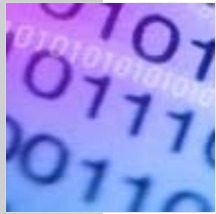# Transforming Global Supply Chain with EPC/RFID Seminar
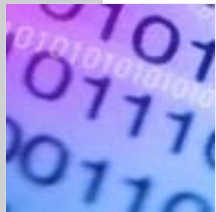
Mr. K K Suen (孫國江先生**)**
Chief Architect and Principal Consultant
GS1 HK and EPCglobal HK

Agenda

- **Basics of RFID**

- **Introduction to EPC Standards**

- **EPCglobal UHF Gen-2 Standard**

- **EPCglobal Network Architecture**

- **HK EPCnetwork Case Sharing**

GS1 HK Background

- *GS1 Hong Kong, a new name of Hong Kong Article Numbering Association, is a non-profit making, independent industry support body for global supply chain standards and technologies*

- *Set up by the Hong Kong General Chamber of Commerce in 1989 to locally administer the EAN●UCC system (now called GS1 System) of numbering & bar coding*

- *Current membership over 4,600 companies across multiple industries in Hong Kong*

Mission:
To drive and optimize business efficiency and performance of Hong Kong enterprises through the provision of world-class value chain standards and know-how.

GS1 Solution & Service

The Global Language of Business

OVERALL BENEFITS:
Improving efficiency & visibility in supply and demand chains

GS1 Solutions & Services

| GS1 BarCodes	GS1 eCom	GS1 GDSN	EPCglobal Powered by GS1
Global standards for automatic identification	**Global standards for electronic business Messaging**	**The environment for global data Synchronisation**	**Global Standards for RFID-based Identification**
RAPID AND ACCURATE ITEM, ASSET OR LOCATION IDENTIFICATION	RAPID, EFFICIENT & ACCURATE BUSINESS DATA EXCHANGE	STANDARDISED, RELIABLE DATA FOR EFFECTIVE BUSINESS TRANSACTIONS	MORE ACCURATE, IMMEDIATE AND COST EFFICIENT VISIBLITY OF INFORMATION

Automatic Identification and Data Capture (AIDC)

AIDC

Automatic Identification and Data Capture (AIDC)

- ❖ **Use Machine to Identify Objects**
- ❖ **Auto-Data Capture**
- ❖ **Examples**
  - **- Barcode**
  - **- Smart card**
  - **- Biometric Technologies**
  - **- Voice Recognition**
  - **- Optical Character Recognition**
  - **- RFID**
  - **- etc …**
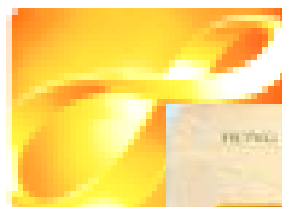
| Increase Efficiency | Reduce Data Entry Error | Free up Resources |

e.g. Barcodes (Linear and 2-D)

Data
Carrier
Data ← 5 412345 678908

4891668326689
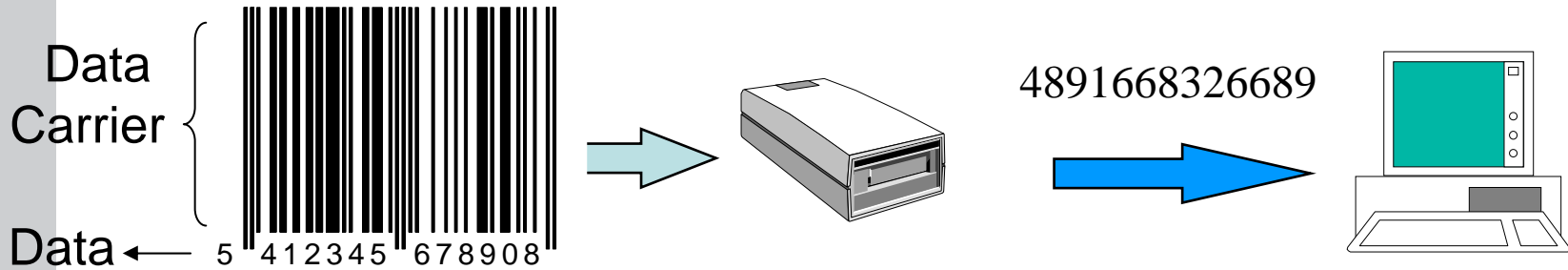
- Identification number (ID) and other standard data are represented in barcode format and can be captured automatically by scanner. Scanner transmit data to computers for further processing.

5 412345 678908
EAN-13

1 2 3 4 5 6 7 0
ITF

PDF-417

(01)00012345678905
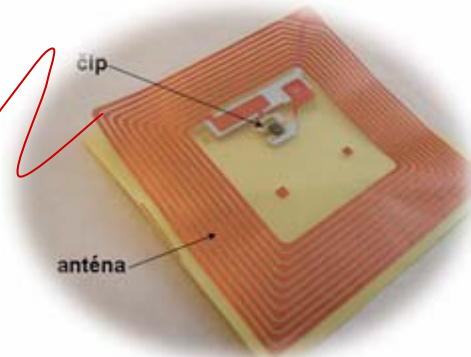**RSS-14 Stacked**

Composite Symbology

GS1 EPCglobal
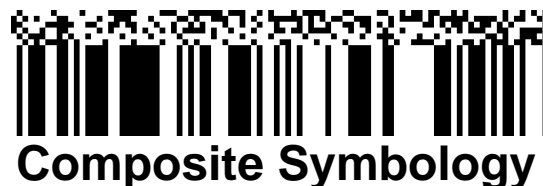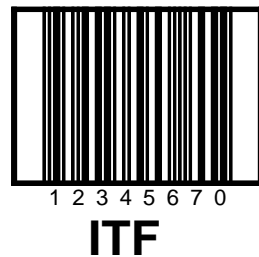
RFID

Background

HK Applications
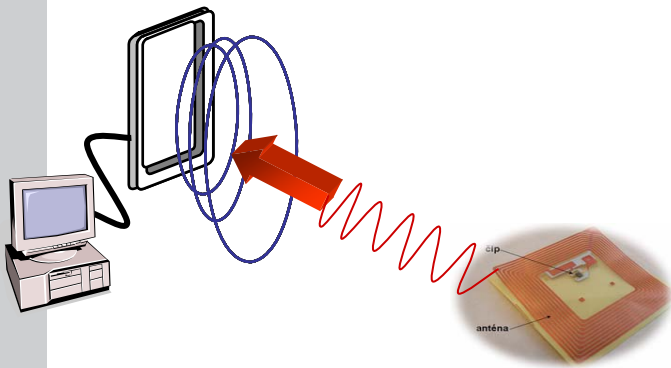
- *AutoToll*

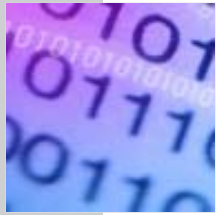- *Octopus*

Non-contact reading

EPCglobal
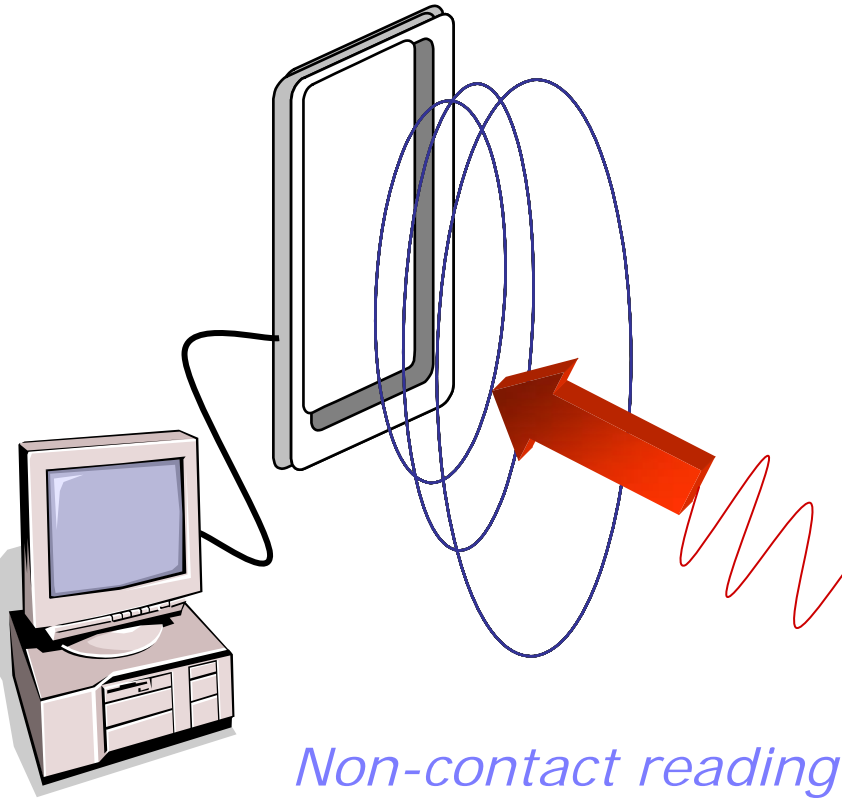
Background
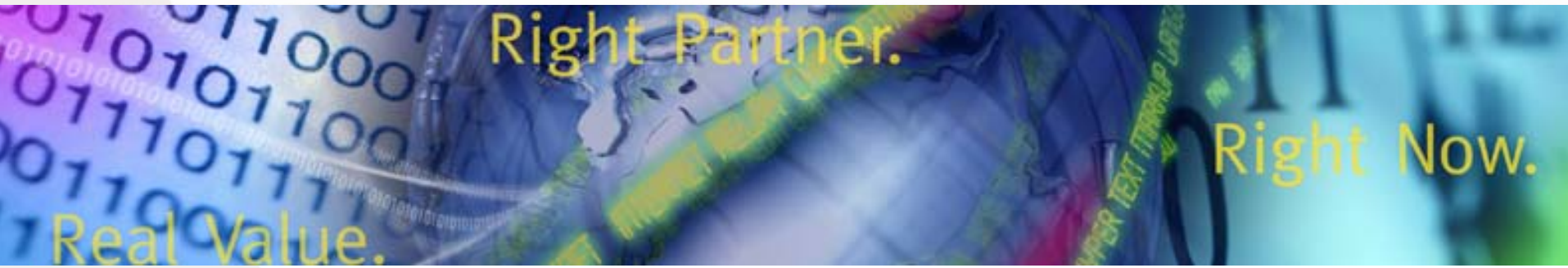
- ❖ **Proven Technology Invented 50 Years Ago**
- ❖ **Employed by Military in WWII**
- ❖ **Impractical for Commercial Application in the Past**
- ❖ **Currently Applied in New Context**

RFID versus Barcodes

- Barcodes need a visible line of sight, RFID doesn't
- RFID readers can read multiple tags at same time
- RFID Tag data can be rewritten or modified
- RFID Tags can be read at far greater ranges
- Barcodes area generally cheaper that RFID tags
- RFID Tags can be linked to other devices such as sensors
- Barcodes can be visually read by people
- RFID Tags can be reused
- RFID systems can suffer from interference
- RFID Tags can easily be read on the move

How Dose RFID Work in Retail Supply Chain?

