Using Rockwell Arena® for Simulating RFID-Enabled Supply Chains

Arena User Group Meeting 2008

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Hasso Plattner Institute for IT-Systems Engineering
Potsdam, Germany
Agenda

- **The Hasso Plattner Institute**
- Research Group of Prof. Hasso Plattner
- Processing of Large-scale Data in the Pharmaceutical Supply Chain
- The Need for real Data in Software Engineering
- Arena in Teaching and Research at the Research Group
- Next Steps
First National IT-Summit at HPI
Hasso Plattner Institute

- Hasso Plattner Institute for IT-Systems Engineering – HPI – is located in Potsdam. It was founded in October 1998.
- The institute is completely financed by the foundation of Hasso Plattner, one of the founders of SAP.
- Over 20 years foundation pays more than 200 Million Euro for HPI.
- HPI is affiliated with the State University of Potsdam (“An-Institut”)

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HPI – Teaching

- HPI offers two university level programs of study
  · "IT-Systems Engineering" with international accepted degrees
  - Bachelor of Science (3 years, about 80 students per year) and
  - Master of Science (2 years, about 60 students per year)
- Students are enrolled at the (state) University of Potsdam
- At time, about 420 of the best talented IT students are enrolled at HPI
- Until now, already 300 Bachelors and 100 Masters graduated
HPI – Cooperations and Bachelor Projects

- Cooperation with government institutions, industry (SAP, IBM, MS, Software AG) and universities (Stanford, MIT)

- For teaching practical IT skills and experiences students have to pass a so-called Bachelor project
  - in teams of 6-8 students have to solve a complex software task for a third party from industry or government
  - duration: 1 year, 2nd semester full time
  - teams are supervised by a professor and his research group
HPI – Partners of Bachelor-Projects
In 2005, Hasso Plattner founded **Hasso Plattner Ventures (HPV)**

HPV is a new, in Germany unique combination between a venture capital fond and a business incubator for young IT-companies

HPV is located on the HPI campus to collaborate easily...
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Enterprise Platform and Integration Concepts
Prof. Dr. Hasso Plattner / Dr. Alexander Zeier

Research focus on the technical aspects of enterprise software and design of complex applications:

- Main Memory Based Data Management for Enterprise Applications
- Human-centered Software Design Processes
- Real-time Integration of RFID Technology in Enterprise Systems
- Maintenance and Evolution of SOA in Enterprise Platforms
EPIC: Current Research Projects

- Memory-Based Data Management for Enterprise Applications
  - In-Memory Column Databases for rapid joins with business-relevant large-scale enterprise data
- Maintenance and Evolution of SOA Systems
  - Investigating the maintenance phase of the software lifecycle for SOA Systems
- RFID and Enterprise Platforms
  - Research in Supply Chain Management with RFID-Technology
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Pharmaceutical Supply Chain in the US

- One of the most complex supply chains
- Top 10 producers: 60% market share in 2004
- Wholesale Distributors:
  - less than 50 companies
  - Top 3: 90% market share
- 3.2 billion prescriptions per year
  - market of over $ 200 billion

Source: "Modeling supply chain network traffic" (Williams et al.)
The Health Strategies Consultancy & IMS Health
Picture by NVinacco (flickr)
10% of pharmaceuticals are counterfeit
- $32 billion dollar industry

Pedigree legislation
- makes the supply chain traceable
- makes every trade partner sign off on every drug package
- electronic handling of pedigrees advisable

E-Pedigree
- Item-Based Tracking
- Track & Trace via Electronic Product Code (EPC)
- Favorable Technology: RFID

Source: "Modeling supply chain network traffic" (Williams et al.)
The Pharmaceutical Supply Chain

**Raw material A** in barrel 9
**Raw material B** in barrel 3
Delivered on **Truck 33**

**ACME Aspirin**
*Delivered on Truck 25*
*Left stock 8:47 PM on Truck 76*

**From Chemical Supplier X,**
**Truck 33, Barrel 3 and 9**
**ACME Aspirin**, produced with **A and B**
To **Distributor Z** on **Truck 25**

