
Networked RFID in Supply Chain Operations

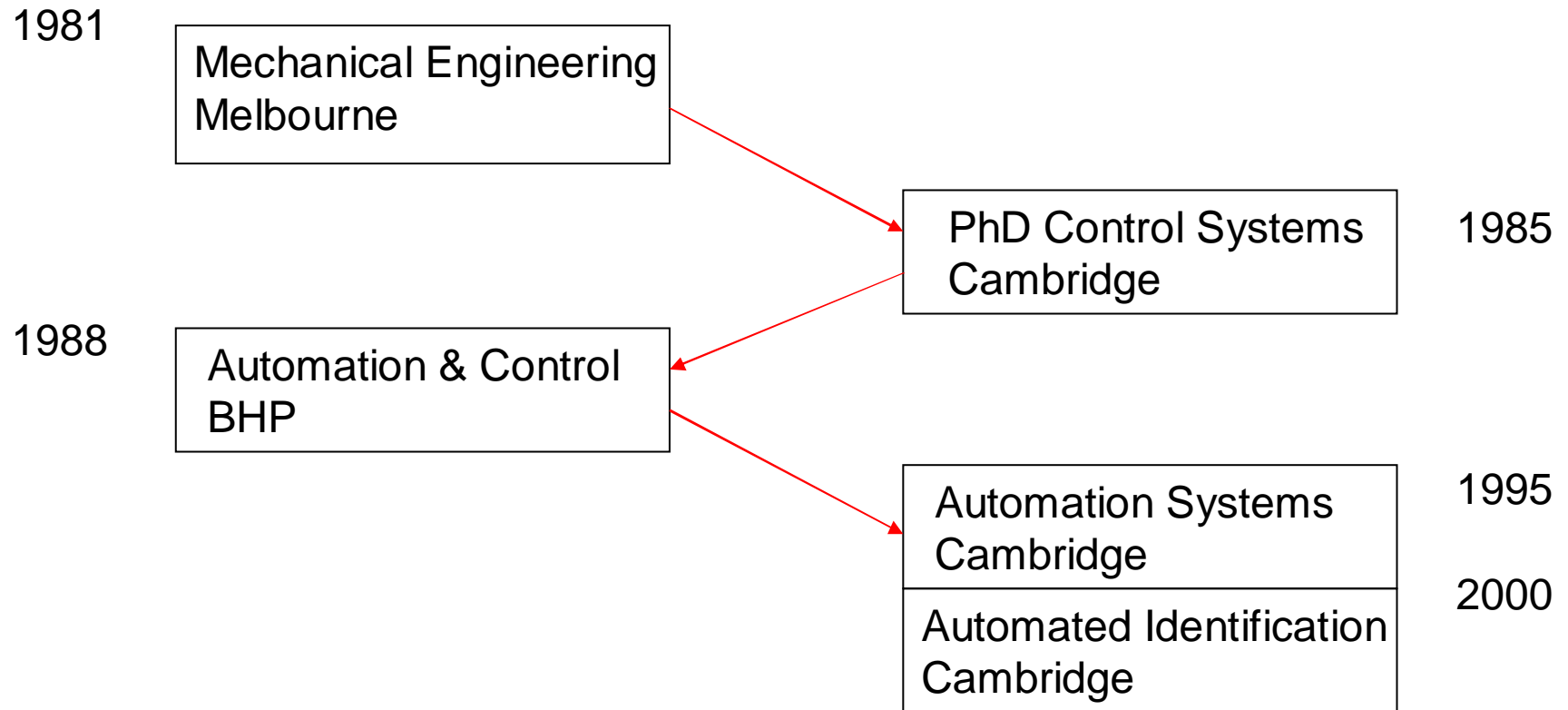
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Institute for Manufacturing
Cambridge University Engineering Department

Australia
July 2004

INTRODUCTION

Introduction: Duncan McFarlane



Introduction: Auto ID Center

- **Mission**

- Re-think the role and implementation of the barcode
- Connecting information and physical flows (“ bits to atoms”) in the supply chain

- **What do you need to do this?**

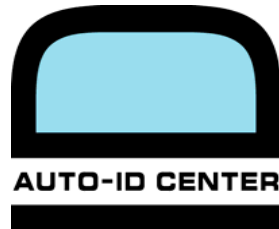
- Some way of automatic, reliable transfer and update of information based on physical operations
- One single, low cost system for the whole supply chain
- RFID as the key element

Auto-ID Centre sponsors

- Gillette
- Wal-Mart
- P&G
- Unilever
- Kraft
- Philip Morris
- Nestle
- Best Buy
- Target
- Tesco
- Home Depot
- CVS
- BT
- Sun
- Philips
- Intel
- ST Micro
- Canon
- Alien
- NTT
- Metro
- Mitsui
- Pfizer
- Sara Lee
- USPS
- UPS
- DoD
- UCC/EAN
- Accenture
- IBM
- Coca-Cola
- Pepsi
- Kodak
- NCR
- SAP
- Symbol
- Ahold
- Metro
- Carrefour
- Kelloggs
- Kimberly Clark
- Johnson & Johnson
- Home Depot
- Chep
- AC Neilson
- Accenture
- CGEY

...103 in total

Introduction: EPCglobal and Auto ID Labs



31 October 2003

1 November 2003



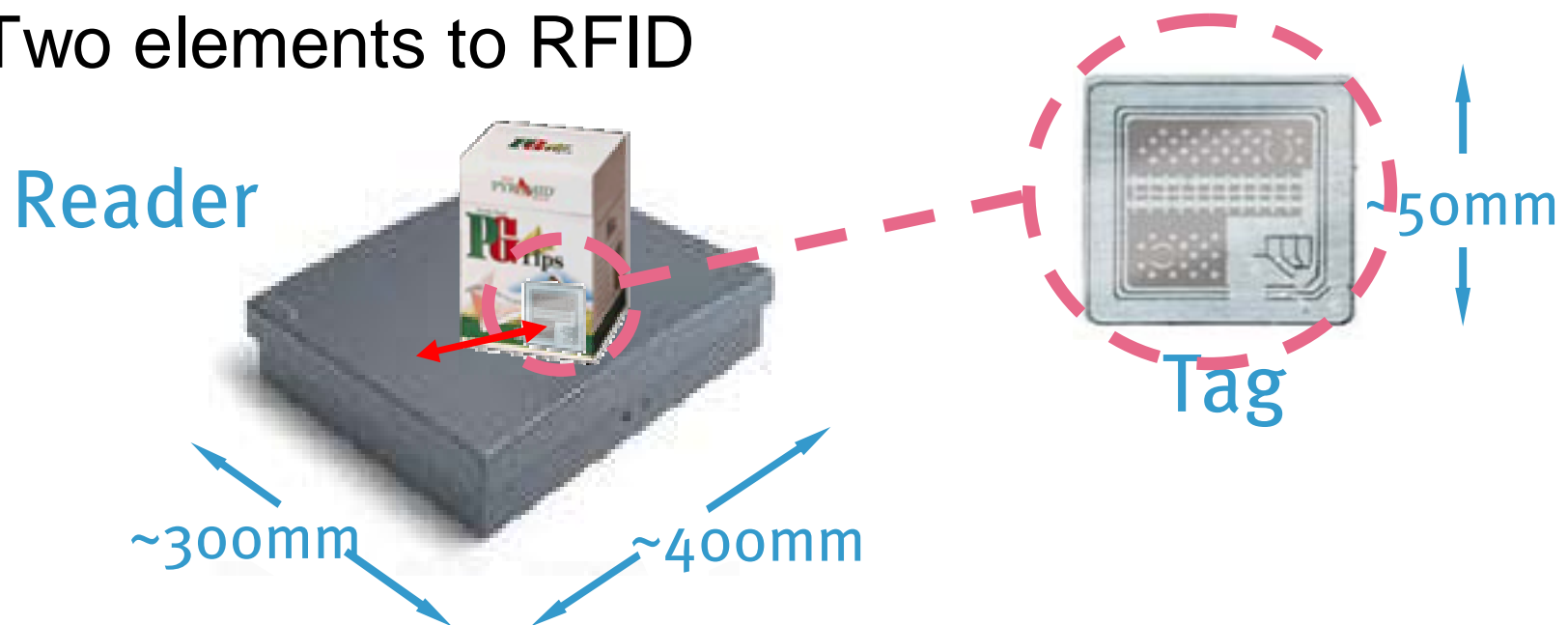
(UCC/EAN owned)



FUNDAMENTALS: What is RFID?