In a grocery store…

SHELF NETWORK

WIRELESS GRID

FLOOR NETWORK
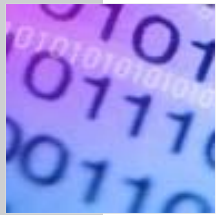
Case Packaging Machine

Case Read

Case to pallet aggregation and Fork lift assembles customer order

Fork lift truck mixed pallet re-aggregation reads

Case to pallet aggregation

GS1 EPCglobal

Order is checked for accuracy

Verification tunnel reads
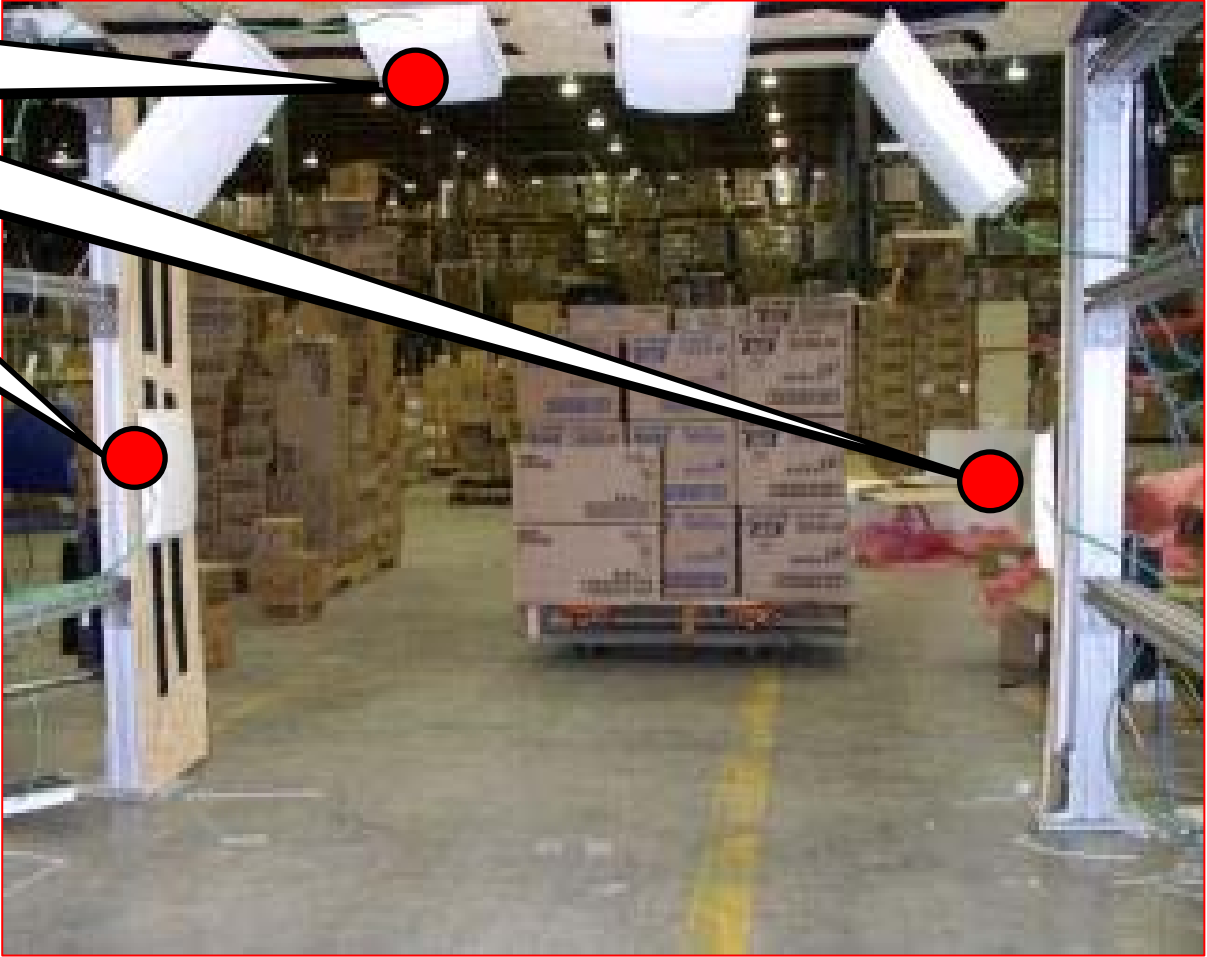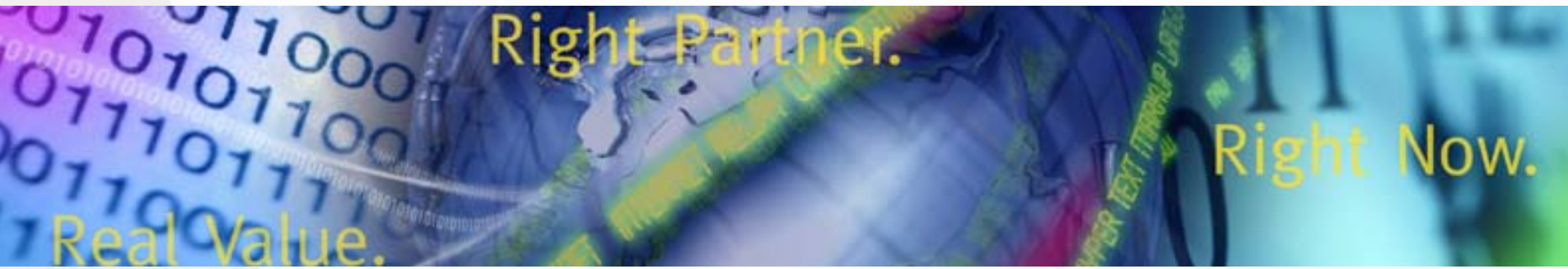
EPC Standards

Global Standards

Trading Partner		Trading Partner
Trading Partner	**Industrial Standard** **Common Protocol** **Interoperability** **Encourage Technology Competition** **Drive Cost Volume Relationship** **Lower Cost of Changes**	Trading Partner
Trading Partner		Trading Partner

- **EPC (Electronic Product Code)**
- Proposed in 1999 by MIT Auto-ID Lab with support from over 100 MNCs, universities and GS1 (EAN.UCC)
- Global standard formally released in Oct 2003 and managed by **EPCglobal**
- EPC is a standard NOT only on RFID, but the whole concept of RFID application on supply chain and sharing information across the EPCglobal Network

GS1 EPCglobal

EPCglobal Network Infrastructure Framework

EPCglobal Core Services and other shared services

Shared Service Interactions

Peer-to-peer exchange of data about EPCs

EPC Data Exchange Standards

EPCglobal Subscriber

EPCglobal Subscriber

EPC Infrastructure Standards

Exchange of physical objects with EPCs

EPC Physical Object Exchange Standards

EPCglobal Network Infrastructure Framework

EPC Tag Data Standard

RFID Protocols
-Class 0
-Class 1
-UHF Class 1 Gen 2

EPC Data Exchange Standards

EPC Infrastructure Standards

EPC Physical Object Exchange Standards

Exchange of physical objects with EPCs

EPC (Electronic Product Code)

A number ………………………… In a RFID Tag

The EPC Number disected (96 bit version)

21.203D2A9.16E8B8.719BAE03C

Header 8 bits

EPC Manager
28 bits
(> 268 Million)

Object Class
24 bits
(> 16 Million)

Serial Number
36 bits
(<68 Billion)
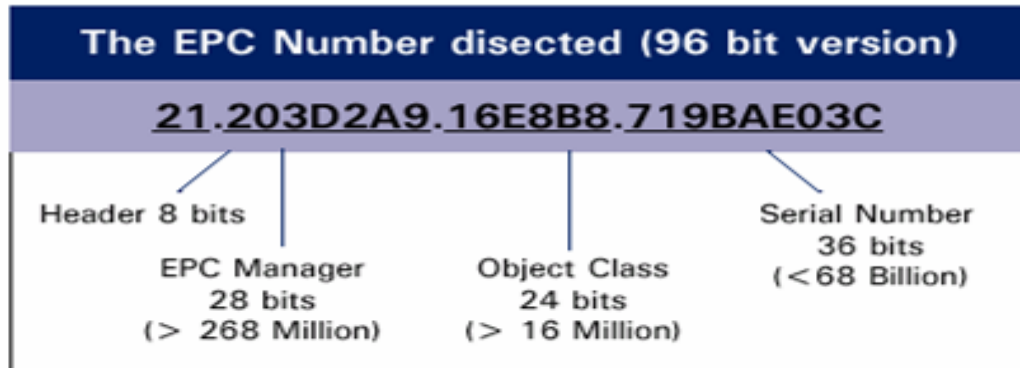
Source: Auto-ID Center

