



Research in RFID

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[Yesterday, tomorrow]

- There is a lot of self-satisfaction in this industry
- RFID has been around for 50 years
- The Auto-ID Center is 8 years old

- But the bulk of the innovation lies ahead

History

See “Shrouds of Time *The history of RFID*,” Landt 2001

- 1948: Backscatter (see Landt 2001)
 - Stockman, H. "*Communication by Means of Reflected Power*", Proceedings of the IRE, pp1196-1204, October 1948.
- 1974: Automotive license plates
 - Sterzer, F., "*An electronic license plate for motor vehicles*", RCA Review, 1974, 35, (2) pp 167-175
- 1998: DISC, Auto-ID Center founded at MIT
- 2001: First standards presented
- 2002: Gillette orders 500,000,000 tags from Alien
- 2003: Wal-Mart, DoD Mandates
 - EPCglobal launched, Center retired
- 2004: More mandates
- 2005: First bulk tagging
 - Emergence of Gen 2
 - Multi-site deployments
 - Beginnings of value
- 2006: Next Generation research

[The opportunities]

Technology

- Tags
- Semiconductors
- Packaging
- Protocols
- Antennae
- Readers
- Middleware/Reader
- Middleware
- Databases
- Enterprise architecture
- Distributed systems
- Identity management
- Business process

Applications

- Supply chain
 - Retail
 - Healthcare
 - B2B
 - Critical goods
- Logistics
 - Travel/airports
 - Defense
 - Heavy industries
 - Asset management
- Operations
 - Factory
 - DC/warehouse
 - Institutions
 - Maintenance
- Personal systems....

Analysis

- RF Systems
- Communications
- Security
- System dynamics
 - Supply chain
 - Planning
 - Execution
 - Policy
 - Demand planning
- Social/ethical
- Business planning
- Macroeconomics
- Policy/frequency

[Everything is different with RFID]

- Power is limited
- Cost is an issue
- Bandwidth is limited
- Memory is a premium
- Data is fast but... fallible
- Tag connectivity is sporadic
- The range of applications is large
- The range of related technologies is huge

[The opportunities]

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[Protocols]

- Physical layer
 - Traditional
 - LF, HF and UHF (different data rates, asymmetries)
 - UWB
- Logical layer
 - Interference avoidance
 - Tag sessions
 - In-band reader coordination
 - Security
 - Data types
 - Sensors
 - Ad hoc networking

[Security]

- Reader-tag security
- MW-reader security
- MW-application security
- Inter-corporation security
 - ONS anonymity
 - Securing corporate EPC-IS communication

[Reader-tag communication]

Technical	Business	Impact
■ Authenticating the tag	■ Counterfeit detection	■ Brand/criminal investigation
■ Authenticating the reader	■ Privacy	■ Social
■ Preventing eavesdropping	■ Privacy/business security	■ Social/Business espionage
■ Preventing tracking	■ Privacy/security	■ Social
■ “Personalizable”	■ Consumer	■ Consumer rights

[This is difficult!! Let's brainstorm...]

Protect privacy:

- ☹️ Encrypt the number on the tag?
 - ☹️ Doesn't prevent tracking
- ☹️ Delete serial number on the tag?
 - ☹️ Doesn't prevent tracking
- ☹️ Insist tag authenticates reader
 - ☹️ Every tag knows every reader? Key management.
- ☹️ Keep changing number
 - 😊 All numbers point to on EPC
 - ☹️ Computational challenge for readers

Prevent counterfeits:

- ☹️ Traditional encryption
 - ☹️ Expensive
- ☹️ Challenge-response
 - ☹️ Secret must be provisioned to readers

Prevent eavesdropping:

- ☹️ Encrypt reader-tag coms
 - ☹️ Too expensive
- ☹️ Put key info on weak reverse channel
 - 😊 Works OK

[The opportunities]

