Identity and Product Lifecycle Management: A Role for RFID?

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IfM

UNIVERSITY OF CAMBRIDGE
Institute for Manufacturing

AUTO-ID LABS

Effective Service Strategies

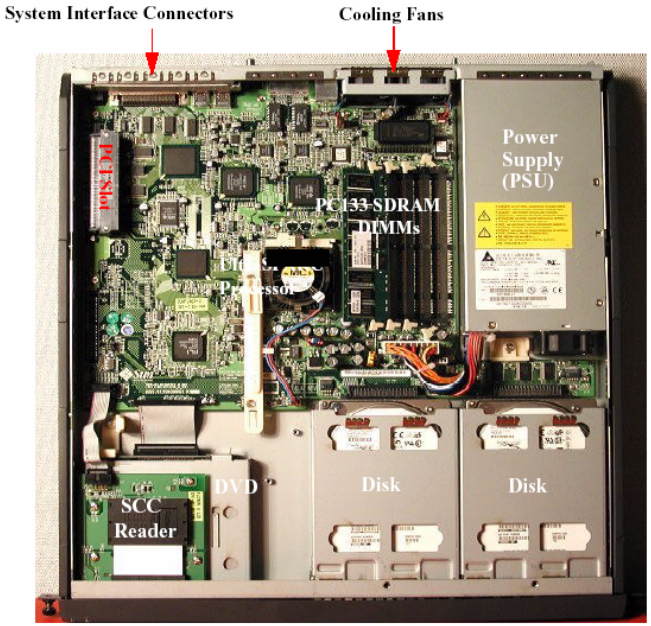
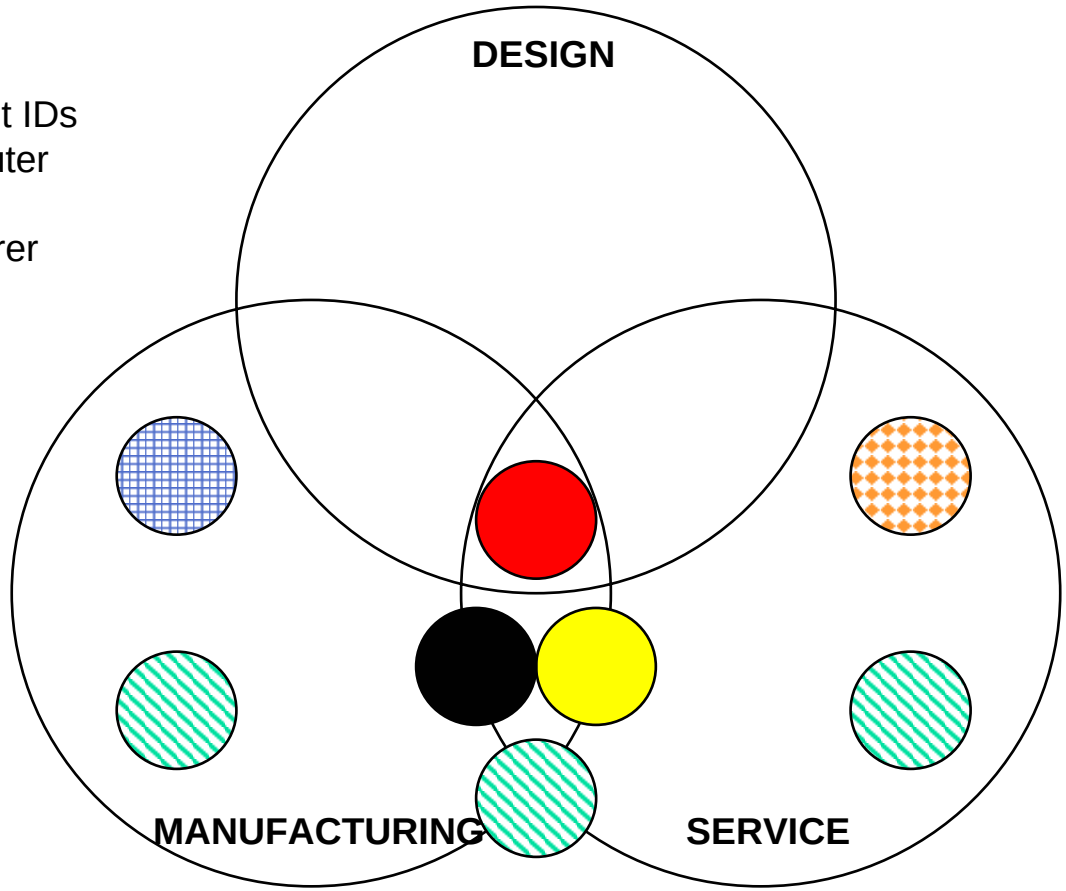


FIGURE 1-2 Internal view of the Netra T1 200 Server

- efficient information retrieval for field engineers
- single point of access to all lifecycle information

Effective Service Strategies

Multiple Component IDs For Computer Systems Manufacturer



KEY

- Work Order Number
- Part Number
- Serial Number
- Component-ID
- Host-ID
- Transport-ID

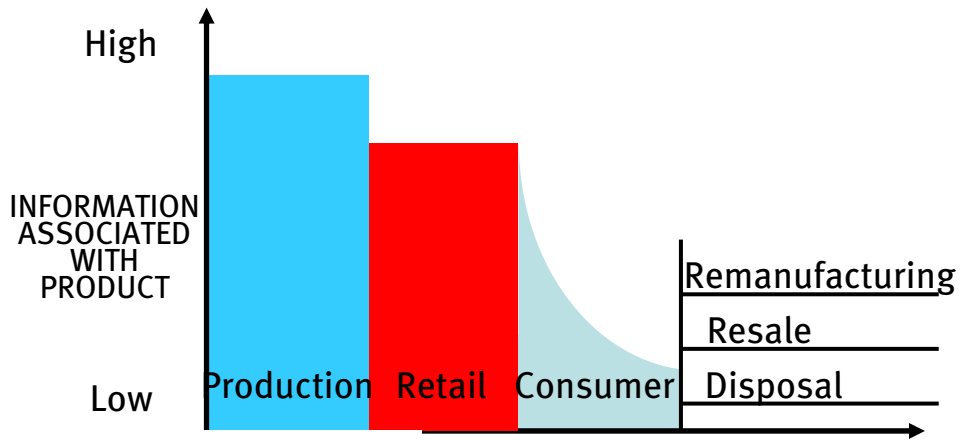
Food Lifecycle Assurance

- Food traceability criticality
  - Source
  - Processing
  - Certification
- Use by Date dependence on distribution / storage
- *Also, FDA requirements on drugs*

Smarter “Waste” Management

Smarter “Waste” Management

- 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



Information Issues for PLM

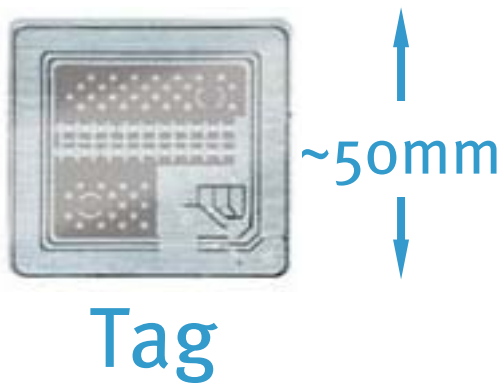
- Requirement for product-oriented information management approach
- Tight coupling between physical items and sub components and the information held about them
- Ability to retrieve information in a simple and timely manner

Overview

- RFID Introduction and Background
- The value of RFID for PLM?
- Industrial Examples

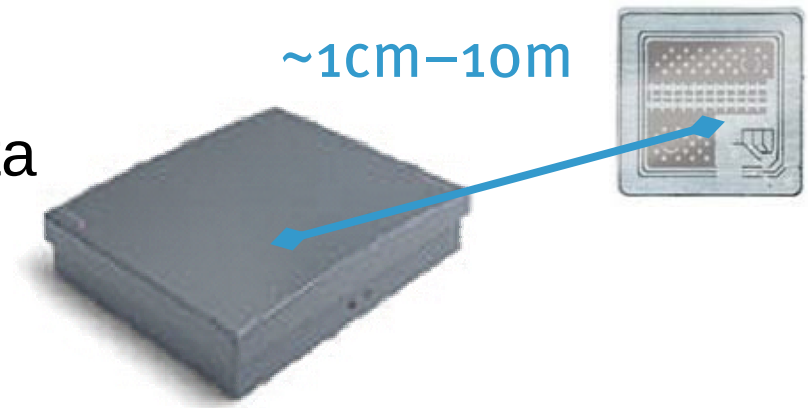
What is RFID ?

- *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

Why RFID?

- Alternative technologies
  - Barcodes (traditional and 2D)
  - Magnetic strips
  - Vision systems

✓ ‘Simultaneous’ identification

✓ Reasonable operating distance

✓ No line of sight; automated reads

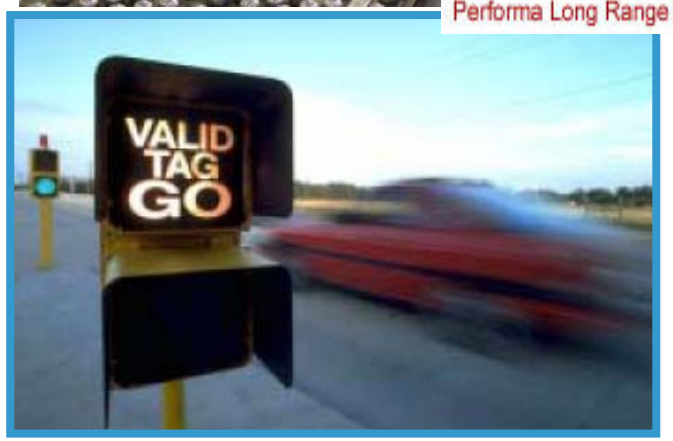
– Not as cheap as some alternatives

– Some problematic items

RFID History

- 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
  - Enabled new set of applications

Performa Long Range Reader



Auto ID Center (1999-2003)

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

- Approach
  - Method for *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 ……
  - Project involving 103 companies, 6 universities, 4 years

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

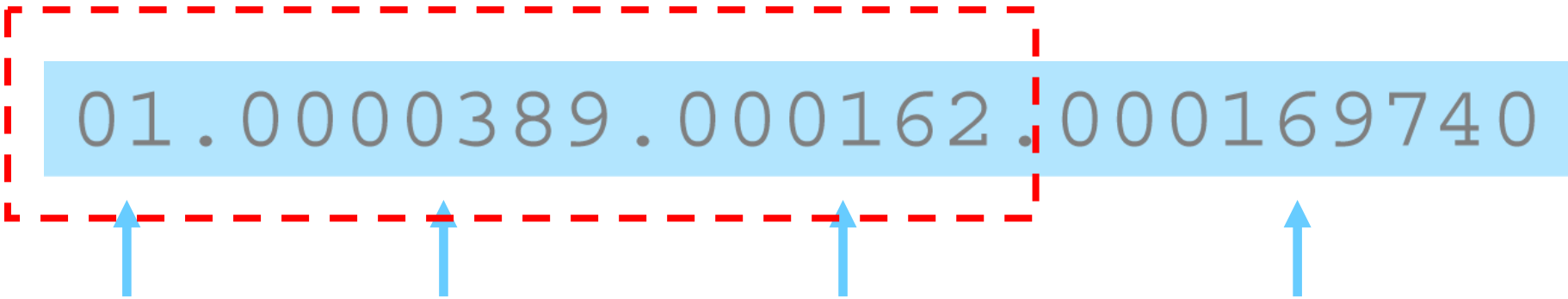
2. business justification through multiple applications/ companies

