Auto-ID Field Test

Lessons Learned in the Real World

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Field Test

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Lessons Learned in the Real World

- What the Auto-ID Center Field Trials have taught us about deployment challenges

Auto-ID Center Field Test

- In March 2001 a team comprised of Auto-ID Center sponsors (technology & end users) was assembled to plan and implement a Field Test aimed at taking the Auto-ID EPC technology from the laboratory to the real world environment with the objective of proving the power and effectiveness of the EPC and to blaze a trail for future adoption

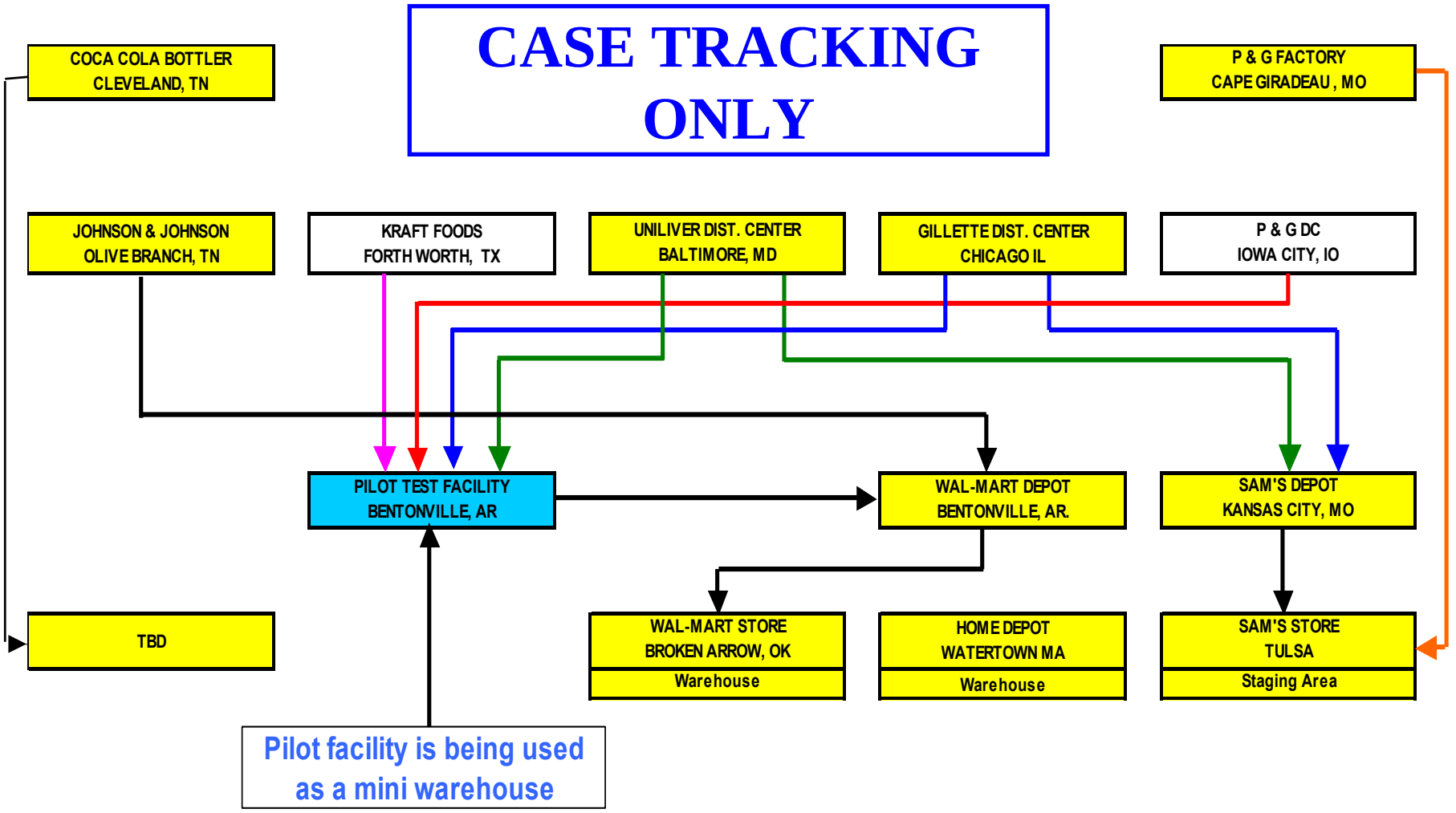
Three Phase Field Test

- PHASE I - PALLET TRACKING Using existing technology
  Evaluate effectiveness of the Auto-ID ONS and Savant development
- PHASE II - CASE TRACKING Using existing technology
  Implement and test aggregation
  Add additional technologies to stress the system.
  Read as many tags as possible
- PHASE III - UNIT TRACKING Using Auto-ID compliant technology
  Implement and evaluate low cost technology
  Develop practical applications to prove *ePC* capability

Field Test Accomplishments

- When implemented correctly, software supports Auto-ID EPC vision of INTRA- organization asset tracking and information sharing across the supply chain
- First generation Auto-ID low cost RFID hardware met requirements for use at the case and pallet in the supply chain

Phase II deployment



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Field Test Tracking

	Manufacturer		Retailer		
DATE	Pallet Aggregation	Door	IN Door	Portals 1& 2	Crusher
10-Nov	98 cases 100%				
16-Nov	117 cases 100%				
17-Nov		Yes			
20-Jan	52 cases 100%	Yes 11:00am			
23-Jan			1 case 11:45am		
24-Jan				1 full case 12:32am 1 empty case 7:25am	1 empty case 8:30am
26-Jan	120 cases 100%				
27-Jan		Yes 12:34am			
30-Jan			4 cases 7:00pm	4 cases 10:00pm	
31-Jan				1 empty case 3:00am 2 empty case 5:00am 1 empty case 7:51am	Crusher Broken
2-Feb	135 cases 97%				
3-Feb		Yes 4:00pm			
6-Feb			2 cases 5:50pm	2 cases 6:00pm	
7-Feb				1empty case 2:50am 1 empty case 7:00am	Crusher Broken

Lessons Learned in the Real World

- Aggregation
- RFID Tags
- Readers/Antennas
- Type of Installation
- Interference
- Feed back loop
- Software

Lessons Learned in the Real World

- AGGREGATION
  - Today's RFID technology does not allow for 100% read and identification of all products at all times within the supply chain
  - Physical properties of objects affect RFID read capability
  - 100% product identification is guaranteed by aggregation
  - Aggregation is the association of multiple tagged items to a single grouping
  - Readability of ANY ONE of the associated tags in the grouping will identify the whole grouping

Lessons Learned in the Real World
Aggregation

1

Pallet has individual tag and EPC Number

Lessons Learned in the Real World Aggregation

1

Pallet has individual tag and EPC Number

2

Cases have individual tags with individually unique EPC # that are aggregated to pallet tag

Lessons Learned in the Real World
Aggregation

1

Pallet has individual tag and EPC Number

3

When one or several of the tags are read, by aggregation the whole pallet is identified

2

Cases have individual tags with individually unique EPC # that are aggregated to pallet tag

Lessons Learned in the Real World

- RFID TAGS

There are instances were generic tags may be acceptable for multiple applications, but learning in the Field Test showed that for best read performance tag design is specific to the application

Tag design is application specific

Lessons Learned in the Real World RFID Tags

- Frequency

What reading distance is required and in what environment?

