

The Impact of RFID and Sensor Integration and Universally Unique Identifiers on Event-Driven Business Enterprise Architecture

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Abstract. This white paper reviews the current state of RFID, the potential impact of RFID and sensor integration, and the potential impact of universally unique identification (UUID) on event-driven business enterprise architecture.

Initial RFID Industry Buzz

Most of the buzz around the industry has been about RFID-enabled logistics processes that are compliance driven. Barcode technology already provides highly accurate readings of data, so it has been difficult to justify a business case for pilot RFID projects that are meant to increase efficiency in the warehouse.

Enterprise processes today are not natively enabled for RFID and require system-integration projects. A large portion of the market in the last few years has focused on RFID data capture in warehouse shipping and receiving environments – working to a great extent on RFID physics and reader integration issues.

However, some companies are now investigating opportunities and developing pilot projects to leverage RFID in their value chain and in key pain-point processes.

Trend: Increased Traction of RFID beyond Compliance

A clear trend indicates that companies are looking beyond compliance to RFID as an enabling technology that adds value.

Companies are evaluating pain points in their international value chain and examining how RFID technology can address the pain points. The processes under examination include verification at the source of the shipped quantity, quality checks, tracking of the shipping process, and so on.

Consider some further examples. Manufacturing companies look for opportunities to automate with RFID in Kanban processes. Other firms evaluate returnable transport items processes to increase visibility and audit capabilities for such items to decrease theft and for better stock management of specialized and high-value, circulating transport containers. Pharmaceutical companies are evaluating anticounterfeit and antidiversion solutions that can be enabled with RFID.

RFID Data Capture and UUID

There are two sides to the RFID paradigm: RFID data capture and unique identification (UUID with an electronic product code [EPC]).

At this time, however, UUID is also a separable paradigm, as seen in the UID program of the United States Department of Defense (DoD). Although RFID is linked to the UID program, the wider UID initiative at the DoD is part of a wider business enterprise transformation program that will ultimately enable situational awareness and net-centric operations.

From RFID to Broader Sensor Integration

Most RFID implementations today focus on the use of passive RFID technologies. The capabilities of active RFID technology are being used in some field trials.

But consider a generalization of data capture technology, so that integration of a single or combined data stream would use passive RFID (linear and 2-D barcode usage with UUIDs are a given in this context) and sensor data (sensing states like temperature, location, and so on) from active RFID, GPS, and embedded systems.

And consider not only the medium of a landline, but also the media of mobile GPRS and SATCOM communication for data transmission. This approach would enable sensing the states of an asset in the field from conceivably anywhere in the world –like the Middle East – and transmitting the states to any business processing application located anywhere in the world – like North America. Of course, this approach could easily be expanded so that a remote field device could also receive central business system instructions, perform a task, and confirm completion of the operation remotely.

This approach has two major implications:

1. Local sensor devices or sensing systems communicate remotely to an enterprise system. Sensed data can be captured directly and remotely from a sensing device – meaning the collapse of geography and of time.
2. Edge devices become more powerful and might deploy some local business logic. As a result, decentralization of some business logic to the devices on the edge is likely.

The Broader UUID Paradigm

Some companies see UUID enabling some fundamental new capabilities like the management of detailed configuration of bills of material. Others view UUID as a fundamental part of business enterprise rearchitecting to enable data harmonization across multiple enterprise systems, collaborative data exchange, and situational or real-world awareness and to enhance asset lifecycle management, accounting, and audits.

But not all industries look at EPC, which is often regarded as primarily suitable for the consumer goods and retail industries. This situation has led other industries (although they might accept EPC-encoded SSCC or GRAIs) to define proprietary encoding schemes, like item unique identification (IUID) and company-specific UUID encoding schemes – at least for assets.

Generally, however, all companies use some sort of UUID that is more or less oriented to the standard URI syntax profile to develop their encoding schemes (as is the case with the EPC). To generalize, it might be helpful to speak about either UUIDs or URI resource-encoding schemes.