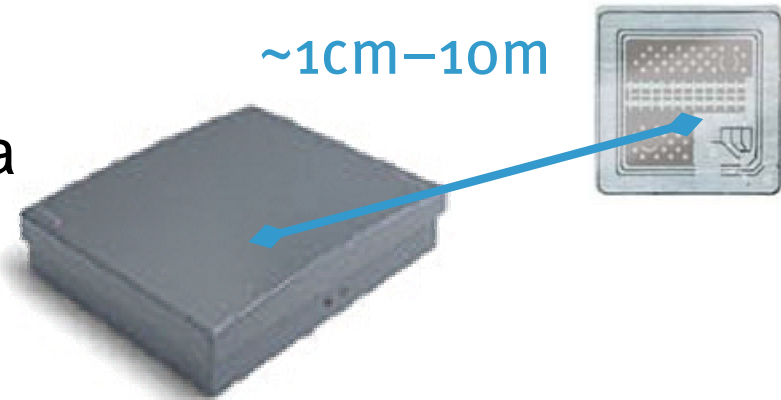
What is RFID ?

- *Radio frequency* identification
- Means of automatically identifying objects
- Two elements to RFID



What is RFID ?

- Typical operation
 - 64 bits to few kilobits of data
 - Range ~1cm to ~10m
 - 50-1000 tags per second
- Reader transmits radio frequency energy
 - Provides power for the tag
 - Enables communication to and from the tag
 - Different operating frequencies are possible

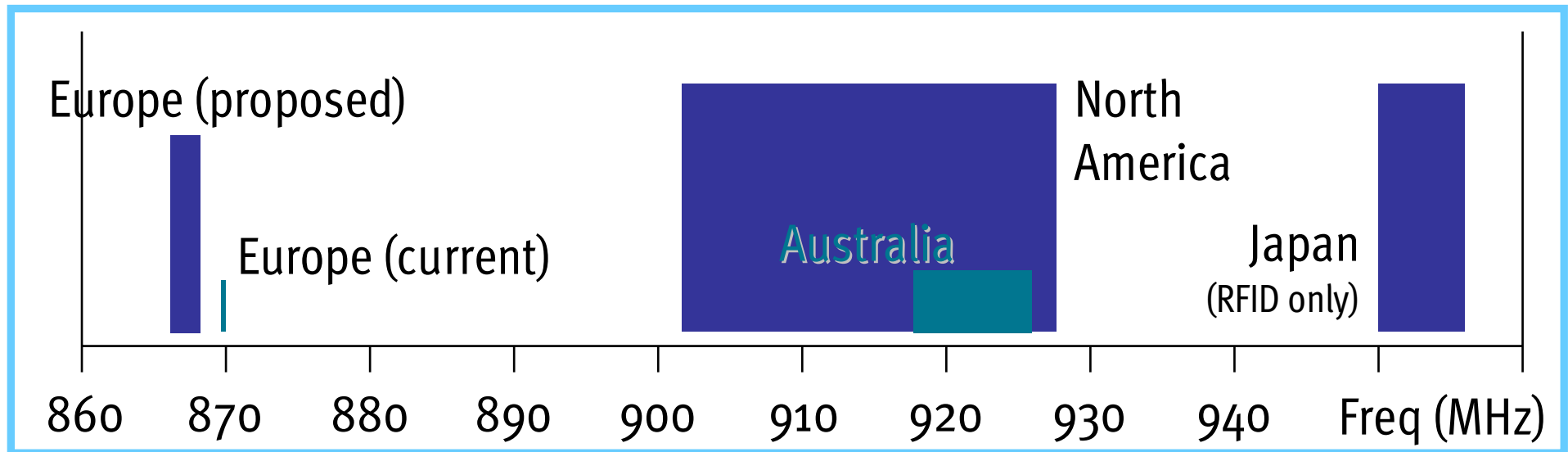


RFID frequency bands

- LF: 125kHz, 134kHz
 - Relatively expensive
 - Low range
 - Robust, but bulky tags
- HF: 13.56MHz
 - Reasonable cost and performance
 - Discreet tags, still quite low range
- UHF: 860-960MHz
 - Latest technology
 - Legislation varies between regions
- UHF: 2.45GHz
 - Technically also UHF, also 'microwave'
 - Smaller antennas (and tags)
 - Typically less range

UHF band legislation

- Need to consider performance implications
- Numerous conflicts still to be resolved



What is RFID ?

POWER?

- Systems discussed so far are *passive*
 - No battery in tag; all power comes from reader
- Possible to build a battery into the tag (*active*)
 - Increased complexity, size and cost
 - Improved performance (range) & functionality

Passive	Cheapest, no battery
Semi-passive (battery assisted)	Much more range and reliability
Active (battery powered)	High performance, sensors, cost!

Why RFID?

- Alternative technologies
 - Barcodes (traditional and 2D)
 - Vision systems
 - Magnetic strips
- ✓ ‘Simultaneous’ identification
- ✓ Robust, reasonable operating distance
- ✓ No line of sight; automated reads
- ✗ Not as cheap as some alternatives
- ✗ Some problematic items

RFID Timeline

- Invented in WWII
- First commercial applications in 1970's
- Larger scale deployment started in 1990's
 - Incompatible products optimised in different ways
 - Vertical application areas
 - Libraries
 - Access
 - Industry
 - Electronic Article Surveillance
- Standardisation efforts and tech devts in late 1990's
 - Create interoperability, drive down costs
 - Opens up a whole new set of applications

FUNDAMENTALS: Auto ID Center's Networked RFID Approach

Auto ID Center: Key Thrusts

1 low cost tags and reader systems

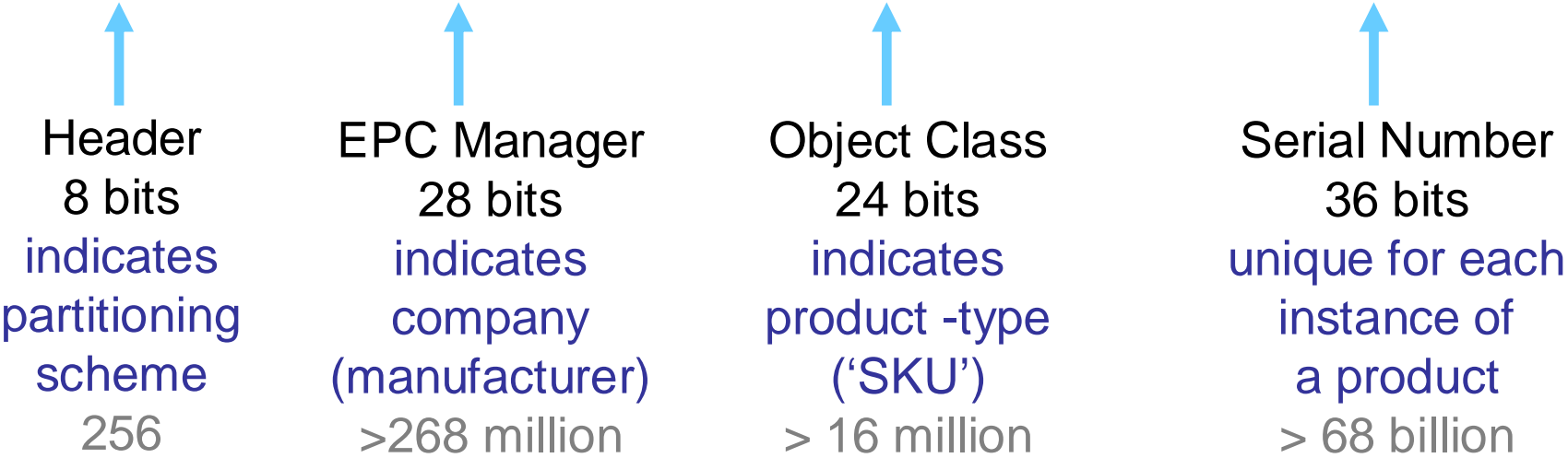
- > reducing chip price = reducing amount of silicon required
- > minimising information stored on chip
- > ID on chip only, other information on data base