-> standardised tag/reader systems

-> standardised data management and communication systems

-> RFID network system as extension to the internet

Unique ID: electronic product code



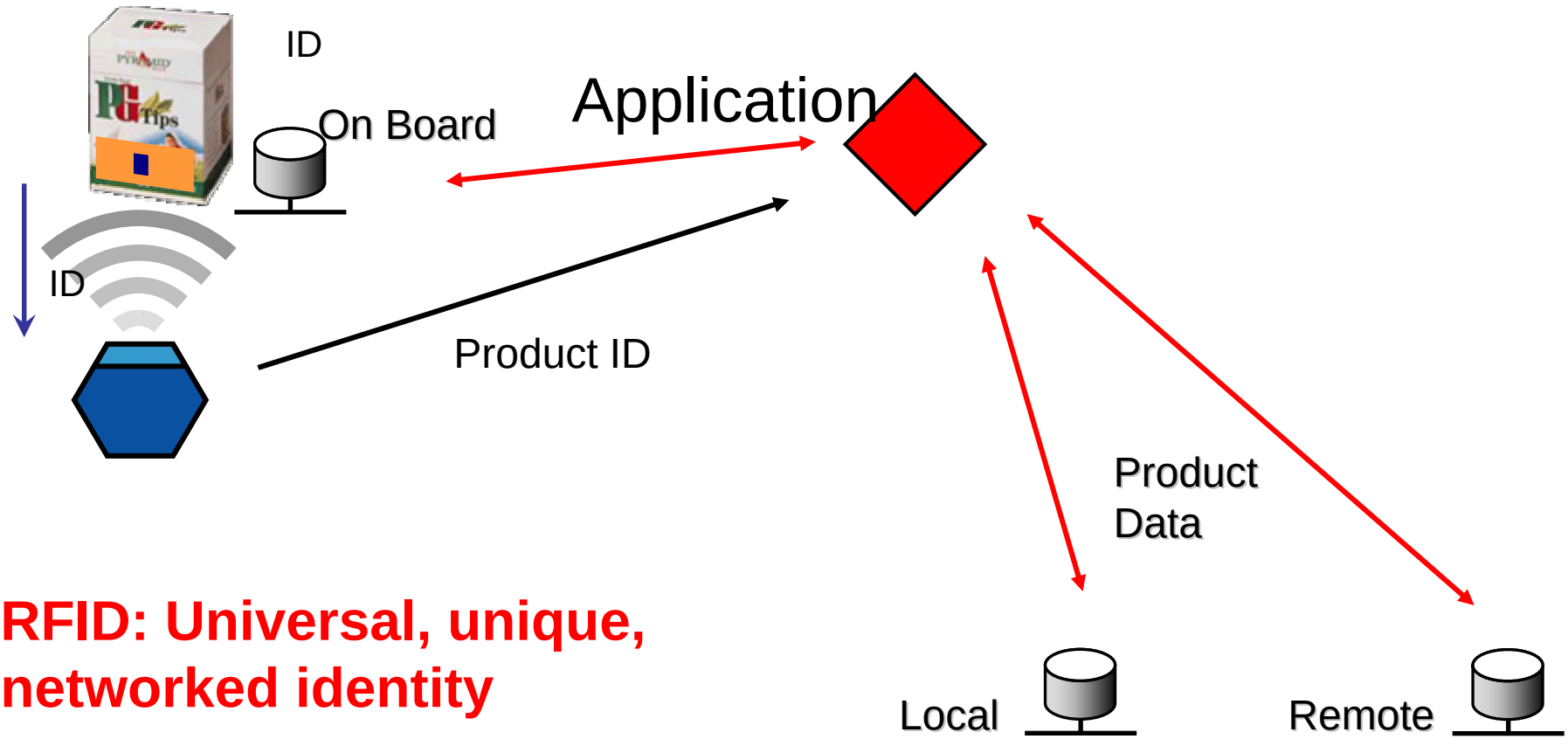
Header
8 bits
indicates partitioning scheme
256

EPC Manager
28 bits
indicates company (manufacturer)
>268 million

Object Class
24 bits
indicates product -type ('SKU')
> 16 million

Serial Number
36 bits
unique for each instance of a product
> 68 billion

“Networked RFID”



RFID: Universal, unique, networked identity

Components of *Networked RFID*

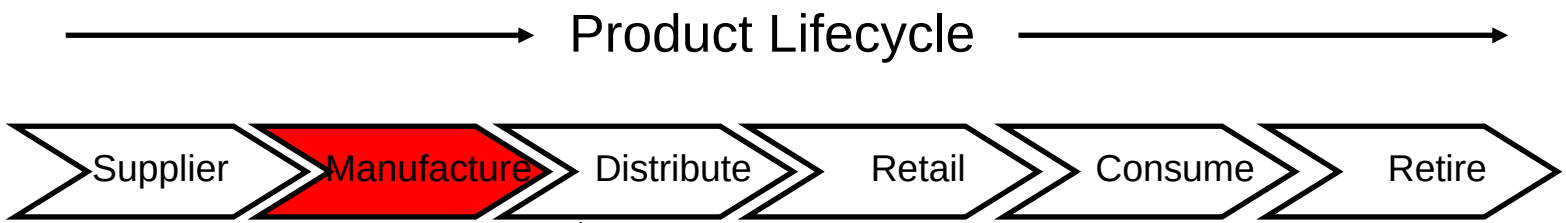
- Unique Identifier
- Standardised, simple RFID systems
- Filtering
- Means of detecting location of linked product information
  - Static
  - Dynamic
- Standard mechanism for querying, retrieving product information

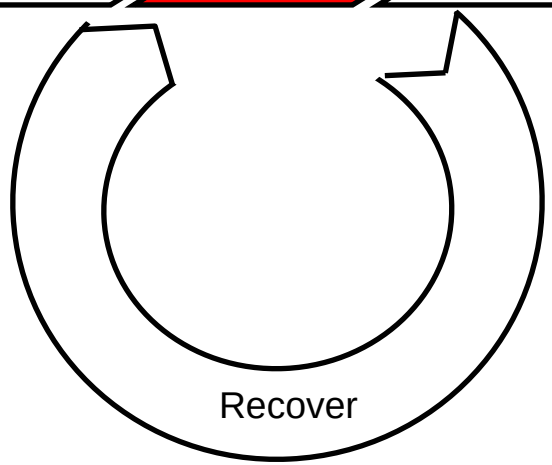
Refer to www.epcglobalinc.org for standards details

Post 1999 RFID Adoption Activities

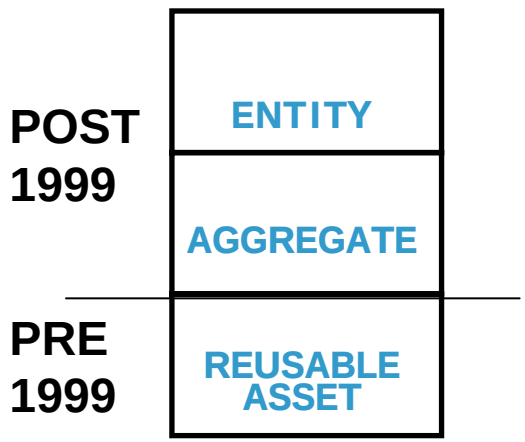
- Very high volumes, low cost
  (Price $0.50 in 1999 to ~$0.05 in 2004 - for 10^{10} tags)
- Multi-company applications
- Many sectors now involved
  - Consumer Goods/Retail: Walmart, Tesco, Carrefour, Metro..
  - Defence: *DOD* suppliers to use RFID since January 2005
  - Aerospace: Boeing/Airbus Forum
  - Pharmaceutical: FDA announced item level tagging for 2007
- Legislation: Food Traceability, Recycling legislation

Post 1999 RFID Adoption Activities





Reusable Asset Lifecycle



Current Issues

- Beginning to exploit networked data
- Examining Longer Lifecycle Products
- RFID as one of a portfolio of ID technologies
- RFID as a key enabler but not a solution
- Quantifiable Business Case

Overview

- RFID Introduction and Background
- The value of (Networked) RFID for PLM?
  - Essence of RFID
  - PLIM requirements
  - Networked RFID support for PLIM
- Industrial Examples

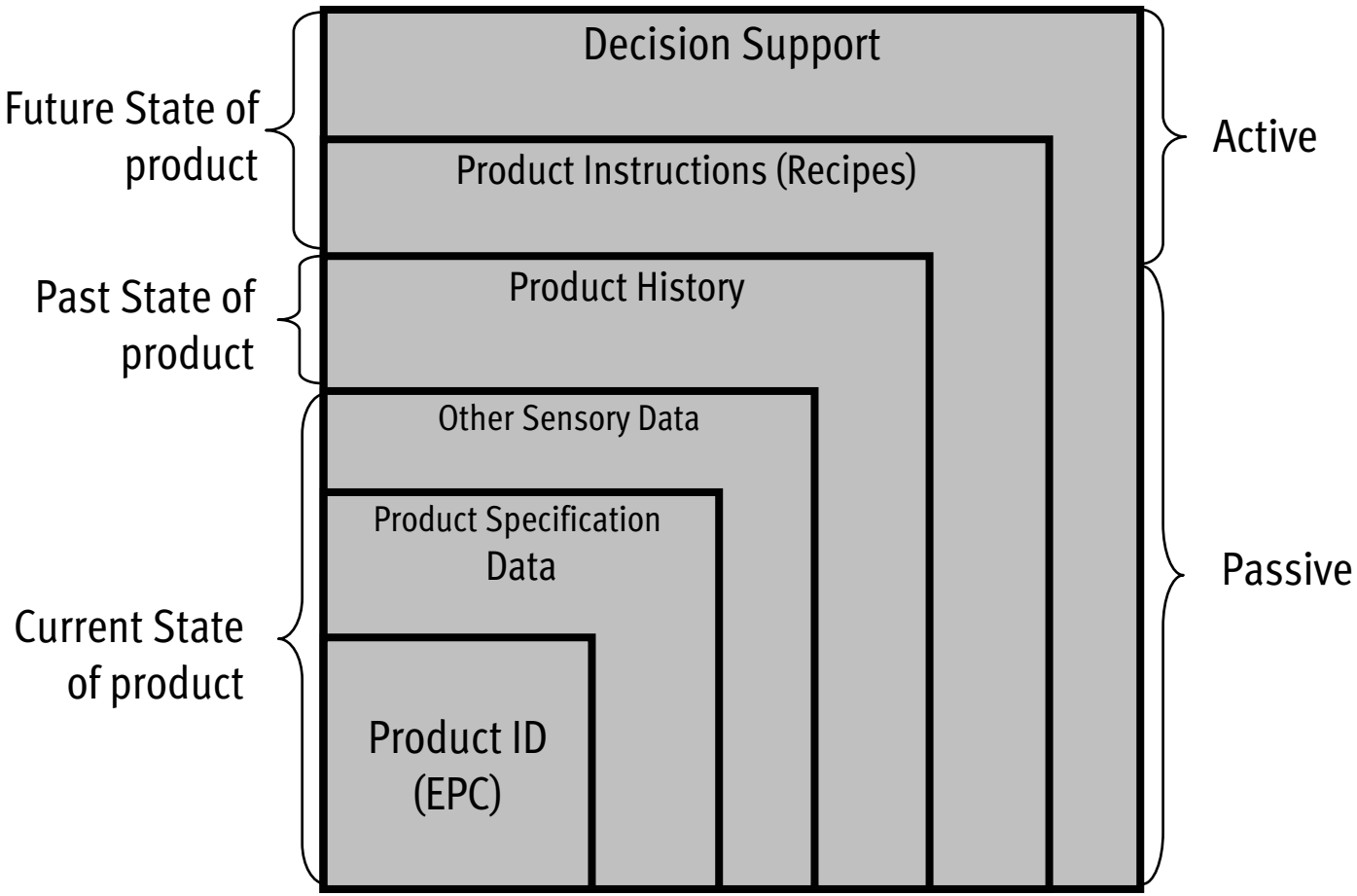
Positioning RFID and PLM

1. Tools to create the product content

2. Tools to manage and optimize the processes involved in the lifecycle of the product from its conception to retirement.

