Prediction, Detection and Proof: Auto-ID on Theft

Edmund W. Schuster
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Agenda

- Introduction to the issue of theft
- The useful attributes of Auto-ID for anti-theft systems
- Our conceptual model of theft
- Implications
- Additional benefits
- Conclusion

“Prediction, Detection and Proof: An Integrated Auto-ID Solution to Retail Theft”

R. Koh, E.W. Schuster, N. Lam, and M. Dinning.“

This article was published by the *MIT Auto-ID Center* on September 1, 2003.

Re-Code.com

- “name your own price”
- Re-code.com offered Internet users a large number of downloadable barcodes that could be printed at home, and applied to merchandise in stores
- The bar codes (with implied prices) were copied from existing sale and promotional merchandise at Wal-Mart Stores
- The company took quick legal action to shut the site down

Introduction

- Theft is a serious problem costing retailers at least $25 billion per year
- Shrinkage accounts for 1.8% (USA), and 1.75% (Europe) of sales.
- For Wal-Mart alone that is $4-5 billion in losses
- Between 60% - 80% of shrinkage is attributed to either internal or external theft
- "[theft is] one of the biggest enemies of profitability in the retail business." Attributed to Sam Walton.
  - Earle, J. "Inside Track – Retailers Turn on the Enemy Within." *The Financial Times* (April 3, 2002).

Introduction (continued)

- **No improvement** during the past 10 years
- The ongoing cost of theft directly **reduces net income** dollar for dollar.
- For a stolen item with a profit margin of 10%, revenues must increase by **10 times the amount of the theft** to recover the net income lost.
  - Albrcht, S., and D. Searcy (2001). "Top 10 Reasons why Fraud is Increasing in the U.S." *Strategic Finance* (May).
- **With lack of pricing power**, few firms are able to recover these losses through higher sales volume or increased prices
- Losses from theft are equal to an estimated **1.1%** of sales

Introduction (continued)

- Theft is part of the broader category of shrinkage and is hard to pinpoint with accuracy
- Total shrinkage, as measured by inventory adjustments, is the only true indicator of theft
- Inventory adjustments also include
  - »process failures
  - »spoilage
  - »accounting errors
  - »vendor fraud
- Few, if any firms know precisely the amount of theft that occurs each year from their stores, manufacturing plants and warehouses.

A lack of Data exists about the theft problem
Adrian Beck, “A Data Desert”

Internal theft is a bigger problem than most companies wish to acknowledge.

The “eBay” outlet

The Limited VS Staples

Introduction (continued)

- **Current investments in technology or other approaches to reduce theft in one area of the supply chain frequently achieve mixed results**
  - »EAS and towers
- **Theft seldom totally disappears. It tends to shift, appearing in other parts of the supply chain where security measures are soft.**
- A comprehensive solution is needed
- **In addition, cargo theft represents** $10 billion **per year in losses for US firms**
  - **Levin, A. "Oscar Heist Puts Spotlight on Cargo Theft." *National Underwriter* (Chicago, 2000).**

THE INDIRECT IMPACT OF THEFT

- **Physical and Perpetual Inventory Synchronization**
  - »The "back flushing" inventory method and out of stocks
- **According to a recent study, nearly 23% of consumers leave a store immediately in response to an out-of-stock.**
  - »Zinn, W. and P.C. Liu. "Consumer Response to Retail Stockouts." *Journal of Business Logistics* 22:1 (2001): p. 59.
- **Pushing Responsibility Downstream**
  - »package design, software example
  - »in-store theft prevention devices
  - »consignment sales
- **Changes in Merchandising**
  - »defensive merchandising (limit items on shelf)
  - »restrictive merchandising (items behind counter, dummy package on shelf)
- **Up to 75% increase in sales from eliminating defensive and restrictive merchandising**

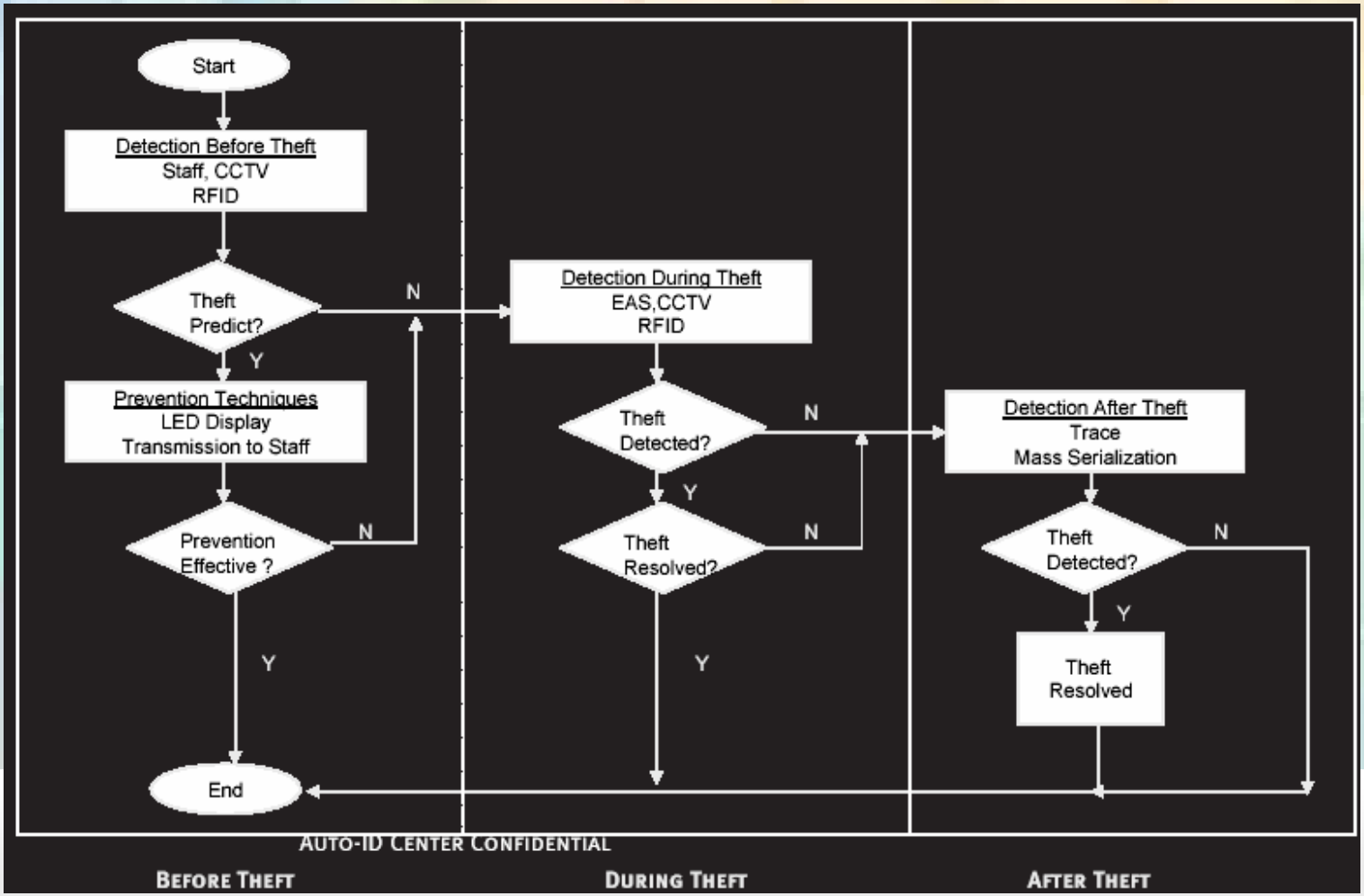
Auto-ID Attributes for Anti-Theft Systems

	TAG/READER	EPC	ONS	SAVANT	PML	PML SERVER
No Line-of-Sight Identification	✓					
Mass Serialization		✓				
Real-Time Visibility	✓			✓		
Track		✓	✓	✓	✓	✓
Trace		✓	✓			✓

A Conceptual Model of Theft

- **Before Theft**
  - » better to predict, detect and deter
  - » combination of technologies
  - » trigger deterrence technologies
- **During Theft**
  - » detection & aid in apprehension
- **After Theft**
  - » ID of stolen items

Prediction, Detection & Proof



The Aspects of Auto-ID That Relate to Theft

USEFUL CHARACTERISTICS TECHNIQUE	NO LINE OF SIGHT	MASS SERIAL.	REAL TIME	TRACK	TRACE
THEFT PREDICTION					
Open Pack	✓		✓		
Sweep Theft	✓	✓	✓		✓
Disabling Tags	✓	✓	✓		
DETECTION DURING THEFT					
Concealment	✓		✓		
Barcode Switch	✓	✓	✓		
Collusion	✓		✓	✓	✓
Intentional Undercount	✓	✓	✓	✓	✓
Trash	✓	✓	✓	✓	✓
PROOF AFTER THEFT					
Burglary		✓			✓
Grab & Run		✓			✓
Fraudulent Refunds		✓			✓
Fraudulent Receipts		✓			✓

Implications

- Migration from proof to deterrence
- Tag integration into packages has application consequences
- Killing of tag = killing of EPC?
- When should a tag be killed?
- The shifting nature of theft

Additional Benefits

- **Increased inventory accuracy**
- **Product display and store layout**
- **Greater control of theft prone items**
- **Source tagging**
- **A dynamic solution**
  - » more information to combat theft
  - » base for an “adaptive system”

The Issue of False Alarm

- One survey shows that 16 percent of people would no longer shop at a store if they were subject to a false alarm and wrongly accused of stealing.
- Further, 50 percent of people surveyed indicated that high technology theft prevention devices make them feel uncomfortable.

Dawson, S. "Consumer Response to Electronic Article Surveillance Alarms." *Journal of Retailing* 69:3 (1993), 353 – 363.

Conclusion

- Auto-ID provides the basis for an integrated solution to theft
- Killing the tag will have implications on proof
- Other benefits from reducing theft
- Auto-ID provides the basis for a dynamic system

Securing the Pharmaceutical Supply Chain

Edmund W. Schuster

Auto-ID Labs

Healthcare Research Initiative (MIT)

Perform fundamental research and development to achieve the vision of ubiquitous intelligent objects in the healthcare industry.

- First meeting: 23 June 2004, Cambridge, MA USA

“Securing the Pharmaceutical Supply Chain”

R. Koh, E.W. Schuster, I. Chackrabarti, and A. Bellman.

This article was published by the *MIT Auto-ID Center* on September 1, 2003.

AGENDA

- Why Pharmaceuticals?
- Counterfeit
- Current technologies to combat counterfeit
- An Auto-ID approach

WHY PHARMACEUTICALS?

- The issue of Product and Supply Chain Integrity is Global

  "Between 5 to 8 percent of the worldwide trade in pharmaceuticals is counterfeit"

  "Approximately 192,000 people (1 person every 2.7 minutes) died in China in 2001 due to the effects of counterfeit drugs. As much as 40% of drugs in China are counterfeit"

  "This is not just something in the back alley. Patients buying prescriptions at their legal pharmacies are at risk too"

WHY PHARMACEUTICALS?

- It is Current

  A recent counterfeit incident involving Lipitor:

  "posed a potentially significant health hazard" according to the FDA.

- Direct Impact on Humans & Livestock

- Extension of our work on CPG

Why Pharmaceuticals?