2. business justification through multiple applications/ companies

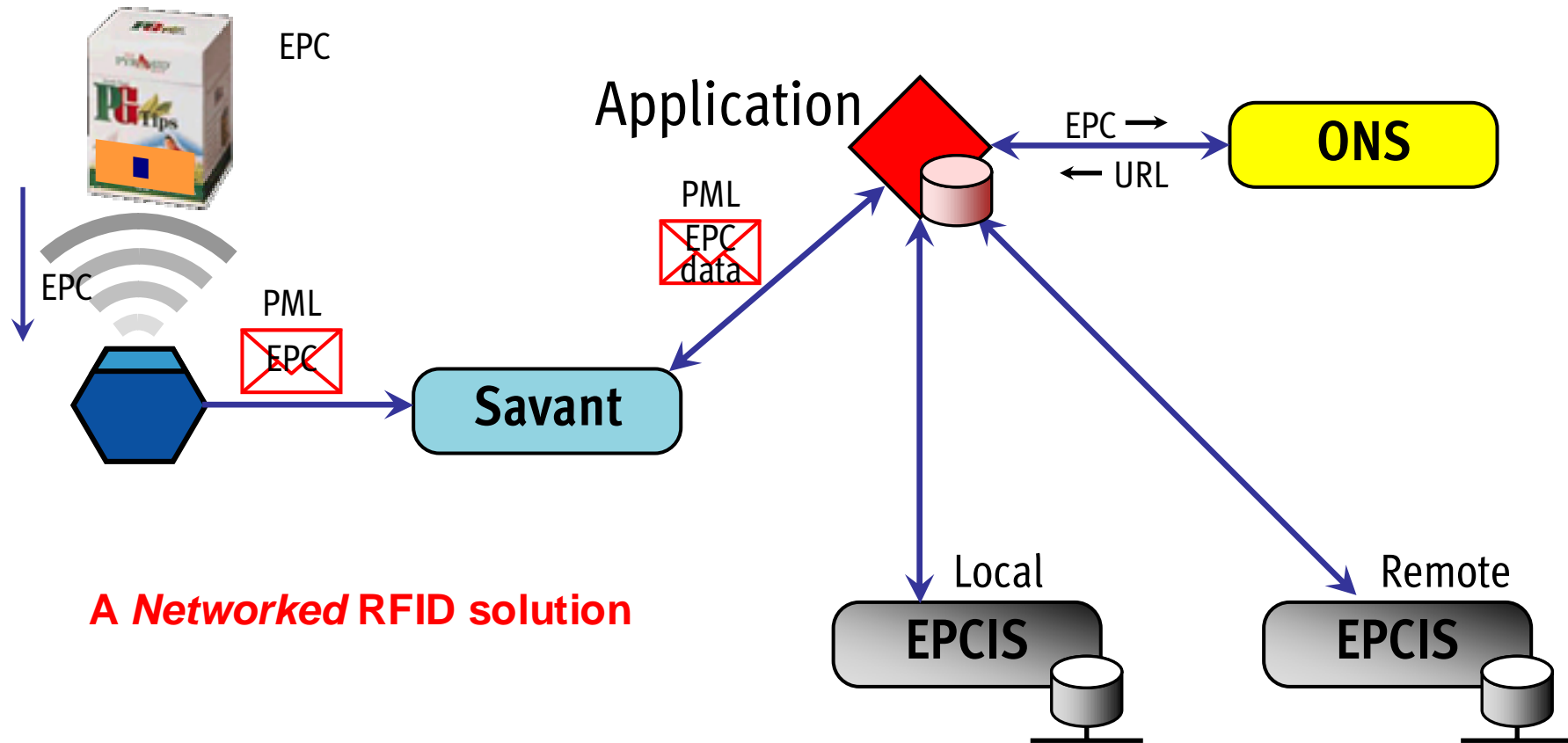
- > standardised tag/reader systems
- > standardised data management and communication systems
- > EPC network system as extension to the internet

EPC – electronic product code

01.0000389.000162.000169740



Auto ID Center: EPC Network



Auto ID Center: Key Thrusts Again

1. low cost tags and reader systems
 - > reducing chip price = reducing amount of silicon tag specs
 - > minimising information stored on chip EPC
 - > ID on chip only, other information on data base EPC/EPCIS

2. business justification through multiple applications/companies
 - > standardised tag/reader systems tag/reader specs
 - > standardised data management and comms Savant/PML
 - > EPC network as extension to the internet EPC/ONS/EPCIS

Auto ID Center: Focus on Retail Supply Chain

- Multi applications for same system
 - Shrinkage
 - Out of stocks/poor on-shelf availability
 - Traceability
 - Inefficiencies in supply chain operation
 - Managing Demand Uncertainty
 - Reduce Stock Holding Levels
- Multiple Companies using same system
- Very low cost and very high volumes

FUNDAMENTALS: Impact of RFID

Extracting Benefits from RFID

Networked RFID provides product data that is:

- Accurate
- Item-level
- Complete
- Automatic
- Timely
- Universal



Typical Product Data

- Item ID
- Size
- Status
- History
- Instructions
- “Location” Information

How can this be made useful?

Extracting Benefits from RFID: Visibility??

Some “quotes”:

*“Auto ID will give us total **visibility** of our supply chain operations”*

*“**Visibility** is critical to improving our service levels while at the same time reducing inventory”*

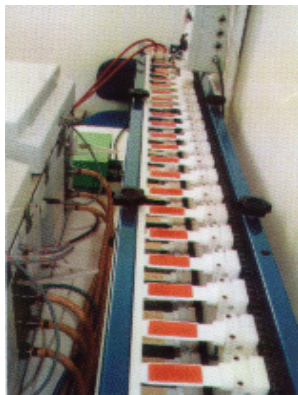
*“We expect that – eventually – Auto ID will provide complete **visibility** throughout the entire life cycle of our products”*

Extracting Benefits from RFID: Visibility??

The availability of information about the status of an object (on a production line/ truck/ shelf) at any given time.

Levels of Product Visibility

- **Visibility In Space** - ability to distinguish between locations of item



- **Visibility In Time** - ability to distinguish between items at different times

- **Visibility In Identity** - ability to distinguish between items with different identity



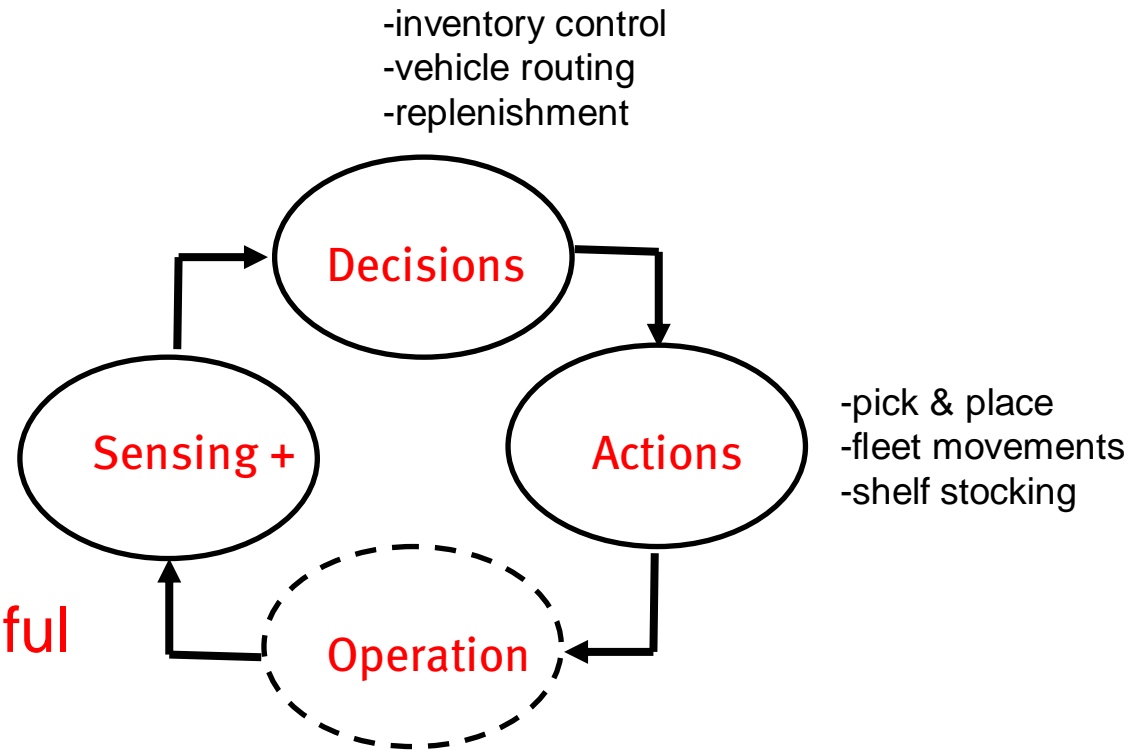
Extracting Benefits from RFID: *closing the loop*

- RFID enhances the *visibility* of operations

BUT sensing doesn't deliver benefits on its own!