**ACME Aspirin** taken from shelf
Pedigree:
- **Truck 76** from **Z**
- **Truck 25** from **ACME**
- **Truck 33** from **X**

Source: Auto-ID Labs, Koh et al. 2003
EPCglobal Network

- EPCglobal: a joint venture aiming at creating a standard for sharing RFID data over the internet

- The EPCglobal Network consists of
  - Electronic Product Codes (EPC)
  - Object Naming Service (ONS)
  - EPC Information Systems (EPCIS)
  - Discovery Services
Electronic Product Code

- Every product tagged with an EPC can be uniquely identified
  - as opposed to knowing the manufacturer or the product class
- EPCs are used on RFID-Tags and 2D-Barcodes
- Possibilities
  - finding information related to an EPC-tagged item
  - tracking an item through the supply chain
  - detecting irregularities and counterfeits
Object Naming Service, EPC Information Services and Discovery Services

- ONS is based on URNs and the Domain Name System
  - query with an EPC to get the URL of the manufacturer’s EPCIS
- EPCIS enables sharing of EPC-related data within and across enterprises:
  - to gain a shared view on EPC-tagged items
  - to improve business processes
  - to find new business opportunities
- Discovery Services
  - ONS only gives manufacturer’s EPCIS
  - finding all members of the supply chain that were in touch with a given EPC
  - non-trivial architecture, not yet defined
Research at EPIC

- Huge amount of data exchange between EPCglobal components
  - questions of scalability and performance
- Integration into existing middleware
  - testing RFID-middleware as Software as a Service (SaaS)
- Discovery Service Architecture undefined
  - examining different possibilities
  - comparison of approaches
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Different approaches for an architecture are possible
  □ Implementation of each is not feasible

For modularized, decoupled architectures in SOA environments

Simulation of different possibilities based on
  □ benchmarks of the surrounding components
  □ knowledge of the framework in use
  □ other values (e.g. network latency)

Simulation of message passing and remote procedure calls (RPCs)

Gives indicators for the behavior of the architecture under realistic circumstances

Applies here, too:
  □ Simulation does not make decisions, it makes decisions easier.
Software Tests with normal test data

- Usual Software Tests are not realistic
  - Either test data is pulled by the software
  - Or a script pushes data into the software
- Tests depend mostly on the data itself
  - Only useful for bug-fixing and stability tests
    - “Can my software handle this data?”
    - “Can my software handle this much data in this much time?”
      - More complex, still manageable with self-made tools

  “Can my software handle a specific amount and type of data based on multiple schedules?”
Software Tests with realistic data generation

- Data is generated by the simulation software
- Simulation software provides environment for:
  - Scheduled data input
  - Data input based on probabilities
  - Conditional data input
  - Detailed statistics and evaluation

- Simulation based data generation automatically covers:
  - Best case, worst case, average case
  - Data that might have been forgotten
  - Data input behavior that might not have been expected
Software Tests with Simulation Data

- Useful if software integrates into a complex process
- Good: simulation model exists beforehand
- Problem: Interface between Arena and own software
  - writing test data to disk, read in later
  - VBA-module makes HTTP-Request
    - Easy to integrate calls in times of SOA and REST, SOAP, ...

- The EPCglobal Network is a perfect candidate to be tested with simulation data from the Pharmaceutical Supply Chain!
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RFID-Technology enables the exchange of huge amounts of data
Architecture of the EPCglobal Network is not finished
Many research is conducted in the area of:
  - Scalability and Performance
  - Authorization, Authentication and Privacy Issues
  - Integration into existing middleware
EPIC research in the area of Scalability and Performance
  - Testing of existing components
  - Prototyping of components
  - Integration of these components
  - Benchmarking with several instances in virtual machines
Integrating Arena with RFID-Infrastructure

- **RFID-Infrastructure in a company**
  - Items with EPC
  - Readers
  - Middleware
  - Internal System (e.g. ERP)
  - EPCIS

- **Actors from outside**
  - Query and Discovery

- **Arena acts as an RFID-Reader**
  - testing the setup with simulated readers
Integrating Arena with SAP Auto-ID