- The Changing Regulatory Environment:

The Florida "pedigree" law

1. Drug Name
2. Dosage
3. Container size
4. Number of containers
5. Drugs Lot or Control numbers
6. Business Name and Address of ALL parties to each prior transaction, starting with the manufacturer
7. The date of each previous transaction

The Italian Bollini Law

COUNTERFEIT

Types of Counterfeit:

- False Product

GENUINE

COUNTERFEIT

COUNTERFEIT

Types of Counterfeit:

- False Product
- Tampered Product
  - Adulteration
  - Substitution
- Unacceptable Status of Product
  - Expired
  - Returned
  - Recalled
  - Discarded

COUNTERFEIT – THE CAUSES

- Improved computer technology
  - Nearly any label can be counterfeited
- Small secondary wholesalers
  - An active secondary market exists for pharmaceuticals
  - An active gray market exists
- An increase in expensive drug therapies

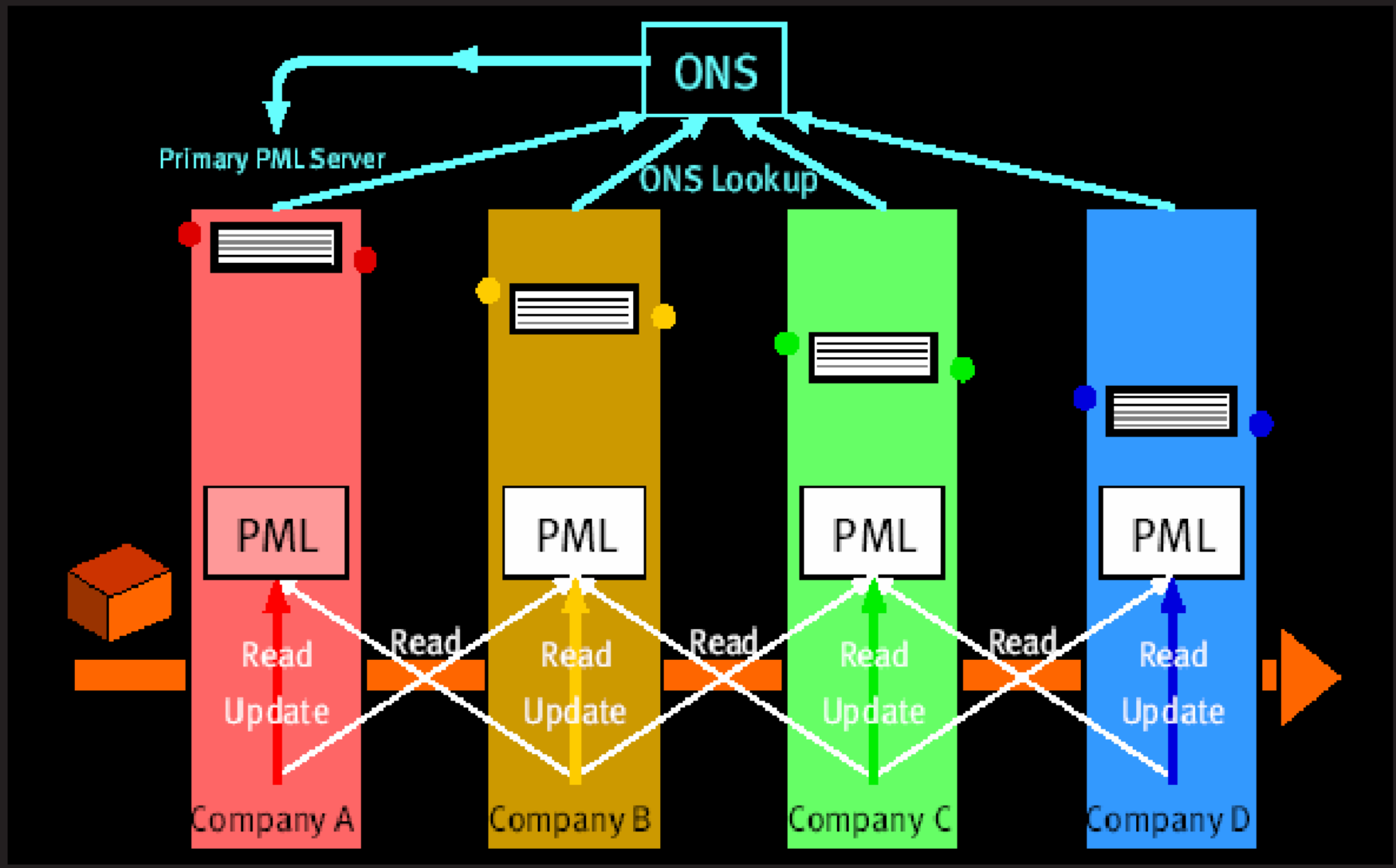
TECHNOLOGIES USED TO COMBAT COUNTERFEIT

ANTI-COUNTERFEIT MEASURE	COVERT	OVERT	REPLICATION
Intra-Formulation			
Immunoassay	✓		Low
Unique Flavoring		✓	Low
Package Level			
Design		✓	High
Watermarks	✓	✓	High
Digital Watermarks	✓	✓	New
Fibers and Threads	✓	✓	Medium
Reactive Inks	✓	✓	Medium
Holograms, OVD	✓	✓	High
Bar Code		✓	High

AN AUTO-ID APPROACH

- Drug (EPC) Verification
- Track
- Trace

AN AUTO-ID APPROACH - DRUG (EPC) VERIFICATION



Adapted from work by Mark Harrison of Auto-ID, University of Cambridge.

AN AUTO-ID APPROACH

Track and Trace:

Tracking involves knowing the physical location of a particular drug within the supply chain at all times.

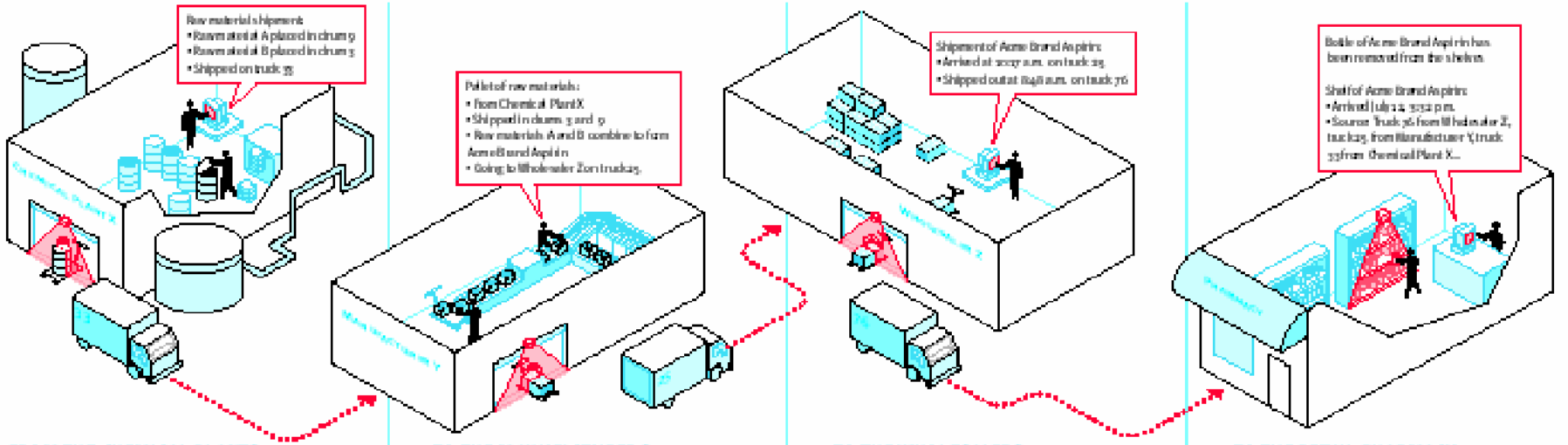
Tracing (pedigree) is the ability to know the historical locations, the time spent at each location, record of ownership, packaging configurations and environmental storage conditions for a particular drug.

AN AUTO-ID APPROACH – TRACK & TRACE

AN ACCOUNTABLE SUPPLY CHAIN: PHARMACEUTICAL PEDIGREE

XPLANATIONS® by XPLANE®

The pharmaceutical supply chain is a complex one. Not knowing the process by which pharmaceuticals make their way to pharmacy shelves can lead to risk in counterfeit products. Auto-ID technology helps manage this risk and maintain pedigree by tagging pharmaceuticals and product packaging with radio frequency identification (RFID) tags each possessing a unique EPC™. This allows products to be tracked, traced and recalled if necessary.



1. FROM THE CHEMICAL PLANTS

Chemical plants create raw materials and place them into drums. Each drum is uniquely numbered and tagged with RFID tags so the EPC™ Network can track them to the manufacturer. From this point on, the history of all raw materials is recorded in the EPC™ Network.

2. TO THE MANUFACTURER'S

Raw materials are tracked and shipped from the chemical plant to the manufacturer. The manufacturer takes the tagged drums and combines raw materials to make pharmaceuticals (e.g. pills and liquids). Next, the pills or liquids are placed into tamper-proof bottles and tagged with RFID tags. The EPC™ Network can easily account for the raw materials that go into each and every bottle. The tagged bottles are then shipped to wholesalers.

3. TO THE WHOLESALERS

Each bottle is tracked to the wholesaler. Product safety requires detailed records and an audit trail. The EPC™ Network puts that information at your fingertips. If necessary, product recalls are easily targeted and executed in a timely manner.

4. TO THE RETAIL PHARMACY

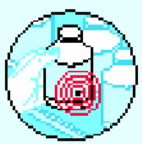
Pharmaceuticals are tracked into and out of the pharmacy. Auto-ID technology tells the Pharmacists where all the pharmaceuticals are, how many bottles have been sold and when. Bottles tagged with RFID tags hold each party in the pharmaceutical supply chain accountable for their actions, ensuring the pedigree of each product.

THE EPC™ NETWORK: HOW DOES IT WORK?

With the new EPC™ network, manufacturers, distributors and retailers will be able to track and trace items automatically throughout the supply chain. Here's how it works:

THE RFID TAGS

An Electronic Product Code (EPC™) is embedded into microscopic "smart tags" and attached to an item's packaging (e.g. drums or bottles). These tags allow the items to be tracked in a completely automated, cost-effective fashion.



THE READERS

Radio Frequency Identification (RFID) readers can scan each smart tag and send the item's EPC™ to a computer running Savant™.

SAVANT™

Savant™, middleware that connects the Auto-ID Network, queries an Object Name Service (ONS) database.