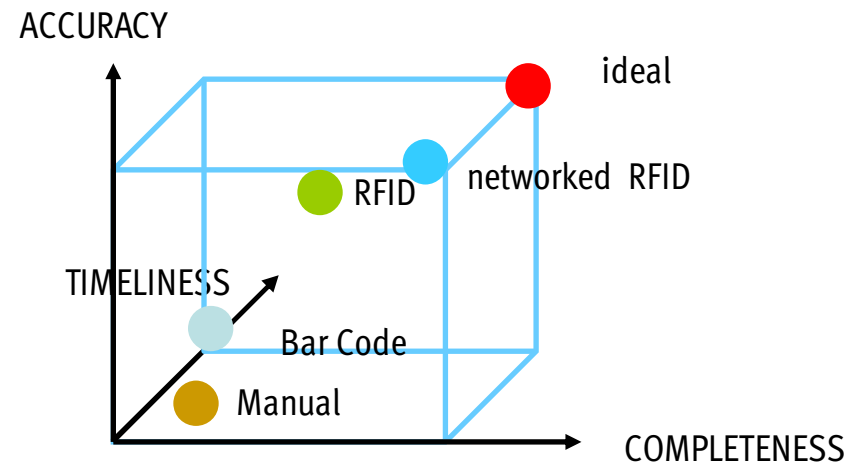
- need to examine the "control" loop

... *visibility* is only useful where it influences a decision



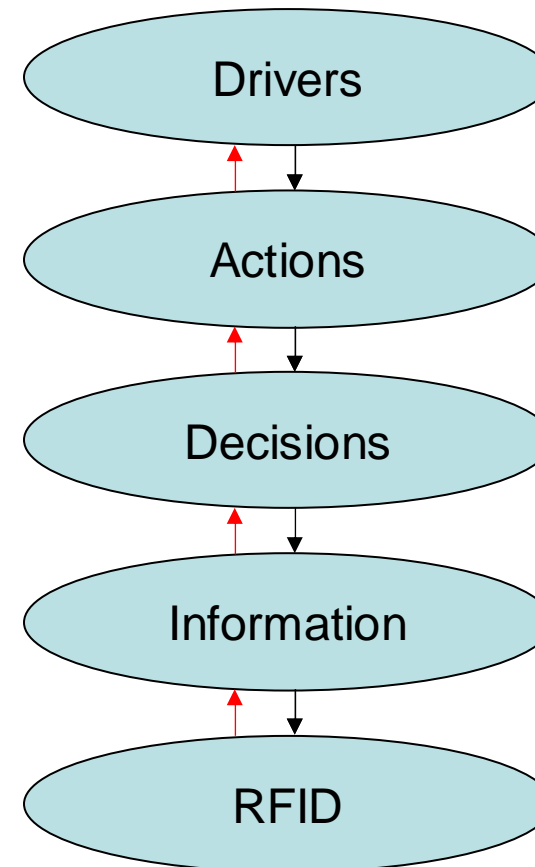
Extracting Benefits from RFID: *Better Information*

- value of networked RFID is in enhancing the quality of product information available to make decisions and take action
- information quality dimensions
 - accuracy
 - completeness
 - timeliness



Extracting Benefits from RFID: *Drivers first*

- business drivers must underpin RFID deployment
- determine actions which impact on drivers – options?
- determine decisions which influence actions – flexibility?
- identify product information characteristics required to change decisions
- map characteristics to RFID or other sensory specifications



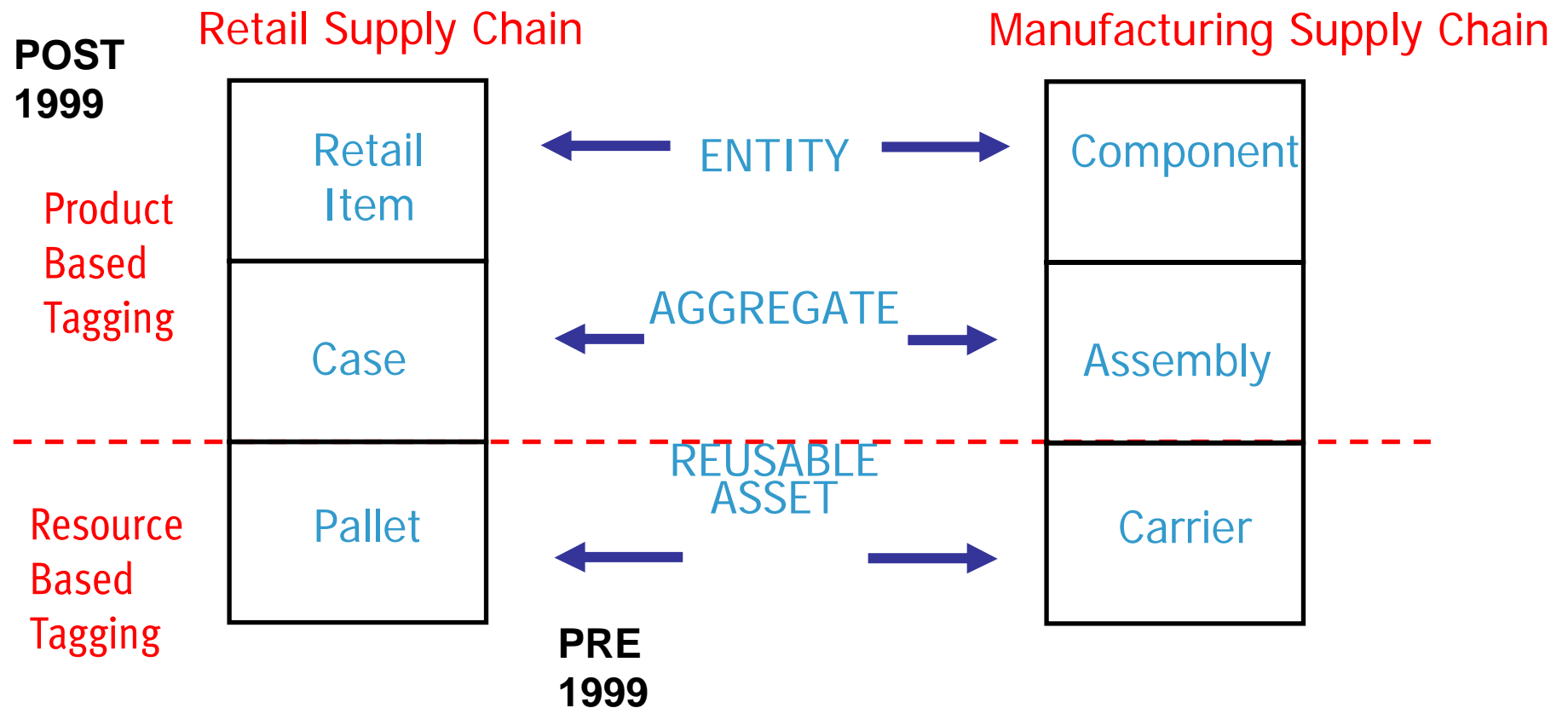
APPLICATIONS: Approaches, Drivers, Mandates

Approaches: Application Characteristics

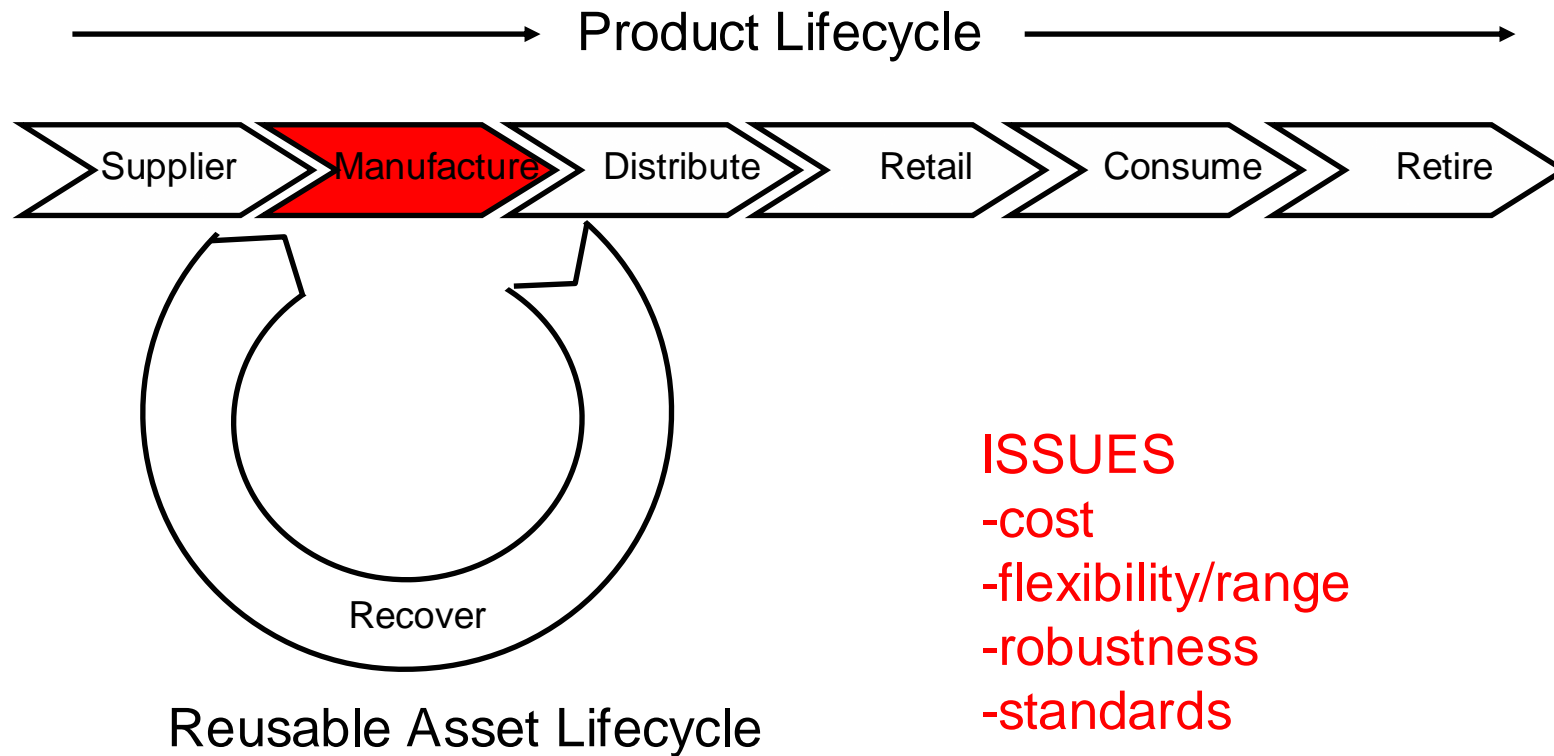
	Tolling	Library	Asset	Baggage	EAS	Supply Chain
Complexity of Information on Tag	M	L	H	L	L	L
Single or Multiple Applications for Each Tag	S	S	S	S	S	M
Volume of Tags	L	L	L	M	M	H
Expected Life of Tag	H	H	H	M	M	L