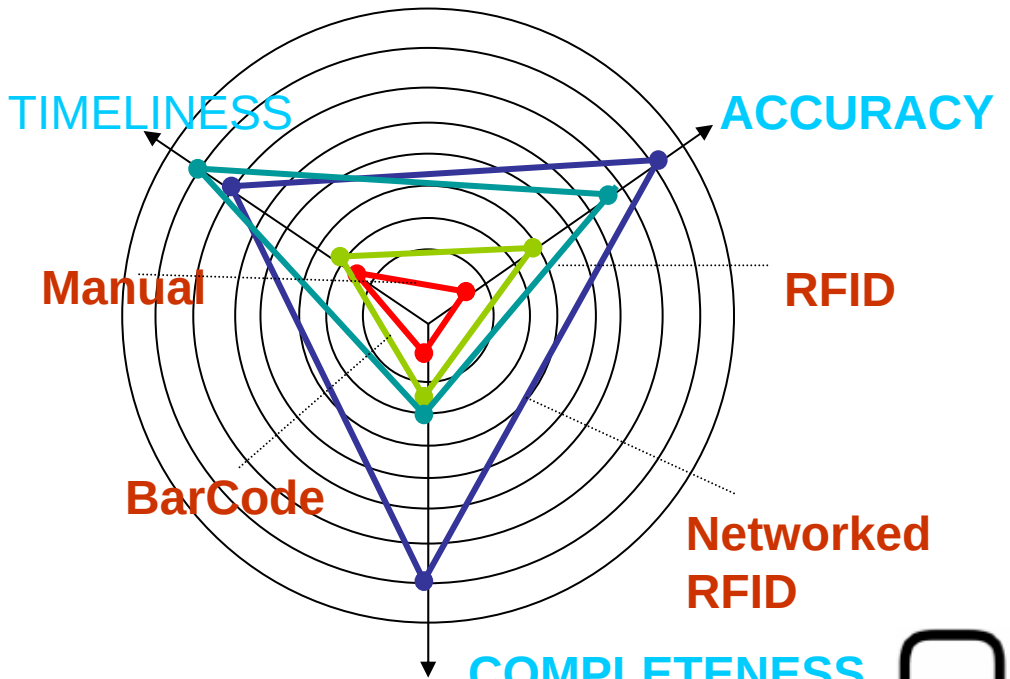
RFID/ID as a means of coordinating product life-cycle information?

Essence of (networked) RFID? Assembling Product Information



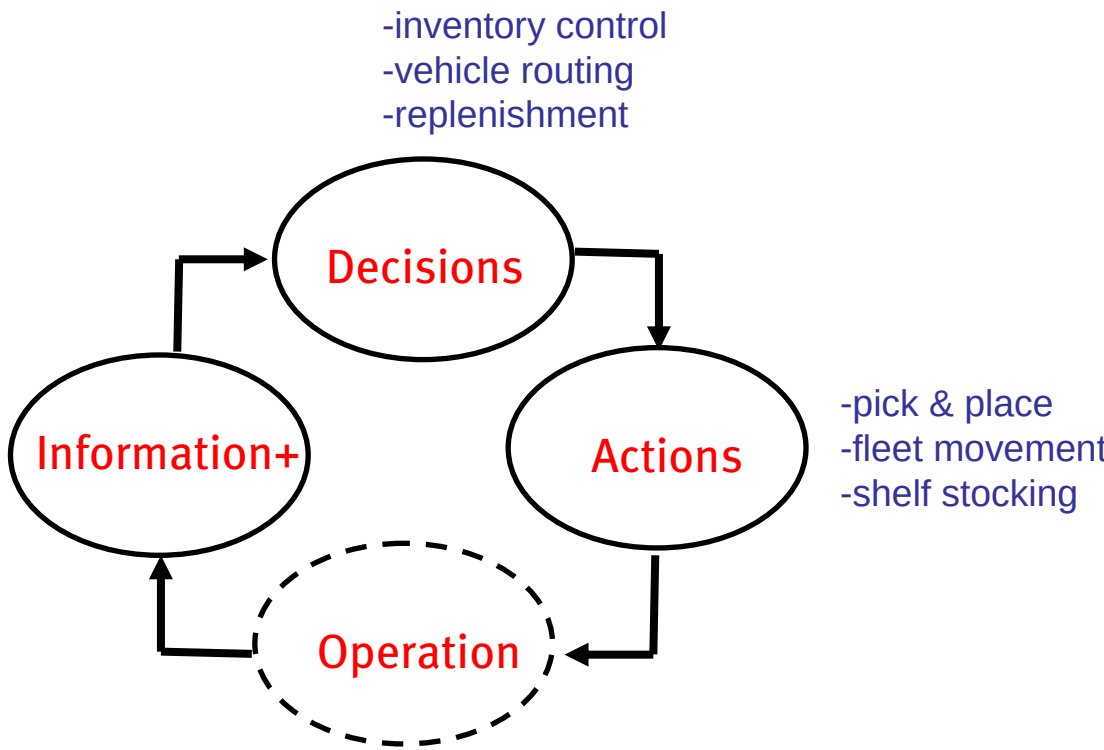
Essence of RFID: *Information Quality*

- impact of networked RFID is in enhancing the quality of product information available
- information quality dimensions
  - accuracy
  - completeness
  - timeliness



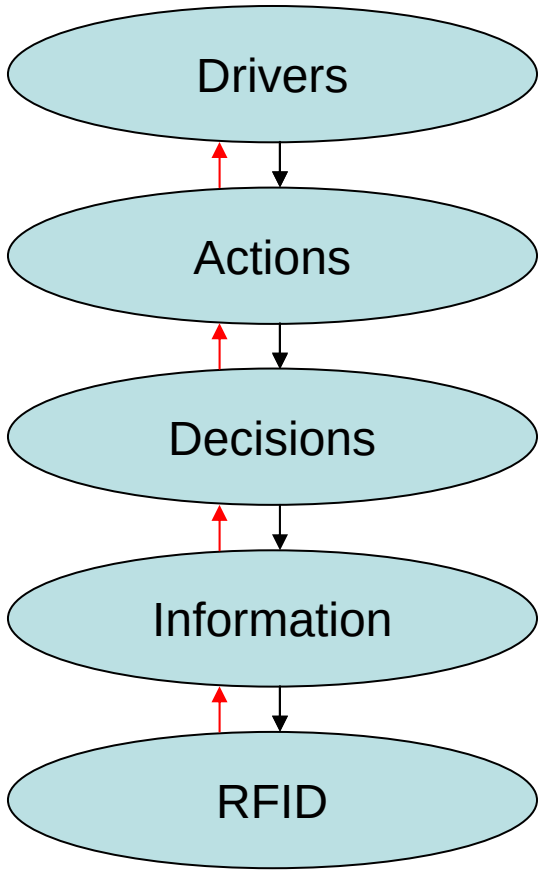
Essence of RFID: Enhancing Decisions

- Information management has no direct value
- Improved information quality must be used to enhance decisions and subsequent actions



Essence of 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



Lifecycle Decisions and Information Needs

Decisions \ Information	Design	Manufacture	Retail	Usage	End-of-Life
Manufacture	Planning & Scheduling	Recipes Design Drawings Handling Constraint				
Retail	Distribution	Handling Constraints		Fulfilment Requirements		
	Store Reordering	Product Identity	"Due by" Dates	Storage Costs Sales Price		
	Shelf Replenishment	Product Identity Storage Constraints	"Due by" Dates	Shelf Locations		
Usage	Usage	Usage Instructions	"Due by" Dates Possible Recalls			
	Repair/Replacement	Reliability data	Disassembly recipes	Warranty details	Maintenance history Usage History	
End-of-Life	Sorting	Product Identity Design changes				
	Recovery option	Reliability data		Replacement history Sale price	Usage sensor data Maintenance history Parts replaced	Reason for return
	Disassembly sequence	Disassembly recipes Irreversible processes				
	Disassembly level	Bill of Materials				
	Recycling	Hazardous materials				

Existing Lifecycle Information Systems

Characteristics

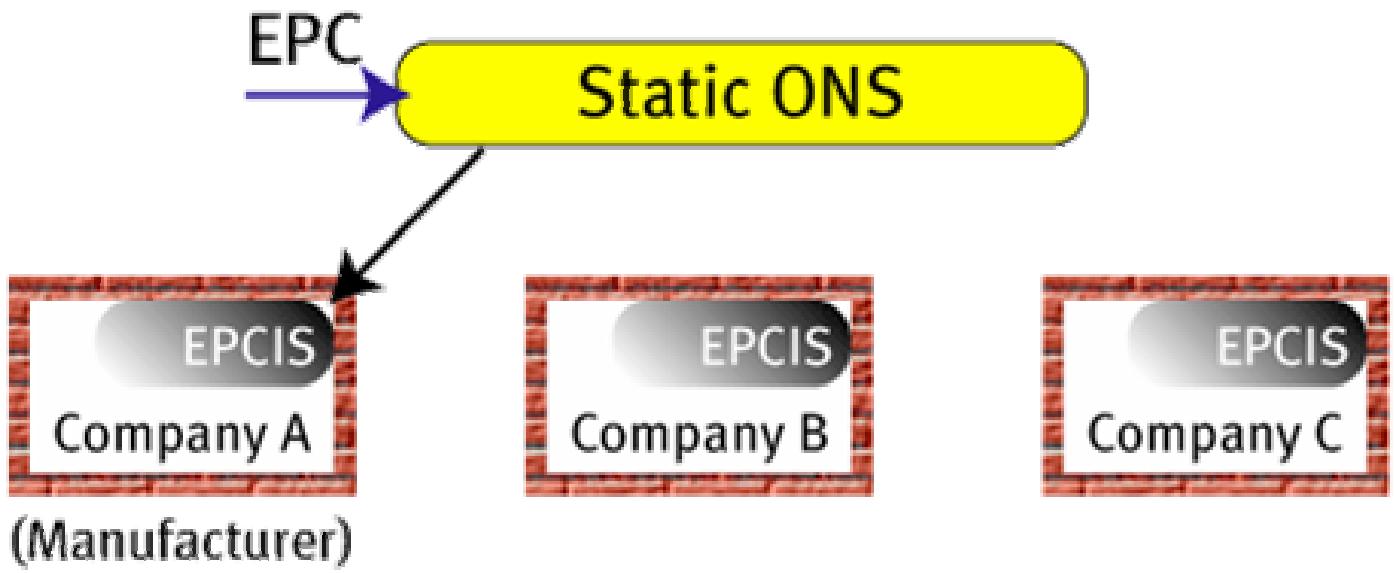
- Unique identification.
- Classifies product data into “static” and “dynamic” classes.
- Provides design & disassembly Information.
- Monitors & records essential lifecycle performance parameters.
- Provides decision support.

Opportunities

- Common standard for data management across product life cycle
- Enable the capture of the dynamic and “static” data.
- Link directly to information about location and state of specific products

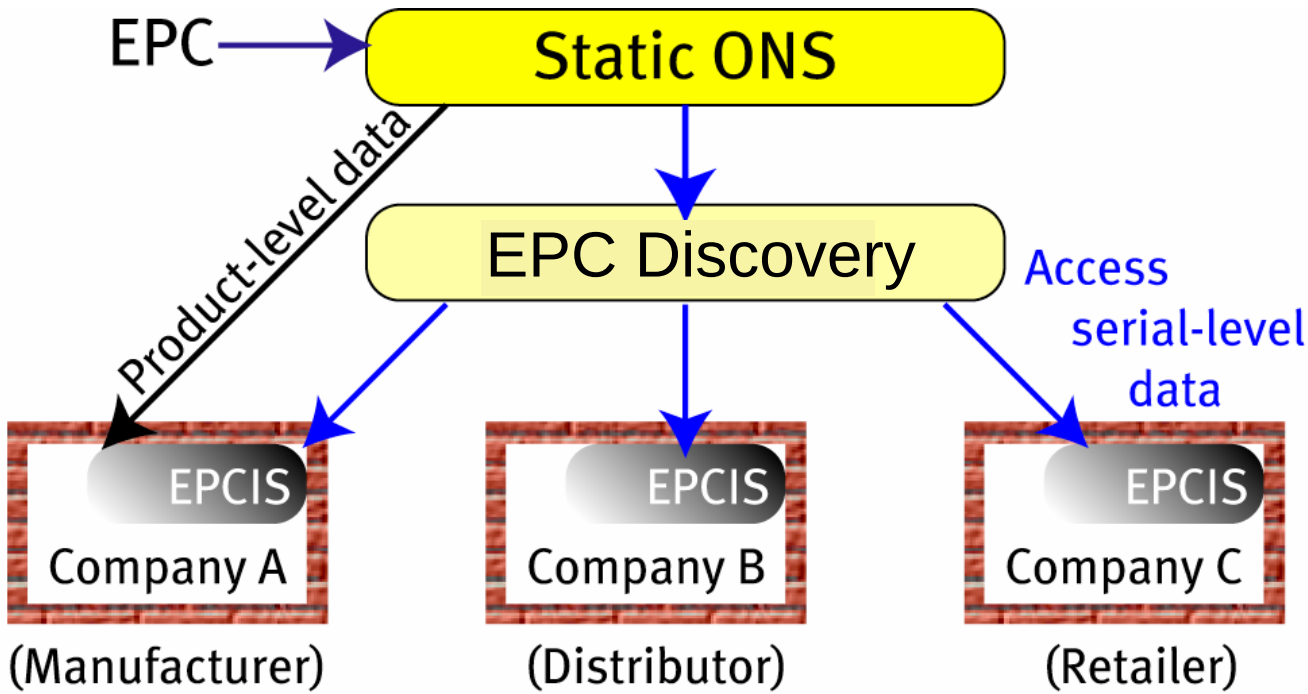
RFID accessed Lifecycle Information Service: Object Name Service (ONS)