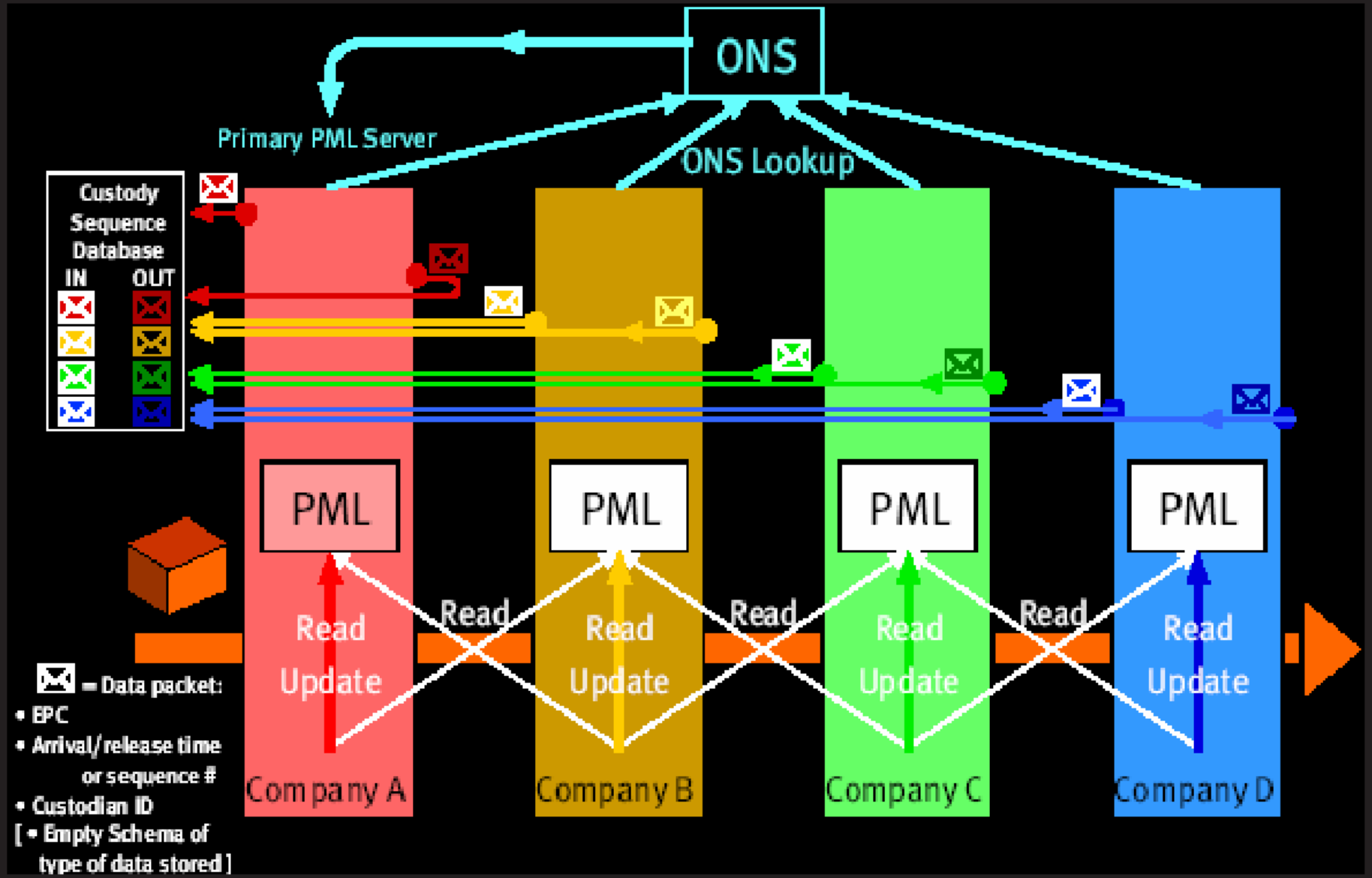
ONS SERVER

The ONS maps the EPC™ to a URL where all of the item's information is stored using Physical Markup Language (PML).

PML SERVER

The PML server contains information about the item itself, its manufacturing, shipping and other related data.

AN AUTO-ID APPROACH - TRACE



Adapted from work by Mark Harrison of Auto-ID, University of Cambridge.

AN AUTO-ID APPROACH

The Complexity of Track and Trace:

- The form of the physical goods can change during each step of the pharmaceutical manufacturing and distribution process.
- Difficulties exist in sharing information through the supply chain
- Present supply chains can be convoluted
- This is a highly regulated Industry

Conclusion

- Global counterfeit of pharmaceuticals is a serious problem
- The EU, FDA and States are responding with new laws and regulations
- Technologies exist to combat counterfeit, yet the problem remains
- Auto-ID offers three potential solutions to the problem
  - Drug (EPC) verification
  - Track
  - Trace

Networked Warfare

- General Henry H. Shelton, Chairman of the Joint Chiefs of Staff

- **"Focused Logistics is the ability to provide … the right personnel, equipment, and supplies in the right place, at the right time, and in the right quantity, across the full range of military operations. "**

- **Joint Vision 2020. US Government Printing Office - Washington DC, (June 2000).**

Networked Warfare

In the Report, General Shelton also states that focused logistics will be made possible

- **"…through a real-time, web-based information system providing** total asset visibility **as part of a common relevant operational picture, effectively linking the operator and logistician across Services and support agencies."**

Networked Warfare

Focused Logistics Transformation Path (from JV2020)

- FY 01, **implement systems to assess customer confidence from end to end of the logistics chain using customer wait time metric.**

- FY 02, **implement time definite delivery capabilities using a simplified priority system driven by the customer's required delivery date.**

Networked Warfare

Focused Logistics Transformation Path (continued)

- FY 04, **implement fixed and deployable** automated identification technologies **and information systems that provide accurate, actionable total asset visibility.**

- FY 04 **for early deploying forces and** FY 06 **for the remaining forces, implement a web-based, shared data environment to ensure the joint warfighters' ability to make timely and confident logistics decisions.**

Networked Warfare

Synergy between DoD and MIT Auto-ID

The MIT Auto-ID Center began in 1999

- predating JV2020 publication by one year
- based on the idea of low cost, passive RFID tags

- **MIT Auto-ID does fundamental technological research**
  - industry vendors focus on applications
  - from the beginning, a premise of "open" systems
- **Linking "things" to web-based information systems**
  - Auto-ID technology includes sophisticated IT infrastructure developed by MIT computer scientists

Networked Warfare

Distinguishing Characteristics of Military Supply Chains

- **Span**
  - – military action in distant lands, with long lead times for movement
- **Diversity in supply**
  - – many different classes of items
- **Fluctuating demand**
  - – instability in planning and execution, creating a complex system
- **Moving end and intermediate supply points**
  - – inventory control becomes a challenge
- **Readiness**
  - – other performance measures are meaningless
- **Supply chain visualization**
  - – real time information on location and amount is critical

Networked Warfare

Important Issues

- Current RFID vendors use propriety systems
- A single, open standard is needed for all RFID applications at DoD
- Interface with the proposed Advanced Logistics Program
- Stockpiling large amounts of inventory in “kits” versus moving to a “warm” inventory system
- Maintenance costs for RFID systems are high

Networked Warfare

General Application Areas for Auto-ID Technology

- **Inventory control**
  - real-time, accurate inventories on all items
- **Defense contractor collaboration**
  - coordination of production plans and inventory visibility through-out the military supply chain
- **Monitoring**
  - reliability of systems
  - control of ordnance shipments
- **Battlefield operations**
  - perimeter security systems to sense friendly incoming vehicles

Networked Warfare

Specific Opportunities for a Joint Research Project

- **Technical Aspects of Auto-ID Technology**
  - scanning on metal
  - shielding from electronic detection by the enemy
  - detailed research, analysis, development and testing of RFID under battlefield conditions, including experimental design
  - information technology infrastructure, data movement and storage

Networked Warfare

Specific Opportunities for a Joint Research Project (continued)

- **Service Parts Inventory Management**
  - supply chain wide, real-time location and inventory information
  - better scheduling for re-manufacturing operations
- **MRE Project**
  - field test already planned for Fall 2003
  - provide the business case for implementation

Enabling ERP Through Auto-ID Technology - Agenda

- Background and references
- Important aspects of ERP affected by Auto-ID, by industry (process vs discrete)
- Some Auto-ID applications within ERP
- The Transactional Bill of Material (T-BOM)
- Warranty process
- Conclusion

References

- "Enabling ERP through Auto-ID Technology" by E.W. Schuster, D.L. Brock, S.J. Allen, P. Kar and M. Dinning. Book chapter to be published by *Stanford University* (Press Fall 2004).
- "Creating an Intelligent Infrastructure for ERP: The Role of Auto-ID Technology" by E.W. Schuster and D.L. Brock. This is a working paper for *APICS* (April 2004).
- "The Prospects for Improving ERP Data Quality Using Auto-ID" by E.W. Schuster, T.A. Scharfeld, P. Kar, D.L. Brock and S.J. Allen. *Cutter IT Journal* (Sept, 2004).

Survey Data

What is your main goal in implementing an Auto-ID solution?

Improve inventory accuracy	55%
Trading partner requirement	13%
Increase inventory turns	10%
Reduce out-of-stock situation	9%
Enhance supplier relationship	9%
Improve fill rates	4%

Sample size - 658 respondents

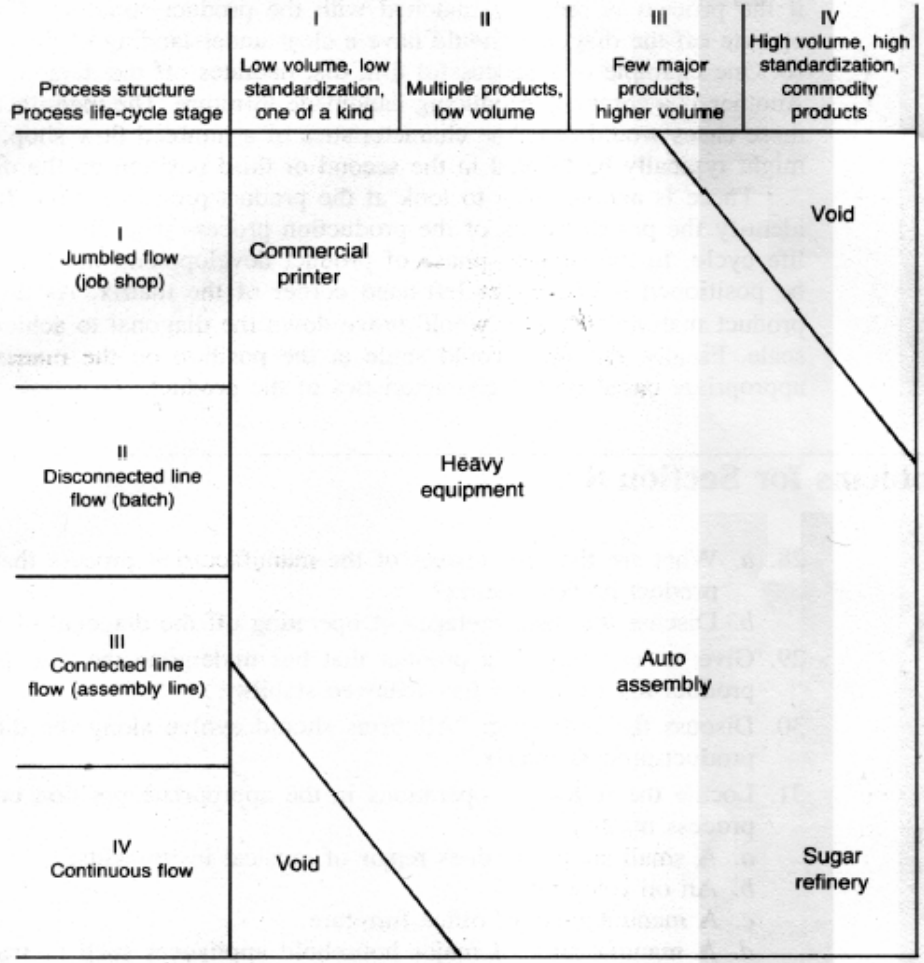
Survey conducted online, April 2004.

