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Introduction to RFID Middleware

Athens Information Technology

2007 - 2013

Agenda

- Operational benefits
- Need for RFID Middleware – What the middleware should do
- Middleware Vendors and offerings
- Levels of a middleware architecture
- Tiers of RFID Middleware

Leveraging RFID Operational Benefits

- Operational benefits of RFID
  - Reducing out-of-stock situations
  - Decreasing labour requirements in the receiving process
- Need to
  - Process the incoming RFID data and intelligently integrate it into your business applications

Difficulties and Risks (1)

- Not all of the incoming RFID data is valuable
  - Excess information (e.g., duplicate reads) must be filtered out
    - Wise use of network bandwidth
    - Avoid confusing information inside your applications

- Not all readers speak the same language
  - Custom integration logic for each reader vendor
  - Resourceful (in terms of time and budget)

Difficulties and Risks (2)

- Different RFID information needs to be passed off to different applications and data stores
  - Reads at the loading dock may need to be passed off only to the plant's local warehouse management application
  - Demand stream information coming from a retailer may need to be sent to the supplier's supply chain forecasting solution

Critical Notifications

- New breed of software called RFID middleware

- Forrester Research defines middleware as

  – "Platforms for managing RFID data and routing it between tag readers or other auto identification devices and enterprise systems"

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Understanding Middleware Needs

- Varying scope of RFID middleware
  - Depends on Stakeholder

- Early RFID middleware solutions focused on features like
  - Reader integration and coordination
  - Electronic product code (EPC)
  - Track-and-trace tools
  - Baseline filtering capabilities

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RFID Middleware Functionality (1)

- Reader and device management
  - Allow users to configure, deploy, and issue commands directly to readers through a common interface
  - E.g., "turn off" a reader

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RFID Middleware Functionality (2)

- Data management
  - Intelligently filter and route the data to the appropriate destinations
  - Low-level logic and more complex algorithms
  - Tools for aggregating and managing EPC data in either a federated or central data source

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RFID Middleware Functionality (3)

- Application integration
  - RFID middleware solutions need to provide the messaging, routing, and connectivity features required to reliably integrate RFID data into existing SCM, ERP, WMS, or CRM systems
    - Ideally through a services-oriented architecture (SOA)
  - A services-oriented architecture is essentially a collection of services, which communicate with each other

RFID Middleware Functionality (4)

- ## Application integration
  - – The communication can involve either simple data exchange or two or more services coordinating some activity, such as order placement or inventory control

  - – Middleware needs to provide a library of adapters to popular WMS and SCM applications (e.g., SAP or Oracle E Business Suite)

  - – APIs and adapters for using standard technologies like JMS, XML, and SOAP (third-party applications)

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RFID Middleware Functionality (5)

- ## Partner integration
  - ### Need to share RFID data with partners to improve collaborative processes
    - #### Demand forecasting and vendor-managed inventory

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RFID Middleware Functionality (6)

- RFID middleware must provide
  - B2B integration features like partner profile management
  - Support for B2B transport protocols
  - Integration with a partner's data over communications such as EDI, Web-based systems like AS2, or a well engineered system specifically for EPC data

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RFID Middleware Functionality (7)

- Process management and application development
  - Orchestrate RFID-related end-to-end processes
  - Deal with multiple applications and/or enterprises

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RFID Middleware Functionality (8)

- Inventory Replenishment Example
  - Supposing that your system understands that you have a certain amount of one item coming through the door and the receiving process in the back of the store is tied to the point-of-sale data

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RFID Middleware Functionality (9)

- Process management and application development
  - When inventory level becomes critically low, send a machine-generated message to the distribution centre to order more product
  - Key process management and composite application development features
    - Workflow, role management, process automation, and UI (user-interface) development tools

RFID Middleware Functionality (10)

- Process management and application development
  - Specific tools help you create solutions that fit in with your existing applications
    - Benefit of machine-to-machine communication in a custom environment

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RFID Middleware Functionality (11)

- Packaged RFID content
  - Packaged routing logic, product data schemas, and integration with typical RFID-related applications and processes
    - E.g., shipping, receiving, and asset tracking are major assets