- Redirection service – telephone book
  - For finding which database relates to a given EPC
- Similar to DNS, with additions



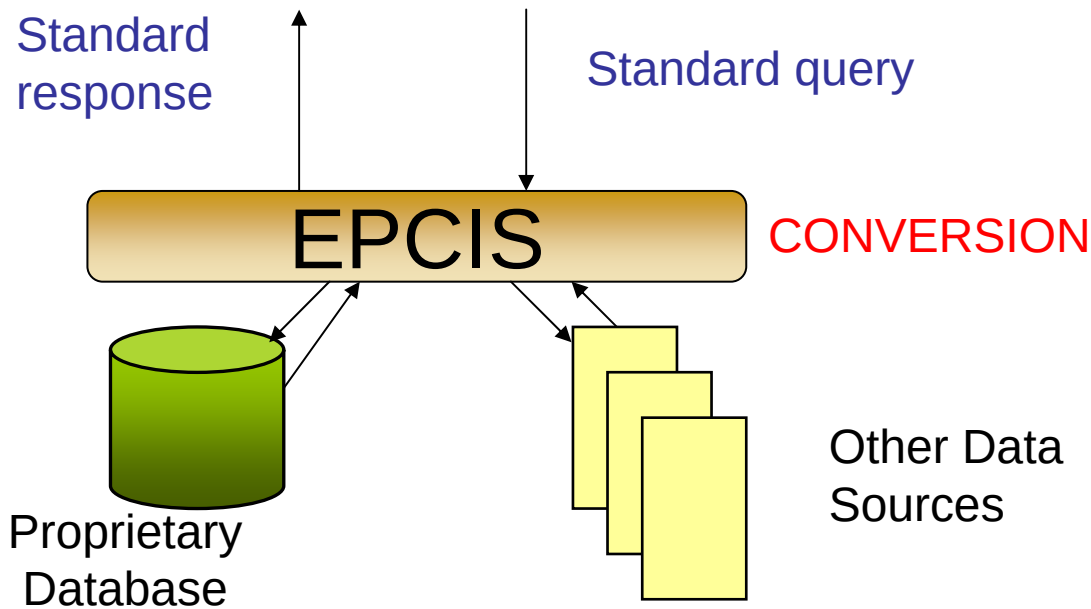
RFID accessed Lifecycle Information Service: EPC discovery service

- Registry to point to multiple databases
  - Supports a sequence of custodians through the supply chain
  - Several information stores within an organisation

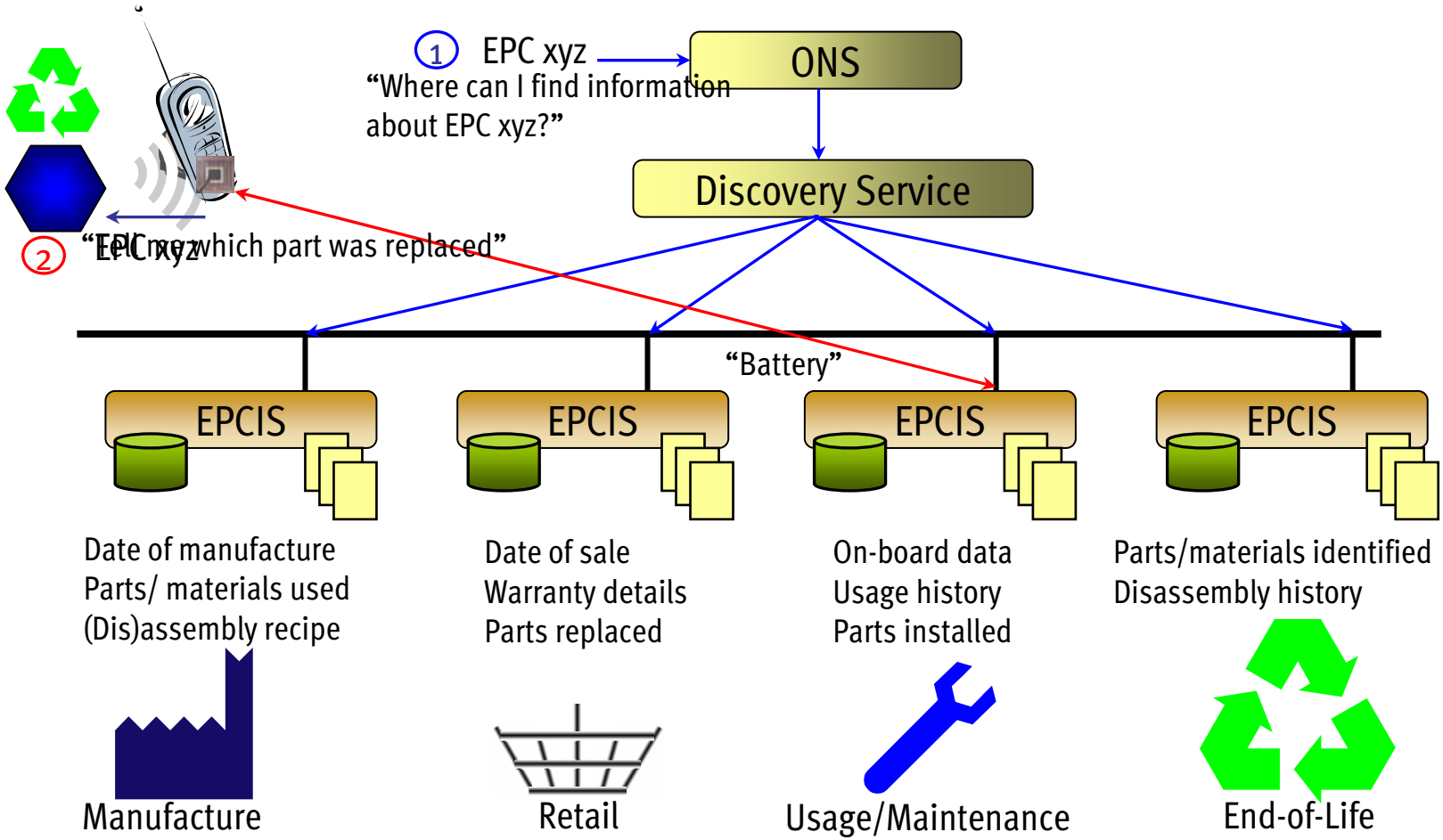


RFID accessed Lifecycle Information: EPC Information Service

- provide an open, universal approach for accessing product data
- solution as a set of interface specifications



How can it work?



Overview

- RFID Introduction and Background
- The value of (Networked) RFID for PLM?
- Industrial Examples
  - Using the Networked RFID model
  - Quantifying the Value

Example 1: Using Networked RFID in Photocopier Maintenance

- Part of ongoing study with leading copier manufacturer
- Illustrative comparison between information retrieval processes today and with Networked RFID support
- Product level analysis only

Product Life Cycle Information

Manufacture

Retail

Usage/Maintenance

Product Database	
Product	Copier
Model	EP192
BOM	{…,…,…}
Warranty	Mftr – 1yr

Shipping Database	
Batch No.	788
Retailer ID	WM189

Production Database	
Batch No.	788
Serial Nos.	XYZ, OUP,….
Date of Mftr	10th May 2002

Product Life Cycle Information

Manufacture

Retail

Usage/Maintenance

Product Database	
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BOM	{…,…,…}
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Shipping Database	
Batch No.	788
Retailer ID	WM189

Sales Database	
Transaction ID	123
Date of Sale	25th July 2002
Product	Copier EP192
Serial No	XYZ
Warranty	Extended – 3yrs

Production Database	
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Serial Nos.	XYZ, OUP,….
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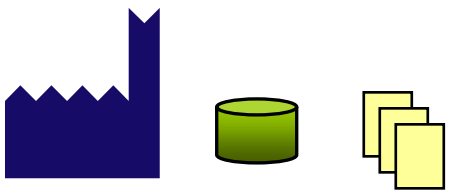
Product Life Cycle Information



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Maintenance Logbook	
Date	30th Sept 2004
Parts_replaced	{part 1, part 2}
Notes	……

Production Database	
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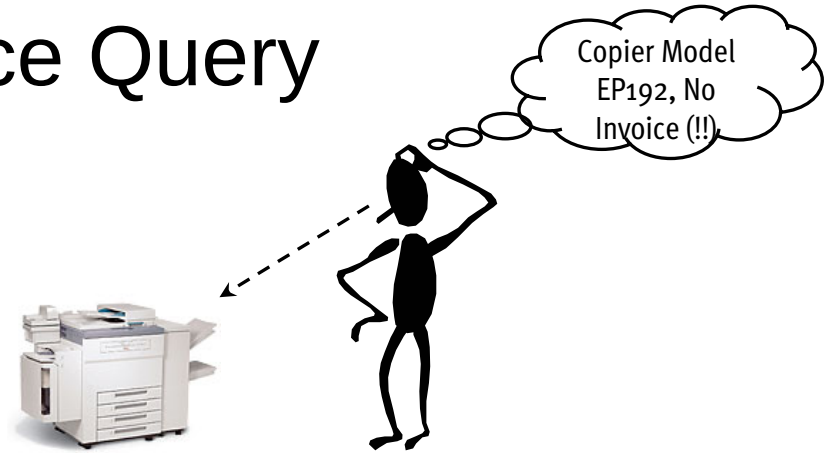
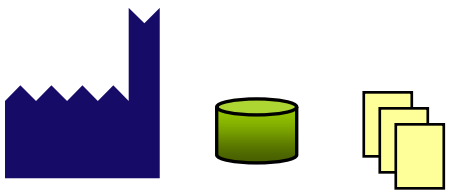
Current Maintenance Query





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Production Database	
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Serial Nos.	XYZ, OUP,….
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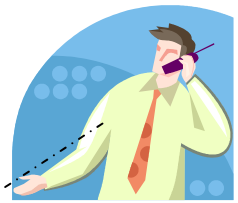
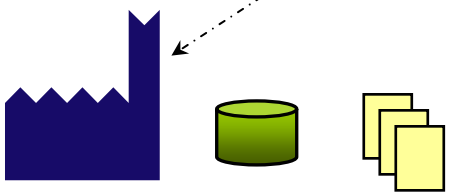
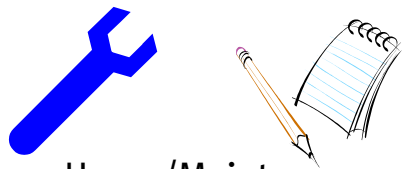
Current Maintenance Query

"Can you give me some information about EP192 Serial No. XYZ please?"







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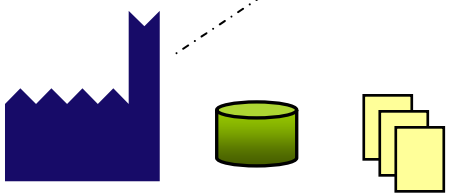
Current Maintenance Query

"Sure. Give me some time."