One of the most important inputs to ERP is data about objects such as **raw materials**, **work-in-process**, and **finished goods**.

Class A MRPII and Cycle Counting

ERP is Different based on Industry

The Product-Process Matrix



SOURCE: Robert H. Hayes and Steven C. Wheelwright, "Link Manufacturing Process and Product Life Cycles" in the *Harvard Business Review* (January–February 1979). ©1979 by the President and Fellows of Harvard College; all rights reserved. Reprinted by permission.

Bill of Materials Structure

- **V Structure**
  - » the process industries, few raw materials combined with a large number of end items
- **A Structure**
  - » traditional discrete manufacturing of machines and equipment, large amount of raw materials and work-in-process, low end-item inventory
- **T Structure**
  - » single design, with many options, automobile manufacturing

Our Definition of Accuracy

- **Accuracy: correct value for a measurement at the correct time.**
- **In dynamic systems, timeliness is very important for data input into ERP because measurements of inventory and other values for business processes are constantly changing.**

Auto-ID has great potential to increase:

» the amount of data

» the accuracy of data

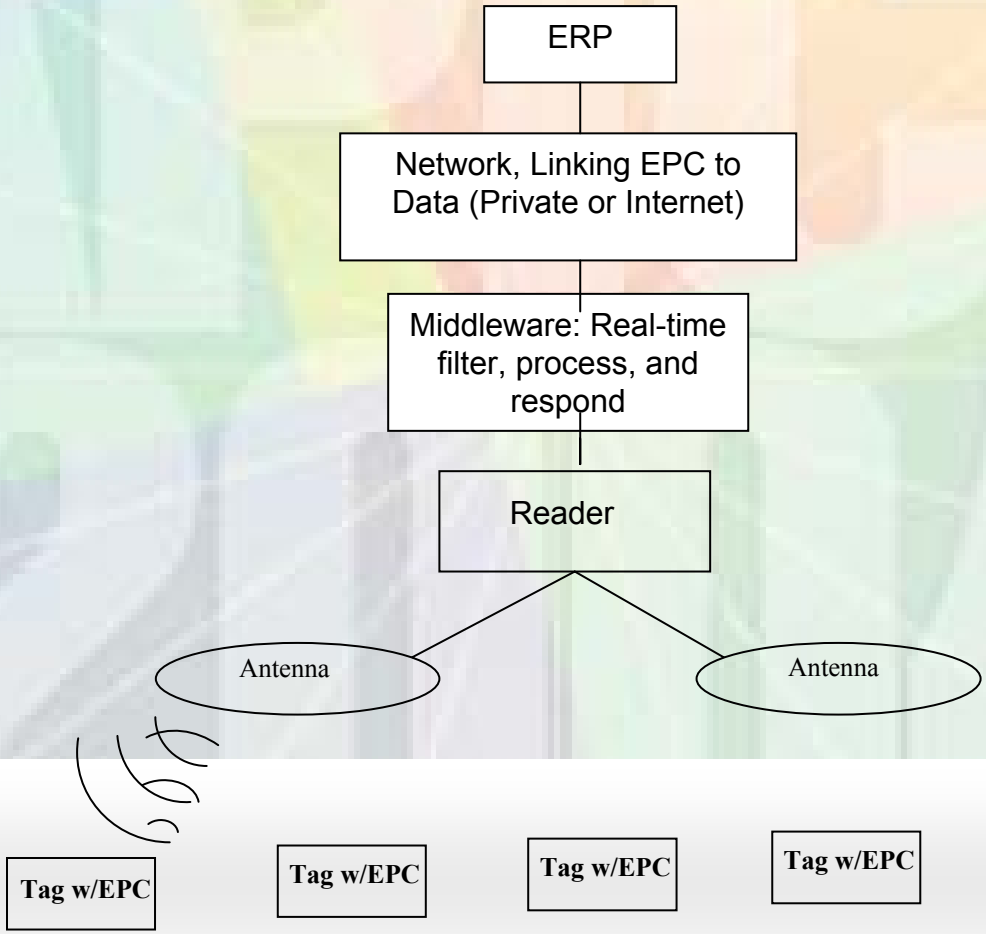
» the timeliness of data

	MRP (1960s)	MRPII (1980s)	ERP (1990s)	ERP + Auto-ID (2008)
Data Capture	**Manual**	**Barcode + Manual**	**Barcode + Manual**	**RFID**
Data Type	**SKU code**	**SKU code**	**SKU code or item serial number**	**Mass serialization – a serial number for each item or component**
Pro/Con	**Improved planning capabilities – limited data available, accuracy problems**	**Speed collection of data and improved accuracy, Batch mode – delays in updates**	**Standardized collection of data, some lot control – limited serial number control, lack of middleware, mature technology**	**Granular data at serial number level, middleware to manage serial numbers, common standards, real time – initial stages of development, technology to read tags must be refined**

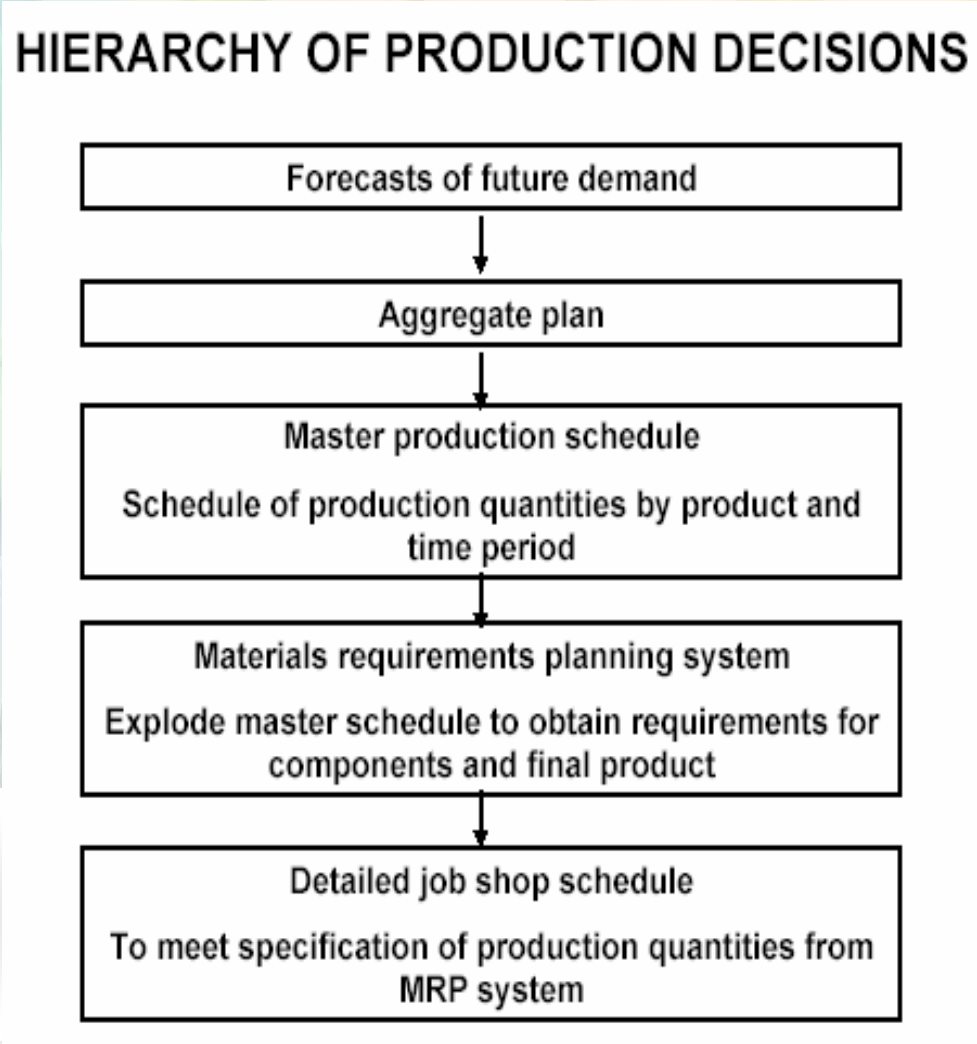
Characteristics of Tags

	Active	Passive	Semi-Passive
Power Source	**Battery**	**Induction from electromagnetic waves emitted by reader**	**Battery and Induction**
Read Distance	**Up to 30 meters**	**3 meters**	**Up to 30 meters**
Proximity Information	**Poor**	**Good**	**Poor**
Frequency Collision	**Hi**	**Medium**	**Hi**
Information Storage	**32 kb or more. Read/Write**	**2 kb Read only**	**32 kb or more. Read/Write**
Cost/Tag	**$2 - $100**	**25 ¢**	**Under Developed Some applications**

High Level View of ERP and Auto-ID



ERP Planning and Scheduling Structure



Impact of Auto-ID on ERP

- The ability to have manufacturing plant and supply chain wide visibility of objects identified with the EPC allows for large amounts of information and executable instructions to be assigned to an object.

- Given real-time data, new possibilities exist to apply advanced algorithms such as math programming and heuristics in every practical aspect of planning and scheduling.

Important Question

How to manage all of the EPC data obtained from tagged items within a supply chain?

Managing serial numbers for trillions of objects is a difficult challenge for current ERP systems.

Transactional Bill of Material (T-BOM)

- **History of movement for an item (pedigree information)**
- **A schematic of the serial numbers for all components contained in the finished item**
- **A mechanism to allow a query for authentication by any party within a particular supply chain**

Bostwick, Peter. 2004. "Method and System for Creating, Sustaining and Using a Transactional Bill of Materials (TBOM ™)." ***U.S. Patent Office*: Washington, D.C. Patent Pending (peter@certefi.com)**

Intended Goals of T-BOM

- **Enhance system integration for Auto-ID**
  - » current ERP uses lot control for tracking
- **Supply chain wide track and trace**
- **Authentication**
- **Management of service parts**
  - » version control