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RFID Middleware Functionality (12)

- Architecture scalability and administration
  - Reliably processing huge amounts of data
  - Balance processing loads across multiple servers and automatically rerouting data (e.g., when a server fails)
  - Features need to span all tiers of the architecture even the devices that are located near or on the actual readers

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Vendors and Offerings (1)

- Vendor landscape

  – Small start-ups with unique solutions

  – Big companies with solutions only on paper

  – Everything in between

- Open Source Solutions

Vendors and Offerings (2)

- Reader vendors
  - Some of the readers provide the previous mentioned middleware features, and it is expected many more to do so in the future
  - Middleware features that readers provide are very basic and typically limited to things like stripping out duplicate reads

Vendors and Offerings (3)

- Reader vendors
  - More sophisticated filtering and routing, you need more contextual information, like data from multiple readers and business logic that may reside in existing business applications
    - Not available to individual readers

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Vendors and Offerings (4)

- Vendors like ConnectTerra, GlobeRanger, and OATSystems emerged out of the early pilots sponsored by the Auto-ID Center
  - Products that integrate with RFID readers filter and aggregate data and even incorporate business rules

Vendors and Offerings (5)

- Some vendors have come out of device management for the Department of Defence, like Cougaar Software
  - Involvement in pilots and RFID standards development has turned them into valuable resources for practical RFID middleware know-how

Vendors and Offerings (6)

- Application vendors
  - Provia Software
  - Manhattan Associates
  - RedPrairie
  - SAP
  - Oracle
  - Sybase

Vendors and Offerings (7)

- Offer software
  - RFID-enabled applications for warehouse and asset management
  - RFID middleware solutions (reader coordination, data filtering, and business logic capabilities)

Vendors and Offerings (8)

- Giants
  - Vendors like Sun Microsystems, IBM, Oracle, and Microsoft are extending their application development and middleware technology stacks to handle RFID
  - Each of these vendors is working to amass RFID experience and bring a strategic RFID middleware architecture to market
  - Bring unparalleled experience with highly scalable application platforms

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Vendors and Offerings (9)

- Integration specialists
  - Integration specialists like webMethods, TIBCO Software, and Ascential Software are adding RFID-specific features like reader coordination and edge-tier filtering to their existing integration broker technologies
  - Extensive experience with high-volume data and process-integration scenarios
  - Opportunity to capitalize on RFID adopters that have already invested heavily in their integration broker technology

Vendors and Offerings (10)

- The Auto-ID Center at MIT was the source of many early RFID standards
- First product (Savant)
  - "a data router that performs operations such as data capturing, data monitoring, and data transmission"

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Vendors and Offerings (11)

- Auto-ID Center envisioned Savants working together in a hierarchical framework to manage EPC data throughout the enterprise

- Savant standard is the basis for RFID middleware

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Middleware Architecture

- Middleware architecture Inception
  - Understand the RFID middleware architecture tiers
  - Evaluate your existing middleware investments
  - Prioritize your middleware needs according to your deployment plans

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Tiers of RFID Middleware (1)

Tier	What It Does	Where It's Located
The Edge Tier: The primary function of the edge tier is to serve as the first line of defense from an overburdened network	Very basic filtering to filter noise and superfluous data from the network, such as duplicate reads, which often still exist despite advances in reader technology. May also aggregate multiple reads into "packages" of data that can be passed up to local applications, rather than sending individual read information	Close to – or even on – the readers themselves. In the past, this logic resided on separate boxes, placed as close to the readers as possible. As readers become more intelligent, they host this middleware logic themselves, nipping unwanted reads in the bud right at the source

Patrick J. Sweeney, "RFID For Dummies" April 2005

Tiers of RFID Middleware (2)

Tier	What It Does	Where It's Located
The Operational Tier: The role of this tier is to do more context-based filtering that requires knowledge of other reads coming through the system	Decides where to route the data – either to a local warehouse management system or up to the enterprise, for example. Raises flags when exceptions occur (like when a pallet tries to leave a distribution center without enough cases on it) using business-event management logic. Stores some RFID data in a database so that a monitoring application can track all traffic flowing through that site	At individual sites, like warehouses, distribution centers, or retail stores