**…When Applied together,
Can Uniquely Identify an Object**

Total = 309,485,009,821,345,000,000,000,000 item identities
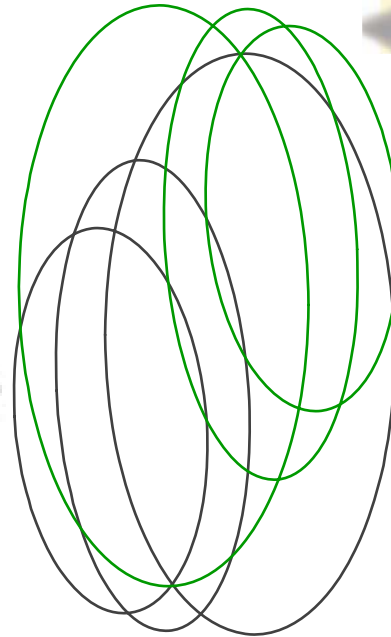
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RFID System
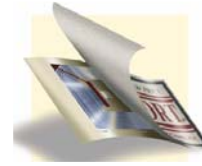
Tag

Reader

Air Interface Protocol

This specification is a fundamental component of the EPC system

Specifications Released

- Ultra-High Frequency
    - 900 MHz Class 0
    - 860-960 MHz Class 1 Generation 2 released in Dec 2004 and became ISO 18000-6c
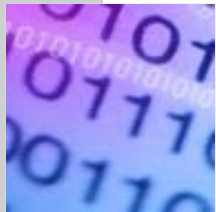- High Frequency
    - 13,56 MHz Class 1

ISO

GS1 EPCglobal

RFID Frequency Allocation

- ❖ **Spectrum allocation to allow use of Gen 2**
- ❖ **UHF spectrum (860-960 MHz) & power regulation (2w erp/ 4w eirp)**
- ❖ **HK OFTA assigned dual band and approved by Legco in 03/2005**
- ❖ **865-868 MHz (2W erp) & 920-925 MHz (4W eirp)**
- ❖ **Significant progress made:**

ITU Region		
1	2	3
EU and Africa	Americas	Asia

EU and Africa	Americas	Asia
Europe	USA	Australia
CEPT	Canada	New Zealand
South Africa	Central America	Japan
Israel	South America	South Korea
		Singapore
		Hong Kong
		China
		Taiwan
		India

GS1 EPCglobal

Type of RFID Tags

- **Active Tags**
  - Battery power both RF circuitry & memory
  - Longest Read Range
  - Short Battery Live (a few days to 12 months depends on Tag functionality and Cost)
  - Good for Location Based Application
  - Cost: $$$

- **Semi-Active Tags**
  - Reader activates RF circuitry, but battery powers memory
  - Medium Read Range
  - Long Battery Live (a few years)
  - Cost: $$

- **Passive Tags**
  - Reader powers both RF & memory
  - Short Read Range
  - No Battery Required
  - Cost: $
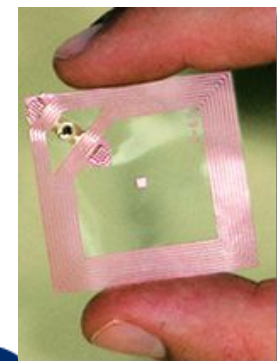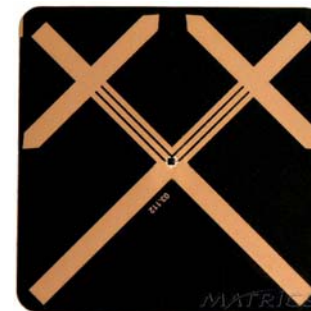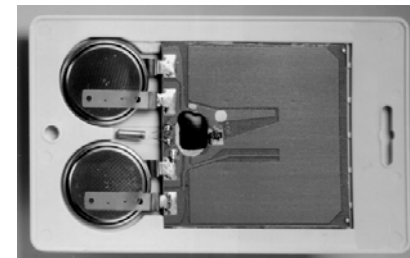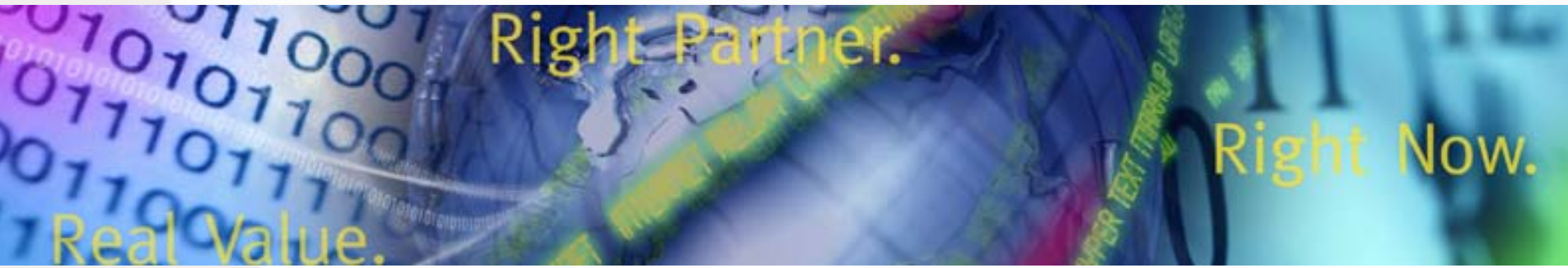
Types of RFID Tags

Class	Comments
Class O	"Read-only" Passive identity tags
Class I	Write once passive identity tags
Class II	Passive tags with added functionality e.g. memory or encryption
Class III	Semi-passive RFID tags
Class IV	Active tags – communicate with readers and other tags on the same frequency band
Class V	Essentially 'readers' – can power class I, II and III tags as well as communicating with class IV and with each other.

EPC Air Interface Standard Evolution

```
Class 0
RO  ─┐
      ├─→ [HAG] ─→  UHF Gen-2  ─→  Class 2 Hi-Mem RW
Class 1        WORM  ─→  Class 1 HF WORM
WORM ─┘                  ─→  Class 3,4
                         ─→  ISO 18000-6C
```

Class 2
Hi-Mem RW

Class 0
RO

HAG

UHF Gen-2
WORM

Class 1 HF
WORM

Class 1
WORM

Class 3,4

ISO
18000-6C
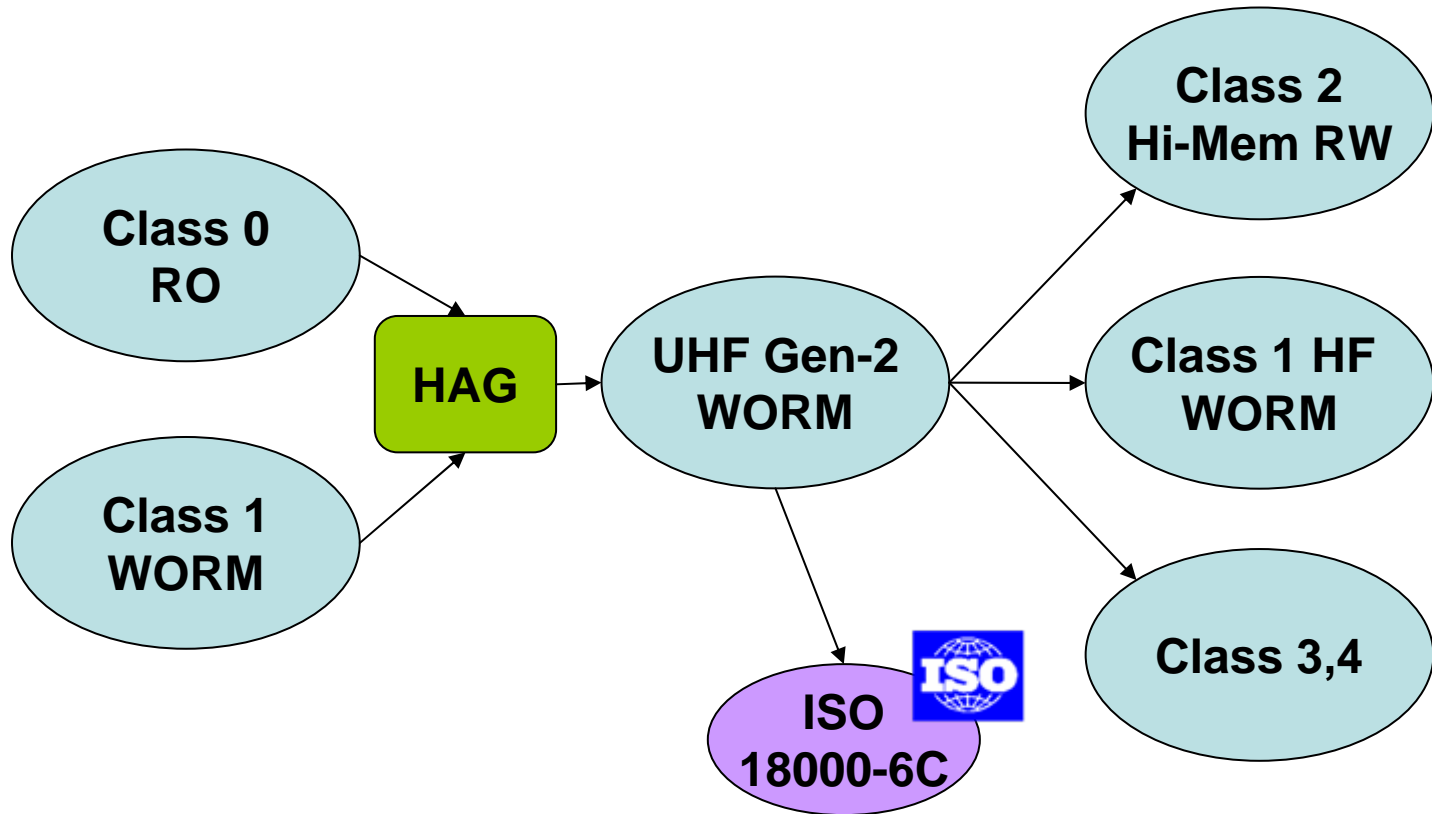
EPCglobal UHF Generation 2 Standard