Source: Hodges, McFarlane, Radio Frequency Identification: Technology, Applications and Impact, OECD Report, Dec, 2003

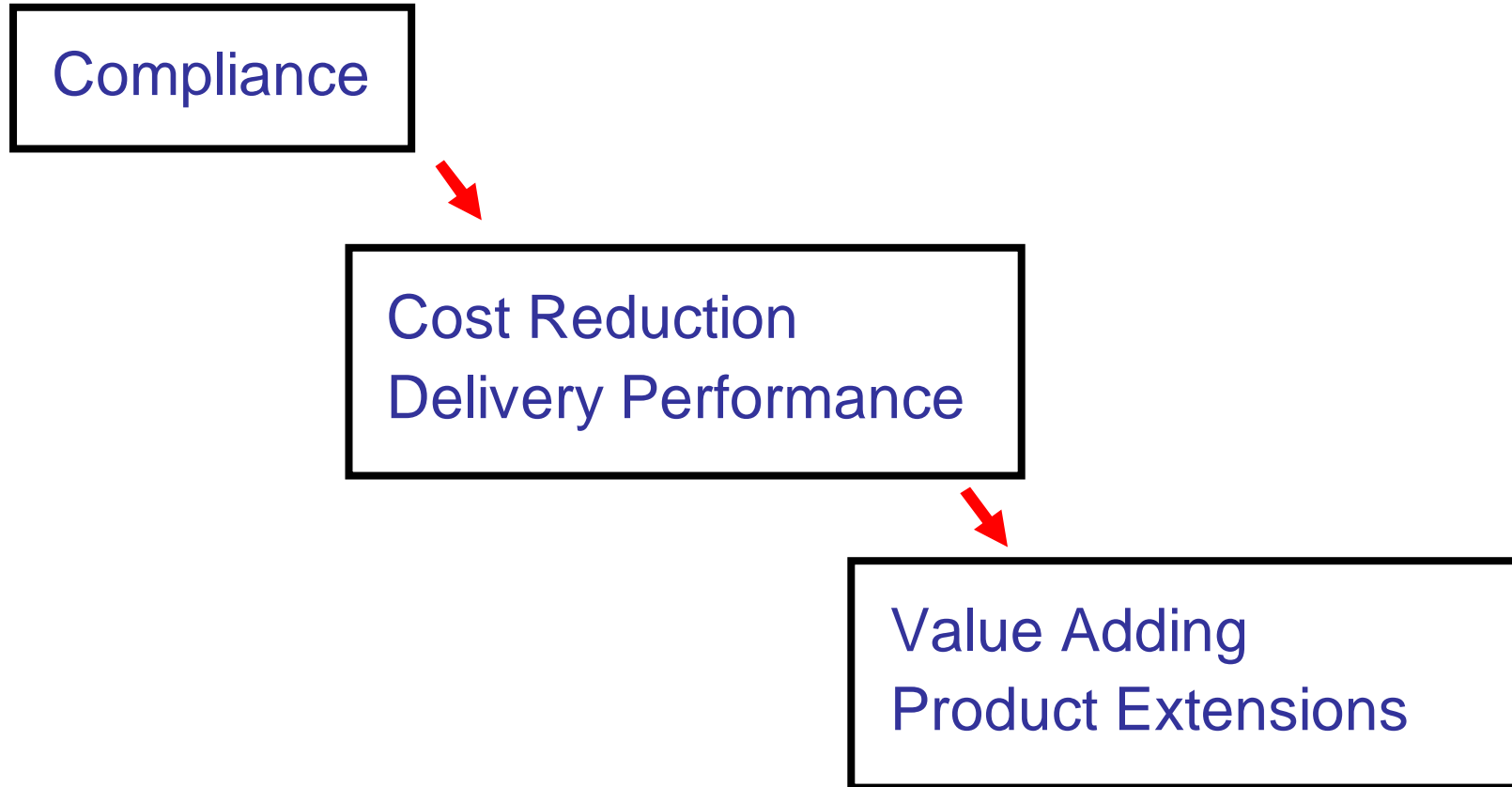
Approaches: Deployment Levels



Approaches: Tag Lifecycle



Drivers – *Zero, Short, Medium Term*



Mandates & Influences

- FMCG/Retail
 - WalMart: By January 2005 top 100 suppliers must use EPC tags on cases and pallets
 - Tesco: Selected product lines to be tagged starting Sept 2004
 - Also Target, Albertsons, Metro
- Defence: *All DOD* suppliers to use RFID by January 2005 (active/passive mix)
- Aerospace: Boeing/Airbus announcement
- Automotive: Automotive Associations examining
- Other influences: FDA, Pharma, Food Traceability, Recycling legislation

APPLICATIONS: Sectoral Views

FMCG/Retail: Wal-Mart mandate

- By January 2005 top 100 suppliers must use EPC tags on cases and pallets
 - Extends to *all* suppliers by end 2006
 - Mandating EPC numbering and tags
- “What we see with RFID is an infrastructure breakthrough. We are very committed to it.”
– Mike Duke, President and CEO of Wal-Mart Stores

FMCG/Retail: Tesco mandate

- Initially: tags for pallets, cages, trays and cases
 - Class 1 UHF, European regulations on frequency & power level
 - EPC but no other information
- Selected product lines to be tagged starting Sept 2004
 - Phase 1 will be completed over 2 years
 - Following this, will extend to all products
- Readers at all points in supply chain
 - DC dock doors (for delivery verification)
 - Store shelves possibly (for replenishment)

FMCG/Retail: Status

- mandates in place
- significant trials in 2004 in USA and Europe
- WalMart involving suppliers 100-300 in current discussions
- focus likely to be on stand alone RFID deployment (c.f. networked deployment in first instance)
- focus on case and pallet
- item level tagging being trialled in high value areas
 - CD, DVD
 - clothing
 - razors



High-speed conveyor belts and state-of-the-art technology help move merchandise efficiently through the distribution centers, keeping Wal-Mart's nearly 3,000 stores in stock.



Wal-Mart Supercenters range from 100,000 square feet to more than 260,000 square feet and offer shoppers a wide variety of goods and services.

FMCG/Retail: Example (UK)

- **Application:** Fresh Produce Distribution in UK (shipping, receipt)
- **Driver:** time reduction (80%), waste red'n
- **Action:** Fresh Produce Delivery stock checking
- **Decision:** Reordering, supplier production planning
- **Information:** accurate and timely batch level information
- **RFID:** HF read/write tags on product carrier trays and portal readers



FMCG/Retail: Example



- **Application:** FMCG, shipping
- **Driver:** Productivity
- **Action:** ForkLift Loading
- **Decision:** Quality Check
- **Information:** Pallet identity (speed)
- **RFID:** HF Tagging of navigation points, readers on forklifts to ensure high speed loading accuracy

FMCG/Retail: Example

- **Application:** Product receipt
- **Driver:** time reduction (80%), OTIF
- **Action:** Delivery stock verification
- **Decision:** acceptance, payment
- **Information:** accurate and timely batch level information
- **RFID:** UHF tags at case level



Defence: DoD mandate

- All suppliers to use RFID by January 2005
 - Active tags on shipments, large containers and large items
 - pre-positioned materiel and supplies
 - unit movement equipment and cargo
 - aircraft engines
 - all sustainment cargo
 - ammunition shipments
 - Passive tags on pallets and cases
 - Passive tags on some items, including items that
 - cost more than \$5,000, dangerous, require serial no for tracking
 - Temperature sensors in some cases, e.g. meals
 - Tag item packaging for now; tag the item when possible
-

Defence: Example

- **Application:** Tagging of food provisions pallets
- **Driver:** tracking and inventory management
- **Action:** Goods inward receipt
- **Decision:** Verification/Acceptance ...
- **Information:** ID, order
- **RFID:** UHF, on pallets, hand readers/portal readers

