Filling in the Blanks with ContextItems:
A lightweight method for extending field operations object models

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Daggett, D.G. (ProAg); Ferreyra, R.A. (Ag Connections); Reddy, Linga T. (John Deere); Rhea, S.T (Ag Connections); Tevis, J.T. (TOPCON)

Background

- Precision agriculture is still limited by a lack of hardware/software systems interoperability.
- AgGateway, a nonprofit consortium of 240+ companies, leveraged its cross-section of precision ag stakeholders to propose a collaborative solution: its ADAPT team created an open-source, field operations common object model.
- The goal: replace current systems' need to support multiple, incompatible data formats, with a single integration to the common object model and a system of manufacturer-specific format-conversion plug-ins.
  - This enables reading/writing to new systems with marginal development cost.
- The common object model meets requirements from AgGateway's SPADE and PAIL projects, including compatibility with the ISO11783-10 standard (ISOXML) and participant companies' own systems.

The Problem

- Growers need to collect increasing amounts of field operations data.
- This usually includes significant amounts of frequently-changing geopolitical-context-dependent information (e.g., EPA numbers, FSA numbers, tax data, etc.)
- Capturing all of this data in the object model of farm management information system (FMIS) software is a moving target, unless it were somehow possible to decouple the infrequently- and frequently-changing aspects of the FMIS data model.
- In terms of requirements thus placed on a data model, an FMIS object model should simultaneously be:
  - Simple/generic vs comprehensive/specific
  - Static vs dynamic: Controlled vocabulary vs extensibility
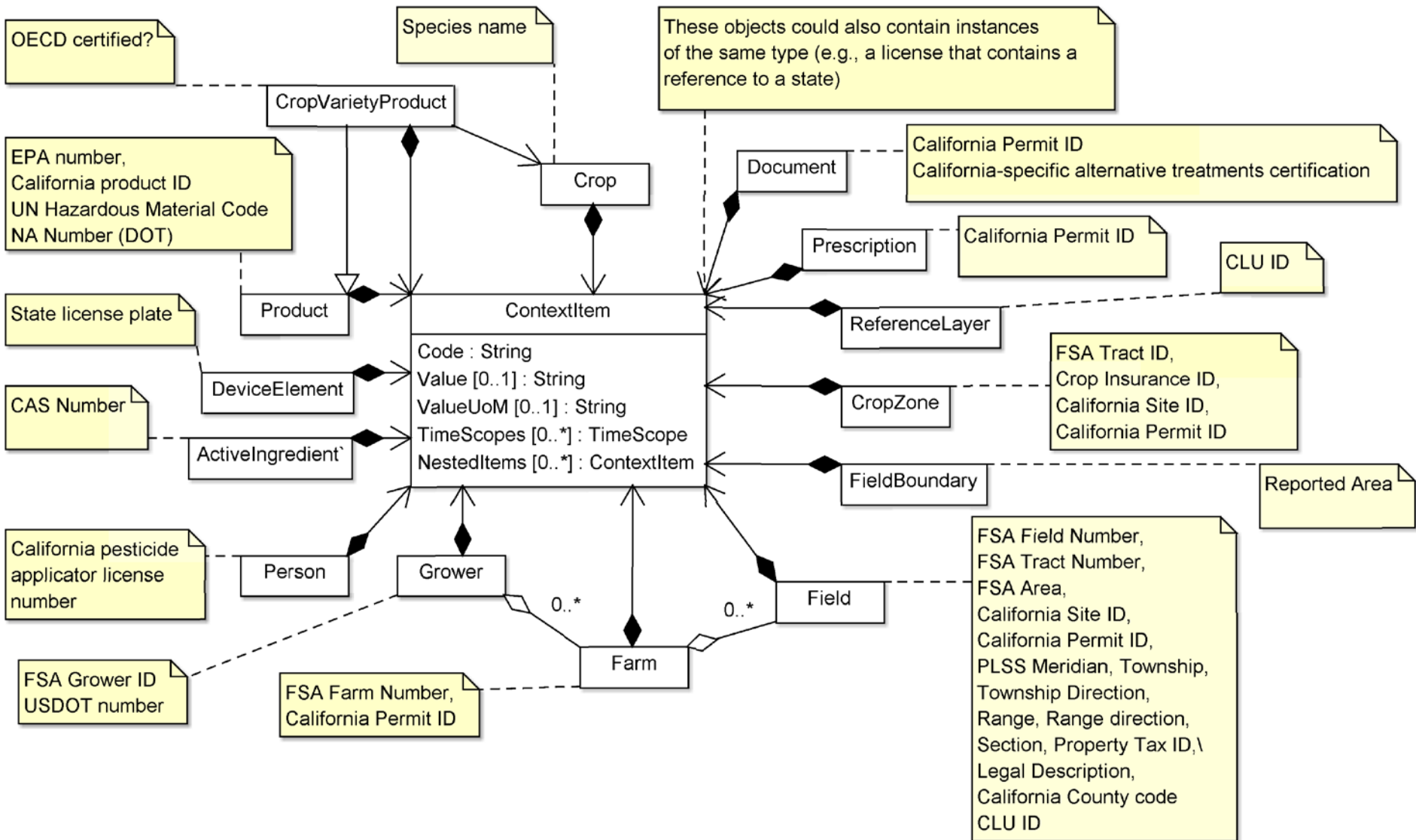
The Proposed Solution: The ContextItem

- ADAPT reconciled the contradictions by defining an object class, the ContextItem, that can be attached to various other objects in the common 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 CIs (e.g. PLSS cadastral information.)