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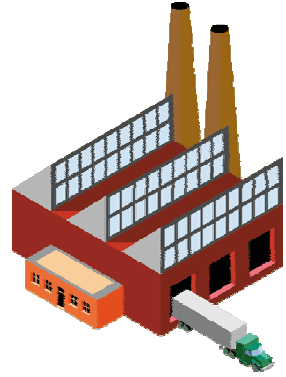
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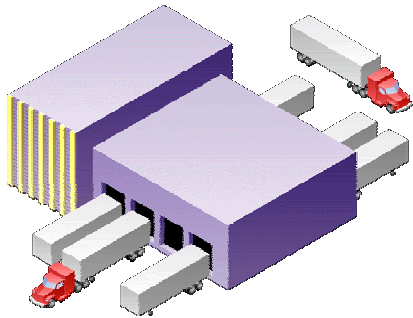
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The goods transfer process

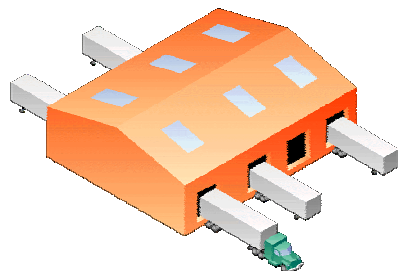
Manufacturing plant



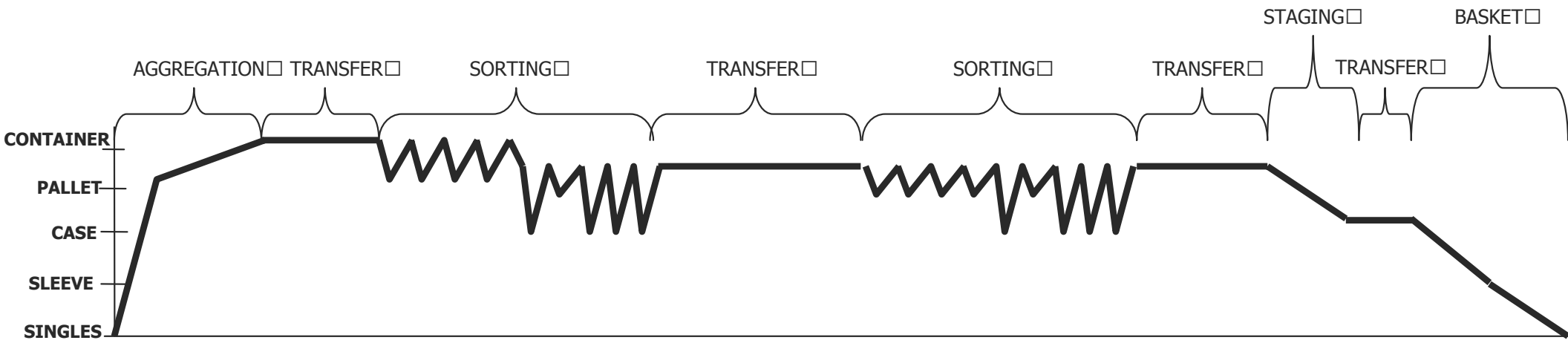
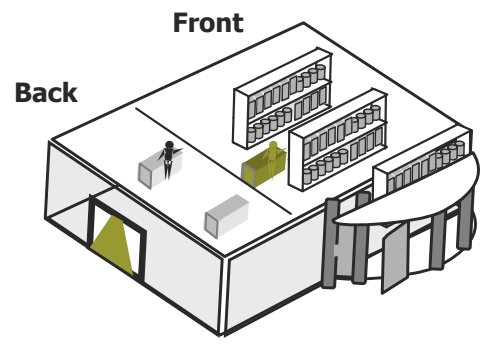
Manufacturer's DC



Retailer's DC



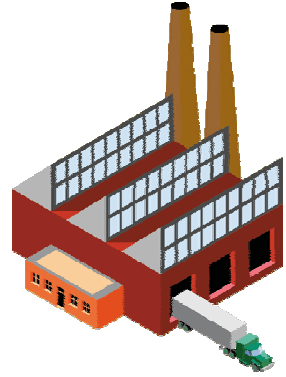
Retailer



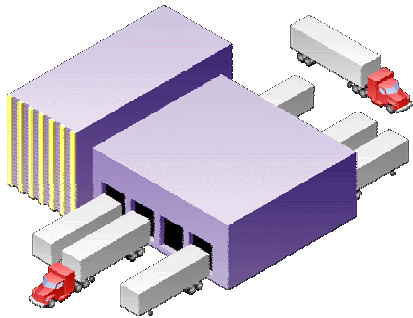
Themes: **timely transfer**
error-proof operations
minimize shrinkage