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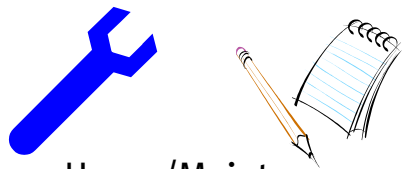

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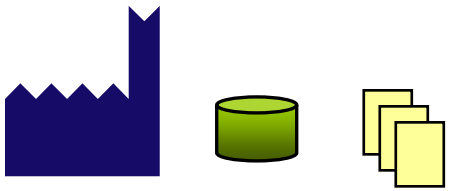

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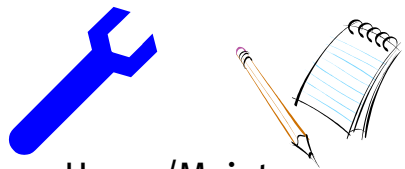

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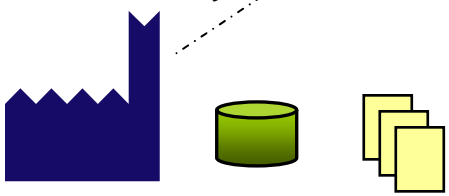
Serial Nos.	XYZ, OUP,….
Date of Mftr	10th May 2002

Current Maintenance Query

Serialised BOM,
Manufacturer Warranty details
No sales data,
sold by Retailer WM189



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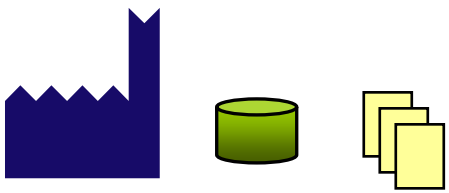
Current Maintenance Query

"Can you give me some information about EP192 Serial No. XYZ please?"



Manufacture

Retail

Usage/Maintenance

Product Database	
Product	Copier
Model	EP192
BOM	{…,…,…}
Warranty	Mftr – 1yr

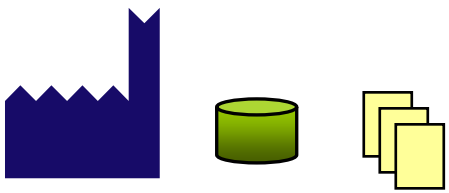
Shipping Database	
Batch No.	788
Retailer ID	WM189

Sales Database	
Transaction ID	123
Date of Sale	25th July 2002
Product	Copier EP192
Serial No	XYZ
Warranty	Extended – 3yrs

Maintenance Logbook	
Date	30th Sept 2004
Parts_replaced	{part 1, part 2}
Notes	……

Production Database	
Batch No.	788
Serial Nos.	XYZ, OUP,….
Date of Mftr	10th May 2002

Current Maintenance Query



"Sure. Give me some time."

Manufacture

Retail

Usage/Maintenance

Product Database	
Product	Copier
Model	EP192
BOM	{…,…,…}
Warranty	Mftr – 1yr

Shipping Database	
Batch No.	788
Retailer ID	WM189

Sales Database	
Transaction ID	123
Date of Sale	25th July 2002
Product	Copier EP192
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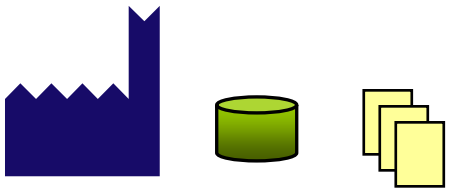
Notes	……

Production Database	
Batch No.	788
Serial Nos.	XYZ, OUP,….
Date of Mftr	10th May 2002

Current Maintenance Query



Manufacture

Retail

Usage/Maintenance

Product Database	
Product	Copier
Model	EP192
BOM	{…,…,…}
Warranty	Mftr – 1yr

Shipping Database	
Batch No.	788
Retailer ID	WM189

Sales Database	
Transaction ID	123
Date of Sale	25th July 2002
Product	Copier EP192
Serial No	XYZ
Warranty	Extended – 3yrs

Maintenance Logbook	
Date	30th Sept 2004
Parts_replaced	{part 1, part 2}
Notes	……

Production Database	
Batch No.	788
Serial Nos.	XYZ, OUP,….
Date of Mftr	10th May 2002

Current Maintenance Query

Date of Sale,
Retailer warranty details

Manufacture

Retail

Usage/Maintenance

Product Database	
Product	Copier
Model	EP192
BOM	{…,…,…}
Warranty	Mftr – 1yr

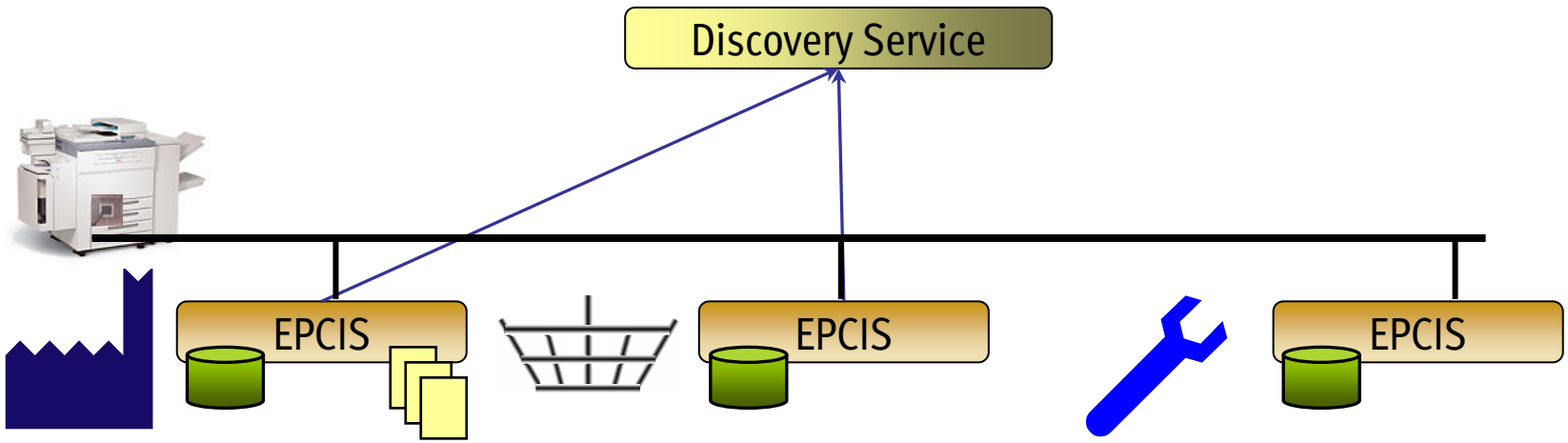
Shipping Database	
Batch No.	788
Retailer ID	WM189

Sales Database	
Transaction ID	123
Date of Sale	25th July 2002
Product	Copier EP192
Serial No	XYZ
Warranty	Extended – 3yrs

Maintenance Logbook	
Date	30th Sept 2004
Parts_replaced	{part 1, part 2}
Notes	……

Production Database	
Batch No.	788
Serial Nos.	XYZ, OUP,….
Date of Mftr	10th May 2002

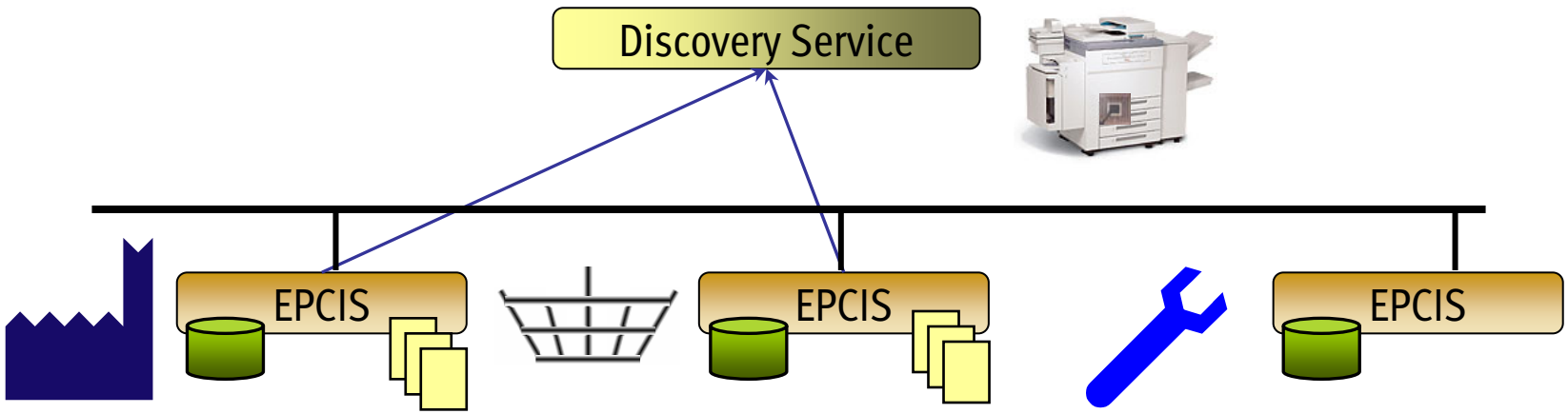
Product Life Cycle Information (2)



EPCIS Association Event D/B	
EPC_child	EPC_parent
abc	XYZ
def	XYZ

Manufacturer Database	
EPC	XYZ
Date of Mftr	10th May 2002
Warranty	Mftr – 1yr

Product Life Cycle Information



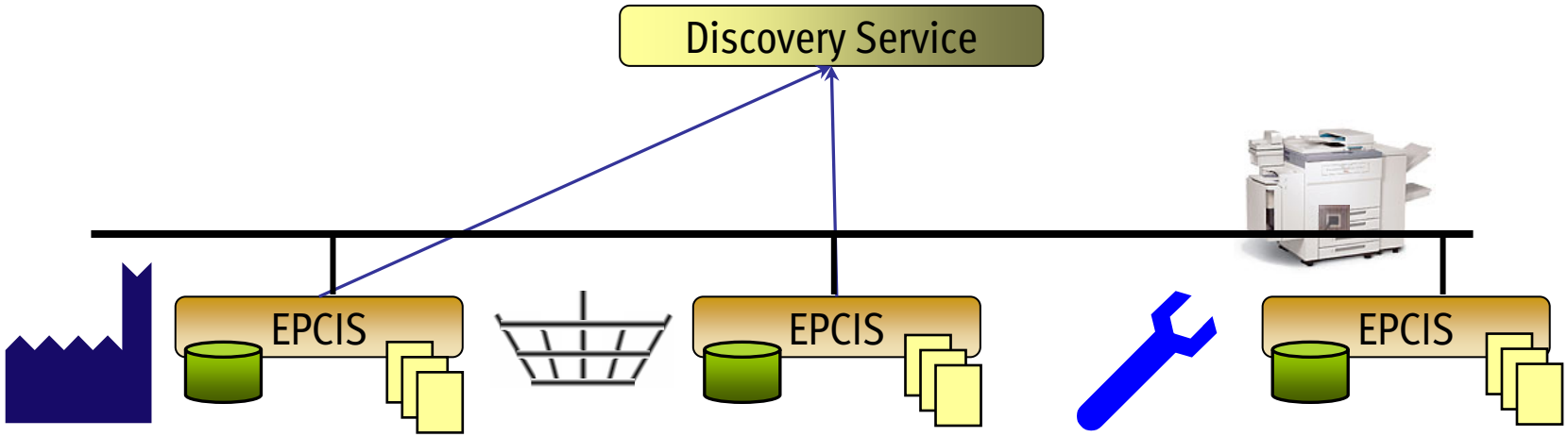
EPCIS Association Event D/B	
EPC_child	EPC_parent
abc	XYZ
def	XYZ

EPCIS Business Event D/B	
EPC	Transaction ID
XYZ	123
OUP	876

Manufacturer Database	
EPC	XYZ
Date of Mftr	10th May 2002
Warranty	Mftr – 1yr

Sales Database	
Transaction ID	123
Date of Sale	25th July 2002
Warranty	Extended – 3yrs