Shortcomings

ERP Systems

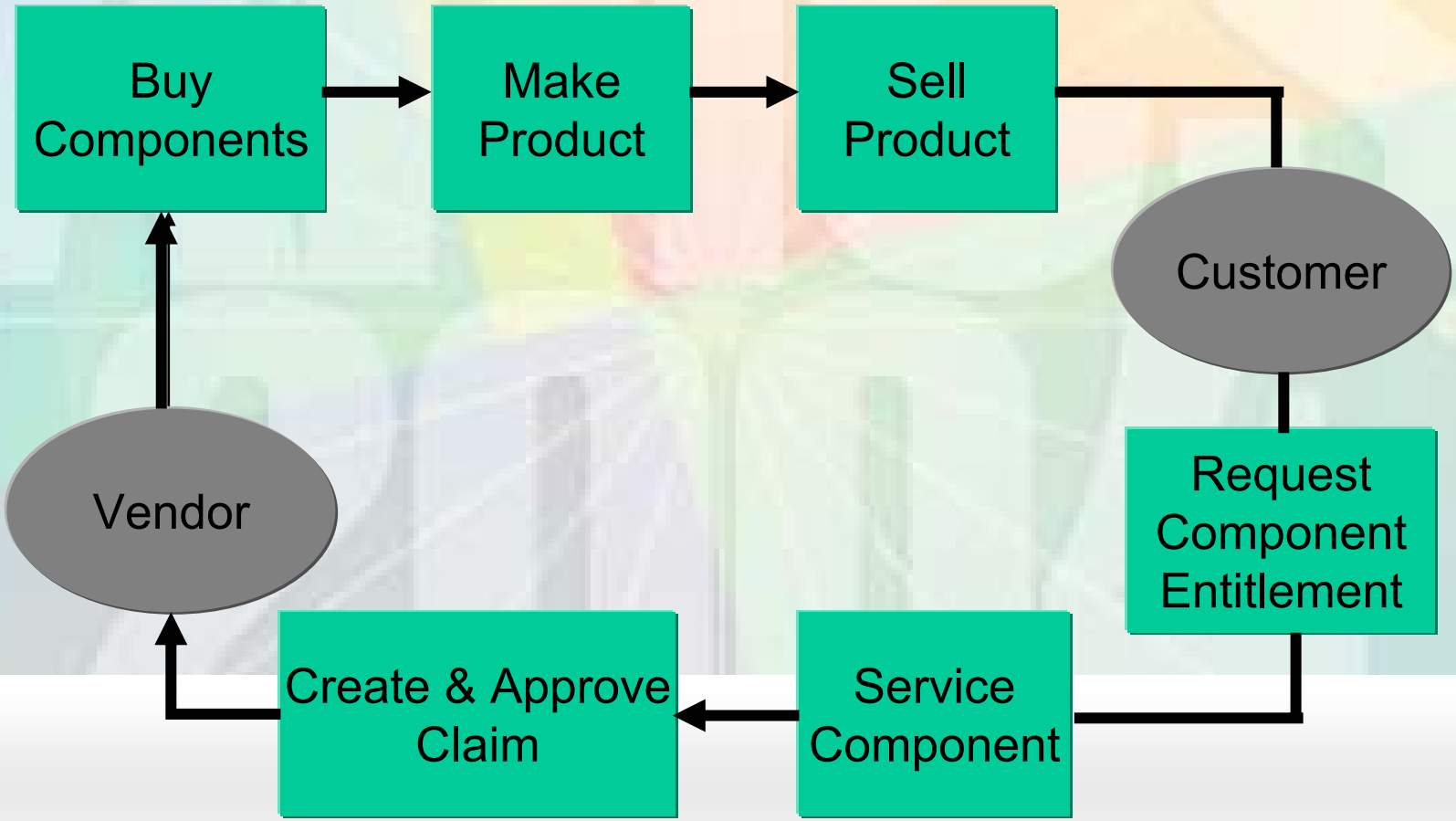
- Higher focus / level of detail
- Requires customization
- Expensive development environment
- Upgrade concerns
- No business rules engine
- Difficult to include external systems data

Custom Solution

- Expensive – one off solution
- Integration issues
- On-going support and maintenance

Product Liability Management

- Customer Entitlement Authorization
- Vendor Warranty Recovery
- Returns Processing
- Service & Installed Base Management
- Marketing & Special Pricing Programs
- Grey, Theft & Counterfeit Protection


Buy Components
Make Product
Sell Product
Customer
Request Component Entitlement
Service Component
Create & Approve Claim
Vendor

Warranty Benefit Results

Real-time transaction based

- Immediate and accurate response to customer
- Reduce service and repair costs
- Drive after-market warranty sales
- Check entitlement for unit and components

Analytics based

- Monitor fraud
- Installed base visibility
- Enable product quality analyses
- Increase vendor recovery

Conclusion

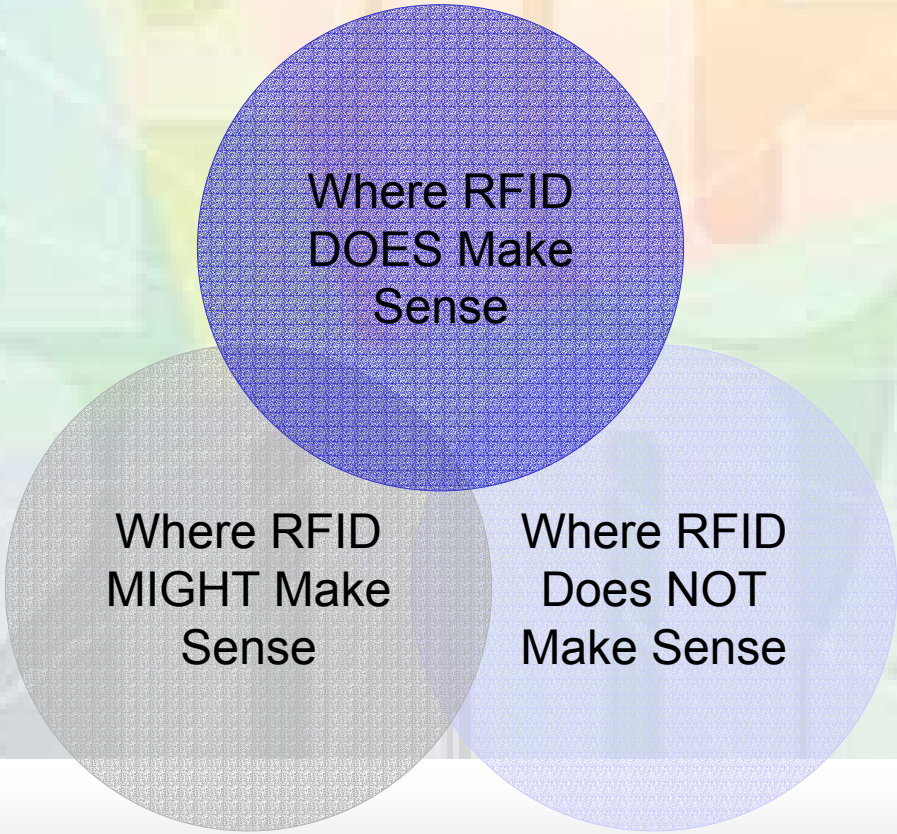
- Auto-ID will increase the amount, accuracy and timeliness of data
- There are few integrating mechanisms to get the data into ERP systems
- With more data, the nature of ERP systems will change
- There is no one model for Auto-ID and ERP, it is industry specific
- We are just beginning concerning research in this application area

"Getting on Board: Building a Business Case for Auto-ID at Dell"

Mark Dinning and Edmund W. Schuster

Published in APICS – The Performance Advantage (October 2004)

Sorting Out RFID



Mark Dinning, RFID Project Leader
Dell Inc.

Our Goals for Today

1. Understand the RFID Scorecard
2. Build the Business Case
3. Determine What to do Next

RFID Scorecard

Benefits

Characteristics of the Affected Process	Current Situation?
Labor Intensive Process	_____
High Rate of Errors	_____
Ineffective Optical Scanning	_____
Benefits	Will Imp. Allow You To?
Reduce Labor	_____
Reduce Errors	_____
Reduce Inventory	_____

Cost

Implementation Complexity	Will Imp. Be?
In a Limited Footprint	_____
On a Limited Number of Products	_____
Within One Company	_____
Operational Expense	Will You?
Be Able to Share Investment Cost	_____
Tag a Reusable Asset	_____
Tag at the Pallet/Case Level	_____
Avoid Item-Level Tagging	_____

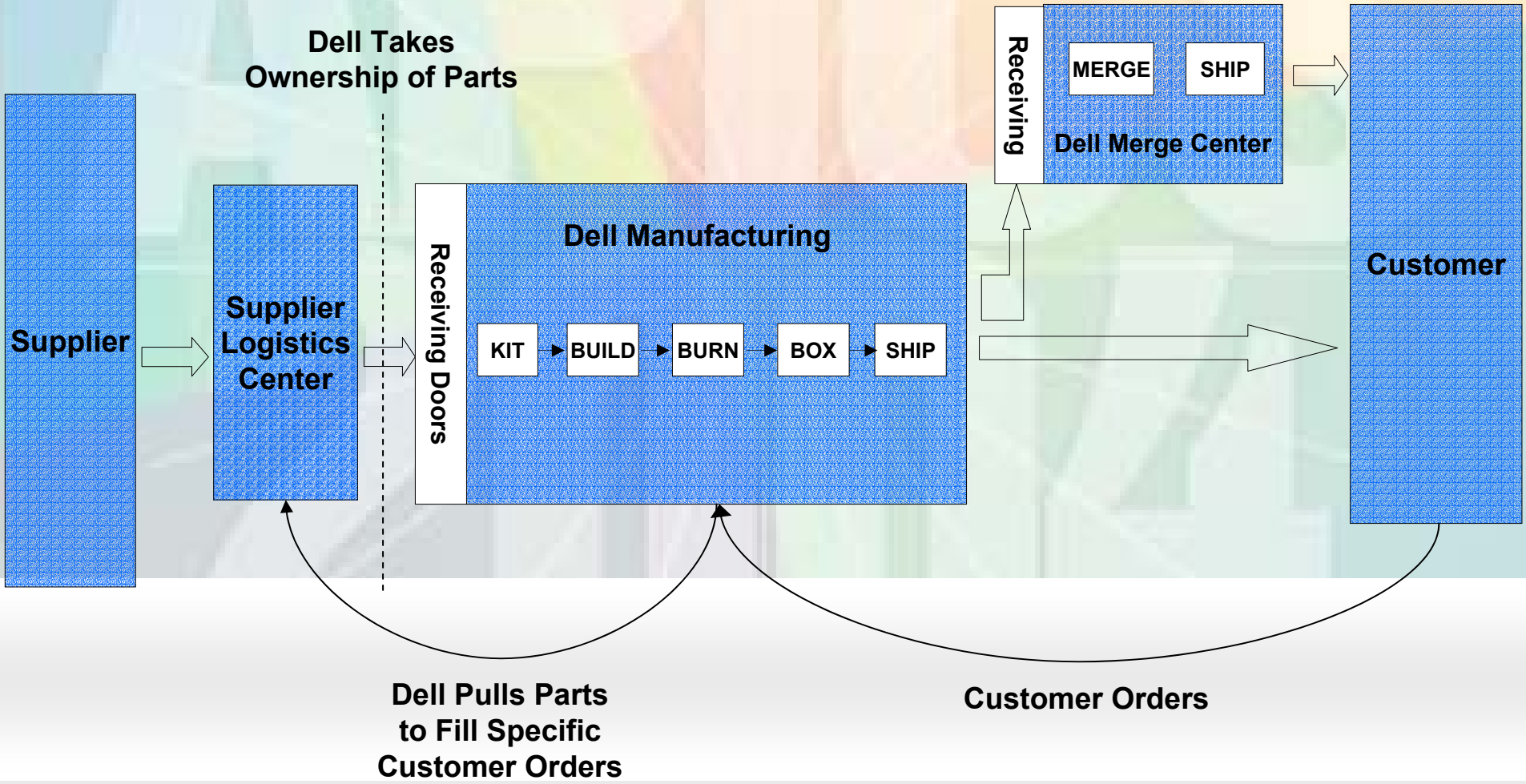
Future

Longer Term Considerations	Does Imp. Lead To?
A Scaleable, Repeatable Solution	_____
Increased Visibility	_____
Increased Velocity	_____

Yes = Advantage
No = Disadvantage

Other Considerations
Increased on Shelf Availability
Unified Anti-Theft Device
Anti-Counterfeit Solution