What really happens

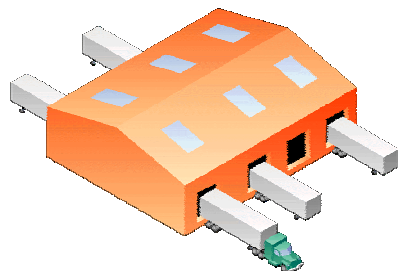
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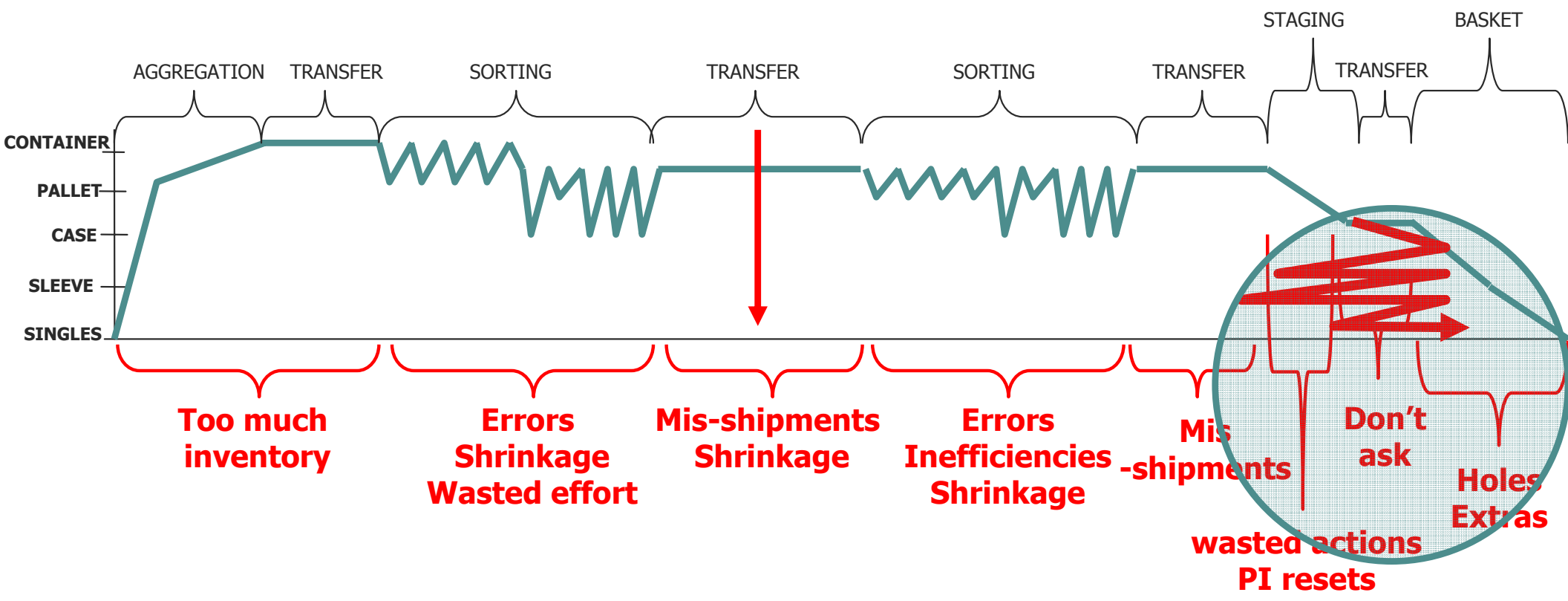
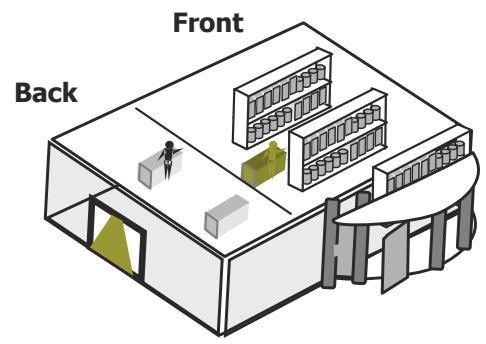
Manufacturer's DC