Lessons Learned in the Real World RFID Tags

- Frequency

915MHz	Preferred for longer distance reads
	Acceptable for door and conveyor installations
	Good for case and pallet application
13.56MHz	Preferred for shorter distance reads
	Best suited for unit and shelf reads

Lessons Learned in the Real World RFID Tags

- Frequency
- Functionality

Class 0 tag	Read only and it's programmed at manufacturer
Class 1 tag	WORM (Write Once Read Many). Programmed at the fabrication or at manufacturer during application

Lessons Learned in the Real World RFID Tags

- Frequency
- Functionality
- **Tag Antenna Type**

  Tag antenna design may need to be customized to fit specific applications

  Product limitation such as:

  - Physical size,
  - Packaging materials,
  - Product composition (liquid, metal, powder etc.)
  - Location on package (inside/ outside)

  All of the above will affect tag readability

Lessons Learned in the Real World RFID Tags

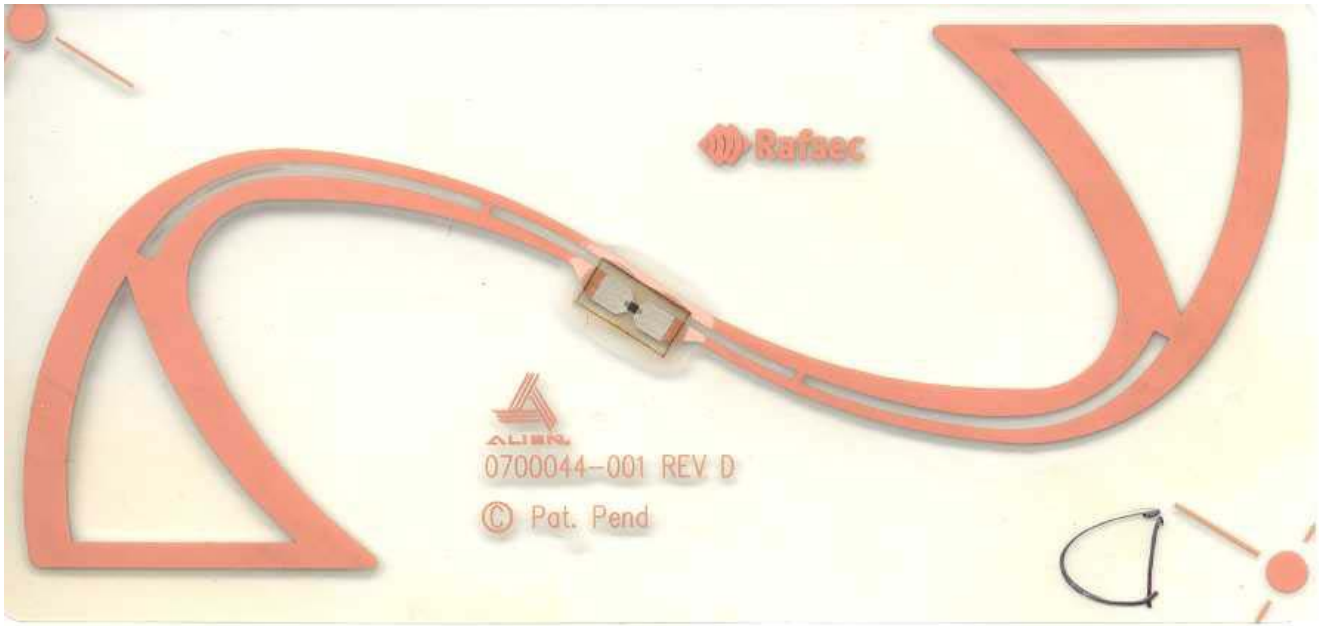
- Frequency
- Functionality
- Tag antenna type
- Cost versus performance

Tags can be manufactured with increase capability and functions.

(Read/write memory, temperature telemetry and profiling)

Specific application requirements need to be evaluated versus cost restrictions

Alien/Rafsec "S" Tag

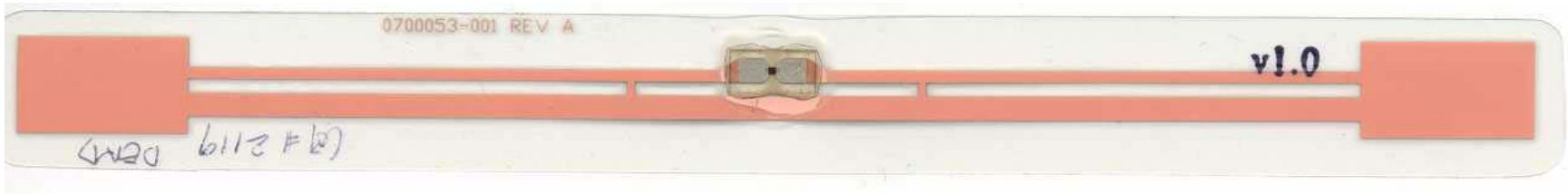


4.5 inches

Used on:

Cases, Dog Food, Coffee Cans

Alien/Rafsec "I" Tag

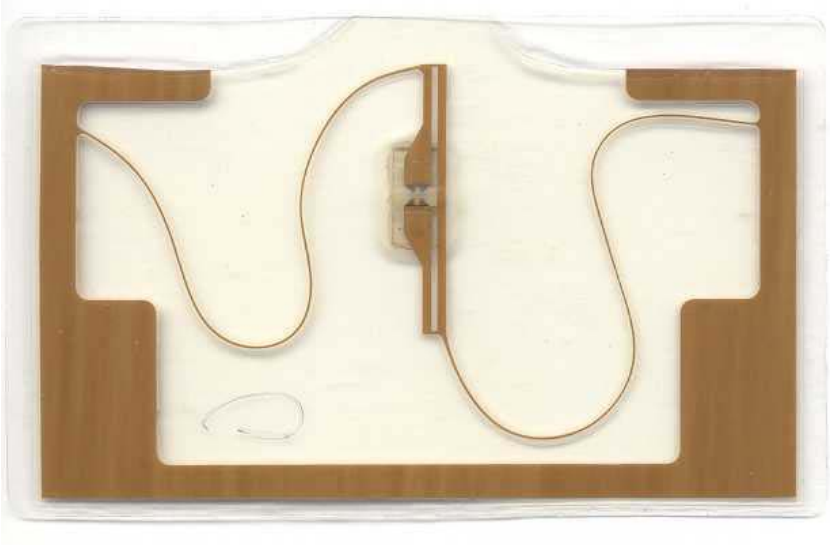


6.0 inches

Used on:

Cases, Shampoo Bottle, Aerosol Cans

Alien/Rafsec "C" Tag

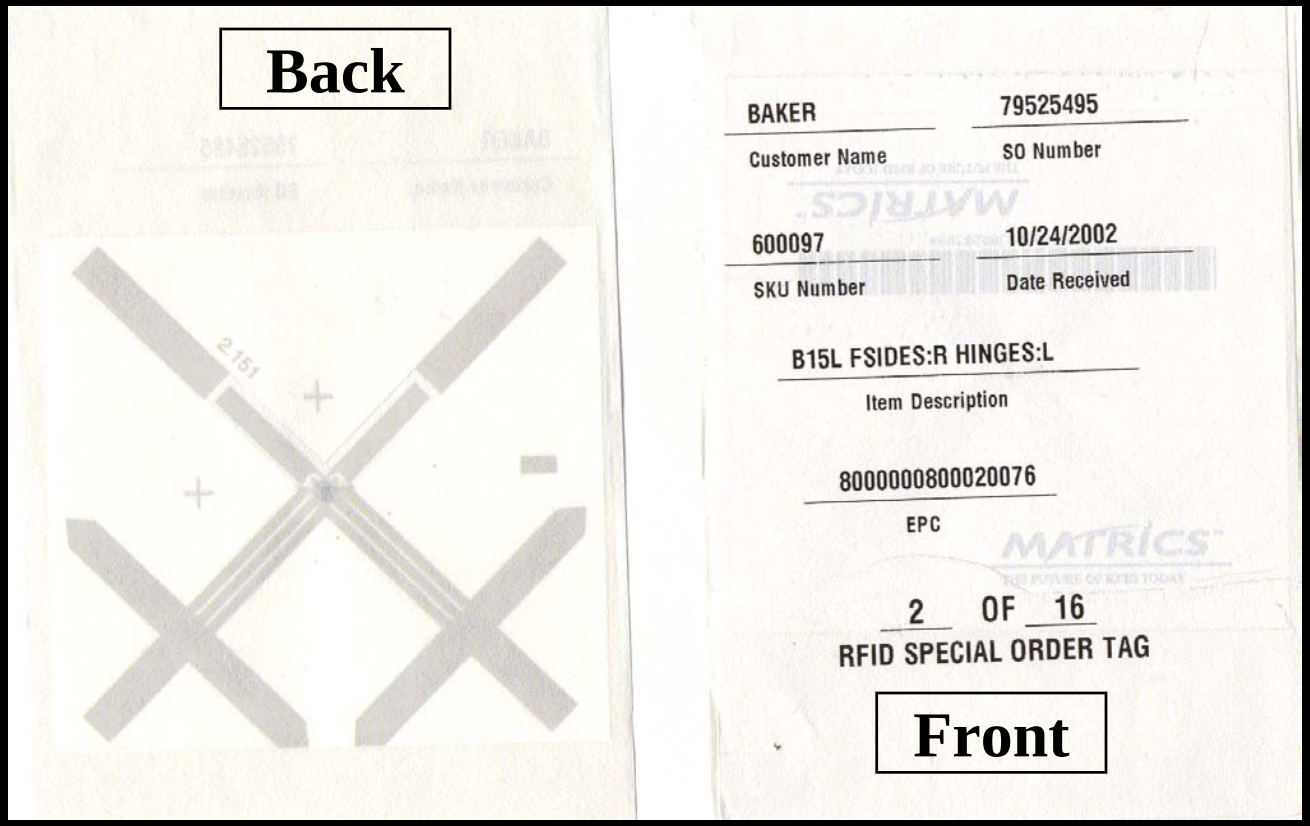


6.0 inches

Used on:

Bar Soap, Paper Products

Matrics RFID tag/Printed Label Combination



Used in combination with the need for a printed label

Lessons Learned in the Real World RFID Tags

- Frequency
- Functionality
- Tag antenna type
- Cost versus performance
- **Tag application**

Read capability objective will determine tag placement (100% actual reads versus aggregations reads)

Product limitation such as:

Physical size

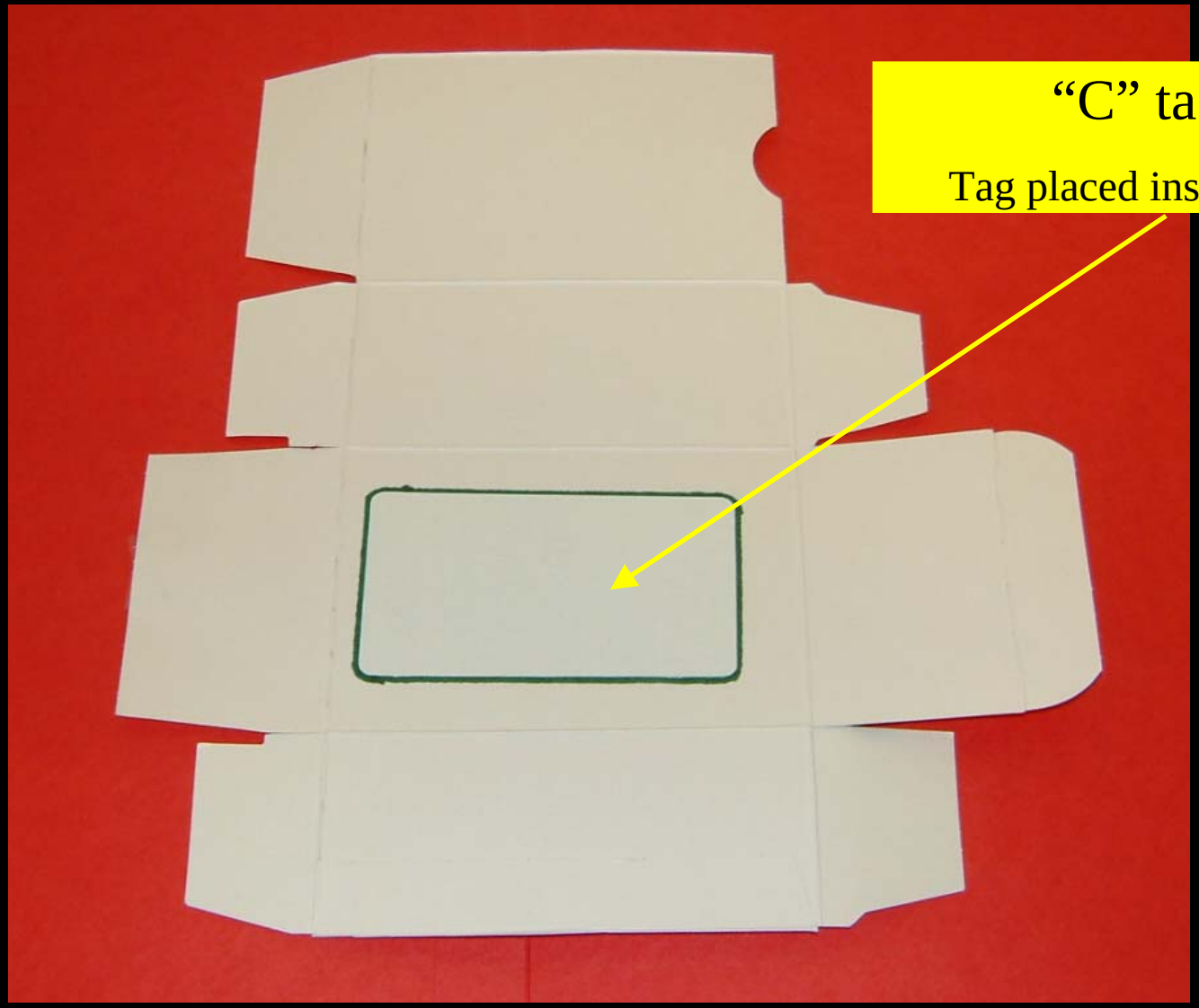
Packaging materials

Product composition (liquid, metal, powder etc.)

Location on package (inside/ outside)