Patrick J. Sweeney, "RFID For Dummies" April 2005

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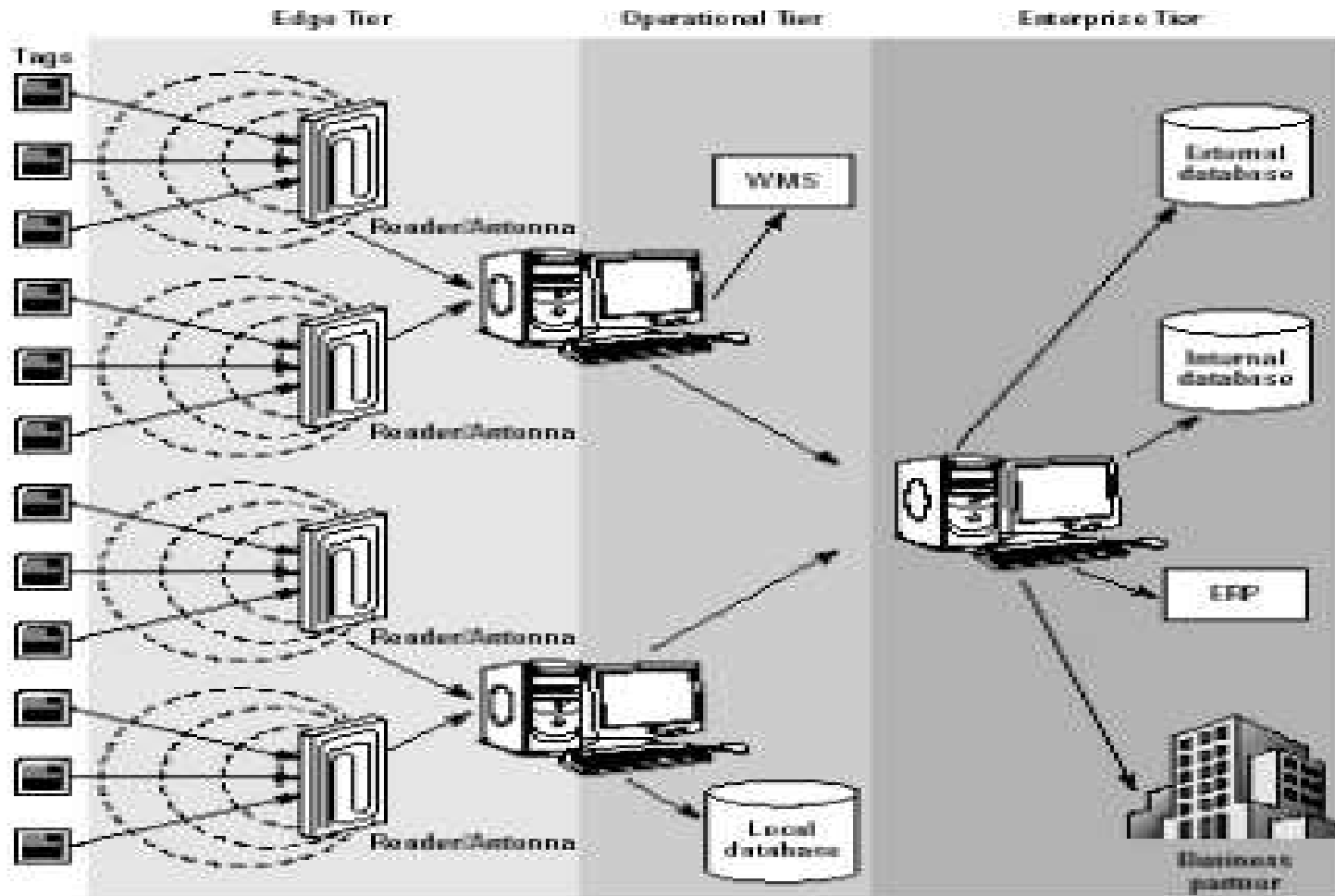# Tiers of RFID Middleware (3)