Retailer's DC



Retailer



[The Opportunities in retail]

	<u>DC</u>	<u>DC-BR</u>	<u>BR</u>	<u>BR-SF</u>	<u>SF</u>	<u>Storage</u>
Time	<ul style="list-style-type: none"> • Dwell time • Code date 	<ul style="list-style-type: none"> • Timeliness 	<ul style="list-style-type: none"> • Dwell time • Code date 	<ul style="list-style-type: none"> • Code date (<i>seasonals, expiry date, promotions</i>) 	<ul style="list-style-type: none"> • Customer experience 	<ul style="list-style-type: none"> • Dwell time • Code date
Quantity (Inventory)	<ul style="list-style-type: none"> • Automatic Receiving • Location • Replenishment 	<ul style="list-style-type: none"> • Shrinkage 	<ul style="list-style-type: none"> • Assumed Receipt • DSD • Location • Replenishment 	<ul style="list-style-type: none"> • In-flow measurement • Shrinkage 	<ul style="list-style-type: none"> • Automatic replenishment 	<ul style="list-style-type: none"> • Location
Configuration	<ul style="list-style-type: none"> • Code/rule compliance (<i>food+chemicals, firearms, etc.</i>) 	<ul style="list-style-type: none"> • Code/rule compliance 	<ul style="list-style-type: none"> • Code/rule compliance 	<ul style="list-style-type: none"> • Display/collateral 	<ul style="list-style-type: none"> • Ensemble availability 	
	Reusable assets					
Regulation	Pedigree Code Date/Age				<ul style="list-style-type: none"> • Age check 	
Sensors	Temperature/freshness					
	Shock					

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Opportunities in pharma

- Supply Chain
 - Error-proofing
 - Out-of-stock
 - Automatic replenishment
 - Store-to-store transfers
 - Overstock
 - FEFO
 - Expiry
 - Automatic replenishment
 - Cold chain
 - Recalls
- Brand/quality protection
 - Counterfeit detection
 - Track and trace
 - On-the-spot authentication
 - Parallel trade
- Claims management
 - Receipt management
 - Contractual pricing
- Returns management
 - Expiry management
 - Reverse logistics
- In the Hospital
 - Automatic replenishment
 - Error-proofing
 - Consignment selling
- In the Home
 - Telemedicine
 - Home compliance/grey care
 - Recalls
- In the Lab
 - Assay tracking
 - Clinical trials
- In Europe
 - Insurance fraud
 - Parallel trade
- Medical equipment
 - Compatibility

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[What is a supply chain plan?]

- A sequence of actions (and some control policies) related to material movement
 - Move this amount of inventory
 - At this time
 - To these locations
- Supply chain plans updated weekly
- Hope everything works out

Does it?

No

Evidence points to poor execution

■ Inventory Management:

- **Inventory uncertainty:**
 - 65 % of 370,000 records inaccurate (Raman *et. al.*)
 - Transportation uncertainty: Perfect delivery is dismal
- **Stock-outs:**
 - Average 9% out of stock in retailers world-wide
 - Lost sales due to stock-outs: 4% (*Gruen. et. al.*)
- **Overstock: Huge channel inventories**
 - CPG average 11 weeks inventory
 - Retailers average 7 weeks inventory
 - Locked up capital, industry-wide (Industry studies.)
- **Expiry**
 - Drug FIFO's
 - Recalls

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What is the future of the supply chain?

- Will retailers spin-out their supply chains?
 - All Direct Store Delivery?
 - Pay-per-scan?
- Will 3PL's rule? Will UPS take over? Will it be all small shipments?
- Will off-shoring end?
 - Zara-like local manufacturing
 - Shipping from Asia an economic disadvantage
 - Delayed commitment

[The opportunities ...are vast]

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[Conclusions]

- Tweaks, evolution, transformation
- The academic world has the opportunity to guide the evolution and the transformation