The above factors will contribute to tag locations

Lessons Learned in the Real World RFID Tags



Lessons Learned in the Real World RFID Tags

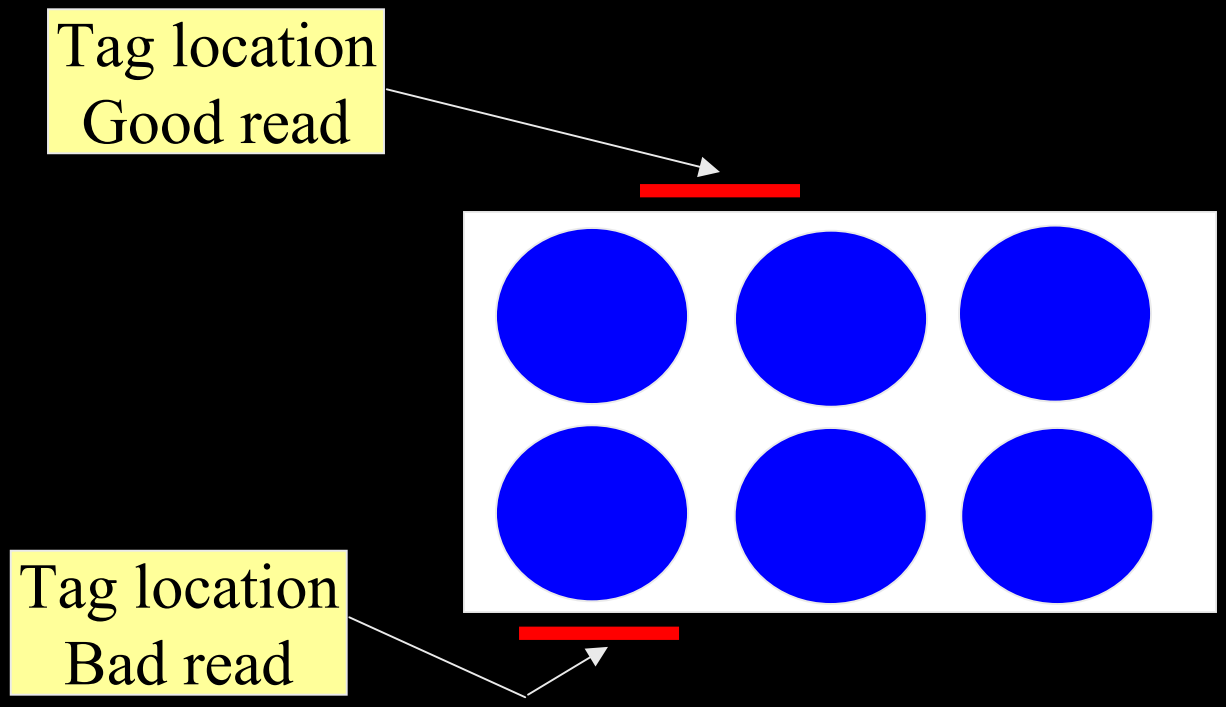
Lessons Learned in the Real World
RFID Tags

"S" tag

Tag placed in between layers of paper

Lessons Learned in the Real World RFID Tags

- Coffee (2 lb cans)



Lessons Learned in the Real World
RFID Tags

I tags specifically located for the capability of 100% case read

Lessons Learned in the Real World

- READERS AND ANTENNAS
  - Antennas must be certified with readers
  - Antenna types are:

Circular: Orientation independent

Good for: random tag orientation or uncontrolled environment

Linear: Orientation dependent. Often higher performance

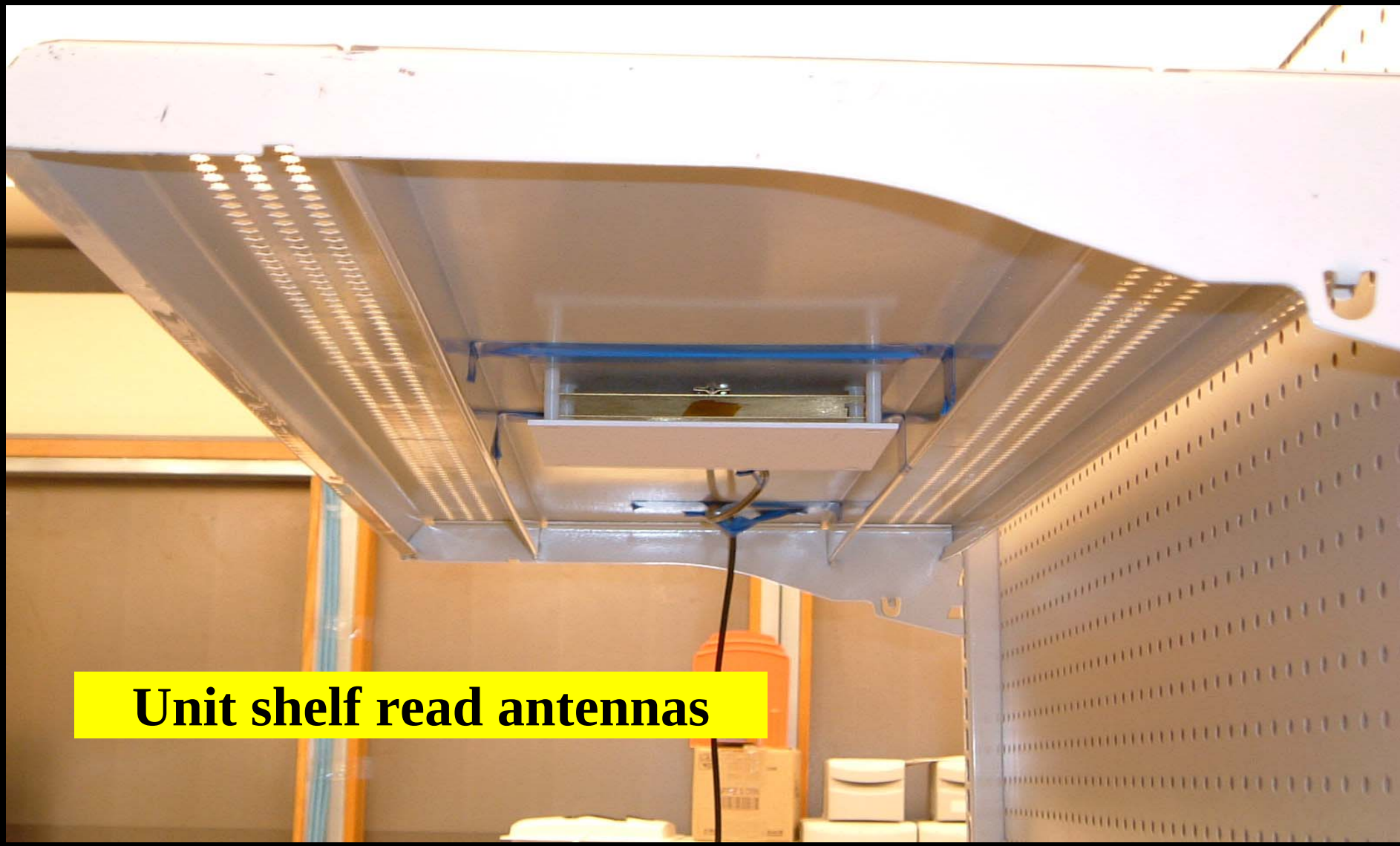
Good for controlled environments

Custom: Designed for specific applications

  - Multiplexing of antennas to readers for simplicity of installation is beneficial

Lessons Learned in the Real World
Readers/Antennas

Lessons Learned in the Real World
Readers/Antennas



Lessons Learned in the Real World

- TYPE OF INSTALLATION
  - Portals (doors) (Pallet/case ID by aggregation)
  - Conveyor (100% case ID)
  - Table top (100% case ID)
  - Fork Lift Truck (Pallet/case ID by aggregation)
    De-aggregation/Re-aggregation
  - Rack/Pallet space (Pallet/case ID by aggregation
  - 100% case read tunnels (verification)