Product Life Cycle Information



EPCIS Association Event D/B	
EPC_child	EPC_parent
abc	XYZ
def	XYZ

EPCIS Business Event D/B	
EPC	Transaction ID
XYZ	123
OUP	876

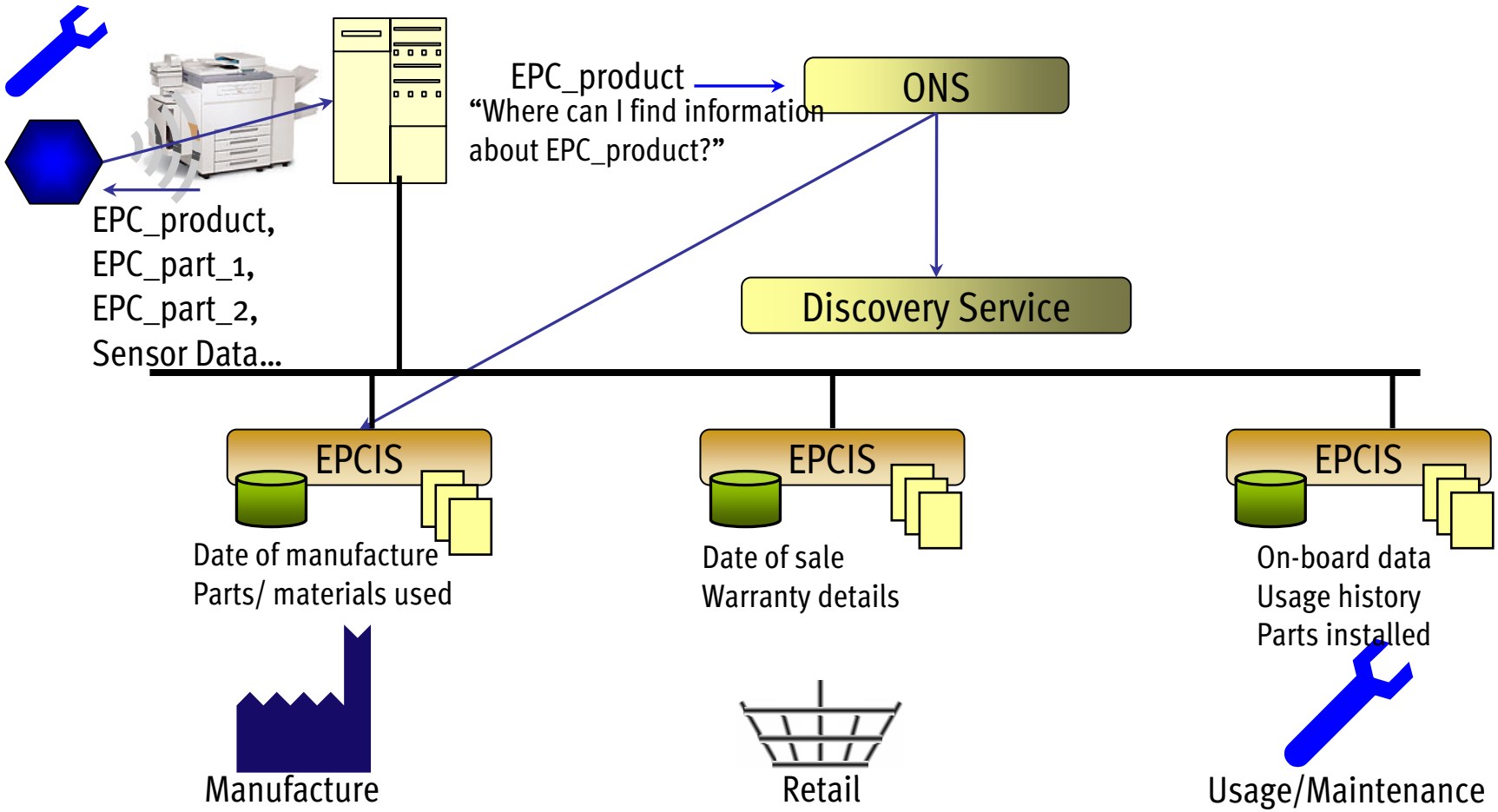
EPCIS Business Event D/B	
EPC	Job Number
XYZ	222
OUP	333

Manufacturer Database	
EPC	XYZ
Date of Mftr	10th May 2002
Warranty	Mftr – 1yr

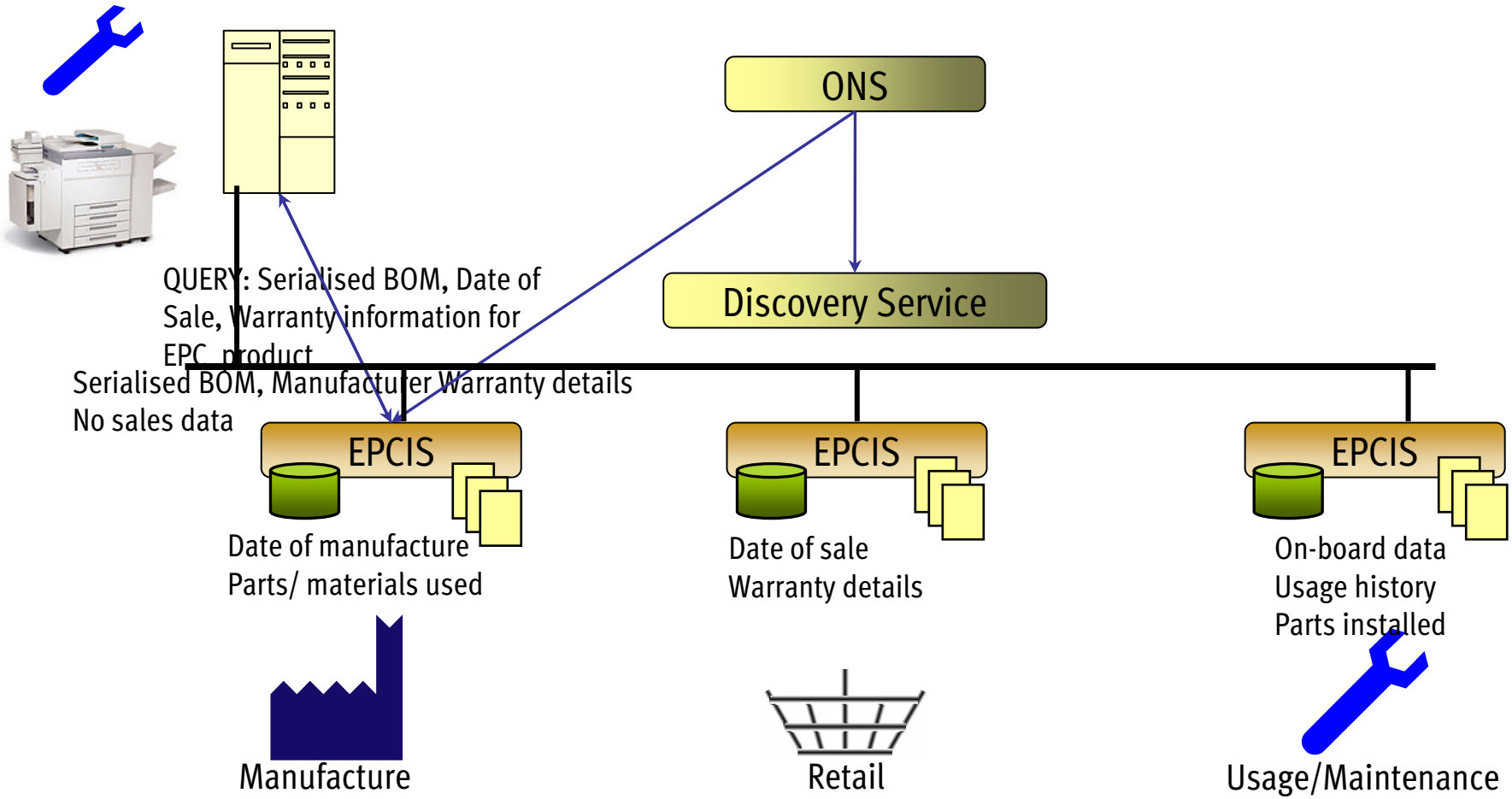
Sales Database	
Transaction ID	123
Date of Sale	25th July 2002
Warranty	Extended – 3yrs