Tier	What It Does	Where It's Located
The Enterprise Tier: The highest level in the architecture is similar to existing enterprise integration tools from vendors like TIBCO, webMethods, and so on. The goal of this tier is to accept data from the operational tier and incorporate it into enterprise-wide processes and/or applications	Connects with common enterprise applications and data stores, like SAP or a centralized product information database. (Advanced systems will actually have process-management capabilities and some prepackaged logic for this task.) Communicates data to external business partners, like an advanced shipping notice that needs to be sent from a manufacturer to a retailer	Oftentimes at one central data source where the information can be mined and acted upon for business decisions

Patrick J. Sweeney, "RFID For Dummies" April 2005

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Three-tier Architecture

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Prioritizing Middleware Needs (1)

- Immediate demand for a wide spectrum of RFID middleware functionality

- Standards bodies like EPCglobal are constantly updating middleware standards

- Many of the vendors have adopted accelerated product release schedules to stay current with changing standards and get enterprise-class products to market as quickly as possible

Prioritizing Middleware Needs (2)

- Coordinate your RFID middleware investments with your expected RFID rollout timeframe

- Understand the physics first and then design the middleware solution around your infrastructure and rollout for best results

- The middleware space is only getting more and more competitive, so take your time and make the right decision

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Prioritizing Middleware Needs (3)

- Long-term multi-tiered RFID middleware architecture

- Path to reach that end state varies
  - Early adopter?
  - More conservative RFID adoption timeframes?

Middleware Depends on Deployment Scenario(s) (1)

- Forrester evaluated leading RFID middleware vendors using approximately 75 criteria that spanned everything from edge-tier features to enterprise-level process management

    – www.forrester.com/Research/Document/Excerpt/0,7211,34390,00.html

    – 13 RFID middleware vendors in the assessment

Middleware Depends on Deployment Scenario(s) (2)

- ## Results varied across vendors
  - Impossible to compare

- ## Evaluation separated into two components
  - one for early adopters and
  - one that focused on features most important for supporting longer-term, high-scale deployments

Overview of RFID Middleware Platforms

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RFID Middleware (1)

- ## RFID Middleware

  - ### Key element of every non-trivial RFID Deployments, where

    - Many distributed readers and antennas (e.g., in factories, warehouses, and distribution centres) capture RFID data

    - Data are conveyed to a variety of applications (e.g., ERP/WMS systems)

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RFID Middleware (2)

- **Key Middleware Functions**
  - Data Collection, Filtering, Event Generation – Business Events, RFID Information Sharing

- **Related EPC standards**
  - EPC-RP, EPC-LLRP, EPC-ALE, EPC-IS

- **RFID Middleware Platform**
  - Alleviates Deployment and Integration Complexity

Taxonomy of RFID Middleware Platforms (1)

- ## RFID Middleware Platforms
  - – Complex Landscape
- ## OSS / Research
  - – Currently over fifty (50) projects in sourceforge.org
  - – Early Research Platforms
    - • WinRFID, RFIDStack, …
  - – EPC Based
    - • Singularity, FossTrak, Accada, RadioActive, Mobitec, Logicalloy…