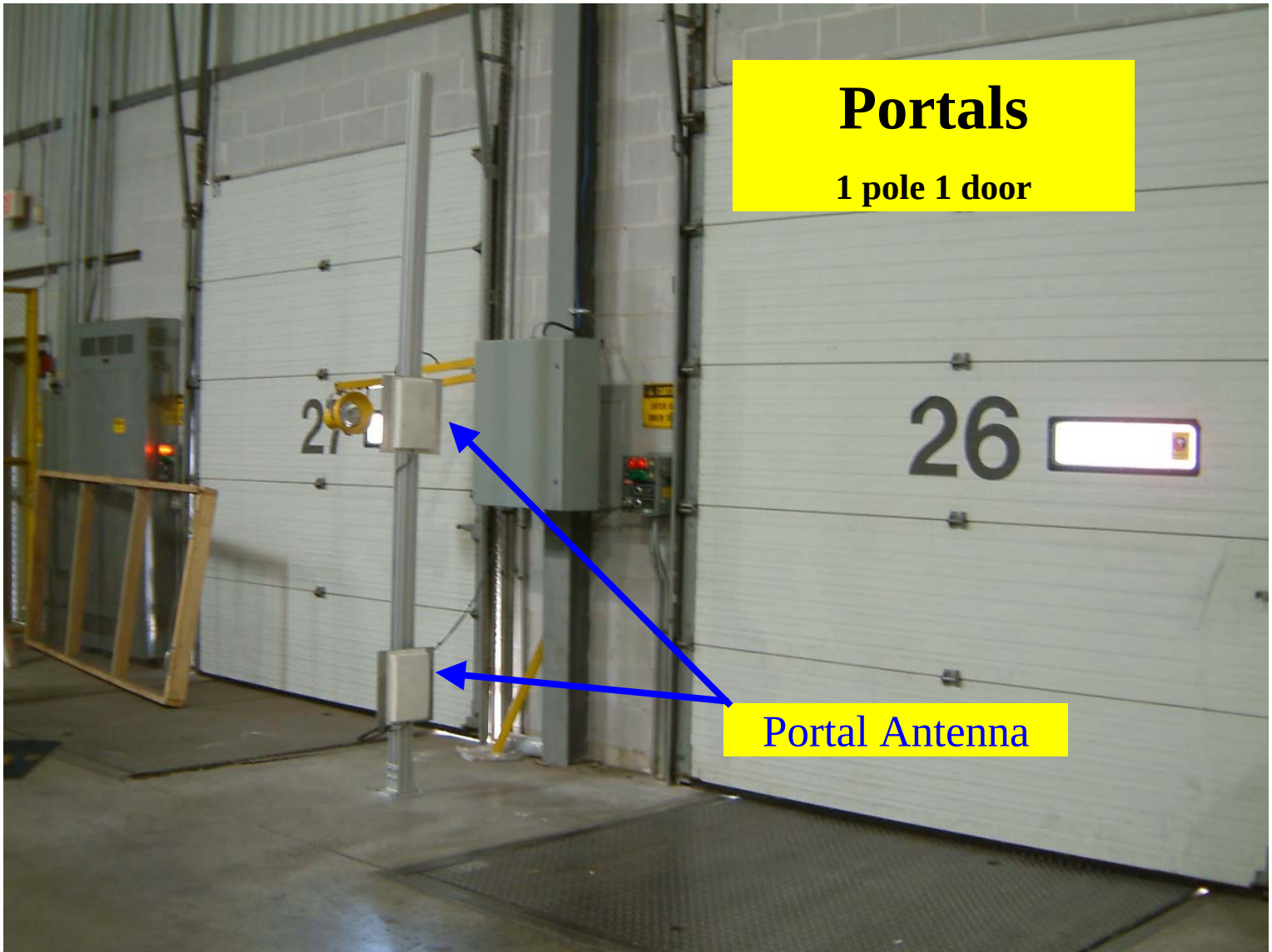
Lessons Learned in the Real World
Type of Installation

- PORTALS/DOORS

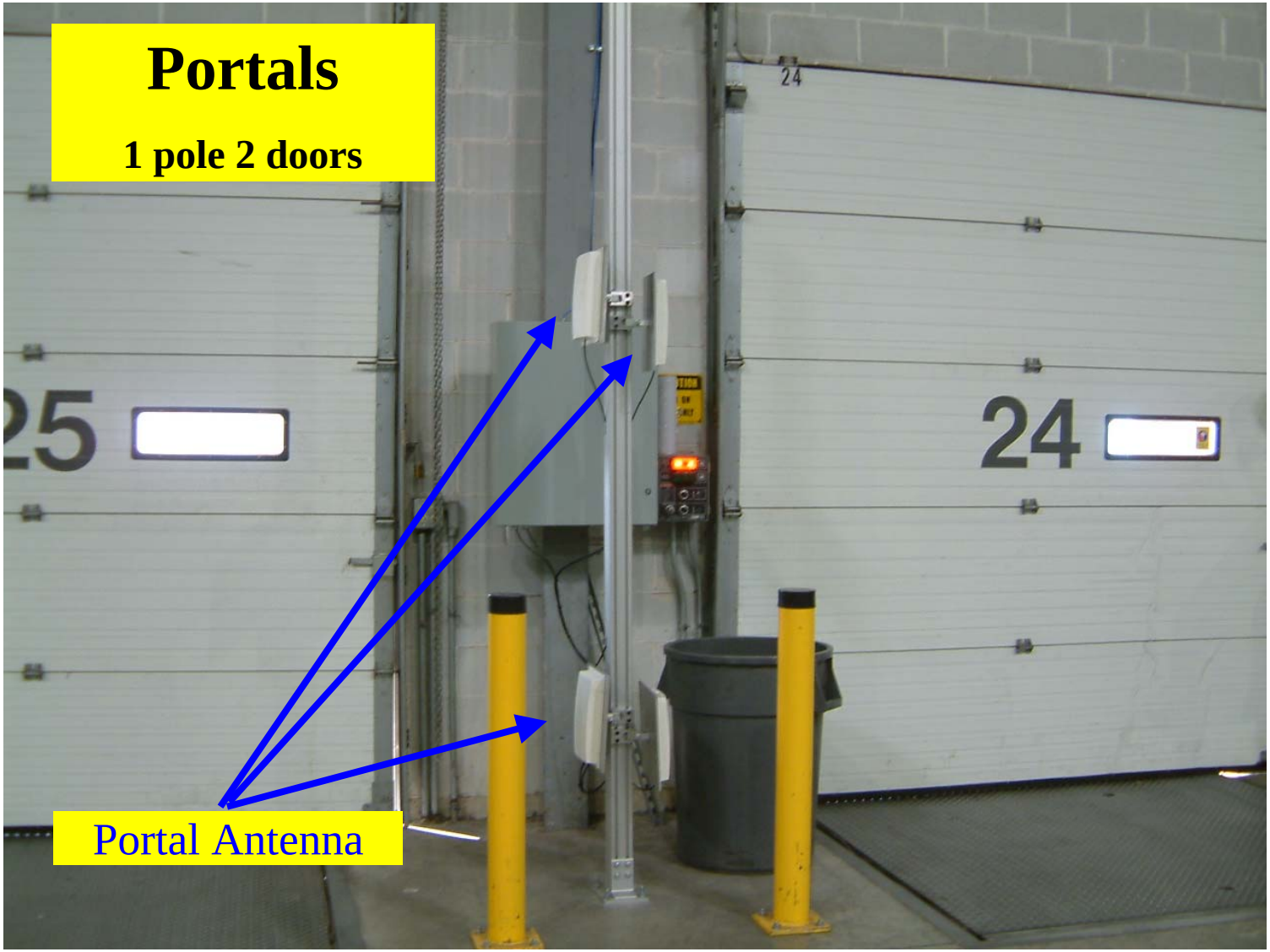
  Considerations include:

  - Typically not able to read 100% of cases on pallet.
  - Pallet identification only through aggregation
  - Size of door (width)
  - Pallet movement and truck loading patterns
  - Physical robustness
  - Wiring configuration (multiplexing readers/antennas)