Maintenance Log	
Job Number	222
Parts_replaced	{EPC_323}
Notes	……

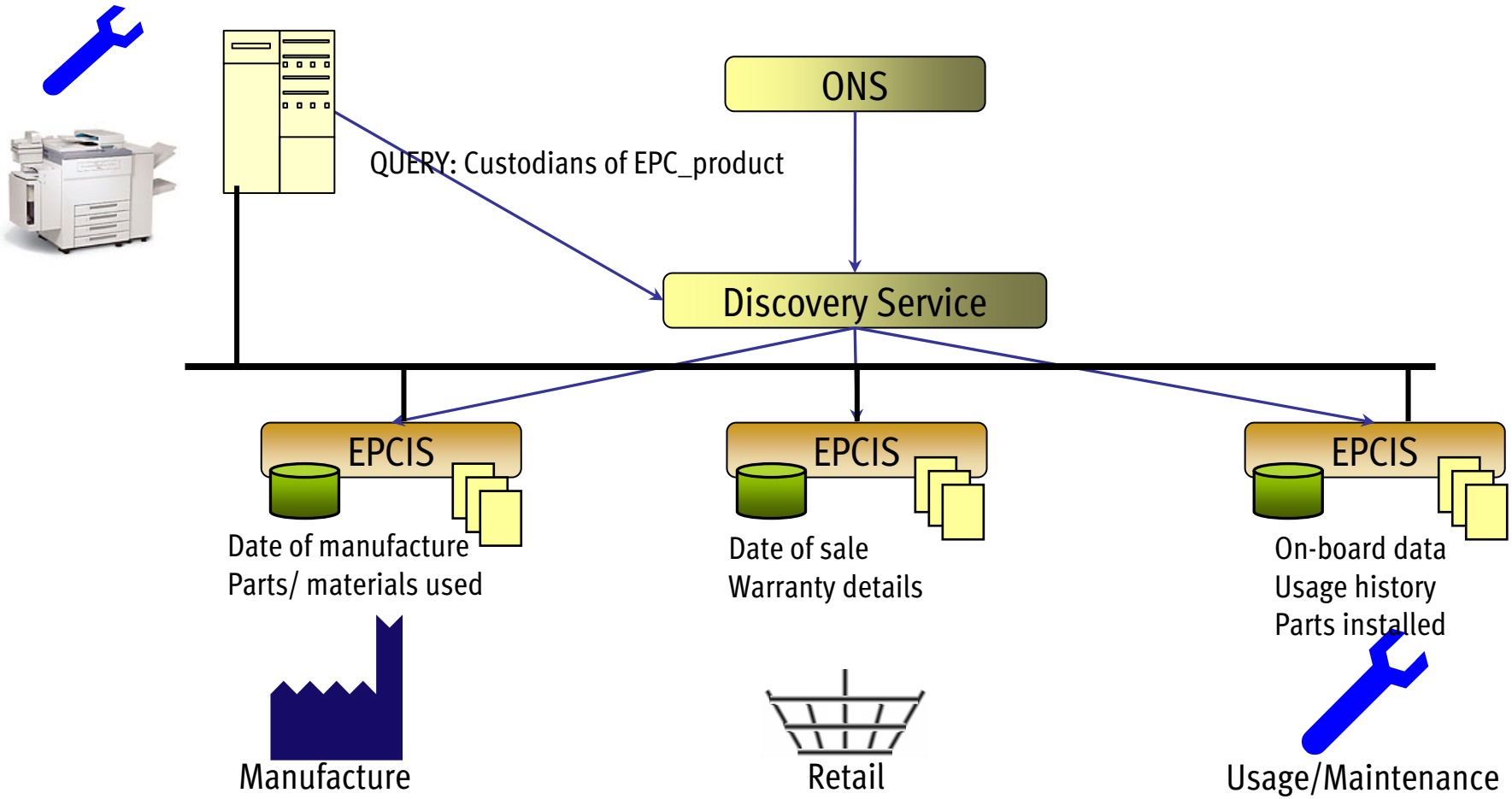
Networked RFID Maintenance Query



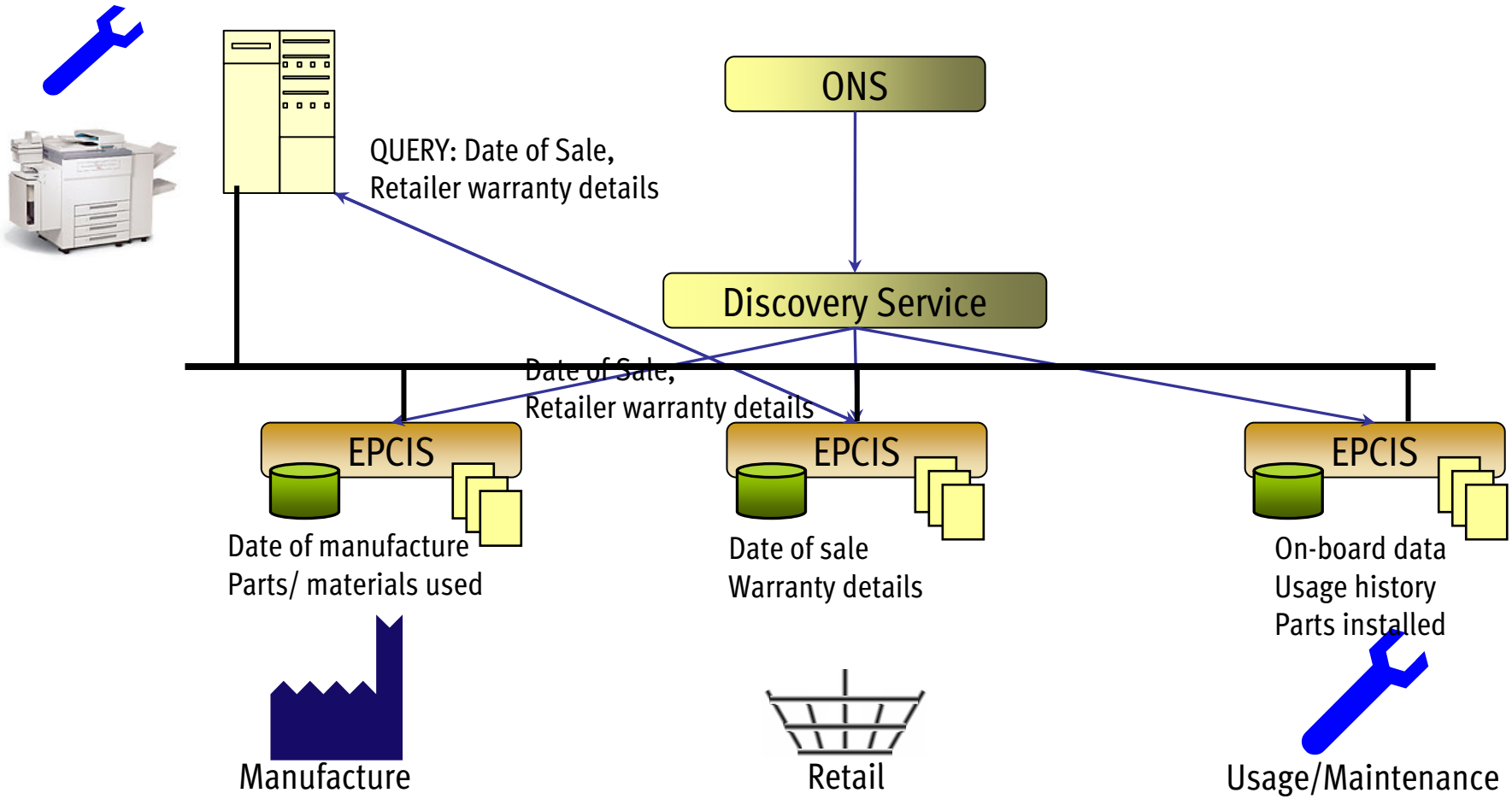
Networked RFID Maintenance Query



Networked RFID Maintenance Query

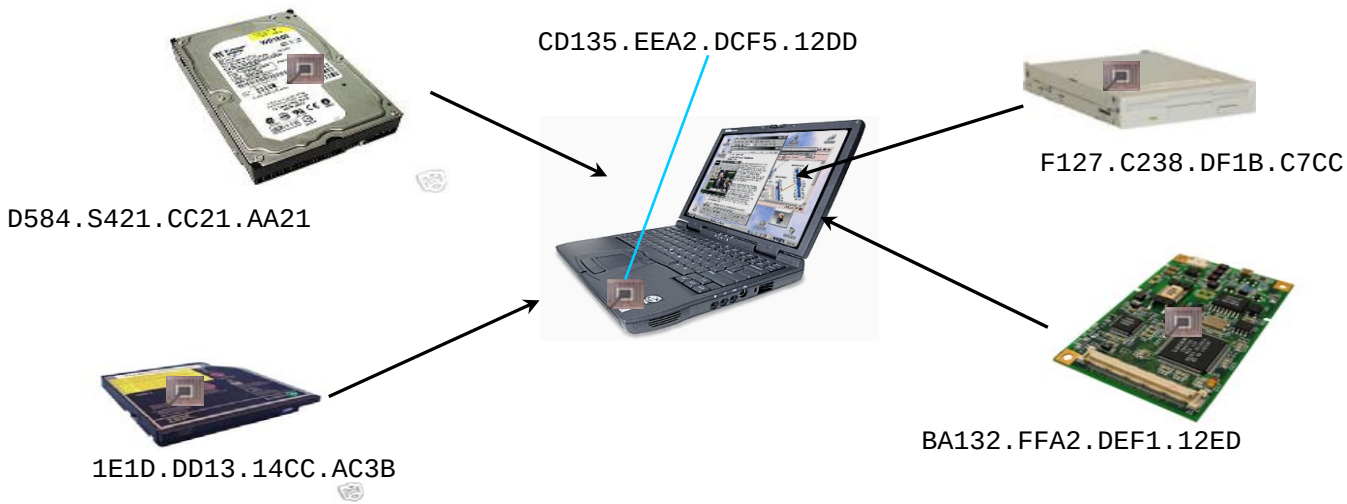


Networked RFID Maintenance Query

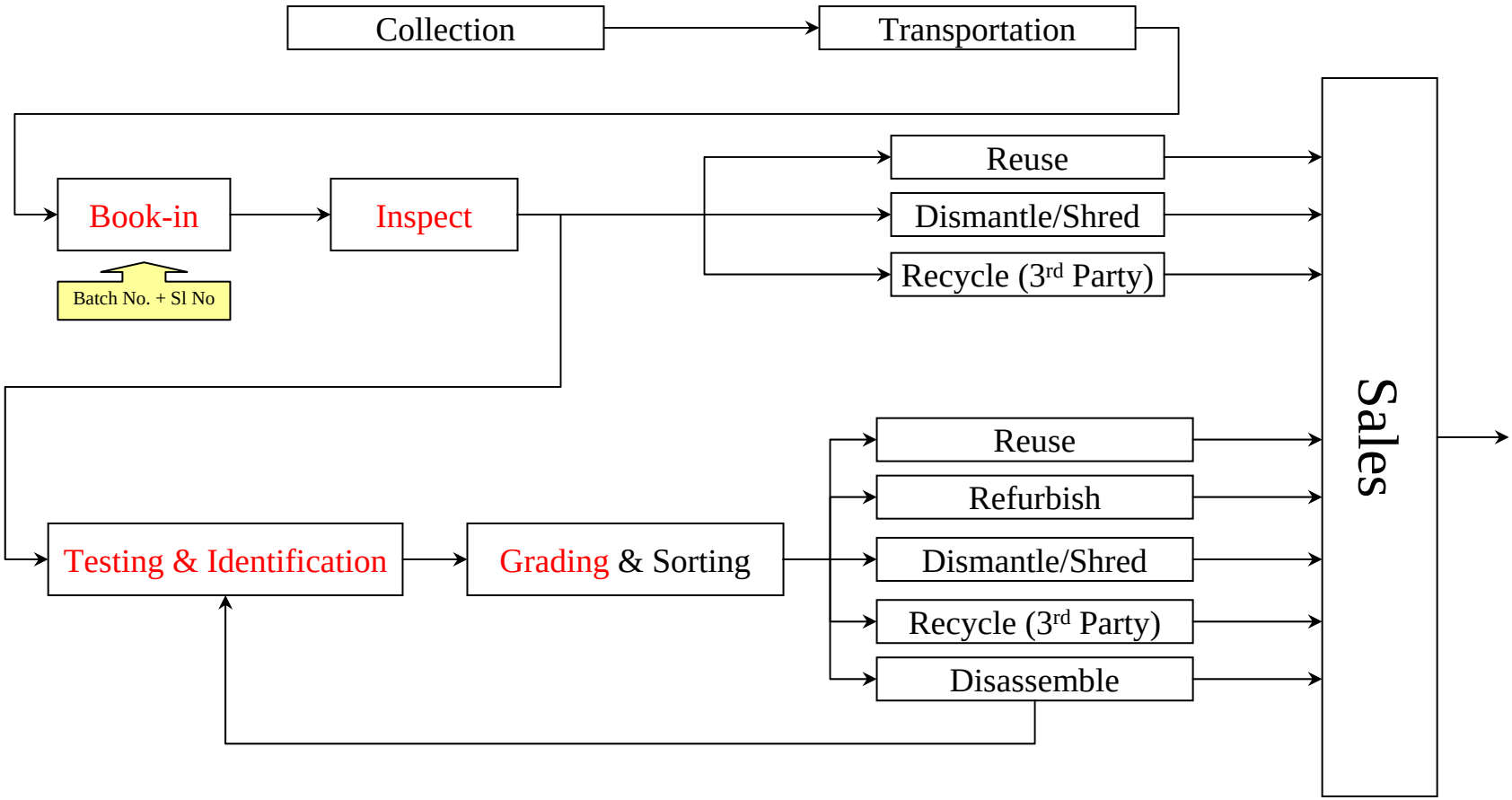


Example 2: Establishing the Impact of Networked RFID in Computer Recycling

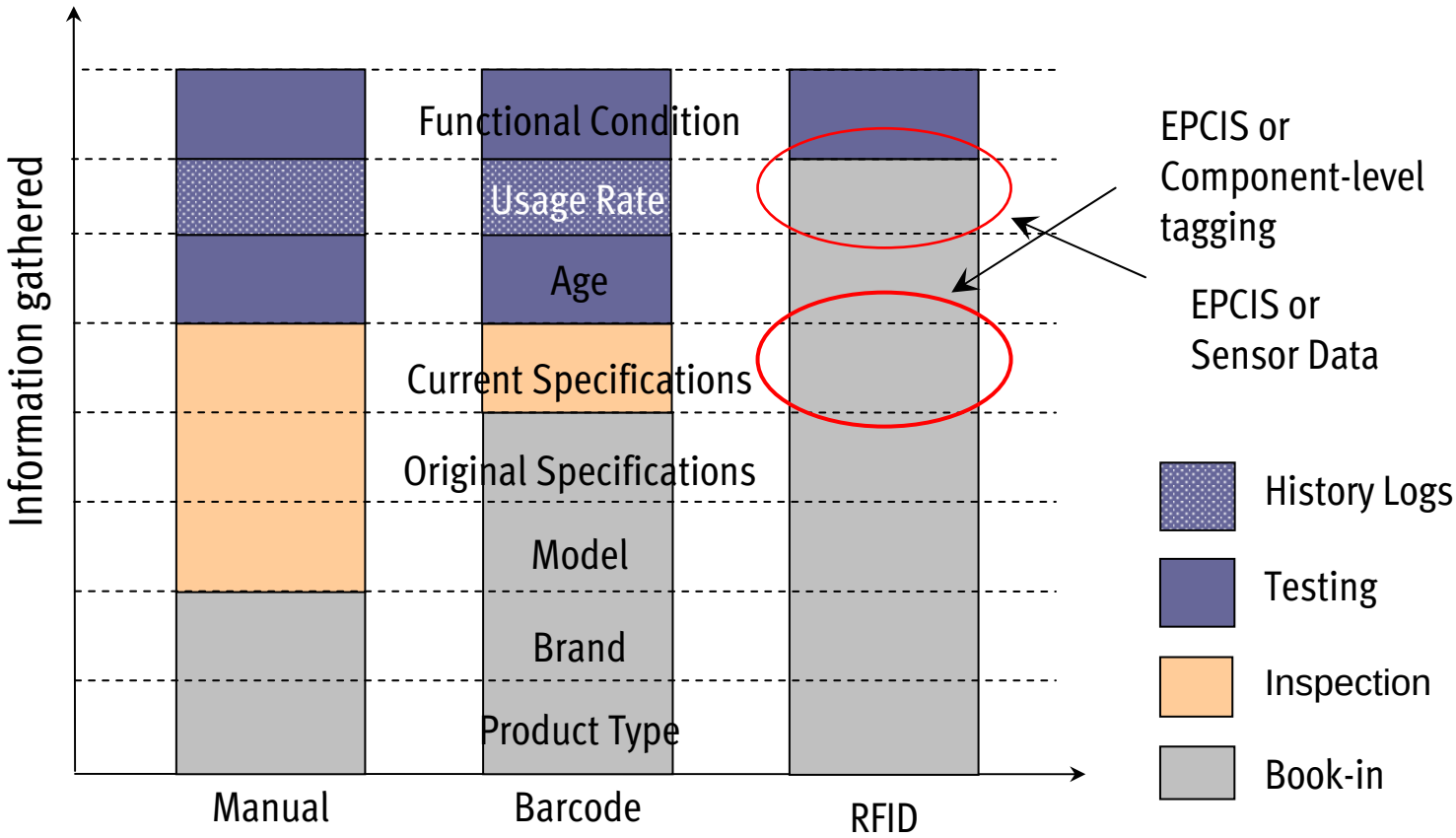
- Part of ongoing study with a number of computer recyclers in UK, France
- Analysis based on assumption that Networked RFID solution is in place
- Product and component level analysis