Gen2 is Here, Now

Impinj Monza™ Gen2

- Gen2 Monza™ silicon first introduced in April, 2005
  - 96-bit EPC
  - 10m read, 8m write range
  - Writes 800 tags/minute
  - 100 million Monza™ tags shipped
- GrandPrix™ system solution
  - Reader, silicon, tags

GrandPrix™ System Solution
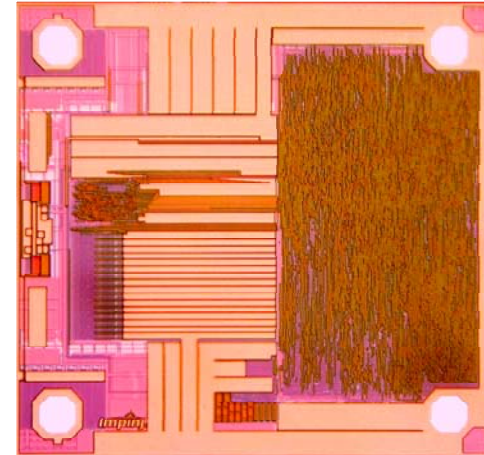
Speedway™ Gen2 Reader

Dense-Reader Mode Goal

- 10's or hundreds of readers operating simultaneously
  - Reliably reading pallets & items
  - Without needing synchronization

Dense-Reader Mode Testing

Legend

▮	Reader
▮	Antenna

Test Setup
Units under test: 2 readers, each controlling 2 antennas
Interferers: Up to 13 Interferers per side, all transmitting

Interfering reader(s)
(simulating adjacent door)
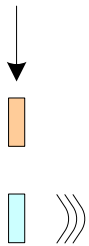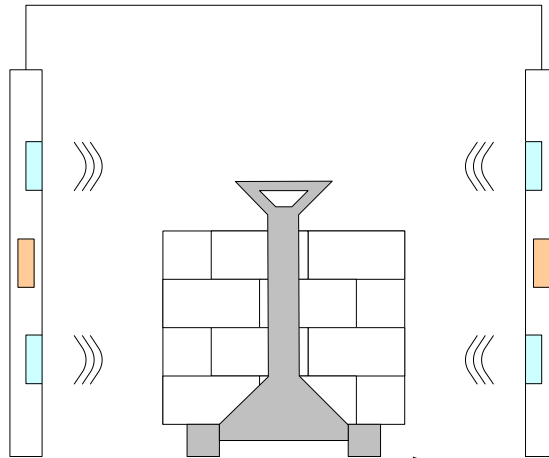
Interfering reader(s)
(simulating adjacent door)
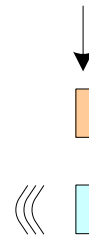
3 m   3 m   3 m

Metallic Stand
For reader and antenna mounting

Pallet of Tagged Items
Tags buried within pallet

Dense-Reader Mode Works

- **Impinj Speedway™ reader on either side of dock door (FCC certified)**
- **Avery AD-620 (Triflex™) tags on each of 40 boxes of Caress® soap**
- **All readers transmitting simultaneously**
- **Inventory reliability is achievable**

Chart — Inventory Reliability vs. Number of Interfering Readers:

Number of Interfering Readers	Inventory Reliability
0	100%
8	100%
16	99%
26	97%
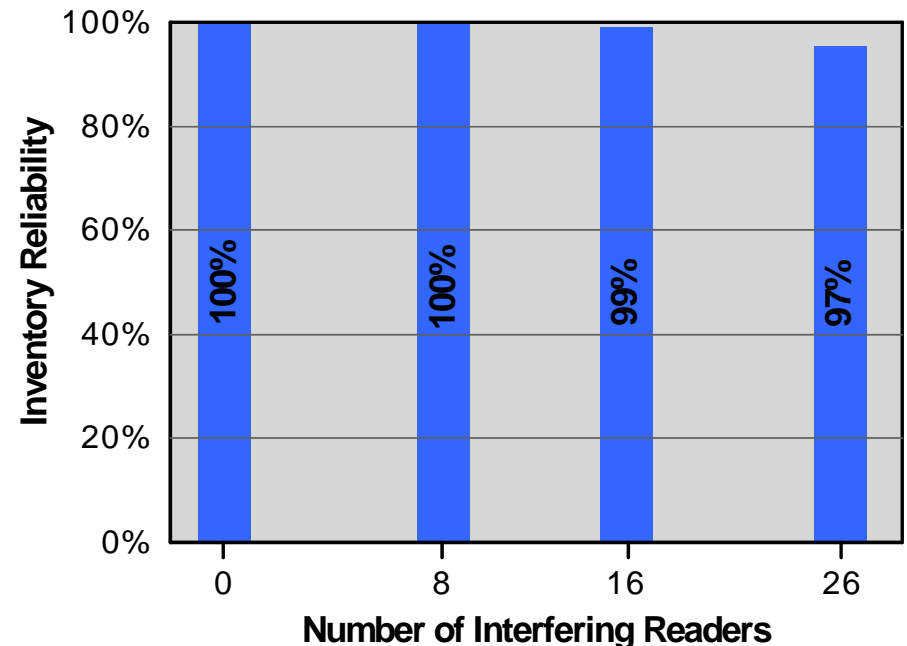
Worldwide Tag Operation

- Gen2 tags can operate worldwide
    - Same tag operates in Asia/Europe/US
    - Exceptional sensitivity across all regions
    - No need to use different tags for different locations

Propeller Tag Frequency Response (Monza™ Silicon)
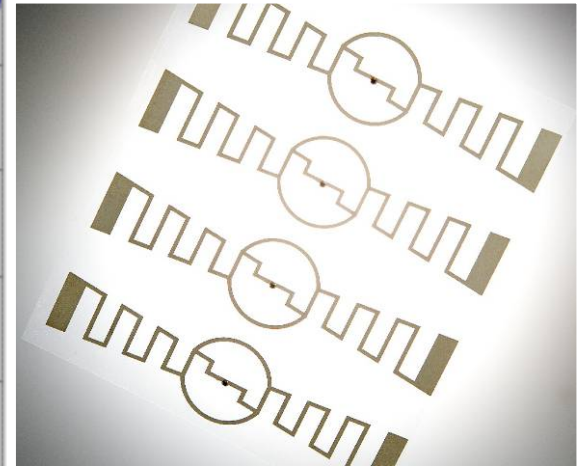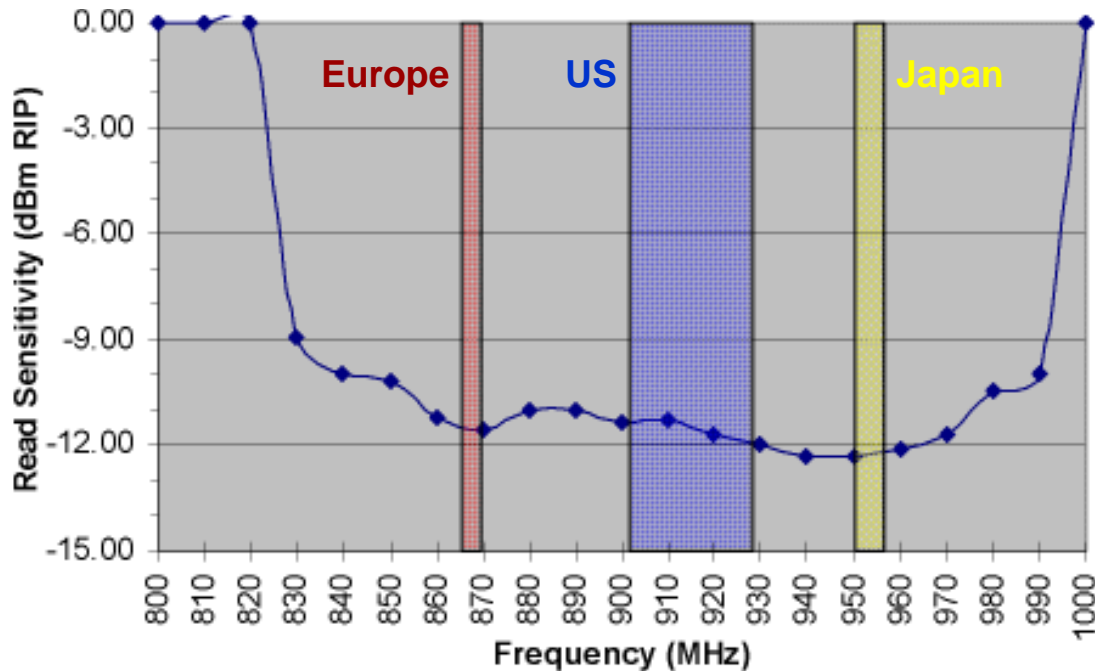
UHF Gen2 on Items?
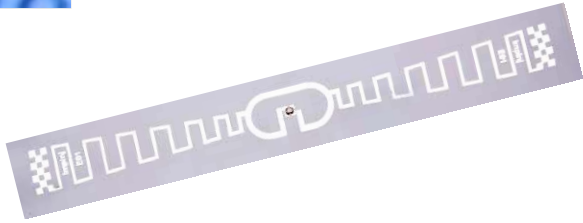
Some claim that "UHF can't work on liquids"

Many claim that "UHF can't work, it's the Physics!"
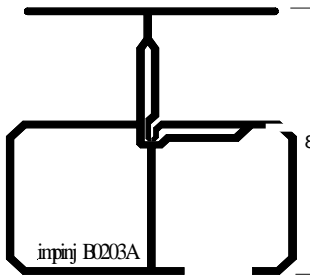
Some worry that "UHF tags don't fit"

inpinj B0203A

GS1   EPCglobal

UHF Gen2 Tags Can be Small

- Fact #1: UHF pallet tags need long range
  - Require large far-field antennas
- Fact #2: UHF item-level tags need short range
  - Use small near-field antennas