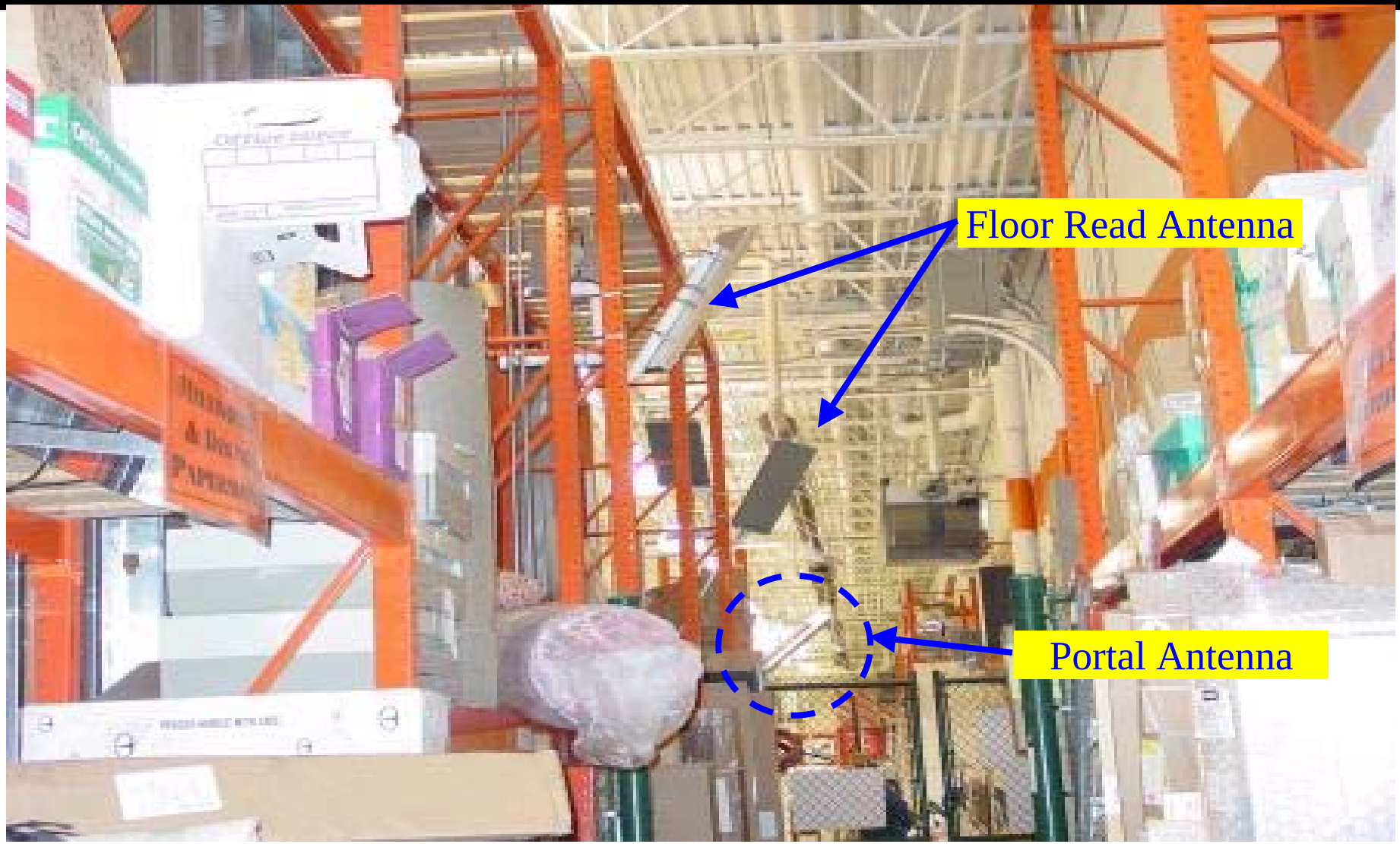
Lessons Learned in the Real World
Type of Installation



Lessons Learned in the Real World
Type of Installation



Lessons Learned in the Real World
Type of Installation



Lessons Learned in the Real World
Type of Installation

- CONVEYOR
  - Considerations include:
    - Capable of writing and reading 100% of all cases
    - Speed and separation of moving cases
    - Electrical noise

Lessons Learned in the Real World
Type of Installation

Lessons Learned in the Real World
Type of Installation

Lessons Learned in the Real World
Type of Installation

Lessons Learned in the Real World
Type of Installation

- TABLE TOP
  - Considerations include:
    - Useful for test environment
    - Requires manual handling

Lessons Learned in the Real World
Type of Installation

Lessons Learned in the Real World
Type of Installation

- FORK LIFT TRUCKS
  - Considerations include:
    - Needs wireless application
    - Several type of trucks
    - Need on board power source
    - Truck needs to be able to de-aggregate and re-aggregate
    - Robustness of antenna and readers installation

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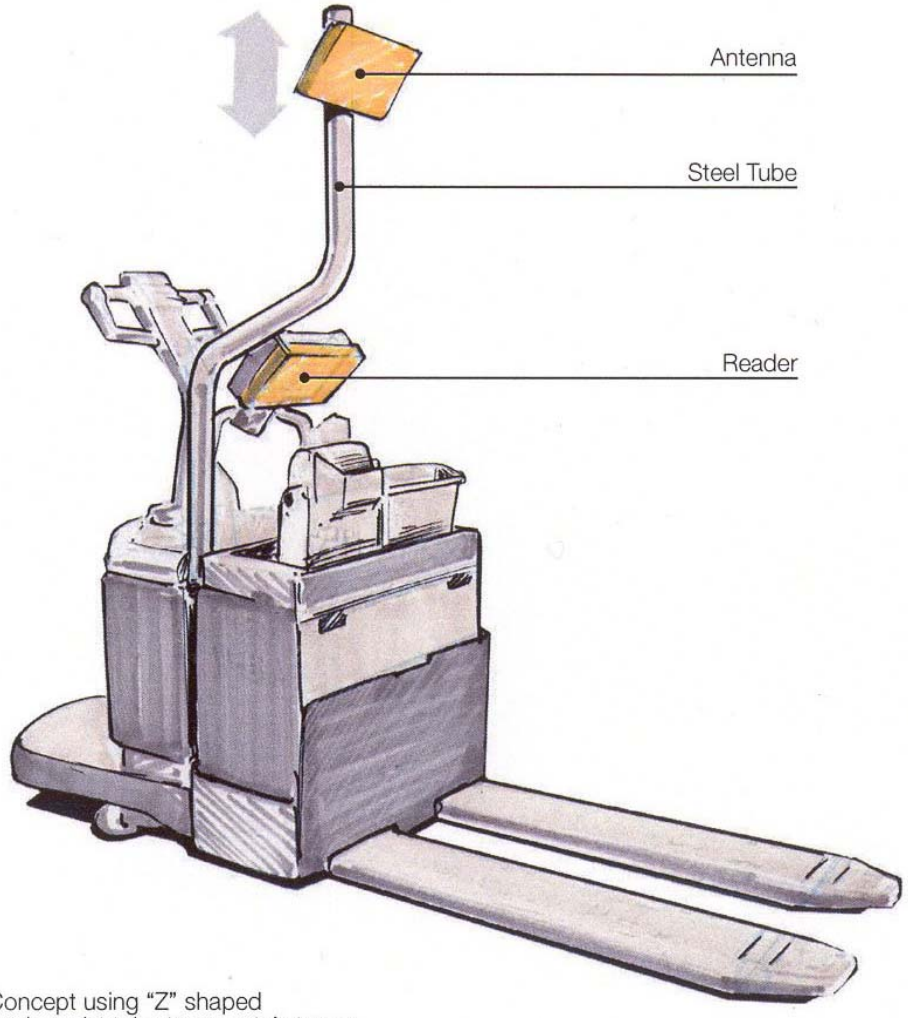
Lessons Learned in the Real World
Type of Installation