UUIDs provide a digital instance identity for resources of all types and can further serve as pointers and keys to data discovery related to an asset or product, a transaction, or an event – not only within an organization, but also for user or machine query over the EPCIS network (leveraging EPCIS data exchange) or, ultimately, over the Web (Semantic Web).

Note that identifiers must be universally unique to ensure global uniqueness that provides an identity to the resource or object identified and ensures instance identity in global collaboration.

Use Cases

The following provides a list of sample use cases related to RFID, sensor integration, and UUID programs that are converging.

RFID-Related Use Cases

- RFID-enabled inbound and outbound processing with ERP integration
- RFID-enabled shop-floor integration (RFID-enabled warehouse management and integration of manufacturing and quality management)
- RFID-enabled RTI scenarios
- RFID-enabled Kanban scenarios
- Pharmaceutical pedigree tracking
- Manufacturing pedigree tracking
- Product tracking and authentication (anticounterfeit and antidiversion)
- Container and port security
- Patient safety – pharmaceutical dispensing in-hospital with RFID
- Retail – CPG data exchange for out-of-stock avoidance and responsive replenishment
- Electronic proof of delivery

Sensor Integration Use Cases

- Remote logistics visibility, location, and stock levels
- Real-time asset tracking with sensor data – cool chain containers
- Hazardous goods compatibility checks between a mesh network and a back-end system

UUID Use Cases

- UID marking and processing – production, goods issue, and goods receipt
- Asset life-cycle management
- Accounting and audits
- Data harmonization across systems
- Real-time asset visibility
- Configuration BOM management and audit trails
- Automated data discovery across enterprise systems and the ecosystems of business partners and the industry

Deeper Enterprise Integration

RFID technology is maturing. Most current issues arise from the lack of integrated RFID solutions between the device and the business process context. RFID projects require and, in the medium term, will continue to require system integration between implementation partners and customization of enterprise systems. A great deal of variance between industry requirements and customer-specific requirements can be observed with RFID solutions today.

This situation clearly suggests a requirement to integrate RFID or sensor integration platform tools or toolboxes with business enterprise systems. Tools should be available to model and deploy an integrated RFID system from sense, read, and write parameters to device ID, location, type, and role concepts and to the ID and business process context of enterprise systems. Similarly, business and technical cross-system monitoring tools should be available to monitor processing across the system – from the data-capturing device to the business process in the back-end system.

The key enablers from an ERP or enterprise system are the processing of unique identifiers and their context data – the enterprise system is agnostic about the data-capture technology. The data stream can be mapped to the business process context through appropriate technology interfaces and mapping engines.

The specific sensor technology used to capture data itself means nothing to enterprise systems. However, in order to enable sensor data stream integration into enterprise systems, the processing of universally unique identifiers and their related context information is critical. New means of capturing data must provide for new ways, new quality, and new timeliness for bringing data into the enterprise context. Universally Unique identifiers are literally the key to integrating streaming sensor data and enable the related data discovery and association to enrich or transform business process and even architectures.

For example – The DoD uses unique identification of asset, people, locations, enterprise structures, data, and items as a fundamental element of business enterprise rearchitecting (see Figures 1 and 2) to achieve network-centric operations and situational awareness.

