

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

Doug B. Applegate, Aaron W. Berger, Daniel T. Berne, Rob Bullock, Ben E. Craker, Dennis G. Daggett, R.Andres Ferreyra, Andrea Gowler, Shannon C. Haringx, Charles Hillyer, Todd Howatt, Bart K Nef, Scott T. Nieman, Stuart T. Rhea, Linga Tarakeshwar Reddy, Joseph M. Russo, Patrick Sanders, Eric D. Schultz, Timothy W. Shearouse, Mark W. Stelford, Joe W. Tevis, Jim A. Wilson, Jeremy W. Wilson

AgGateway is a nonprofit consortium of 240+ businesses working to promote, enable and expand eAgriculture. It provides a non-competitive collaborative environment, transparent funding and governance models, and anti-trust and intellectual property policies that guide and protect members' contributions and implementations. AgGateway primarily focuses on implementing existing standards and collaborating with other organizations to extend them when necessary.

In 2011 AgGateway identified interoperability in field operations (e.g., planting, harvest) as a major challenge: the multitude of proprietary, incompatible data formats among different machine and implement control systems (MICS) and farm management information systems (FMIS) leads to great frustration among users.

The SPADE project was AgGateway's first field operations effort. SPADE has generally followed an Agile Methodology for each field operation: collect expert-mediated user stories; formalize them into business process models and use cases; identify data requirements; perform gap analyses of existing standards, and propose extensions thereto. A key SPADE outcome was the identification of a set of flexibly-defined common "documents" that support farm business processes: Crop plan, Observations and measurements (OMs), Recommendation, Work order, and Work record.

SPADE identified Reference Data: datasets to distribute across the whole industry so different stakeholders can interpret shared documents the same way. This includes names and identifiers of seed varieties, crop protection products, active ingredients, etc. SPADE implemented proof-of-concept (PoC) application programming interfaces (APIs) for machinery and product reference data, and also implemented a PoC index API providing one-stop access to a distributed system of standardized reference data sources hosted by manufacturers and third-party data providers. Other SPADE contributions include defining concepts such as "OK to Spray", contributing terms to AgGlossary.org, and working with the Agricultural Electronics Manufacturers' Foundation (AEF) to expand the widely-respected ISO11783-10 MICS-FMIS communication standard's ability to associate globally-unique identifiers to its own locally-scoped identifiers.

CART is a SPADE sub-project. Its focus is to support grain movement and testing processes, aligning with (and expanding) the AgXML Consortium's CommodityMovement and QualityCertificate messages.

WAVE is another SPADE sub-project. Its scope includes mobile and fixed asset management. It seeks alignment with the new ISO15143-3 mobile asset telemetry standard. Its fixed asset scope (e.g., grain

bin temperatures) also seeks existing-standards alignment, and dovetails with OM work in PAIL and various SPADE teams.

PAIL is SPADE's irrigation-specific sibling. Given the lack of existing irrigation data exchange standards, PAIL is proposing one (via ASABE) that documents irrigation operations and related OMs, including web-service-mediated data-exchange schemas.

SPADE successfully explored the feasibility of an open-source format-conversion toolkit, leading to what is now ADAPT. ADAPT's scope includes a common object model derived from SPADE / PAIL requirements including ISO11783-10 compatibility, a format conversion framework, and an architecture where manufacturer-specific "plugins" convert between proprietary formats and the common model. ADAPT supports FMIS-to-FMIS communication, including the nuanced business processes not covered in ISO11783-10.

Internationalization is an important aspect of this work; several conflicting requirements (universality vs. geopolitical-context-specificity, and controlled vocabulary vs. extensibility) were reconciled creating a context item class and drawing from AEF's experience managing controlled vocabularies separately from the ISO11783-10 data model.