Lessons Learned in the Real World
Type of Installation

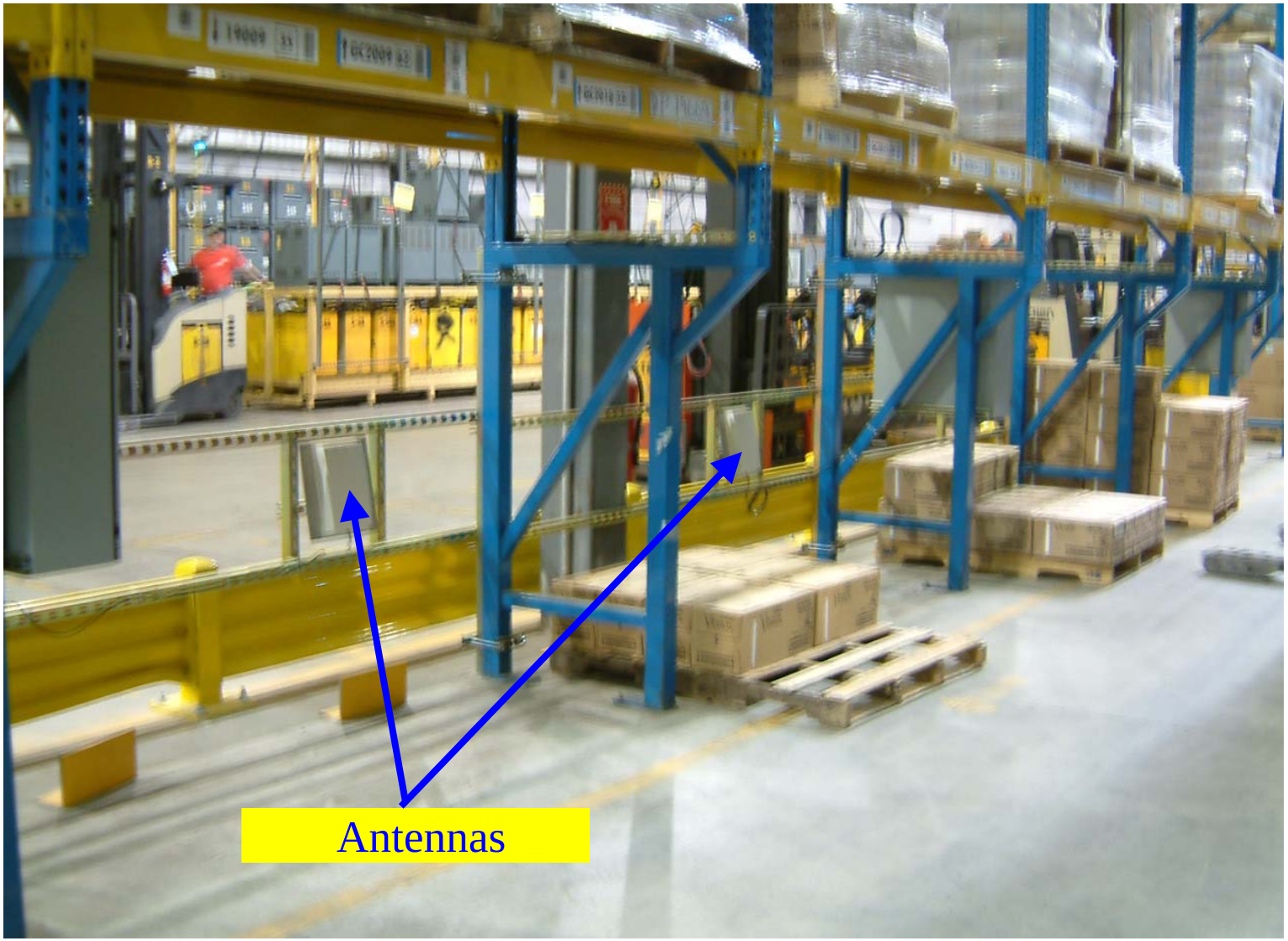


Concept using "Z" shaped work-assist tube to mount Antenna overhead

Lessons Learned in the Real World
Type of Installation

- RACK/PALLET SPACE
  - Considerations include:
    - Power and communication requirements
    - Antenna placement
    - Robustness

Lessons Learned in the Real World
Type of Installation



Lessons Learned in the Real World
Type of Installation

- 100% CASE READ TUNNEL Verification

  Considerations include:

  - Location of tunnel in relation to manufacturing process
  - Mixed pallet configuration
  - Physical size and robustness

Lessons Learned in the Real World
Type of Installation

Lessons Learned in the Real World
Type of Installation

Lessons Learned in the Real World

- INTERFERENCE

  When installing a new RFID system in and environment that already has an RF system in use at the same frequency, the only way to guarantee no interference is to:

  Shut one system off

  Change the frequency of one of the systems.

  If both systems are in play the best that can be done is to try and minimize interference

Lessons Learned in the Real World
Interference

Best one can do is minimize interference

Time Share

On and off

Best for non moving objects

May cause miss reads

Lessons Learned in the Real World Interference

Best one can do is minimize interference

Spilt Band

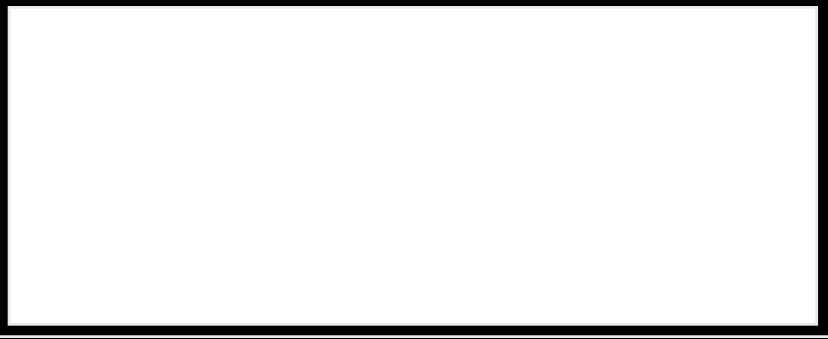
Legal if power band below one Watt

Good for shelf applications

Sacrifice range

Lessons Learned in the Real World Interference

Best one can do is minimize interference



On Demand

Antenna type and location

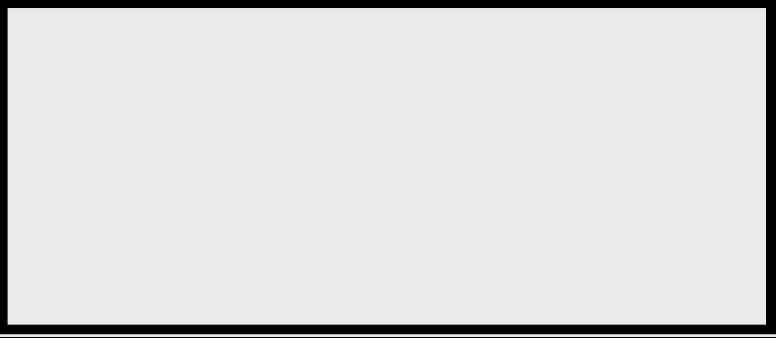
Good for moving tags

(tie in with feed back loop)

Could miss reads

Lessons Learned in the Real World Interference

Best one can do is minimize interference



- Physical Installation
  - Antenna type and location
  - Shielding
  - Adds expense to installation

Lessons Learned in the Real World Interference

Best one can do is minimize interference

Time Share

On and off

Best for non moving objects

May cause miss reads

Spilt Band

Legal if power band below one Watt

Good for shelf applications

Sacrifice range

On Demand

Activate when needed

Good for moving tags

(tie in with feed back loop)

Could miss reads

Physical Installation

Antenna type and location

Shielding

Adds expense to installation

Lessons Learned in the Real World

- FEED BACK LOOP
  - For aggregation to work correctly there must by a feed back that ensures 100% case count to EPC number count.
  - Feed back loop guarantees accuracy between actual case counts and EPC numbers