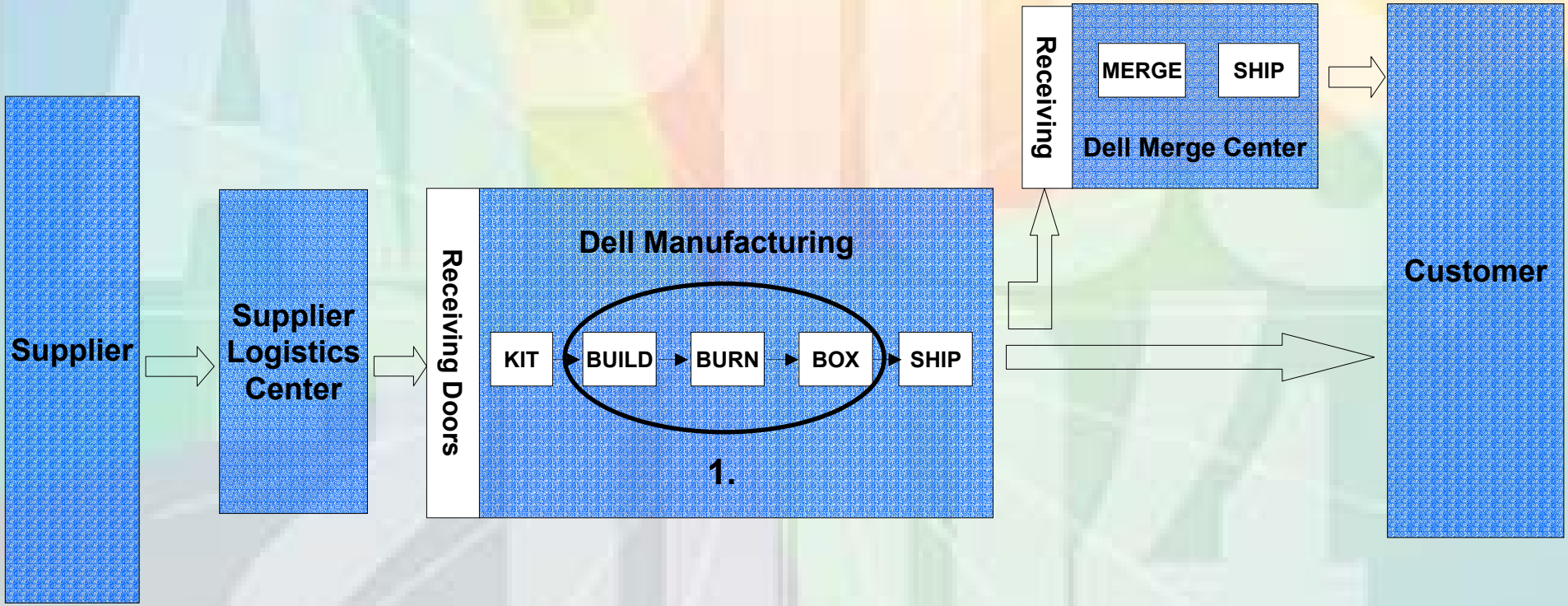
Dell's Supply Chain - Overview



Three Dell RFID Scenarios

1. Tracking Totes and Trays
2. Tracking a High Value Asset from Asia
3. Tracking a Commodity

1. Tracking Totes and Trays



Goal

- Improve Read Rates (Reduce Cycle Time)
- Enhance Tracking and Tracing Capabilities

Tracking Totes and Trays Scorecard

Benefits

Characteristics of the Affected Process	Current Situation?
Labor Intensive Process	**___N___**
High Rate of Errors	**___Y___**
Ineffective Optical Scanning	**___Y___**
Benefits	Will Imp. Allow You To?
Reduce Labor	**___Y___**
Reduce Errors	**___Y___**
Reduce Inventory	**___N___**

Cost

Implementation Complexity	Will Imp. Be?
In a Limited Footprint	**___Y___**
On a Limited Number of Products	**___Y___**
Within One Company	**___Y___**
Operational Expense	Will You?
Be Able to Share Investment Cost	**___N___**
Tag a Reusable Asset	**___Y___**
Tag at the Pallet/Case Level	**__N/A__**
Avoid Item-Level Tagging	**__N/A__**

Future

Longer Term Considerations	Does Imp. Lead To?
A Scaleable, Repeatable Solution	**___N___**
Increased Visibility	**___Y___**
Increased Velocity	**___Y___**

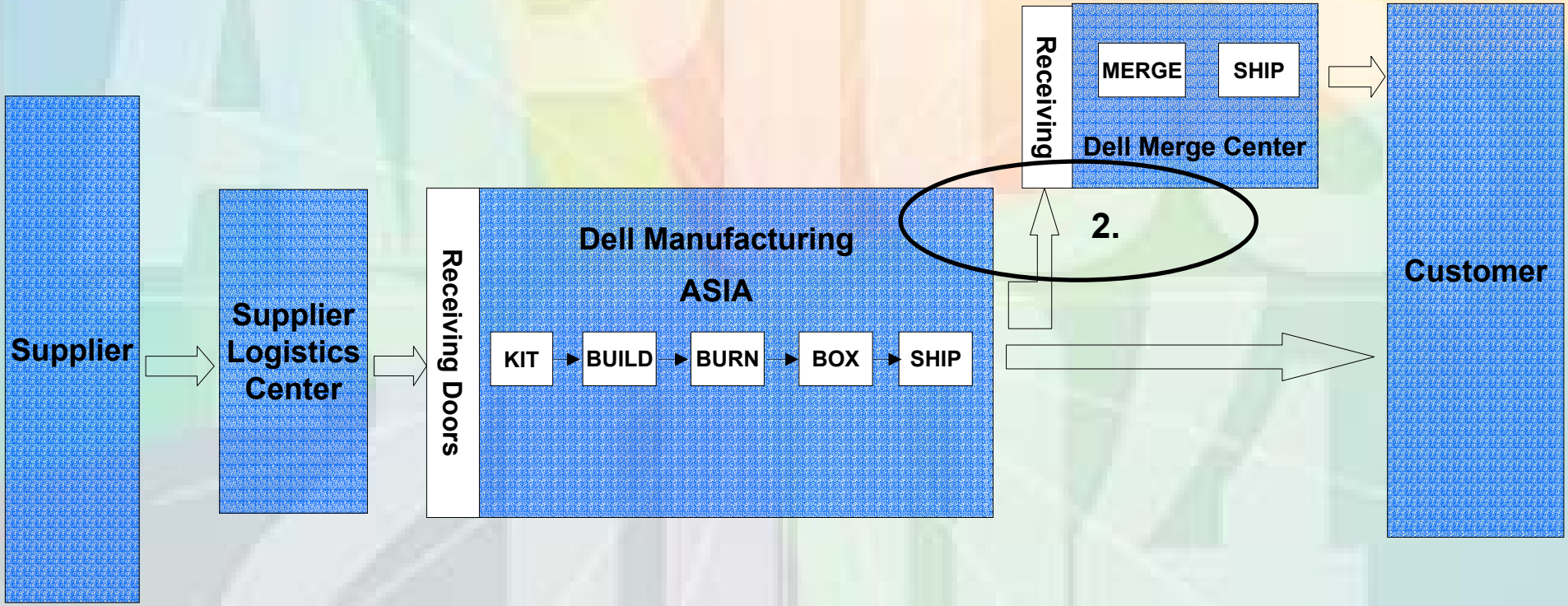
Yes = Advantage

No = Disadvantage

Where RFID DOES Make Sense

Advantage	**10**
Disadvantage	**4**

2. Tracking a High Value Asset from Asia



Goal

- Eliminate Occurrence of Product Being Sent to Wrong Customer
- Reduce Labor in Counting and Tracking

Tracking a High Value Asset from Asia Scorecard

Benefits

Characteristics of the Affected Process	Current Situation?
Labor Intensive Process	**N**
High Rate of Errors	**N**
Ineffective Optical Scanning	**N**
Benefits	Will Imp. Allow You To?
Reduce Labor	**Y**
Reduce Errors	**Y**
Reduce Inventory	**N**

Cost

Implementation Complexity	Will Imp. Be?
In a Limited Footprint	**Y**
On a Limited Number of Products	**Y**
Within One Company	**Y**
Operational Expense	Will You?
Be Able to Share Investment Cost	**N**
Tag a Reusable Asset	**N/A**
Tag at the Pallet/Case Level	**Y**
Avoid Item-Level Tagging	**N/A**

Future

Longer Term Considerations	Does Imp. Lead To?
A Scaleable, Repeatable Solution	**N**
Increased Visibility	**Y**
Increased Velocity	**Y**

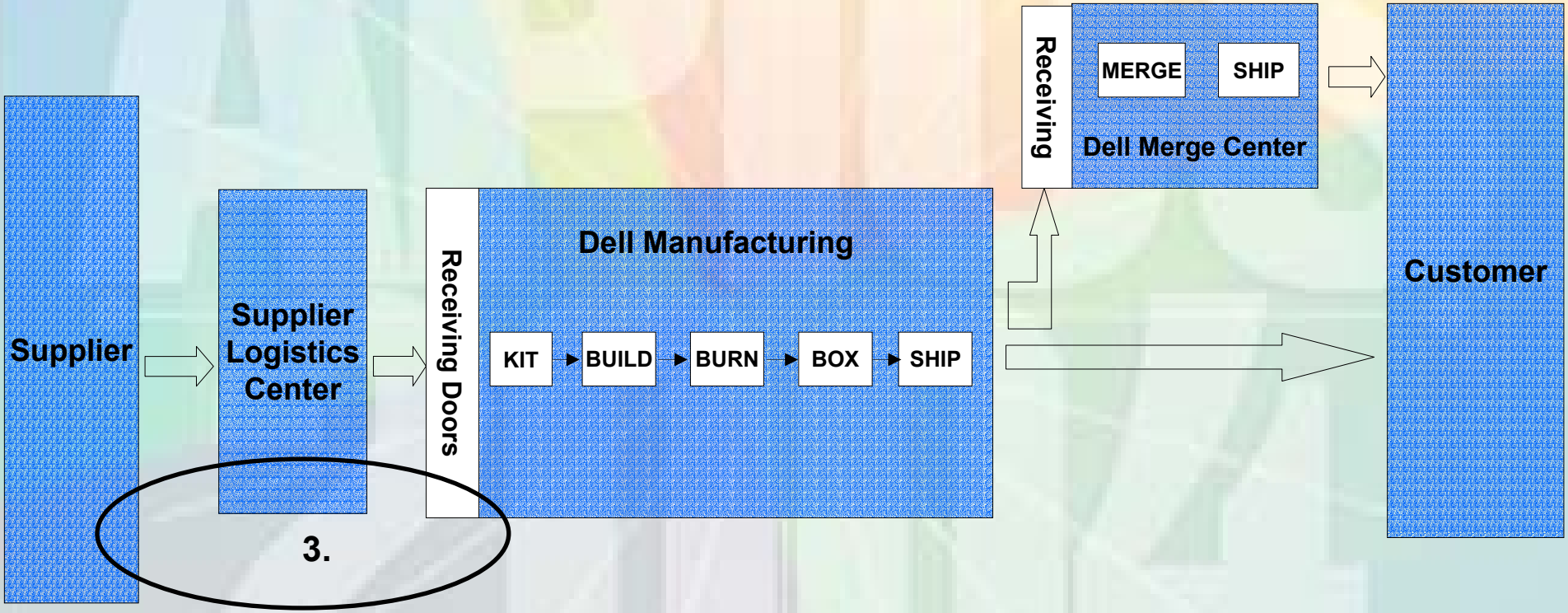
Yes = Advantage

No = Disadvantage

Advantage	**8**
Disadvantage	**6**

Where RFID Does NOT Make Sense

3. Tracking a Commodity



Goal

- Reduce Labor in Counting and Tracking
- Reduce Errors
- Increase Visibility and Velocity