UID in Business Enterprise Architecture at the US DOD

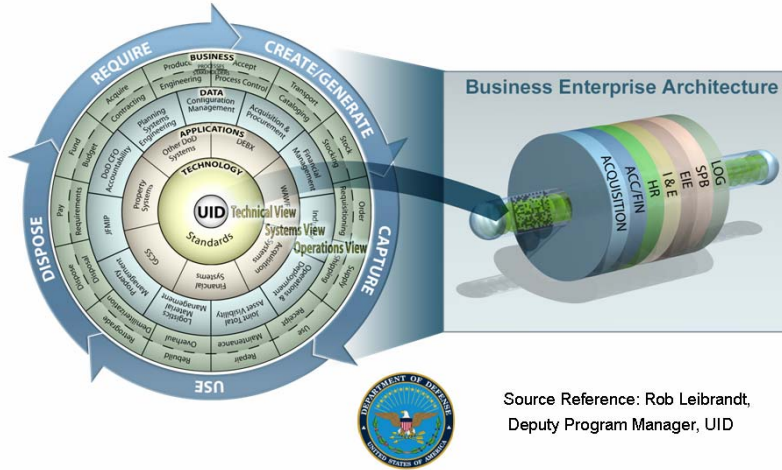


Fig. 1. UID in Business Enterprise Architecture at the US DOD

UID—Integrated Situational Awareness of People, Places and Things

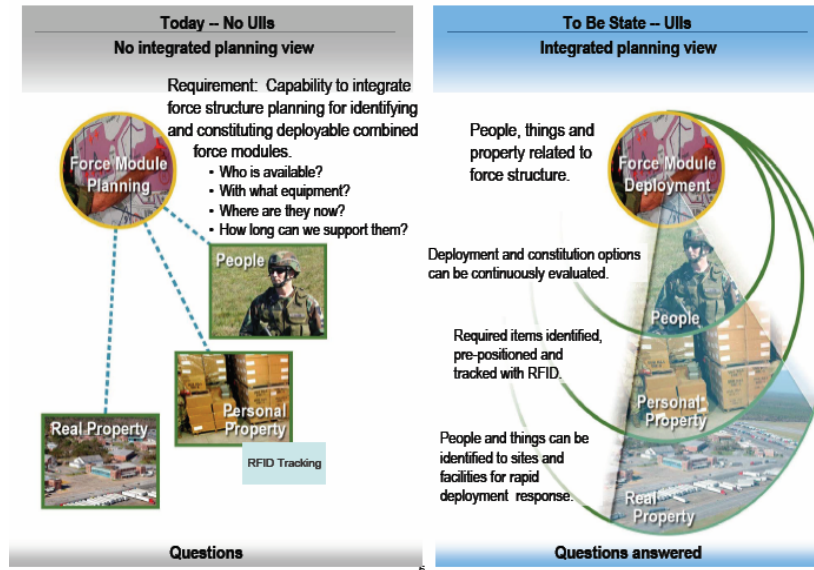


Fig. 2. Achieving Situational Awareness with UID – US DOD

Merging Process and Transaction Centricity and Object Centricity

Business systems are largely process and transaction-driven, and even event-driven in some cases. In transaction and process-centric enterprise systems, the sequence of transactions moves objects through the business enterprise logic space.

Asset, or more generally, resource URIs that universally and uniquely identify an asset or other resource object enable an object-centric view (see Figure 3) that should focus on the object as an ID, follow the object over its life cycle, and record everything that happens to the object – events, transactions, and associations. Such URIs thus may enable an object-focused and object state-driven business enterprise architecture.

Object Centric Worldview of an Asset Life Cycle

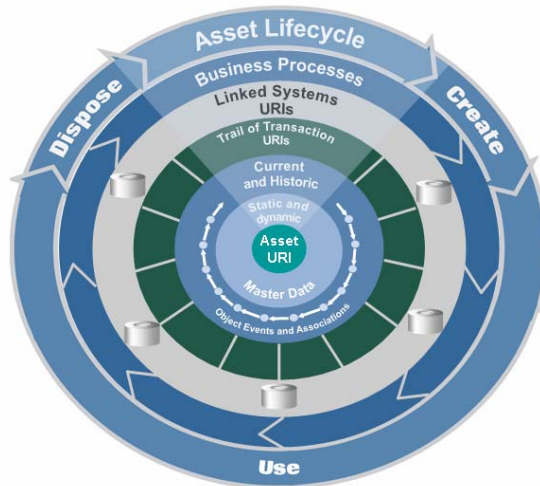


Fig. 3. Possible Object-Centric Worldview of an Asset Life Cycle

In the future, you may have two worldlines. The first is a universally unique asset ID worldline that can extend over many years across the entire asset life cycle. It records everything that happens to the particular object's identity – such as all transaction IDs that imping upon the object over its life cycle, all types of associations, and so on. The second worldline is the transaction ID worldline. All relevant resource URIs like as product or asset IDs are attached to it – transaction IDs.