Banjo™

Button™

80.0 mm

9.0 mm

impinj B0203A

80.0 mm

34
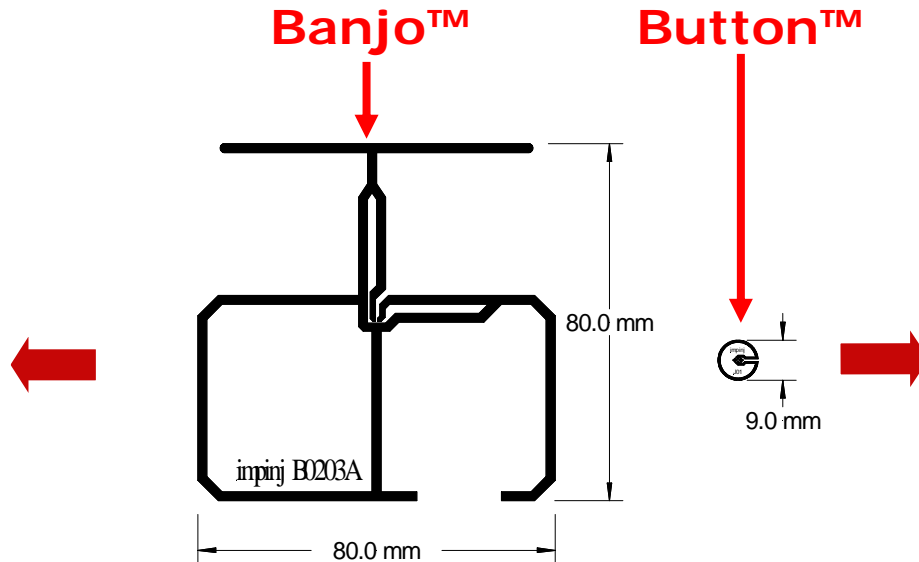
UHF Gen2 Works Fine on Liquids

- ## Near-field UHF is not affected by liquids
  - UHF Gen2 tags not only work on water, they work under water!

UHF Gen2 Works Fine on Metals

- All fields are affected by metals
    - Near field and far field
- UHF can take advantage of the metal
    - Can tune the antenna for metal
    - UHF tags can work better on metal than in free space

UHF Gen2 Works in Close Proximity

- UHF enables simple loop-antenna designs
  - Reduced tag-to-tag shielding
  - Stacked tags are visible to reader
- Gen2 works fine on stacks of DVDs & racks of clothes

Key Gen2 Benefit: Low Tag Cost

HF Item-Level Inlay

UHF Item-Level Inlay

~20 turns fine

1 turn, 1 layer
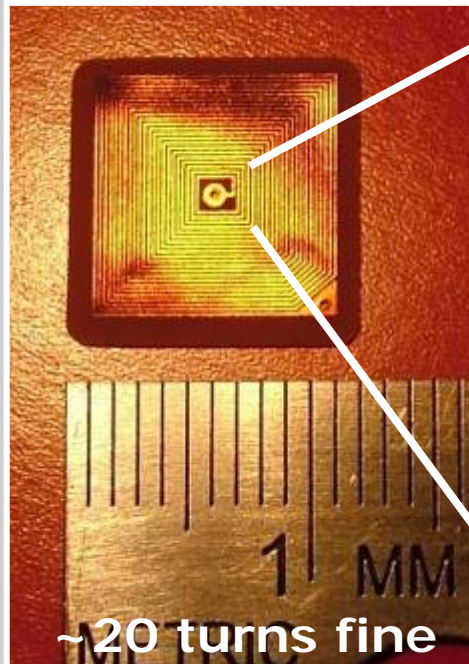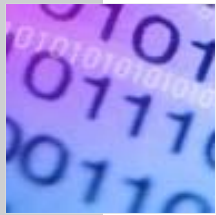
UHF Gen2 Has a Bright Future

- ## A single, open, worldwide standard
  - A single infrastructure that can read pallets, cases, and items
  - Operation in the far-field, near-field, or both

An item-level UHF system

- Near-field coupling
- Confined 60cm read range
- Using the existing Gen2 protocol
  - Same Gen2 tag silicon
  - Same Gen2 readers
  - Simply change the antennas

EPCglobal Network Infrastructure Framework

Reader Protocol

Reader Management

Filtering & Collection (ALE Interface)

EPC Data Exchange Standards

EPCglobal Subscriber

EPCglobal Subscriber

EPC Infrastructure Standards

Exchange of physical objects with EPCs

EPC Physical Object Exchange Standards
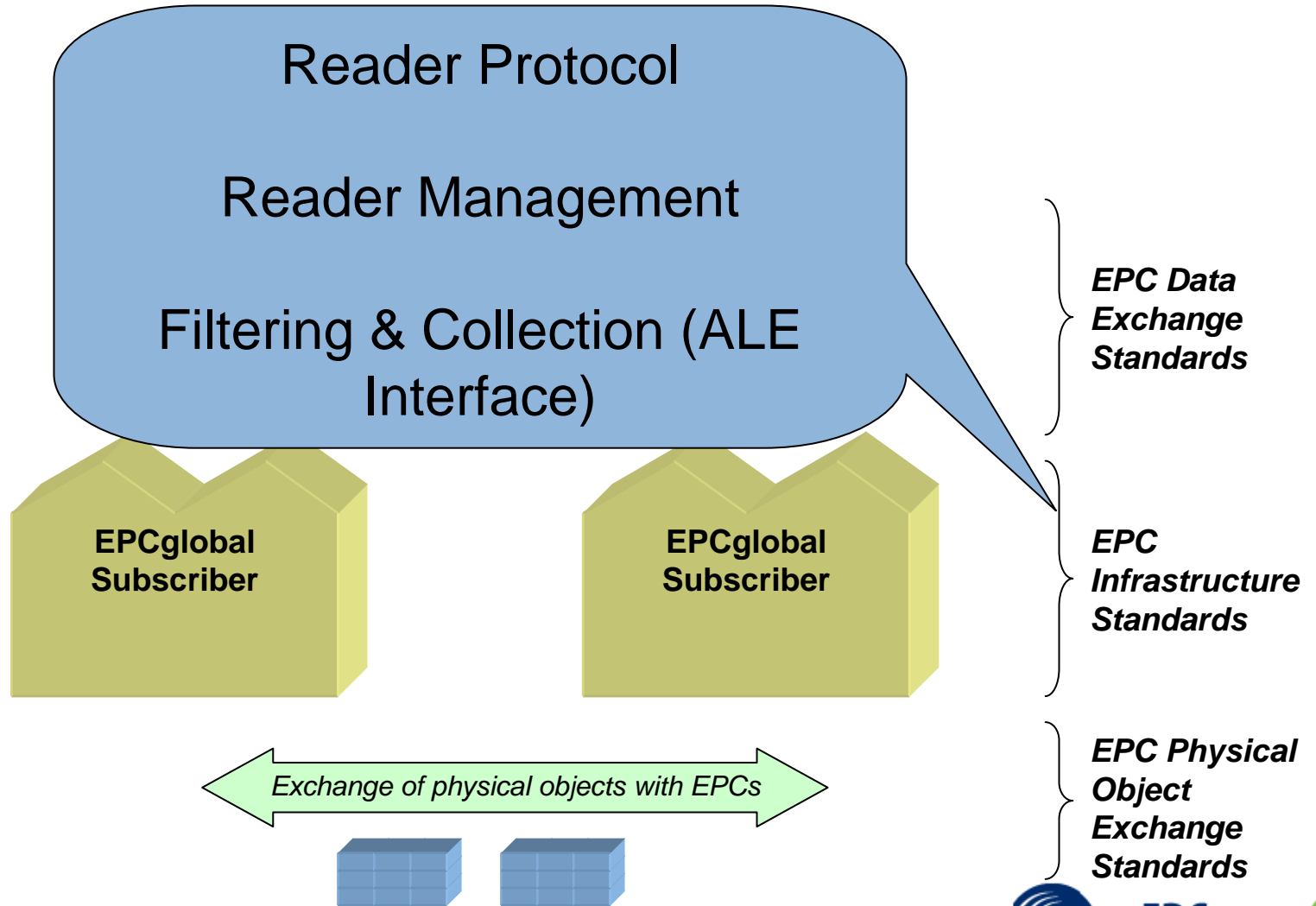
EPC (ALE) Middleware Functionalities

- Data Aggregation
- Event Filtering
- Reader Management
- Customised Business Event Logic

Dock door 1   Dock door 2   Storage bays

EPCglobal Network Infrastructure Framework

EPCglobal Core Services and other shared services

Shared Service Interactions

EPC Information Services (EPCIS)

Object Name Service (ONS)
"Discovery Services" (future)