Tracking a Commodity Scorecard

Benefits

Characteristics of the Affected Process	Current Situation?
Labor Intensive Process	**___Y___**
High Rate of Errors	**___N___**
Ineffective Optical Scanning	**___N___**
Benefits	Will Imp. Allow You To?
Reduce Labor	**___Y___**
Reduce Errors	**___Y___**
Reduce Inventory	**___N___**

Cost

Implementation Complexity	Will Imp. Be?
In a Limited Footprint	**___Y___**
On a Limited Number of Products	**___Y___**
Within One Company	**___N___**
Operational Expense	Will You?
Be Able to Share Investment Cost	**___Y___**
Tag a Reusable Asset	**__N/A__**
Tag at the Pallet/Case Level	**___Y___**
Avoid Item-Level Tagging	**__N/A__**

Future

Longer Term Considerations	Does Imp. Lead To?
A Scaleable, Repeatable Solution	**___Y___**
Increased Visibility	**___Y___**
Increased Velocity	**___Y___**

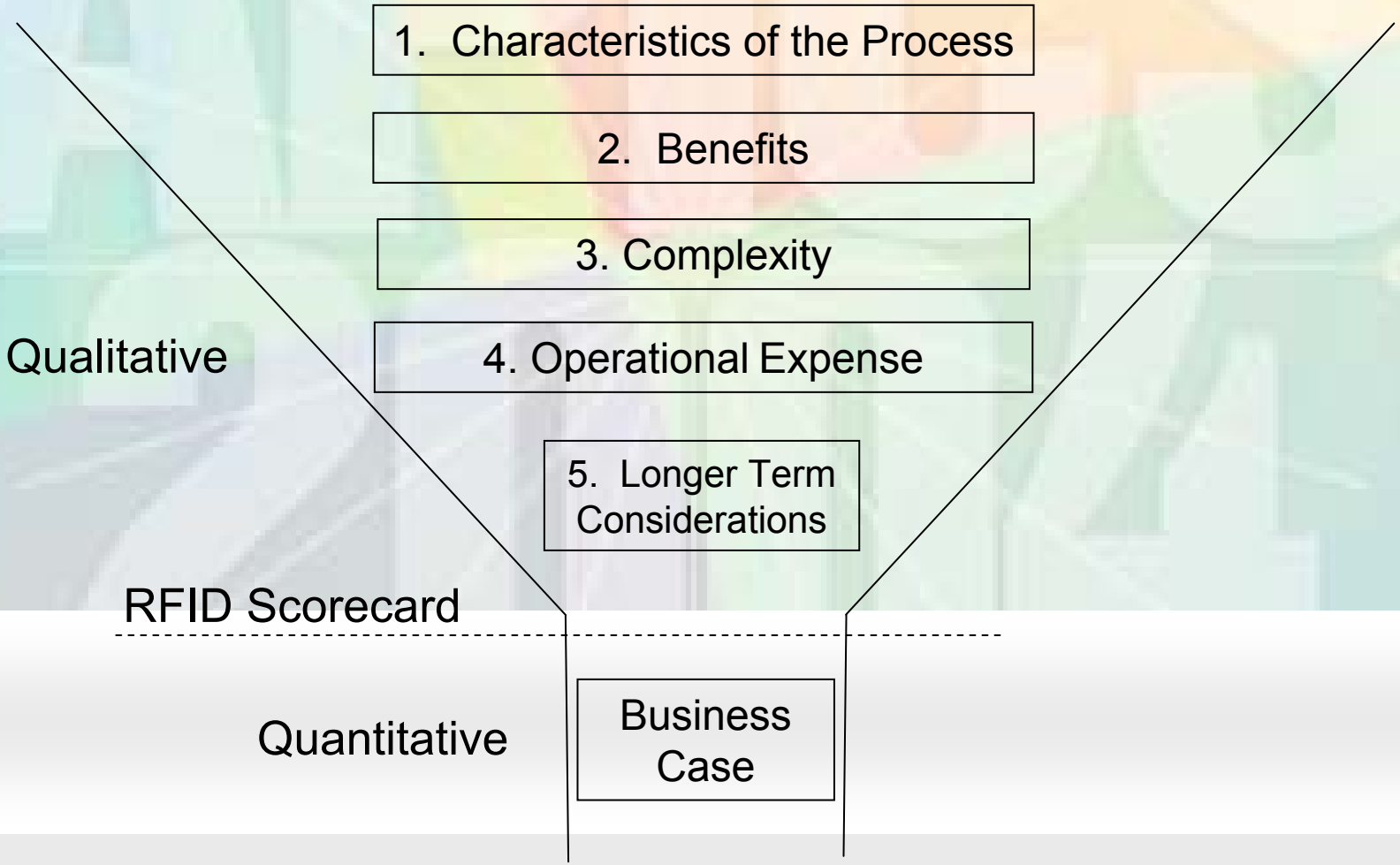
Yes = Advantage

No = Disadvantage

Advantage	**10**
Disadvantage	**4**

Where RFID Might Make Sense

RFID Opportunity Filter



Building the Business Case - Benefits

Benefits	
Reduce Labor	80
Reduce Errors	75
Reduce Inventory	0
Total Yearly Benefit	$155

Building the Business Case - Costs

One-Time Costs	
Hardware	
Readers	5
Application Servers	8
Data Storage	4
Software	
Operating System	2
RFID and Database Software	18
Subtotal for Hardware and Software	$37
Installation and Integration Services	$50
Total One-Time Costs	$87

Recurring Costs	
Support and Maintenance (15% of Hardware and Software costs)	$5
Number of Cases and Pallets Per Year	100
Cost Per Tag	$0.25
Annual Tag Costs	$25
Total Yearly Recurring Cost	$30

Building the Business Case - Payback

Payback Calculation	
Yearly Return @ Stabilization (Annual Benefits Less Recurring Costs)	$125
Installation, Integration, and Stabilization Time (Years)	0.3 years
Years to Recoup One-Time Cost (One-Time Costs/Yearly Return)	0.7 years
Payback	1.0 years

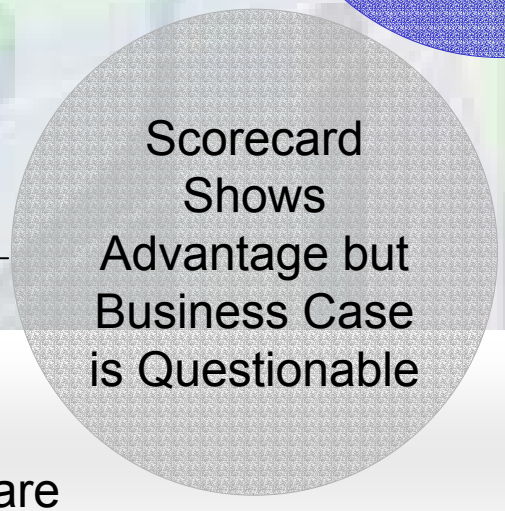
Recap

Yearly Return 155 - 30 = 125

Years to Recoup One-Time Cost 87/125 = 0.7 years

The Decision

Go!



Wait

Monitor the Market

- Cost of Tags
- Cost of Hardware
- Cost of Software
- Cost of Systems Integration

Stop

“An Introduction to Semantic Modeling for Logistical Systems”

David L. Brock, Edmund W. Schuster,
Stuart J. Allen and Pinaki Kar

Several Types of Webs

- **The Web of Information**
  - HTML and the World Wide Web
- **The Web of Things**
  - Linking physical objects together using Auto-ID
- **The Web of Abstractions**
  - Building a network of mathematical models
  - Link models together
  - Link data to models
  - Computer languages & protocols to create a free flow of models in a network (Internet or Intranet)

The Future…

Supply chains that sense and respond to the physical world.

This requires an **Intelligent Infrastructure** for management, control, and automation.

The initial base of the infrastructure is the Electronic Product Code (EPC).

A serial number does not adequately describe an abstraction like a model.

Semantic Modeling - The Goal

- Communication of models between computers to create interoperability
- Run distributed models across the Internet
- Increased model sharing and re-use of model elements
- Increase the productivity of modeling
  - Reduce trial & error
  - Improve mathematical intuition
  - Reduce dependence on literature search
- Redefine the link between models and data…and data to data
- Share models across domains

Implications for APICS Practitioners

- Logistics and operations depend on the flow of data for effective management.
- Auto-ID and other technologies will increase the flow of data.
- Practitioners will need models to interpret data streams
  - Inventory, transportation, warehousing, customer service, purchasing…

Basic Questions

What are the relationships between models?

How are models connected?

In the future, the definition of a model and the sharing of models though a network will become as important as the model itself.

Meaning arises by the way one model is connected or related to other models

Early Work in the Field

- GEOFFRION, A.M. 1987. "An Introduction to Structured Modeling." *Management Science* 33:5.
- GEOFFRION, A.M. 1989. "The Formal Aspects of Structural Modeling." *Operations Research* 37:1.
- MUHANNA, W.A. and R.A. PICK. 1994. "Meta-modeling Concepts and Tools for Model Management: A Systems Approach." *Management Science* 40:9.

Recent Conceptual Work

- **BROCK, D.L.** 2000. **"Intelligent Infrastructure – A Method for Networking Physical Objects,"** ***MIT Smart World Conference*****.**

- **BROCK, D.L.** 2003. **"The Data Project – Technologies, Infrastructure and Standards for Distributed Interoperable Modeling and Simulation,"** ***MIT Data Project Workshop*****, September.**

Recent Applied Work

- **GAZMURI, P and MATURANA, S.** 2001. **"Developing and Implementing a Production Planning DSS for CTI Using Structured Modeling."** ***Interfaces*** **31:4.**