Product Recovery Operations



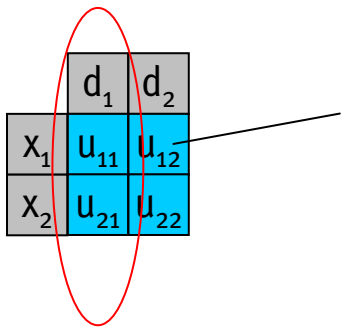
Networked RFID Impact

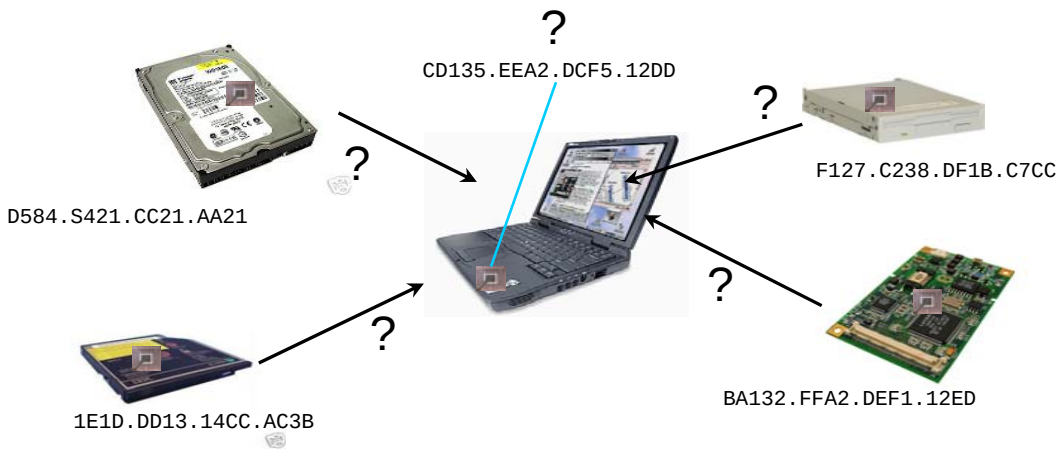


Is there a benefit?

End of Life Decision Effectiveness

Effectiveness or Utility of a decision = f(state)



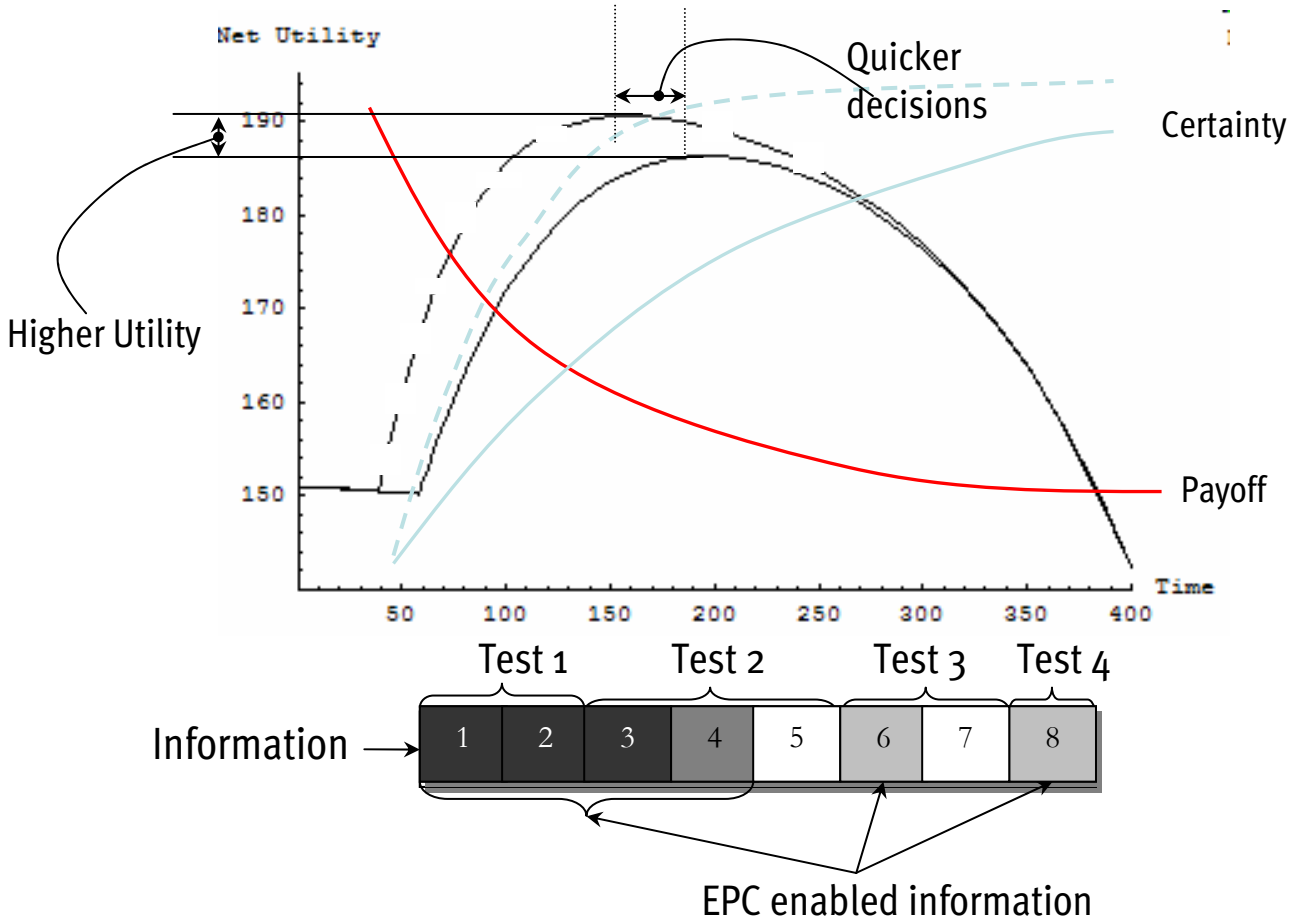


With uncertainty

Expected utility (EU) of the decision outcome.
= f (info of states, payoffs)

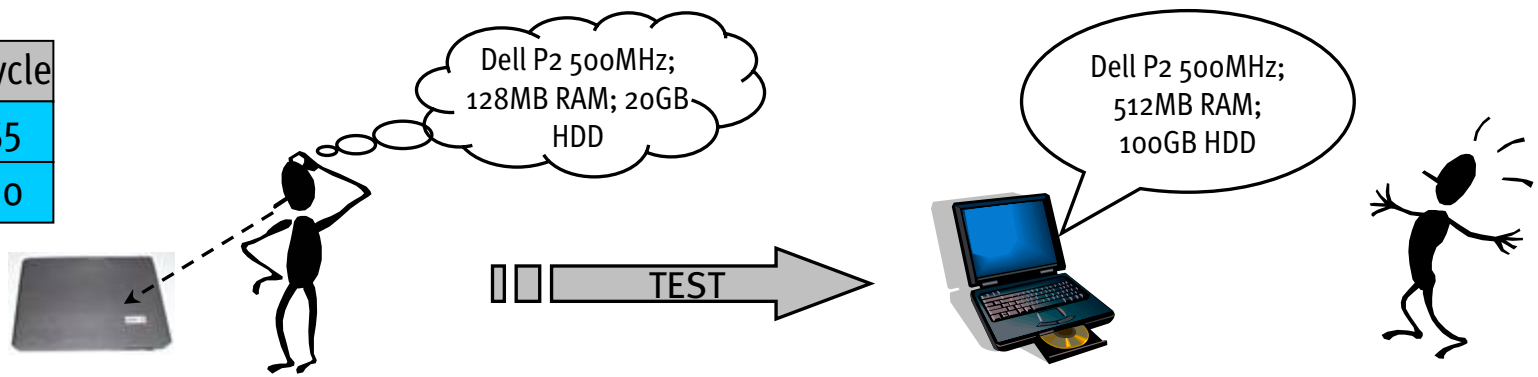
… both vary over time

End of Life Decision Effectiveness



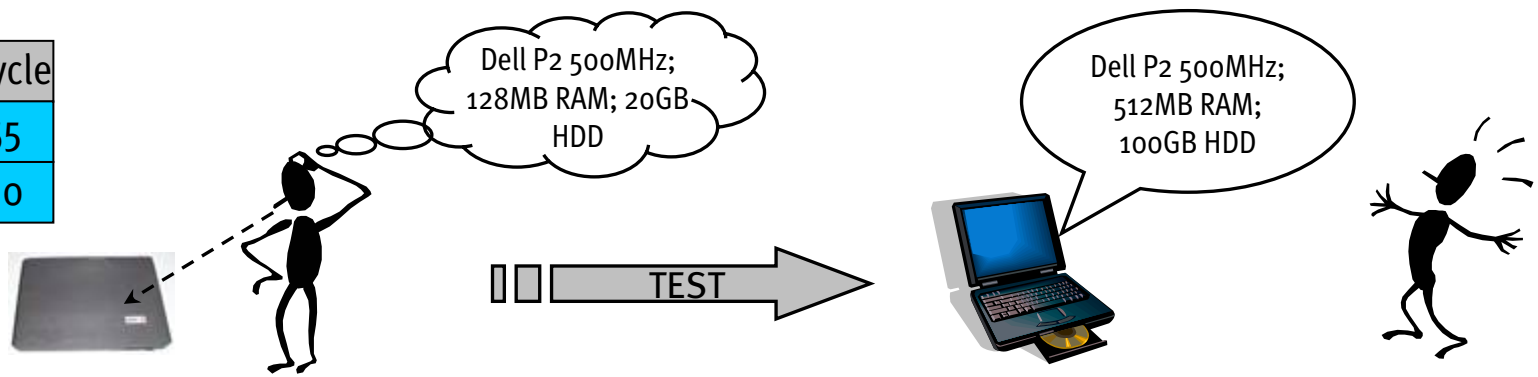
End of Life Decision Effectiveness

	Reuse	Recycle
Good	$300	$55
Bad	-$100	$50



End of Life Decision Effectiveness

	Reuse	Recycle
Good	$300	$55
Bad	-$100	$50



EU (without product information)

$$\max\left[u_{11}\Pr(x_1)+u_{12}\Pr(x_2);u_{21}\Pr(x_1)p+u_{22}\Pr(x_2)\right]$$

=$51.35 (Recycle)

Shifted decision outcome

EU (with product information)

$$\Pr(x_1 \mid i)=\frac{\beta_i \cdot \Pr(x_1)}{\beta_i \cdot \Pr(x_1)+\Pr(x_2)}$$

$$EU_i=\max\left[u_{11}\Pr(x_1 \mid i)+u_{12}\Pr(x_2 \mid i);u_{21}\Pr(x_1 \mid i)+u_{22}\Pr(x_2 \mid i)\right]$$

=$93.45 (Reuse)

Summary

- RFID is simply an automated means for accessing product ID – other approaches also exist
- Product ID coupled to a suitable information service can provide a mechanism for product-oriented information management
- More quantification of information impact on decisions needed
- Enablers for self-managing / intelligent product … "Product Lifestyle Management"

Acknowledgements

- Key Projects
  - *Auto ID Centre* – Global, low cost RFID

    www.autoidlabs.org
  - *Cambridge Innovative Manufacturing Research Centre (UK)* – Value of RFID based Information

    www.ifm.eng.cam.ac.uk/imrc
  - *PROMISE (EU, IMS)* – Product Embedded IS

    www.promise.org
  - Aerospace ID Programme – Aerospace deployment of ID technologies

    www.aeroid.org

- Colleagues at Cambridge, Univ Henri Poincare, St Gallen, Keio, MIT, EPFL, Erasmus