EPC Manager Number Assignment

EPC Data Exchange Standards

EPC Infrastructure Standards

EPC Physical Object Exchange Standards
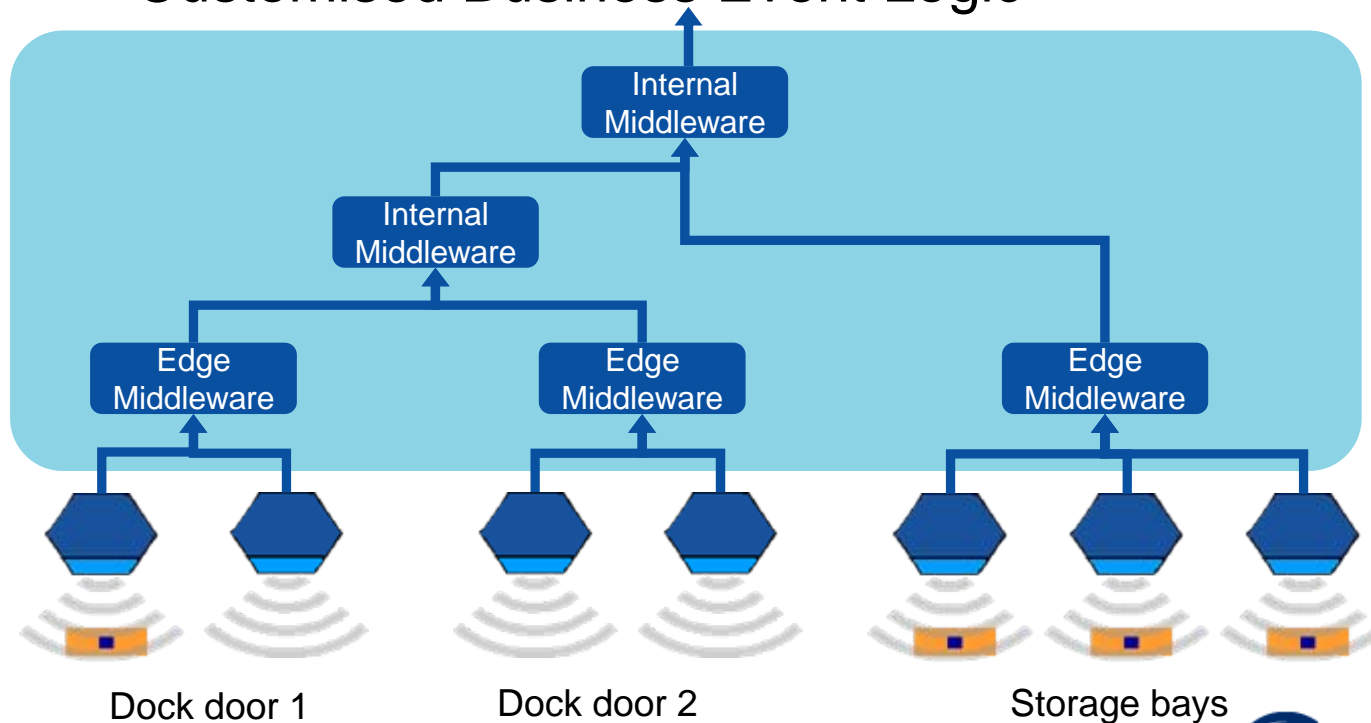
GS1 EPCglobal
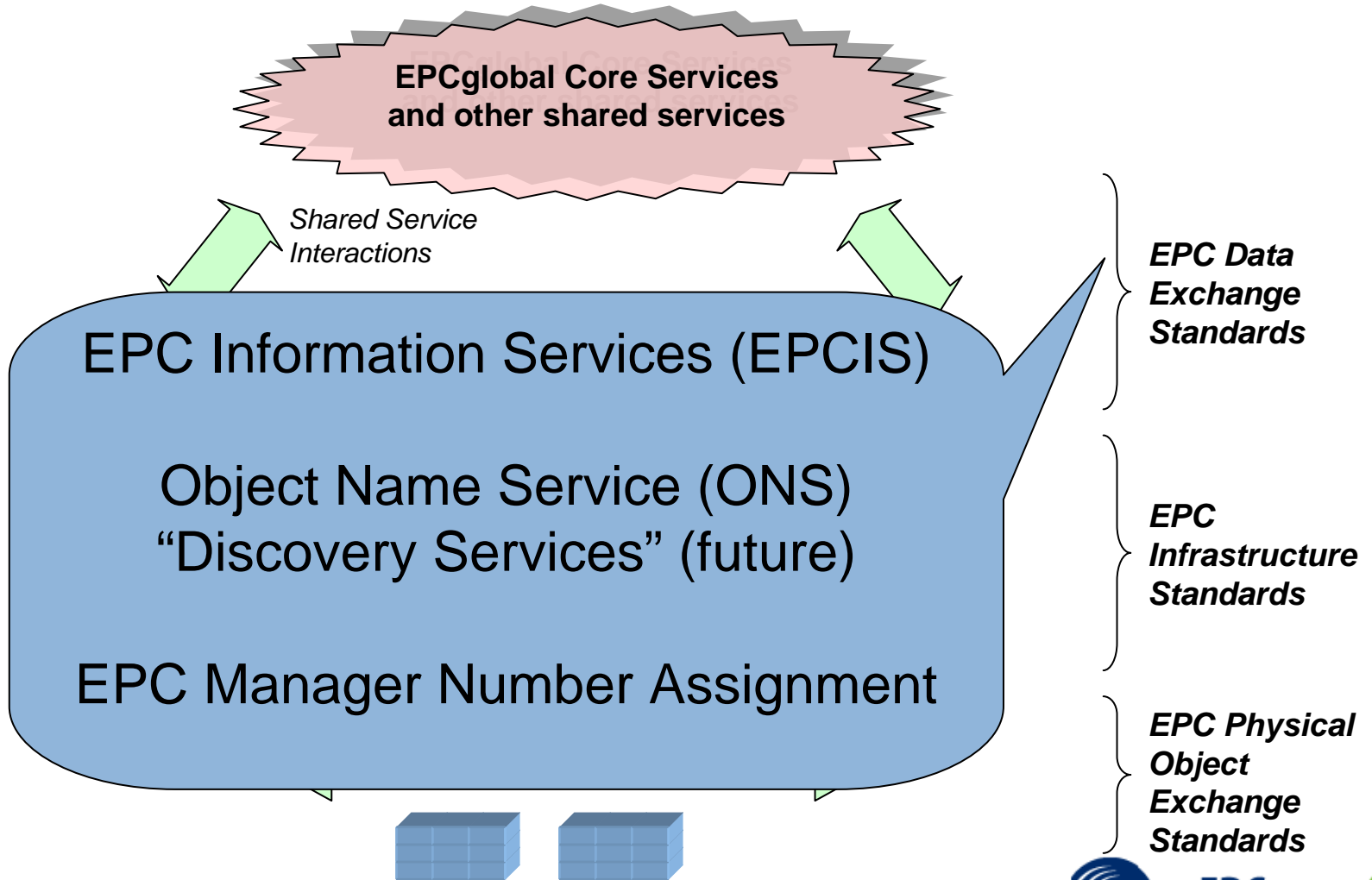
EPC Use Case in Supply Chain

Event Registry

Search & Discovery

Secure Internet Exchange

ONS

Authentication/ Authorization

Intranet 1

Local ONS

EPC IS

Internal Systems (ERP, WMS, etc.)

EPC Middleware

EPC Readers

Intranet 2

EPC IS

Local ONS

Internal Systems (ERP, WMS, etc.)

EPC Middleware

EPC Readers

Self contained EPC Intranets

Interoperability between Intranets

Global Track & Trace over Internet

Product Recall

Total Shipment: 50,000 Drug-A

Saving Cost: Recall 38,000 Drug-A

**Recall Mandatory:3000 Drug-A
Potential Recall: 9000 Drug-A
Total =12,000 Drug-A**

**Recall Mandatory: 3000 Drug-A
Potential Defect: 5000 Drug-A**

Defected item: 1000 Drug-A

DEFECT!! INCIDENT

Nodes with Readers

Defect Detected

Recall Mandatory

Potential Defect

Potential Recall

Manufacturer

Port/Airport 3PL

Port/Airport 3PL

Distributor

Retailer

Shipment Date 1 Aug 2005

Incident date 31 Aug 2005

Condition Monitoring

Goods flow check point

3	3	2	1	2
4	2	6 (Alert)	3	5 (Alert)

NORMAL
Temperature 0-4°C

ABNORMAL
Temperature over 4°C

Manufacturer

Port/Airport
/3PL

Port/Airport
/3PL

Distributor

Retailer

Nodes with
Readers

Item has problem

Tag Read
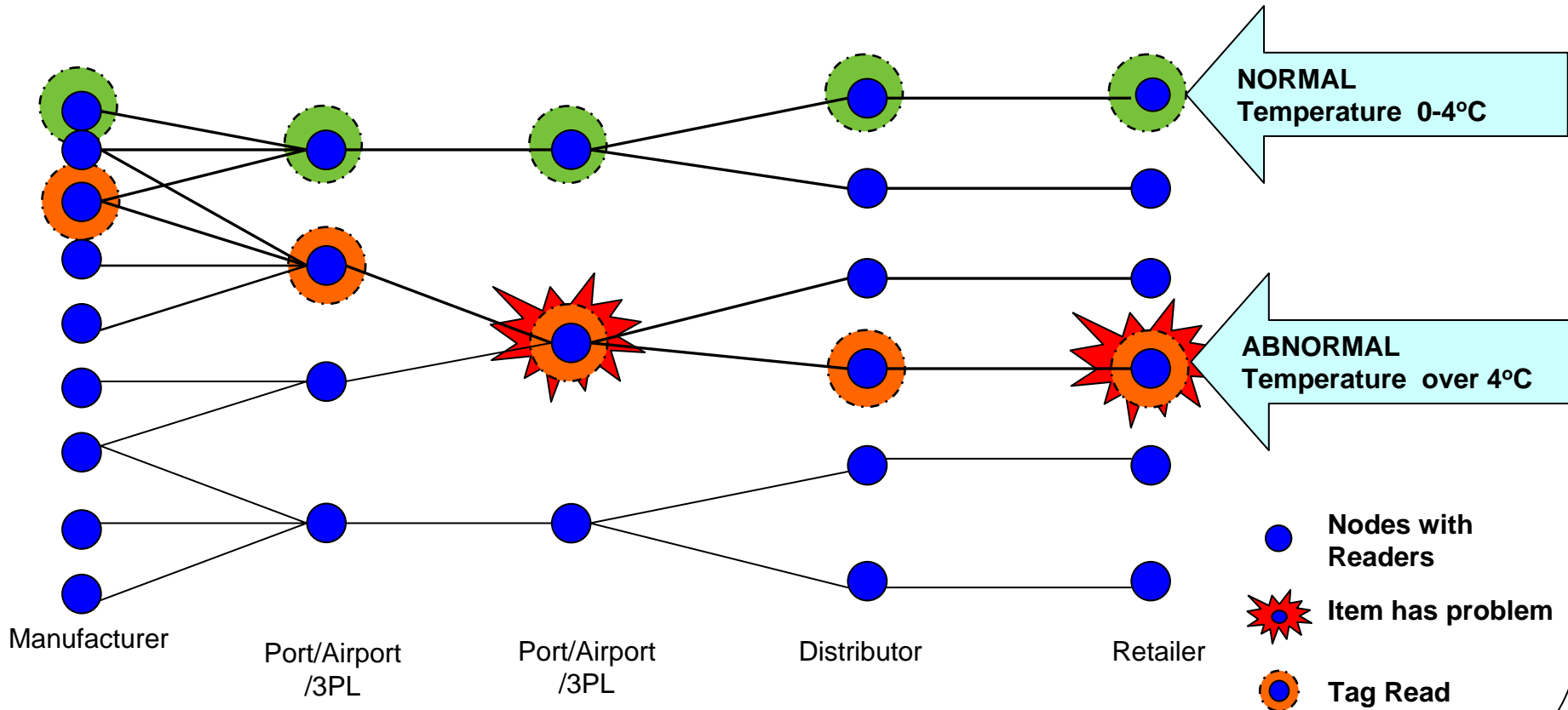
Parallel Goods Identification

Market's Good flow checkpoint (Item number)