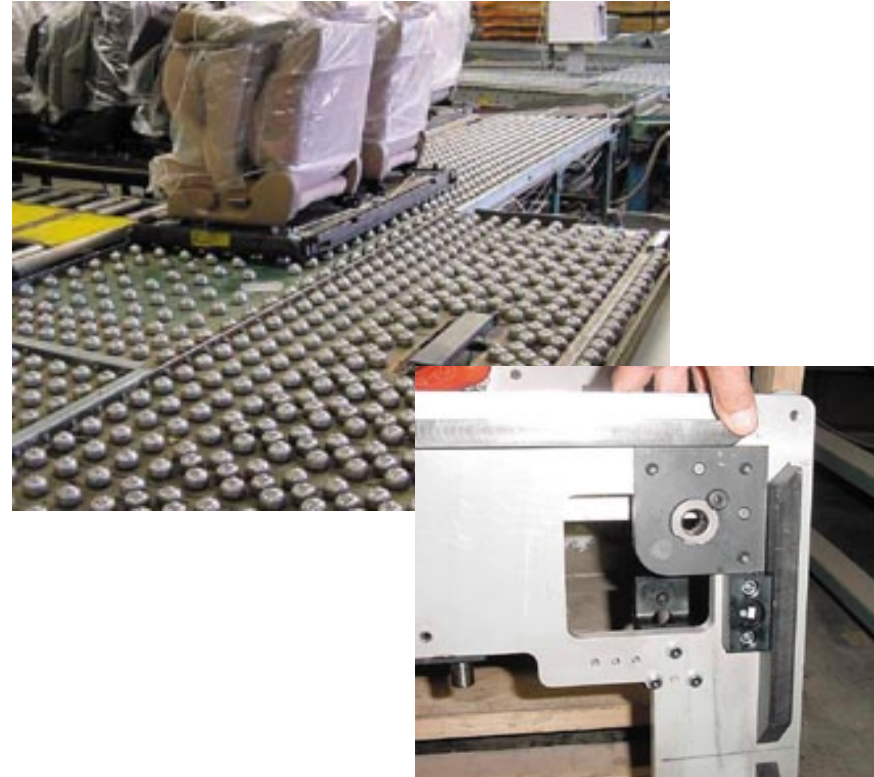


Automotive: Mandates/Issues

- RFID long established – generally active tags
- 46% of all RFID applications in Auto
- Sophisticated production applications exist
 - Production tracking/rerouting
 - Product customisation
- Predominantly carrier oriented, single organisation applications
- Numerous usage applications:
 - Tyre tagging, Access, Vehicle tagging
- Opportunity for a more integrated RFID landscape?

Automotive: Example

- **Application:** Tagging of seat carriers – internal, shipping
- **Driver:** OEM compliance and ensuring high OTIF (also asset utilisation)
- **Action:** ForkLift Loading
- **Decision:** Verification
- **Information:** ID, class (accuracy)
- **RFID:** HF, on carrier, 4x, reader on conveyor



Automotive: Example

- **Application:** Tagging of vehicle carriers
- **Driver:** customisation of each recreation vehicle to specific order needs
- **Action:** Assembly to order
- **Decision:** Selection of Operation
- **Information:** ID, order
- **RFID:** UHF, on carrier, reader on conveyor



Aerospace: Mandates/Issues

- Investigations by individual companies
 - Boeing and Airbus joint initiative (not a mandate!)
 - Aim: promote the adoption of industry standard solutions for RFID on commercial airplane parts
 - Forums in EU, USA, Asia in Summer 2004
 - RFID integrated into Air Transport Association standards
 - ISO 15693 passive, read-write tags, which operate at 13.56 MHz.
 - RFID tags integrated with existing bar codes
 - Federal Aviation Administration (FAA) certification end 2004?
 - Initial Focus on Cabin Parts
 - Military – standards activities exist
 - (Baggage handling initiatives underway)
-

Aerospace: Example



Application: Tagging of aerospace parts, paperwork and tools (internal)

Driver: Improve performance in aircraft assembly - efficiency

Action: Storage and movement of items

Decision: Planning, scheduling, QC

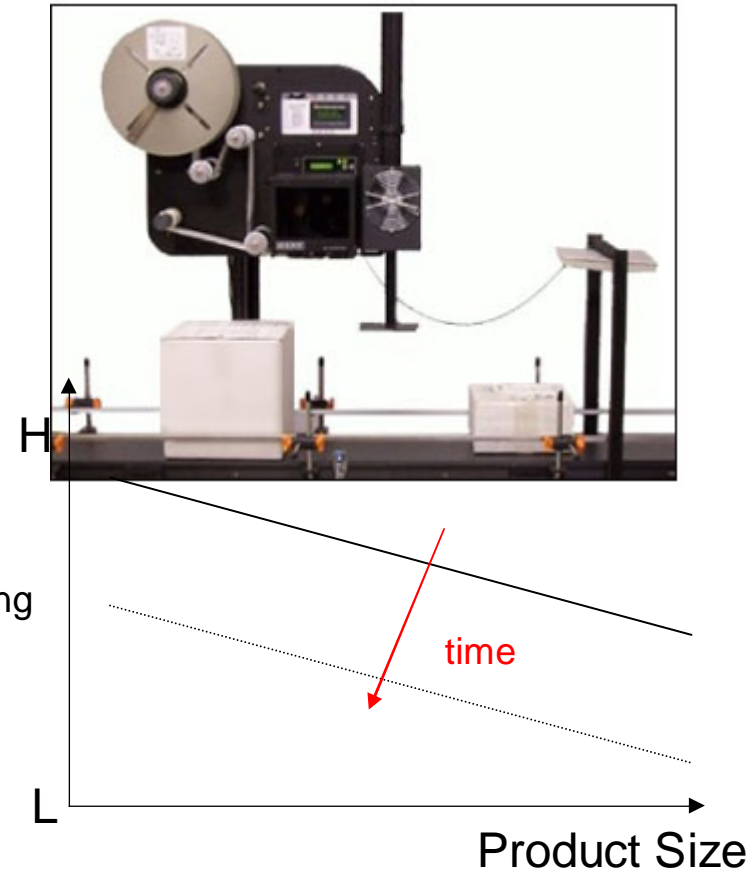
Information: (Accuracy and completeness)

RFID: UHF tagging of reusable containers



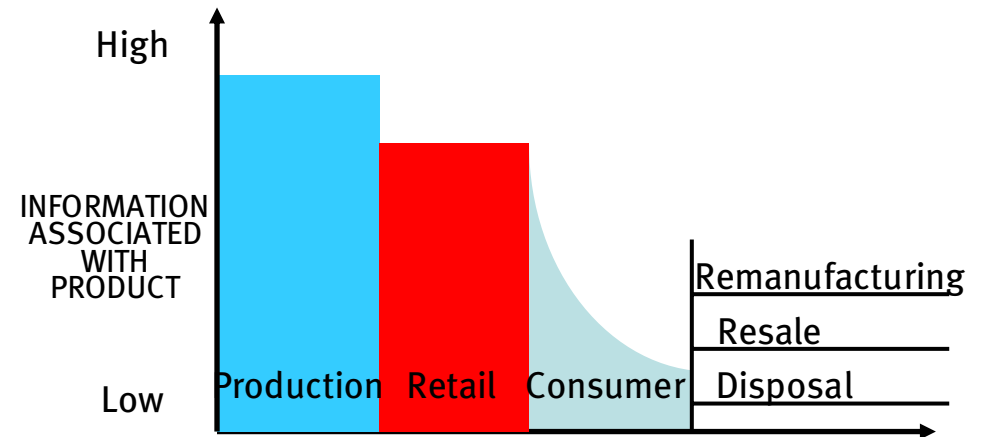
Packaging: Issues

- Possibly the most innovative sector involved in RFID deployment
- Short term deployment of slap and ship systems
- Serious developments
 - New packaging methods
 - New materials (e.g. conductive inks)
 - Life Cycle deployments
- Threat/Challenge: case->item
- Next generation packaging?