Lessons Learned in the Real World
Feed Back Loop

Antenna

EPC tag

Photocell detects a case yellow light comes on

Lessons Learned in the Real World
Feed Back Loop

Antenna

EPC tag

Reader/antenna read tag. If no EPC is identified red light goes on and case is removed and reworked

Lessons Learned in the Real World
Feed Back Loop

Antenna

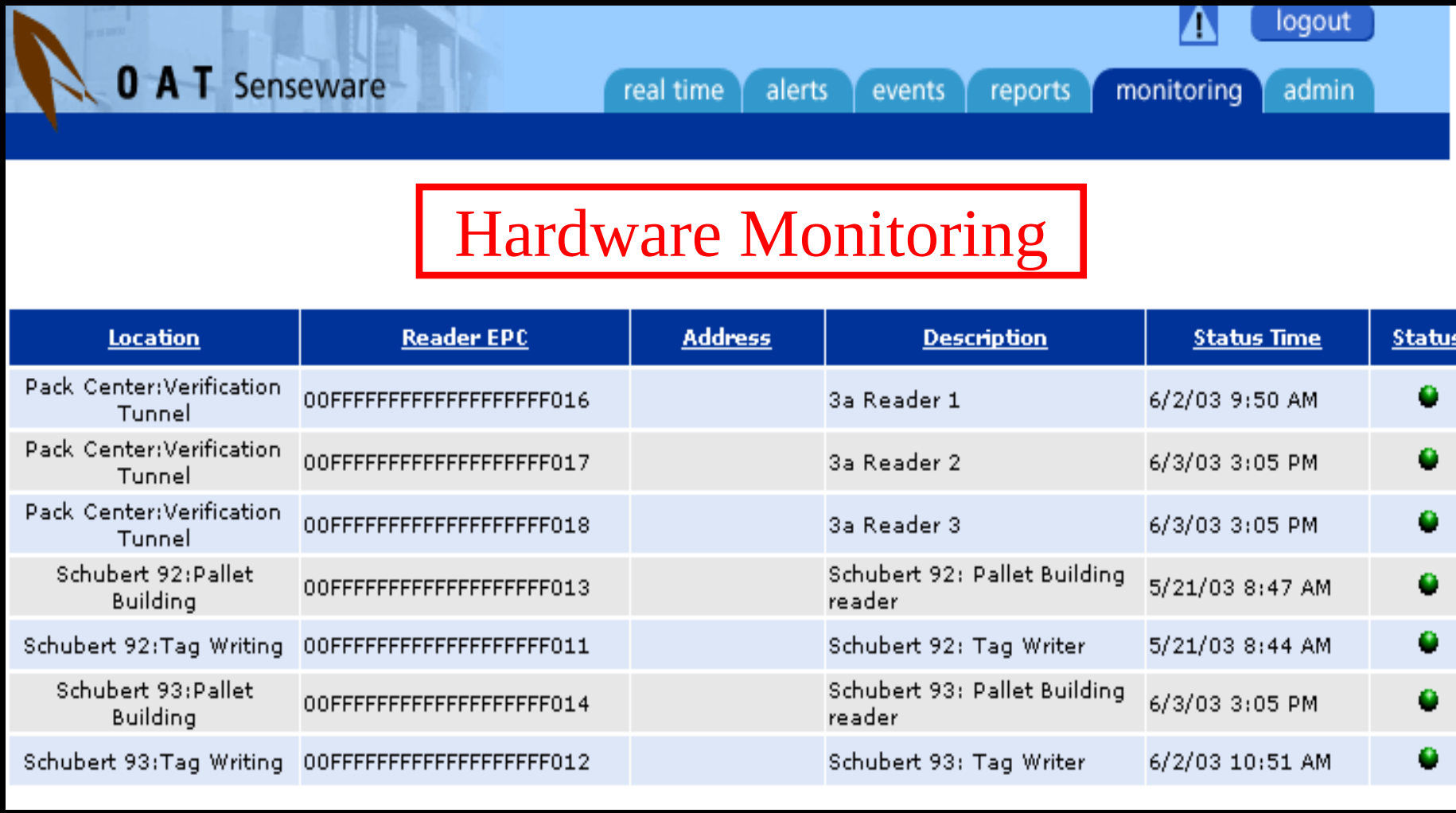
EPC tag

Reader/antenna read tag. If EPC is identified green light goes on and case moves forward

Lessons Learned in the Real World

- SOFTWARE
  - Software systems need to be able to interface with multiple devices such as RFID readers, bar cod systems, motion sensors to create a complete and fool proof system
  - Software systems should be scalable to handle the transaction volumes
  - System should be able to monitor and provide real time feed back to the users
  - System should be able to handle complex logic to identify patterns in the data to make sense of the data

Lessons Learned in the Real World Software



Location	Reader EPC	Address	Description	Status Time	Status
Pack Center:Verification Tunnel	00FFFFFFFFFFFFFFFFFF016		3a Reader 1	6/2/03 9:50 AM	
Pack Center:Verification Tunnel	00FFFFFFFFFFFFFFFFFF017		3a Reader 2	6/3/03 3:05 PM	
Pack Center:Verification Tunnel	00FFFFFFFFFFFFFFFFFF018		3a Reader 3	6/3/03 3:05 PM	
Schubert 92:Pallet Building	00FFFFFFFFFFFFFFFFFF013		Schubert 92: Pallet Building reader	5/21/03 8:47 AM	
Schubert 92:Tag Writing	00FFFFFFFFFFFFFFFFFF011		Schubert 92: Tag Writer	5/21/03 8:44 AM	
Schubert 93:Pallet Building	00FFFFFFFFFFFFFFFFFF014		Schubert 93: Pallet Building reader	6/3/03 3:05 PM	
Schubert 93:Tag Writing	00FFFFFFFFFFFFFFFFFF012		Schubert 93: Tag Writer	6/2/03 10:51 AM	

Lessons Learned in the Real World Software

List of Reports

Current EPCs

EPC Commissioning Report

EPC History

Pack Center Scorecard

Pallets Built

Pallets Verified

Process Errors Log Report

User Actions Log Report

Lessons Learned in the Real World Software

Pack Center Scorecard

9/8/03 12:00 AM -- 9/10/03 12:00 AM

Station 1 Summary

Location	Product	Quantity
Schubert 92:Tag Writing	4007	1674
Schubert 93:Tag Writing	4130A	372

Cases aggregation Summary

Location	Product	Quantity
Schubert 92:Pallet Building	4007	1630
Schubert 93:Pallet Building	4130A	360

Pallets Built

Pallet EPC	Product	Quantity	Location	Location
80006AA6020E050C	4007	90	Schubert 92:Pallet Building	9/8/03 12:20 AM
80006AA6020E050D	4130A	60	Schubert 93:Pallet Building	9/8/03 10:07 AM
80006AA6020E050E	4007	90	Schubert 92:Pallet Building	9/8/03 1:51 AM
80006AA6020E050F	4007	90	Schubert 92:Pallet Building	9/8/03 4:12 AM
80006AA6020E0510	4007	90	Schubert 92:Pallet Building	9/8/03 5:35 AM
80006AA6020E0511	4007	90	Schubert 92:Pallet Building	9/8/03 6:57 AM
80006AA6020E0512	4007	90	Schubert 92:Pallet Building	9/8/03 8:21 AM
80006AA6020E0513	4007	90	Schubert 92:Pallet Building	9/8/03 9:53 AM

Lessons Learned in the Real World

- Summary
  - Aggregation
  - RFID Tags
  - Readers/Antennas
  - Type of Installation
  - Interference
  - Feed back loop
  - Software