A	----	----	----	----	666	(Alert –other market)
B	666	666	666	666	-----	(Alert)

Market A

Parallel Goods
EPC serial number=666

Market B

Manufacturer

Port/Airport /3PL

Port/Airport /3PL

Distributor

Retailer

● Product for Market A

○ Product for Market B

◉ Item with EPC number 666

✸ Counterfeit Item
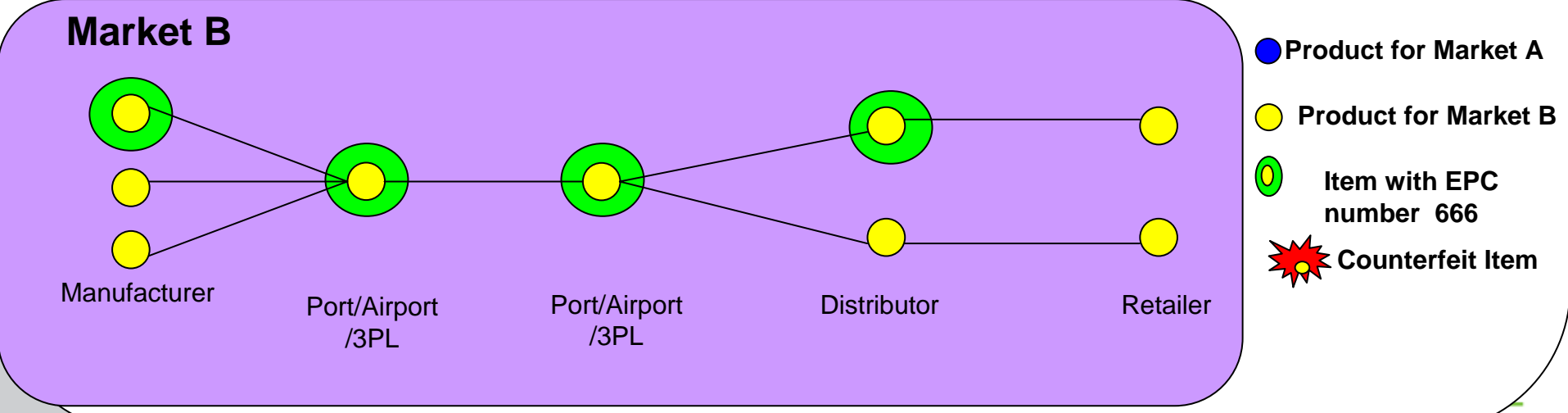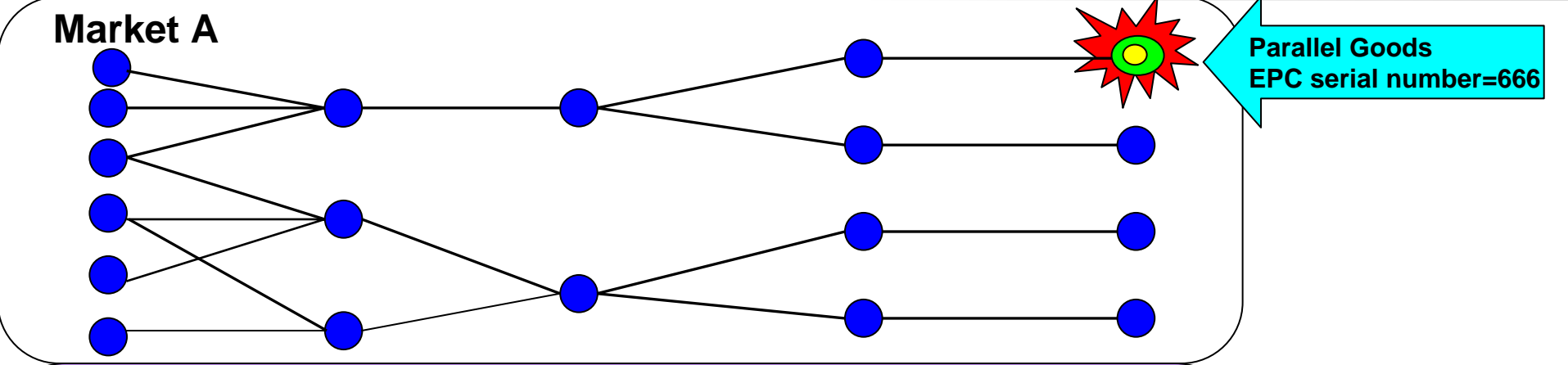
Product Authentication

Goods flow check point (Item number)

| 123 | 123 | 123 | 123 | 123 | (Normal) |
| ---- | ---- | ---- | ---- | 999 | (Alert) Not match in manufacturer's DB |

COUNTERFEIT
EPC serial number=999

NORMAL
EPC serial number =123

Manufacturer

Port/Airport /3PL

Port/Airport /3PL

Distributor

Retailer

Nodes with Readers

Counterfeit Item

Tag Read
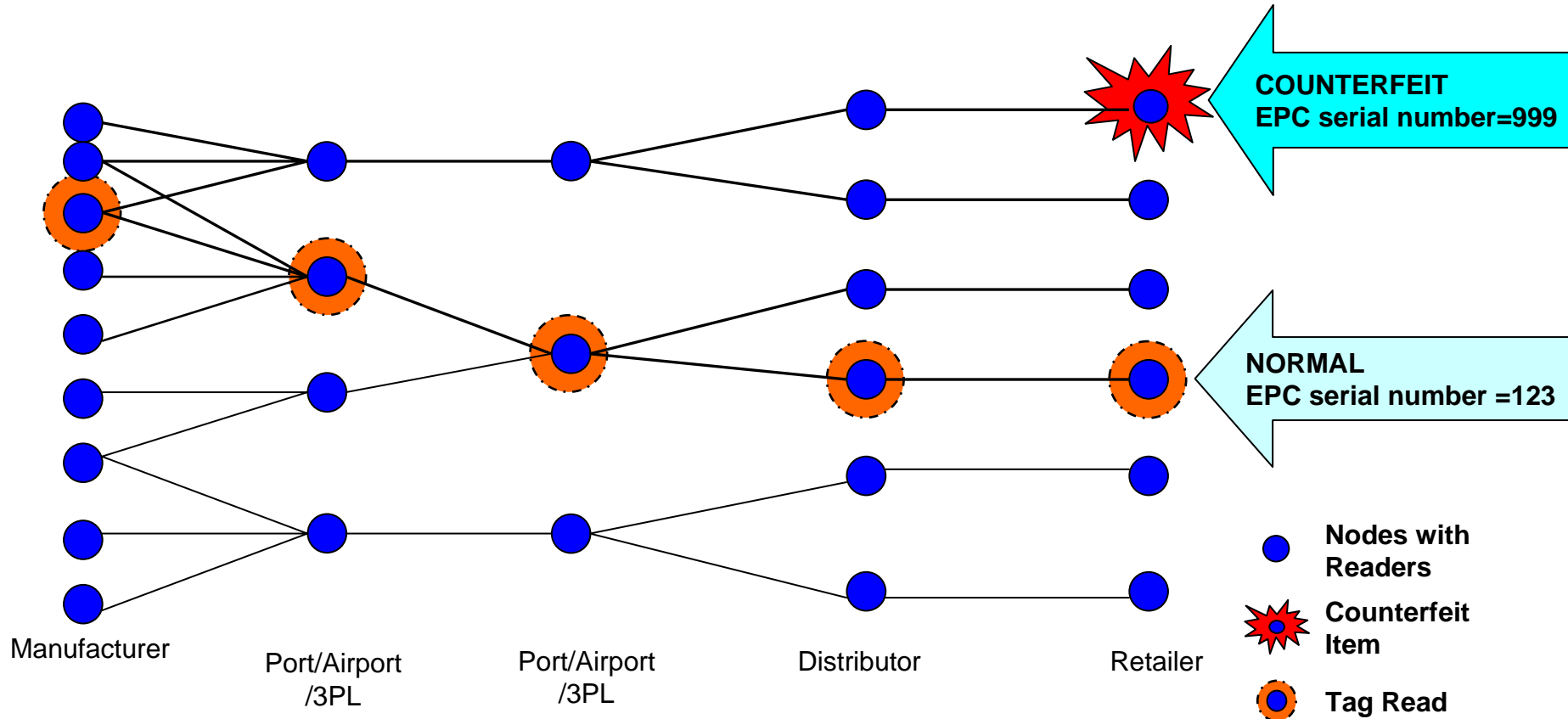
Hong Kong EPCnetwork Infrastructure Project
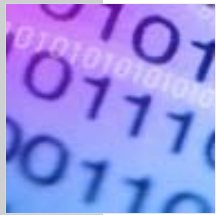
Next generation of Supply Chain Opportunities for Hong Kong & Pan-Pearl River Delta

HK – A Sourcing & Logistics Hub in Pan Pearl River Delta

Manufacturing base with concentration of contract manufacturers

Gateway to backend manufacturing cities with high concentration of buying/management offices for sourcing & logistics support

EPC – Internet of Things that underlines the Next Generation Supply Chain

Potentials of Pan-Pearl River

- PPRD accounts for 40% of China's GDP

- Out of US$412.02 billion of export from PPRD in 2004, HK accounted for US$258.9 billion (over 60%)

- 130,000 enterprises set up by HK entrepreneurs in Pan-PRD; 80,000 factories in Guangdong set up by Hong Kong businesses; about 50% of them are outward processing operations for textiles and clothing, electronic products, toys, clocks and watches.