Recycling: Issues

- Disposal -> Reuse shift
- Legislations: EU, Japan, ...
 - electrical goods
 - auto
 - packaging
- Real disposal costs assigned to user/ retailer /manufacturer
- RFID issue: Product information is key to effective retirement decisions



Recycling: Example



- **Application:** Refuse weight authentication in Scandinavia
- **Driver:** Pay per load for refuse
- **Action:** Waste removal process
- **Decision:** Assigning cost to specific customer based on weight
- **Information:** Accurate ID
- **RFID:** UHF tags embedded in refuse bin, reader on truck

APPLICATIONS: Issues & Challenges

Integration with existing systems

- Systems Integration Challenges
 - Physical hardware
 - Information systems: *middleware*
 - Business process
- Levels (or extents) of integration
 - Connected – barcodes -> RFID
 - Coordinated – enhancing existing processes with EPC data
 - Coherent – redesigning processes from scratch to leverage EPC

RFID Physical Event
to Transaction
Conversion

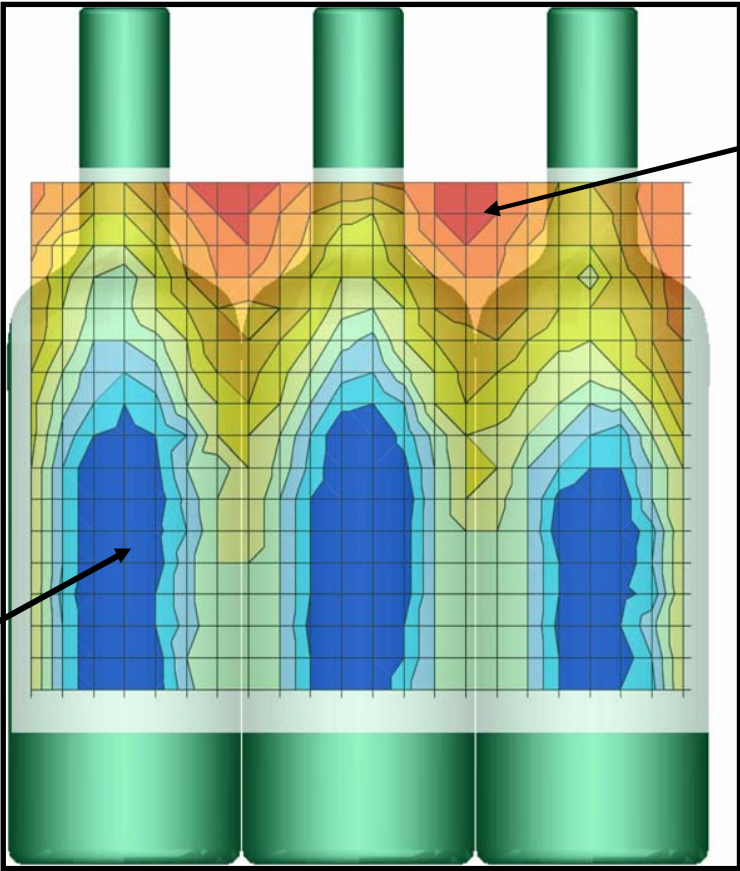
RFID Data to
Physical Event
Conversion

Product/Tag performance

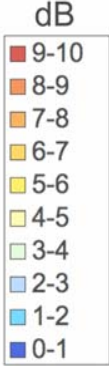


Face of case being tested

Poor tag response

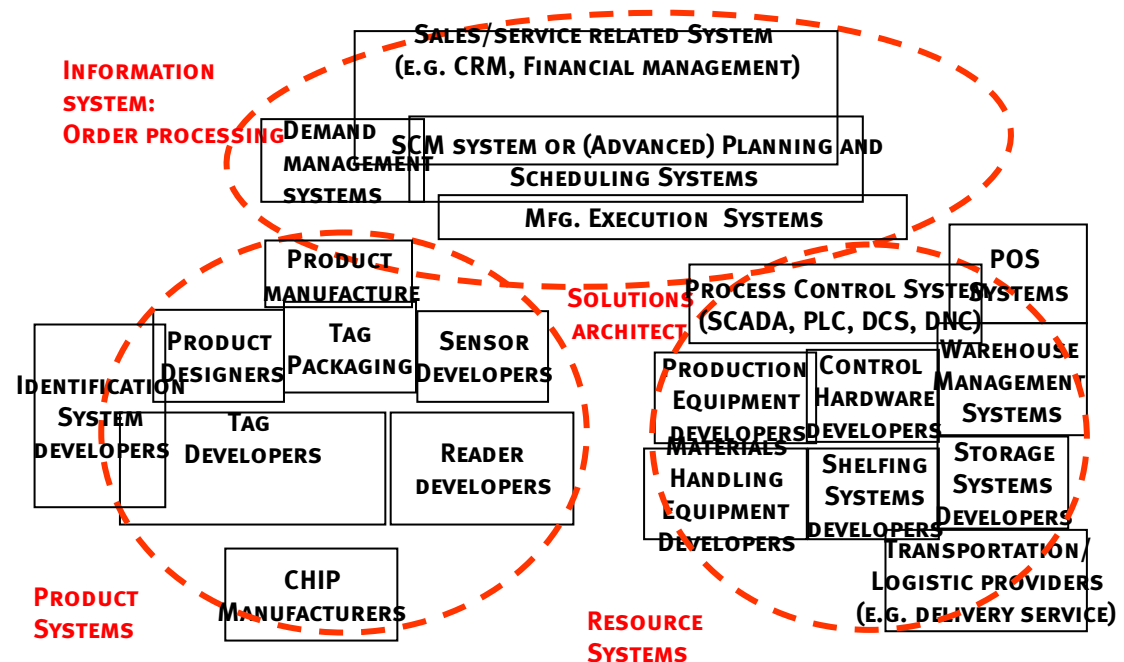


Good tag response

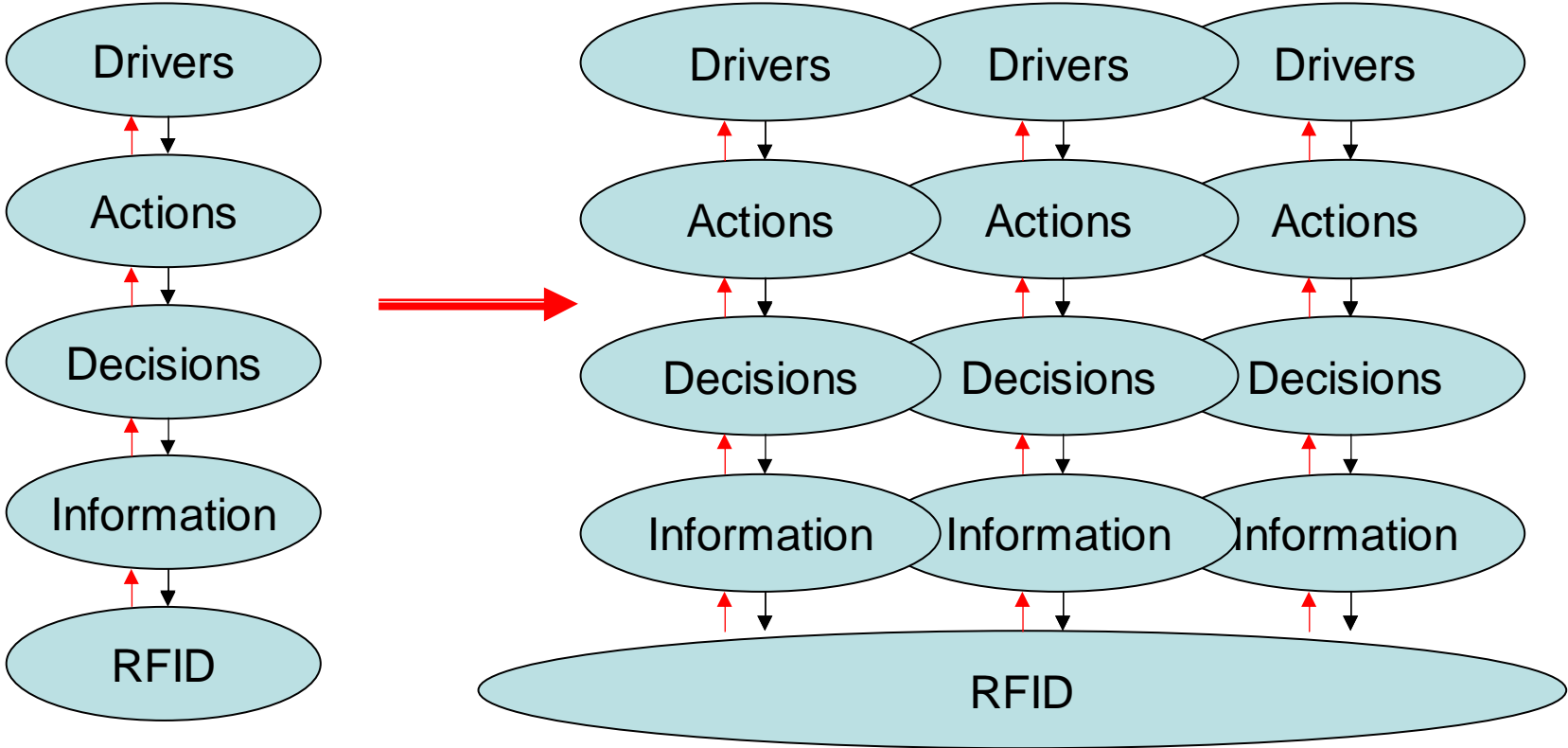


Knowing what to do and who to Work with?