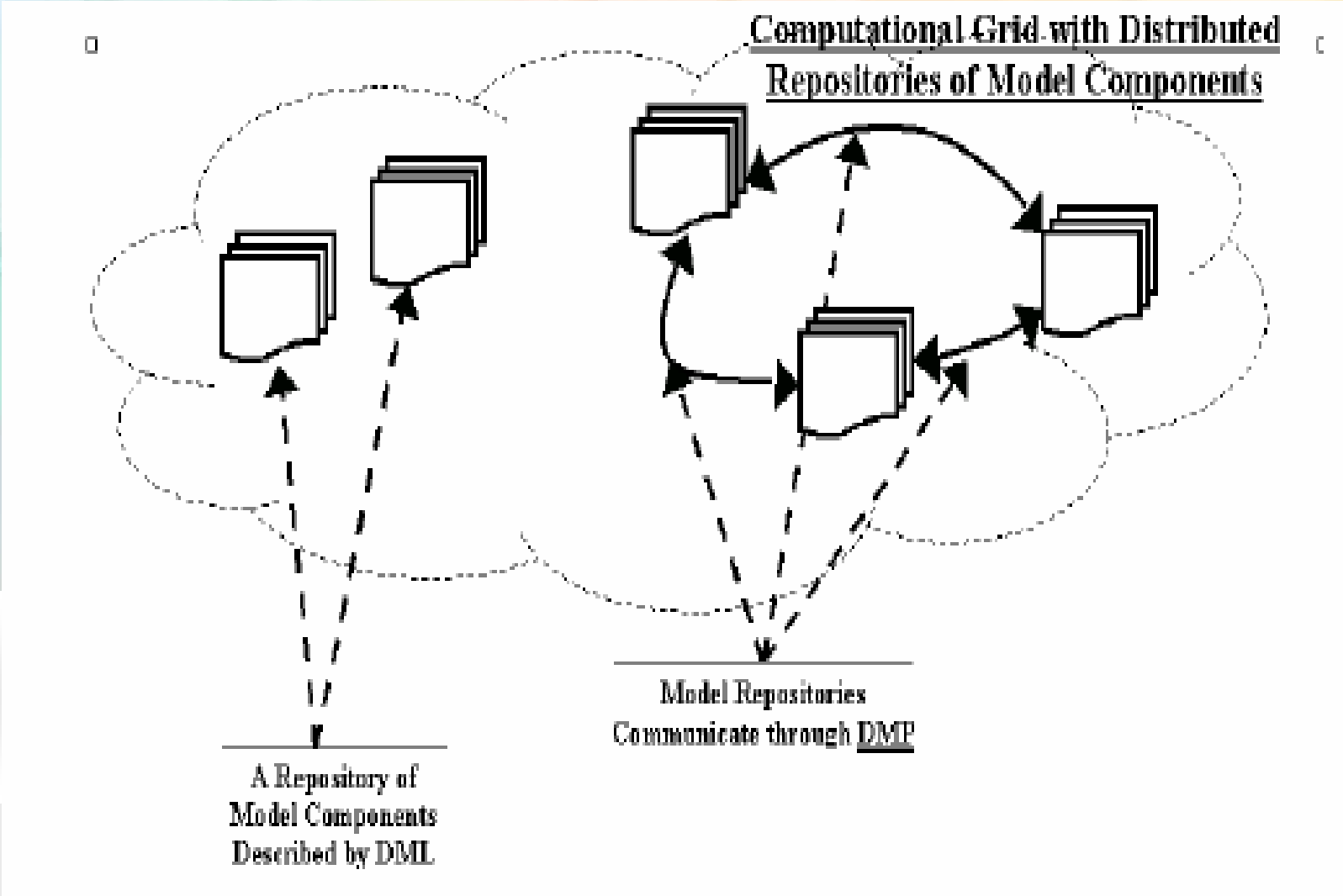
Proposed System - M

- David Brock, Chief Architect
- Initial Design – a System of Languages and Protocols
  - Data Modeling Language (DML), semantic for describing modular, interoperable model components.
  - Data Modeling Protocol (DMP), semantic that describes the communication between the computing machines that host models

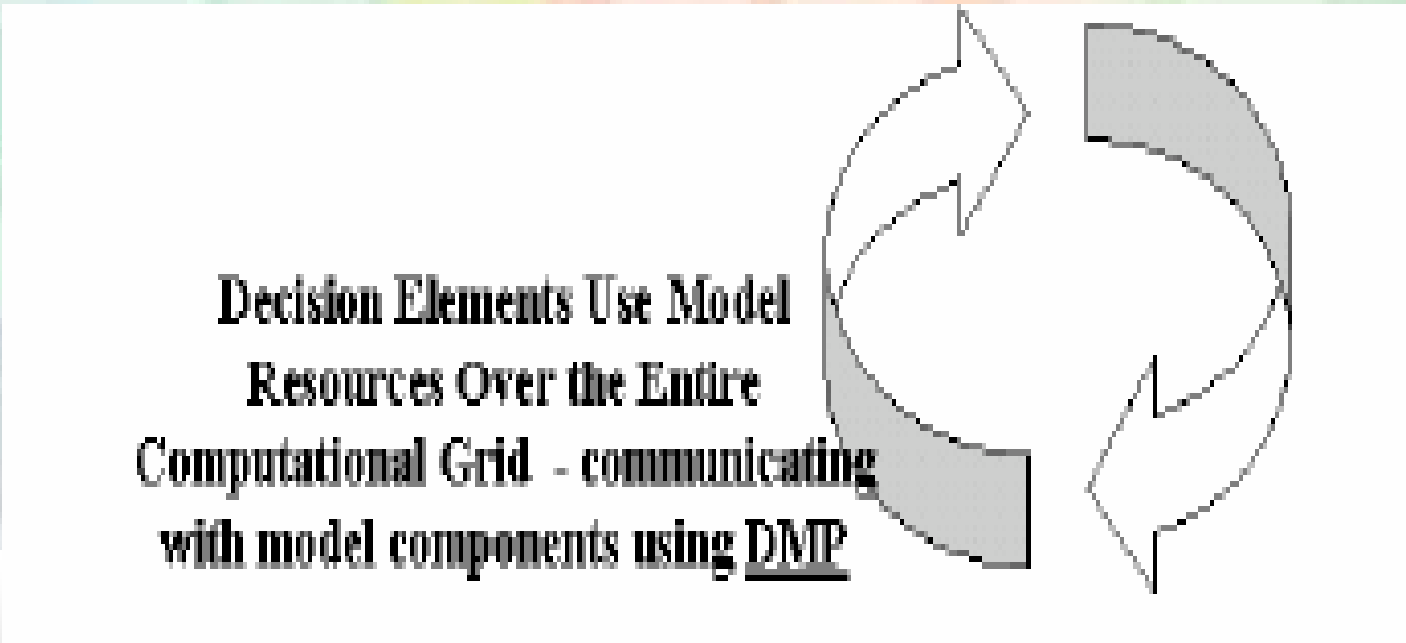
Proposed System – M (continued)

- **Initial Design – a System of Languages and Protocols**
  - Automated Control Language (ACL), specification for describing decision-making elements (outputs).
  - Automated Control Protocol (ACP), helps decision-making elements locate one another, even though the individual models may exist in different host systems and organizations.

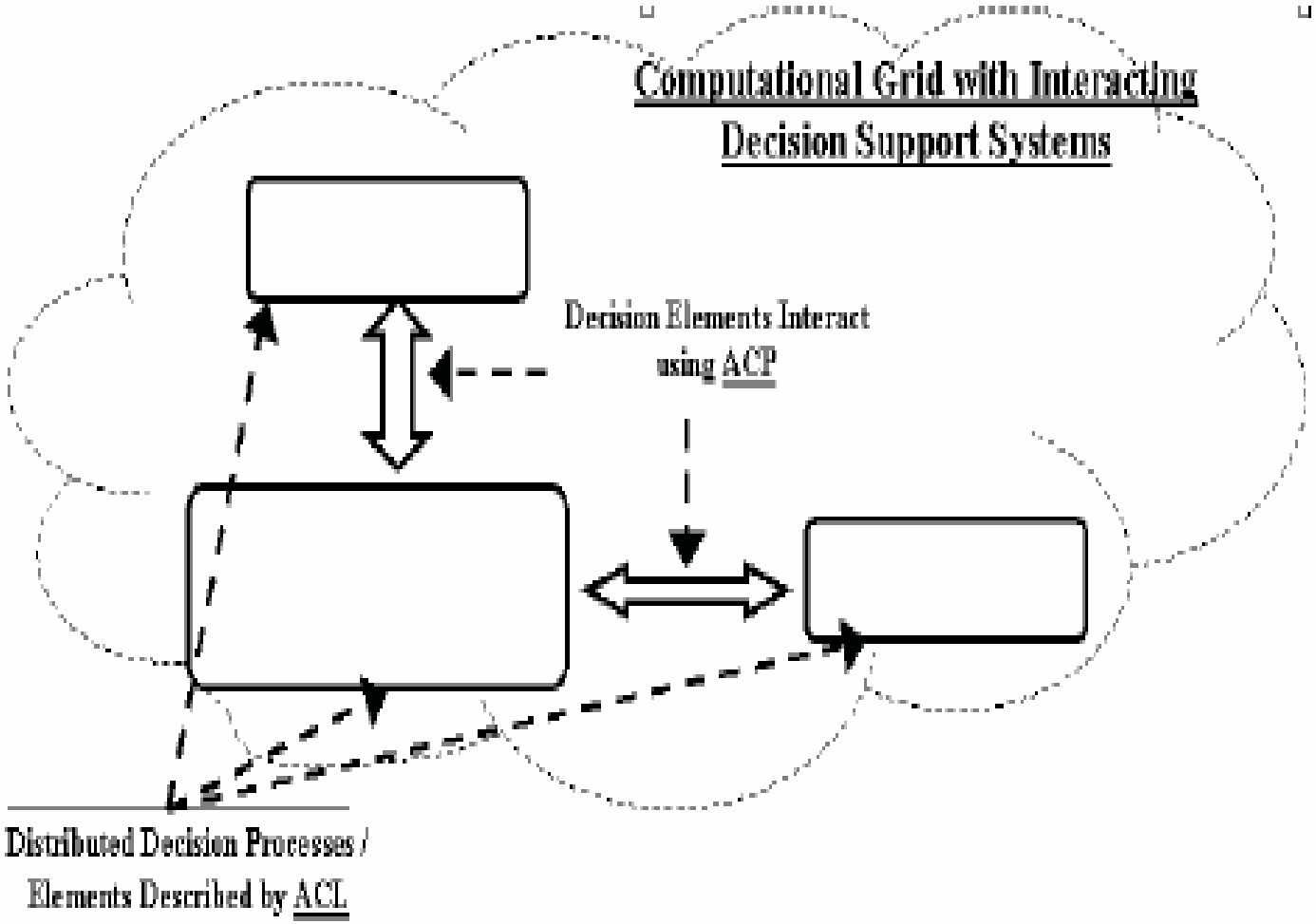
A Visualization of M



Grid Computing Coordination



A Visualization of M



Data Inputs as a Semantic

Data Input	Model A	Model B	Model C	Model D
D1. Beginning Inventory	X	X	X	X
D2. Forecast Demand (by week)	X	X	X	X
D3. Historical Shipments (by week)	X	X	X	X
D4. Historical Forecast (by week)	X	X	X	X
D5. Hold Time (days)	X			
D6. Queue Time (days)	X			
D7. Service Level (% in stock)	X	X	X	X
D8. Set-up Cost ($/changeover)		X	X	X
D9. Set-up Time (hrs/set-up)			X	X
D10. Holding Cost ($/week)		X	X	X
D11. Capacity Limit (hrs/day)		X	X	X
D12. Family Structure (end items per group)		X		
D13. Overtime Cost ($/hr)			X	X
D14. Sequence Dependent Set-up Cost (From–To table of change-over costs)				X

First Prototypes

- **Logistical Systems Including ERP**
  - Forecasting, planning, scheduling, and inventory models
- **Agricultural Models**
  - Harvest risk and planning
- **Retail**
  - Lot sizing for short life-cycle products
  - Lillian Vernon, Inc.

First Prototypes (continued)

- **More General View of Semantic Modeling**
  - **Method to search and re-use elements of mechanical designs** (automobile industry)
  - **Communication between different divisions within a conglomerate** (medical industry)
  - **Analyzing news releases** (financial services)

Next Steps…

- Smart World 2004 – Semantic Modeling
- Meeting date set for Dec. 8, Kresge Auditorium, MIT
- Support from the MIT Industrial Liaison Program
- Speakers representing Intel, IBM, Microsoft, SAP, Wal-Mart, and MIT
- Over 60 people registered from industry, special academic rate available
- Establish The Data Center
- This is large project that will take participation from industry and academia

Auto-ID: The First Intelligent Value Chain

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G8 & G9

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