In all likelihood, a Web service based business architecture might combine both worlds in the future.

Beyond EDI Data Exchange – EPCIS Data Exchange – The Extended Internet

As envisaged, EPCIS data exchange will move business beyond EDI data exchange by enabling companies to exchange data among themselves over the EPCglobal network with data pull (data discovery) and push mechanisms. These mechanisms are likely to further global data synchronization between business partners.

Obviously, infrastructure like EPCIS data exchange or an extended Internet will lead to data virtualization. It will be interesting to see whether businesses will also use this type of future infrastructure to create mashups.

Private and public space repository sections for enabling EPCIS-like or other types of data exchange will likely be required to ensure that external parties cannot access critical and confidential business information. Several industries have expressed this view, which is also observable at the DoD. Proprietary ecosystem data exchanges (for pharmaceutical companies and the aerospace and defense community) can use unique identifiers for data discovery.

Emergence of the Semantic Web

Extending the paradigm even further – it will be interesting to watch the emergence of a Semantic Web, where machines and applications can talk to each other. Great potential exists for extended use of URIs – as a fundamental element of the World Wide Web today and of a future Semantic Web – to serve alongside digital resource IDs and as semantically enriched keys and pointers to data discovery. That's why suggestions call for standardizing resource identifiers as unique identifiers with standard URI syntax to ensure interoperability and to pave the way for the Semantic Web.

Another key to adoption would then depend upon appropriate security for businesses.

Future Perspective

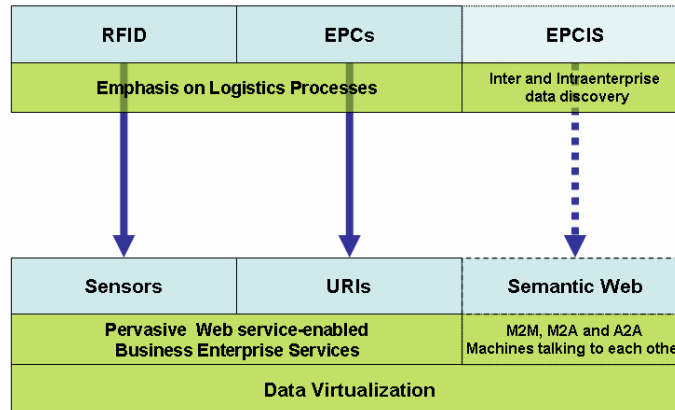


Fig. 4. Future Perspective on a Move to the Semantic Web with Evolving Business Enterprise Architecture

Conclusion

In light of this review, business enterprise architecture and commensurate solutions need to evolve to:

- Facilitate data stream integration from edge sensor devices. An RFID or sensor integration platform tool might be able to facilitate integration of the data stream, help with the related mapping of data from the device to the business context, and comprise process and integration modeling, design time, cross-system runtime activity monitoring, and deployment tools.
- Enable the deployment of business logic to edge devices and integrate such devices with central applications.
- Accommodate UUIDs – oriented to standard W3C URI syntax if possible – Unique resource IDs provide a globally unique identity, perform as digital keys to data discovery (such as attribute information related to an asset), and serve as pointers for finding data in distributed enterprise systems.
- Allow sensor event-driven business architecture to become more important.
- Enable business architectures to leverage the power of data virtualization over the Web where appropriate – and enable mashups that are useful to businesses, for example.
- Consider the creation of public and private space repositories that might be important to update processes, achieve data harmonization and automated sharing across systems, and hold current and historic state information on events, associations, and transactions that relate to an asset over its life cycle.