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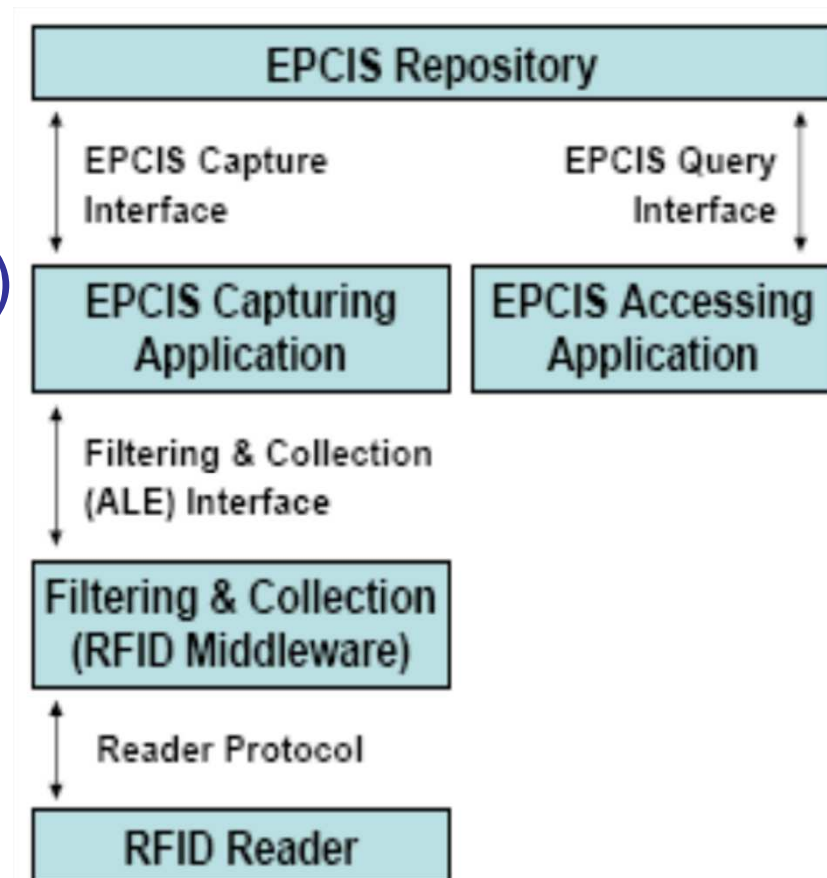# Taxonomy of RFID Middleware Platforms (2)

- ## OSS / Research
  - Some Representative Platform are illustrated in the next slides

- ## Proprietary / Commercial
  - Leading technology vendors
    - IBM, Oracle, Microsoft, SAP, Sun Microsystems, HP, …

FossTrak OSS Platform (1)

- Main contributor
  - ETH, CH
    (http://www.fosstrak.org)
- Platform client
  - Web/Desktop Client
- License
  - LGPL
- Language
  - Java

EPCIS Repository	
EPCIS Capture Interface	EPCIS Query Interface
EPCIS Capturing Application	EPCIS Accessing Application

Filtering & Collection (ALE) Interface

Filtering & Collection (RFID Middleware)

Reader Protocol

RFID Reader

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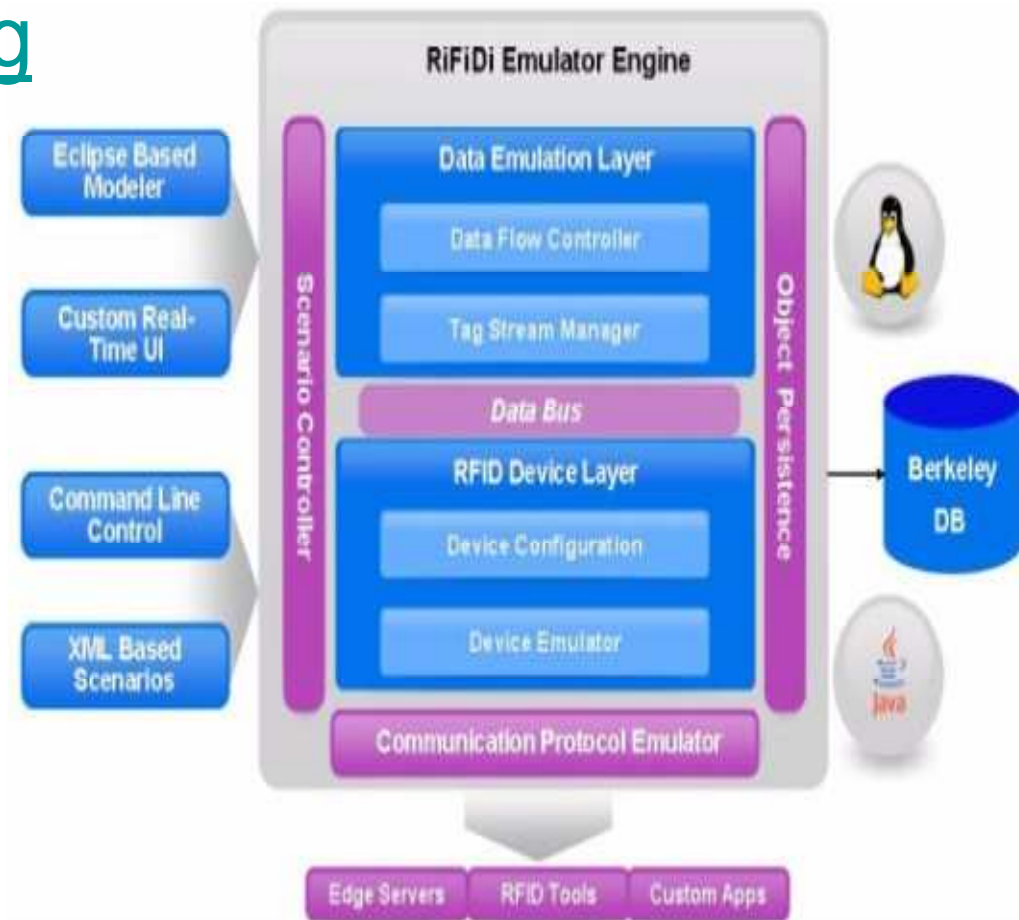# FossTrak OSS Platform (2)