- **SAP Auto-ID Infrastructure (AII)**
  - component of the SAP NetWeaver platform
  - enables communication between RFID-readers and
    - the SAP R/3 software
    - mySAP SCM solution
    - other SAP Enterprise Resource Planning software

- **Goal: simulation of read-events**
  - AII manages read-events in device control middleware
  - HTTP-Interface available
Combining Arena with CrossTalk

- CrossTalk by noFilis is a device management middleware
  - part of the SAP Auto-ID Infrastructure (AII)
  - accepts read-events from RFID-devices
  - acts as a filter and device controller

- Arena simulates multiple RFID-readers and sends read-events to CrossTalk
  - read-events are sent via HTTP-Requests through a VBA-Block
  - variables or entity attributes may be appended to the query
    - RFID-example: entity has attribute “epc”
  - easy integration of read-events in an existing supply chain model
Arena Model with Read-Event Blocks
RFID Tag and Read Gates

- **RFID Tag Gate**
  - EPC-Base: base value
  - Range: maximum of tags

- **RFID Read Gate**
  - Needs an ID
  - URL with reader ID as parameter and "epc="

![RFID Tag Gate](image1)

![RFID Read Gate](image2)
VBA-Source of RFID Read Gate

- Uses Microsoft WinHttp Services
  - activate in VBA-Editor under Tools -> References

```vba
Private Sub VBA_Block_4_Fire()
  ' http read gate - reads EPC attribute only
  Dim m_siman As SIMAN
  Set m_siman = ThisDocument.Model.SIMAN
  ent = m_siman.ActiveEntity
  epc = m_siman.EntityAttribute(ent, m_siman.SymbolNumber("EPC"))
  Dim m_objWinHttp As WinHttp.WinHttpRequest
  Set m_objWinHttp = CreateObject("WinHttp.WinHttpRequest.5.1")
  m_objWinHttp.Open "GET", "`Command`` & epc, False
  m_objWinHttp.Send
End Sub
```
Arena Model with Read-Event Blocks

- Manufacturer
  - Creates Drug Entity
  - Tags Drug Entity
  - Reads Drug Entity (first call to EPCIS)
  - Tags Batch Entity
Wholesaler
- Reads Batch and Drugs
- Stores them until needed and then sends them out
Arena Model with Read-Event Blocks

- Pharmacy
  - Simulation of Customers
  - Drug-Batch comes in, drugs entities are read
  - Final RFID read when sold
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Simulating the Pharmaceutical Supply Chain with Arena

- Developing a more complex simulation of the supply chain with integrated RFID-Technology
- Running the simulation model with Arena and storing the RFID read-events
- Evaluating the generated data sets
  - quantified number of read-events
- Creating a setup of a company’s RFID-Infrastructure
  - with own prototyped test software
  - with enterprise software in business environment
- Testing this setup with realistic data from the simulation
Continuing research with simulation technology

- The supply chain simulation data might give further insights
  - Will the ePedigree-model work efficiently?
  - What is the best way to implement the Discovery Service?
  - Where is further room for improvement in the EPCglobal Architecture?
- Further questions concerning RFID-related software processes
  - Availability, Reliability, Stability
  - Confidentiality, Privacy, Access Control, Customizability
- Enforcing research of enterprise RFID-software based on simulation data
  - Testing the integration of SAP AII into an existing supply chain with Arena?
Literature and web references

- „Follow The Pill: Understanding the U.S. Commercial Pharmaceutical Supply Chain“ by Dan Mendelson and The Health Strategies Consultancy, 2005
- „Modeling supply chain network traffic“ by John R. Williams et al., 2008

- EPCglobal: http://www.epcglobalinc.org/
- Research database about RFID: http://autoidlabs.org/
- CrossTalk: http://www.nofilis.de/
- SAP AII: http://www.sap.com/platform/netweaver/autoidinfrastructure.epx
- Chair of Prof. Plattner: http://epic.hpi.uni-potsdam.de

- Slides available at http://stefanwehrmeyer.com/files/
Thank you very much for your attention!

Questions please!