- **training**: RFID is not straightforward ... yet
- **objectivity**: critical for assessing many options
- **interoperability**: needed to guard future
- **vendor space**: large, complex, growing



Benefits from Coordinated Systems



APPLICATIONS: Future Developments

RFID in Manufacturing: Mass Customisation



Application: Customer Driven,
Customised Packing Operations

Driver: Rapid Customer Response

Decisions:
Customised packing
Late Order Changes



RFID in Manufacturing: Mass Customisation

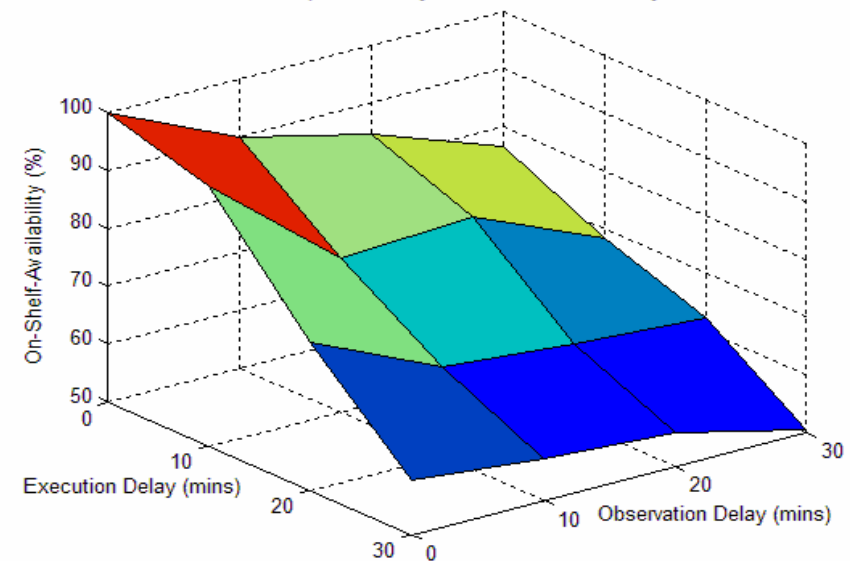


RFID in Retail: New Replenishment

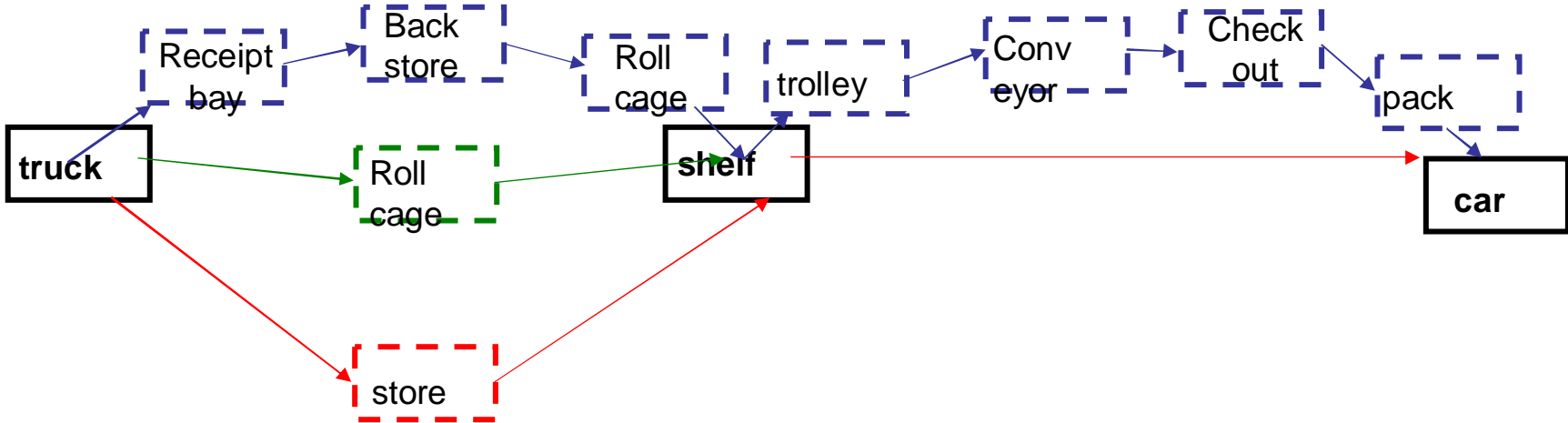
- **Application:** Item Level Tagging
- **Driver:** Reduce shelf space allocation, Improve on-shelf-availability, Reduce out-of-stock
- **Action:** Shelf replenishment
- **Decision:** replenishment frequency, priority and reordering



The Impact of Delays on On-Shelf Availability

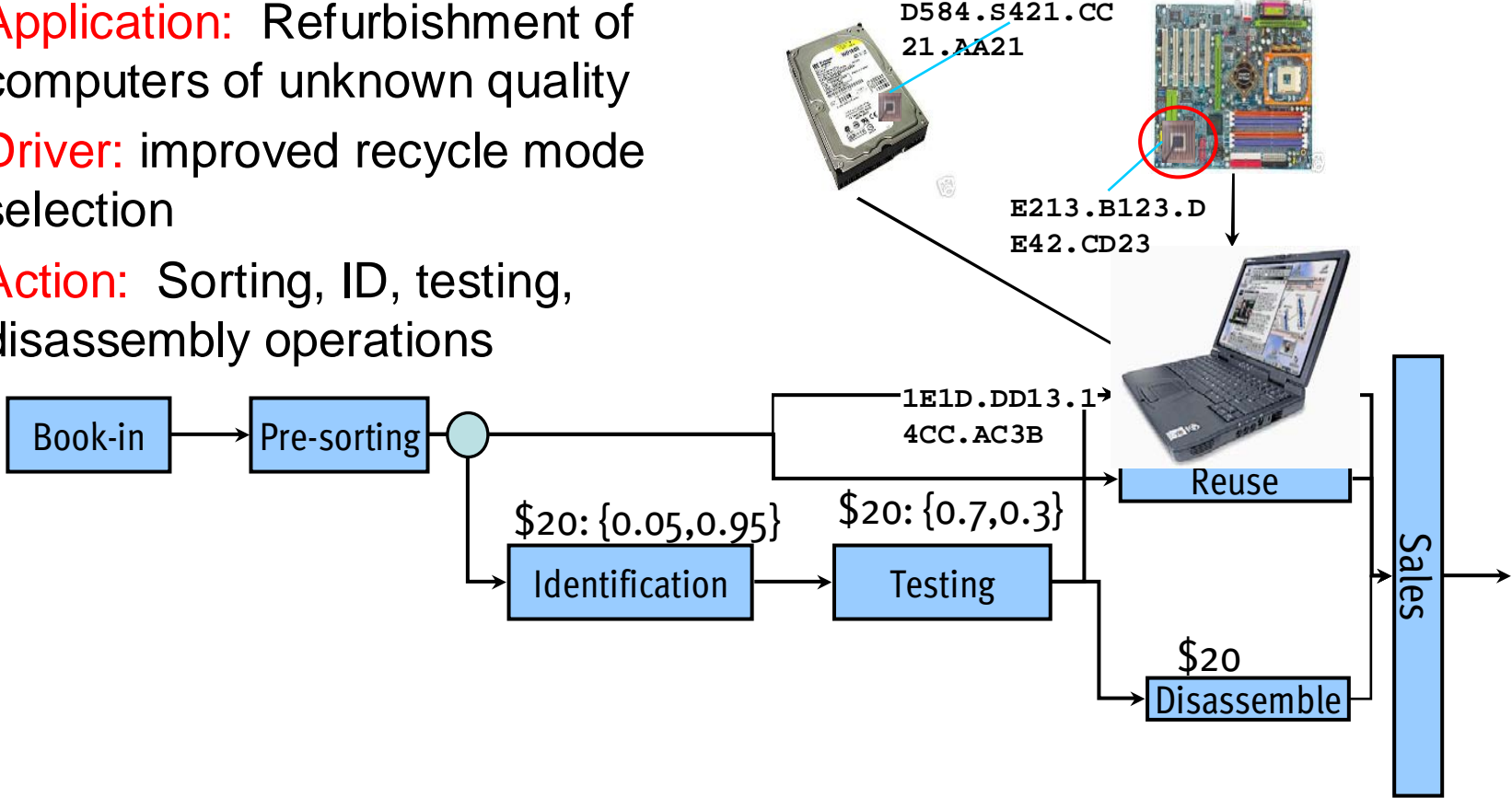


RFID in Retail: Automated Store



RFID in Recycling: Intelligent Reuse

- **Application:** Refurbishment of computers of unknown quality
- **Driver:** improved recycle mode selection
- **Action:** Sorting, ID, testing, disassembly operations



Future Developments

- General: reconsider assumptions in supply chain
 - Inventory: location & levels
 - Fixed vs dynamic supply routes
 - POS as the *good-bye* point
- Manufacturing: customisation and customerisation
- Retail: from *STORE* to *store* OF THE FUTURE?
- Product Lifecycle: Cradle to Grave management of consumer products

Contacts

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- Auto ID Labs Australia: Prof Peter Cole – RFID Technology cole@eleceng.adelaide.edu.au
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