- Strengths
  - Complete EPCglobal protocol stack
  - Large User Community (especially for EPCIS)

- Weaknesses
  - Currently in alpha version

RIFiDI OSS Platform (1)

- http://www.rifidi.org
- License
  - LGPL
- Languages
  - Java/C

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RIFiDI OSS Platform (2)

- Strengths
  - Edge Server Compatibility
  - Tag Streaming Utility to mimic the flow of RFID data
  - Alien ALR 9800 Gen 2 Reader Emulation
  - Lightweight XML-RPC Reader Engine
- Weaknesses
  - Limited configurability for business semantics
  - No support for filtering and business events

Logicalloy OSS Platform

- http://www.logicalloy.com

- License
  - Sleepycat / flexible OEM Commercial License

- Language
  - Java

- Strengths
  - Simple configuration and management tools
  - Integration with existing business systems

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OSS Middleware Platform Features

Available Implementations	Applied EPCglobal Standards						
	ONS	EPCIS	ALE	RM	LLRP	RP	TP
Accada		X	X	X		X	
Rifidi			*		X		X
**Singularity		X	X	X			
RadioActive	X	X	X			X	
Mobitec			X	X			X
UJF RFID Suite	X	X	**	X		X	X
*Logicalloy		Partial (Capture)	X				X
SJS RFID Software			X				

Commercial Middleware Platforms

Product	Vendor	Key Features				
		Lightweight	User friendly	Affordable	Programmable	Privacy-friendly
iMotion	GlobeRanger	Y	Y	Y	N	N
WebSphere	IBM	lightweight version available	N	Low-cost version available	Y	N
Integration Platform	Manhattan Associates	N	Y	N	N	N
OAT Foundation Suit	OAT Systems	Y	Y	Y	N	N
Sensor capabilities	Oracle	N	N	N	Y	N
NetWeaver	SAP	N	Y	N	Y	N
SmartChain	Savi Technology	N	Y	N	Y	N
RFID Interchange	Tibco Software	Y	N	Y	N	N

OSS Platforms: Missing Pieces (1)

- ## General Remark
  - Most OSS platforms are in their infancy
  - Not suitable/appropriate for large scale deployments

- ## No support for
  - Configurable Business Events Generation
  - Integration of sensor data (e.g., temperature)

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OSS Platforms: Missing Pieces (2)

- No support for
  - Integration of Actuators
  - End-to-End Infrastructure Management
  - Privacy Friendly RFID
  - Programmability and (Visual) Integrated Development Environments
  - Business Process Management (RFID-enabled Processes)

References – Additional Reading

- Patrick J. Sweeney II, "RFID For Dummies", Chapter 11: Middle Where? It's Not Just about the Readers, Wiley, April 2005