The ContextItem Object

ContextItem
Code : String
Value [0..1] : String
ValueUoM [0..1] : String
TimeScopes [0..*] : TimeScope
NestedItems [0..*] : ContextItem

o **Code** identifies what a given ContextItem contains: think if it as a number that identifies what **Value** means: is it a PLSS Township number? An FSA Tract ID? An EPA Number? A PLSS Prime Meridian string?

o **ValueUoM** specifies, where appropriate, a unit of measure for Value. We draw from a controlled vocabulary of unit of measure codes (UN Rec 20).

o **TimeScopes** provides the ContextItem with a temporal context.

o **NestedItems** enables a hierarchical organization of nested ContextItems, suitable for multi-attribute data (e.g., US PLSS cadastral data)

ContextItem Examples

The ContextItemDefinition Object

ContextItemDefinition

Id : CompoundIdentifier
Code : String
Version : Integer
Status : ContextItemStatusEnum
ValueType : ContextItemValueTypeEnum
Description : String
Keywords [0..*] : String
Lexicalizations [0..*] : Lexicalization
Properties [0..*] : ContextItem
NestedIDefIds [0..*] : Integer
Presentations [0..*] : Presentation
EnumItems [0..*] : ContextItemEnumItem
DefaultUOM [0..1] : String
AllowConversion [0..1] : Boolean
TimeScopes [0..*] : TimeScope
ModelScopeIds [0..*] : Integer
GeoPoliticalContextIds [0..*] : Integer

- Provides a rich definition of how a specific (as per **Code**) ContextItem's value should be entered / displayed.
- **ValueType** specifies the data type of ContextItem.Value.
- **Lexicalizations** allow multi-language support.
- **Properties** encapsulate values along with (enumerated) ContextItems.

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The ContextItemDefinition Object

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Description : String

Keywords [0..*] : String

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DefaultUOM [0..1] : String

AllowConversion [0..1] : Boolean

TimeScopes [0..*] : TimeScope

ModelScopeIds [0..*] : Integer

GeoPoliticalContextIds [0..*] : Integer

- **NestedIDefIds** specifies a hierarchical ContextItem.
- **Presentations** specify, via a regular expression, how to enter & display the ContextItem.Value.
- **ModelScopeIds** specify what classes in the ADAPT & ISO object models a given ContextItem can be attached to.
- **GeoPoliticalContextIds** specify what geopolitical context (e.g., EU, Lithuania, Wisconsin) a given ContextItem is defined for.

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C.I. ValueType	Examples
Integer	North American / DOT Number FSA Farm Number
Double	FSA area of a field Cotton micronaire value
String	EPA number
DateTime	KY Drivers' License Expiration Date
Boolean	OECD certified crop variety? Restricted-use pesticide?
Enumerated	EPPO Crop Code PLSS Principal Meridian
Nested	PLSS record (contains Principal Meridian, Township, Range, Section, etc.)

Specific Example Use Cases

- ## Harvested Commodity
  - It is important to for regulatory (e.g., crop insurance) purposes to capture what is being removed from the field: planted corn/maize can be used for grain, forage, stalks and biomass

- ## Crop
  - Different manufacturers have their own crop lists; different jurisdictions have their own lists with regulatory implications

- ## Operational technique / cultural practice
  - Regulatory implications (e.g., US NRCS)

Deployment via an API

- AgGateway's SPADE project implemented a RESTful API to provide a machine-readable vocabulary of CIDs (in www.contextitem.org)
- The API can be searched by:
  - ModelScope
  - Geopolitical Context
  - Status
  - Keyword
  - TimeScope
- AgGateway's Standards & Guidelines Committee created an ad-hoc group to manage the vocabulary.

Applicability to ISOXML

- The CI system can be used jointly with ISOXML's feature of associating unique IDs to its own locally-scoped IDs (defined in ISO 11783-10 Annex E.)

- This enables adding geopolitical-context-dependent data to ISOXML's otherwise generic and highly machine-specific scope, with no modifications.

What does this all mean?

- Enables incremental progress
- Extensibility is decoupled from data model versions
- Minimal *a priori* knowledge needed for use
- A starting point for richer semantics in field operations data exchange
- Enabling the use of existing controlled vocabularies
- Encoding proprietary payloads

Future Development

- Anyone can submit new ContextItemDefinitions through AgGateway's Standards and Guidelines committee.
    - Expected publication date of the process: late 2016.
- ContextItemDefinitions are distributed through a RESTful API
    - Expected publication date of the API documentation: late 2016
    - Content could (and should) be cached locally in users' systems.
- Architecting mechanisms to assert relationships between ContextItemDefinition(s), ContextItemEnumItem(s), and external sources of information. This will enable:
    - Linking ContextItemDefinitions or ContextItemEnumItems to definitions such as those found in AGROVOC or AgGateway's AgGlossary (www.agglossary.org), and
    - Asserting relationships among ContextItemEnumItems from different vocabularies (e.g., different machinery manufacturers' crop lists).

Questions?
(Including how you can participate)

andres.ferreyra@agconnections.com

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