design elements to be added later.

Drip: Ongoing Development

- So far, the team has applied the same process & model as other irrigation operations.
  - Unclear whether capturing explicit system interconnections is needed, as opposed to straightforward as-applied reporting.
  - Still collecting data/reporting requirements.
  - Seeking greater involvement of drip irrigation stakeholders.
- Very compact data representation because spatial extents are fixed for a given Setup.

PAIL Status

- Field Trail / Beta Test concluded this year
- Testing and adjusting the schemas
- This work is already influencing the industry in the US
  - Described by an industry insider as “The PAIL Effect”

Summary

- We are working toward an ASABE National Standard
  - Over several decades, this has been successful as a starting point for ISO New Work Item Proposals.
- We invite participation, both through AgGateway / PAIL and ASABE
- We see this work as complementary to the one presented in NWIP N21622
  - We will seek to actively coordinate and collaborate to maximize the value of both efforts.

Thank You!

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