- Pan-PRD (9 provinces + HK & Macau) covers both the upstream and downstream of the supply chain with business activities spanning from natural resources exploration, manufacturing services, to marketing and logistics services

- The vision of the "Internet of Things" is to harmonize the logistics movement with information flow forming an important pillar of the Pan-PRD region

The Hong Kong EPCnetwork Infrastructure Project

EPC Network Infrastructure Project (Q2 2005 – Q1 2007)
(Establishing an EPC Network Infrastructure to enable end-to-end Supply Chain Visibility) managed by GS1 Hong Kong

- Develops EPC Network using global standard, and creates EPC technology reference case through
  - EPC business reference case based on <u>4 pilot projects</u> including global retailers, manufacturers and logistics providers

- Researches in network securities, cross-border technology feasibility study and benefits study of pilots implementation

- Identifies industry requirements of HK and Pearl River Delta

- Fosters better integration of manufacturing and logistics services within HK and Pearl River Delta

- Lowers implementation entry barrier for both technology solution providers and industry users

Vision & EPC Network Project

- Facilitates the development of PPRD as a **global sourcing center**

- Enhances the overall **supply chain efficiency** of the region

- Reinforces **consumers confidence** on PPRD products

- Powers up **management** of businesses within the region

- Expedites **cross border** customs clearance

HKSAR and Guangdong Province also recognize the potential benefits that RFID/EPC may deliver to the region.

A **joint funding scheme** was introduced in Sept 2004 to support different research and development (R&D) projects on this promising technology.

Global End-to-end Visibility

Goods Flow

CHINA	HONG KONG	OVERSEAS

Supply — China/HK Ports — HK / Overseas Ports — Overseas Custom — Demand

Manufactures — 3PL — Warehouse — 3PL — Retailers

EPC Dataflow   **EPC Dataflow**   **EPC Dataflow**

Processes

Manufacturing → Consolidation → Transportation → Warehouse → Shipping → De-consolidation → Distribution

Enabling Infrastructure & Applications

Inventory / Asset Mgt	Warehouse Mgt	Logistics Track & Trace	Work-in-progress

Pilot Applications

EPC Infrastructure

Visibility

The Hong Kong EPCnetwork Infrastructure Project

International Pilot 1 – Vtech / Wal*Mart

EPCglobal Network Infrastructure

Finished product delivery Data

Finished product delivery Data

Finished product delivery Data

Finished product Ship-Out Data

US Retailer	Logistics Service Provider	HK Supplier	China Factory

RFID/EPC Consolidated Data

Finished Product

Finished Product

Host Systems
e.g. ERP, WMS

GS1 EPCglobal

VTech / Wal-mart Pilot

The Hong Kong EPCnetwork Infrastructure Project

International Pilot 2 – Mark Int'l / Maesrk / Target

EPCglobal Network Infrastructure

Finished product delivery Data

Finished product delivery Data

Finished product delivery Data

Finished product delivery Data

Finished product Ship-Out Data

RFID/EPC Consolidated Data

US Retailer	US De-consolidator	HK Consolidator	HK Supplier	China Factory

Finished Product

Finished Product

Host Systems e.g. ERP, WMS

Mark/Maersk/Target Pilot

Slap Tag

Warehouse In
RFID Readers

Automatic
Scanning at
Warehouse Gate In

Mark/Maersk/Target Pilot

RFID Readers at Maersk Logistics Warehouse Gate In

Container Terminal in Hong Kong (Maersk Logistics)

ASN with EPC received at Maersk Logistics warehouse

Mark/Maersk/Target Pilot

Unload Goods
Maersk Logistics
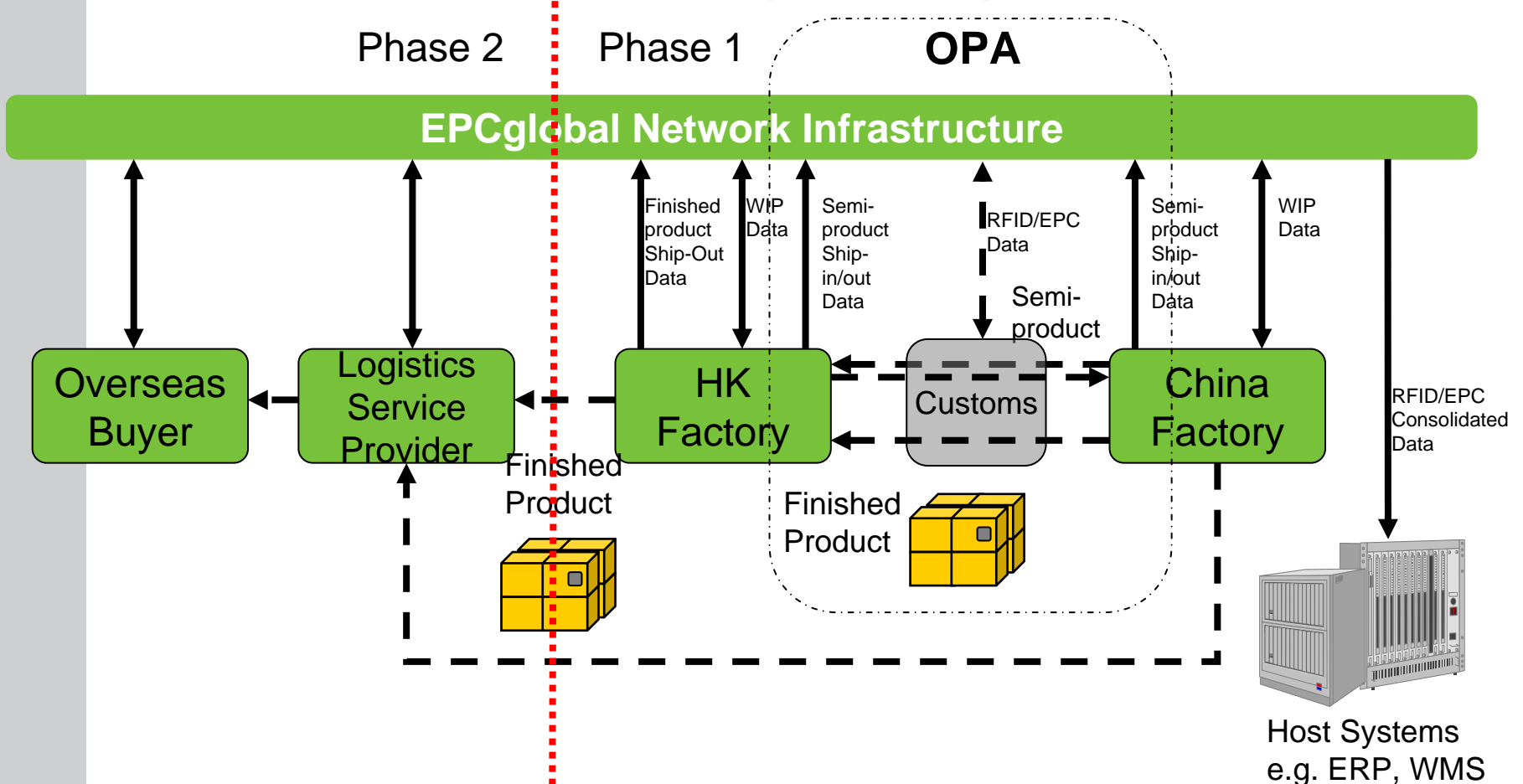Warehouse Gate In
(Automatic Reconciliation
with ASN)

Automatic
Scanning at
Warehouse Gate Out

The Hong Kong EPCnetwork Infrastructure Project

China/HK Pilot 1 – Esquel Group

Phase 2 · Phase 1 · **OPA**

EPCglobal Network Infrastructure

Finished product Ship-Out Data · WIP Data · Semi-product Ship-in/out Data · RFID/EPC Data · Semi-product · Semi-product Ship-in/out Data · WIP Data

Overseas Buyer · Logistics Service Provider · HK Factory · Customs · China Factory

Semi-product

Finished Product

Finished Product

RFID/EPC Consolidated Data

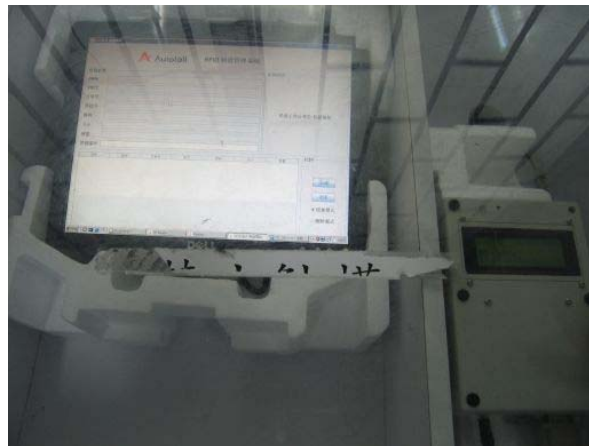Host Systems e.g. ERP, WMS

GS1 **EPCglobal**

Esquel Pilot

UHF RFID tags used in the plastic boxes and HF RFID tags used in bundles

Automatic scanning when semi-finished products gate out and shipped to HK

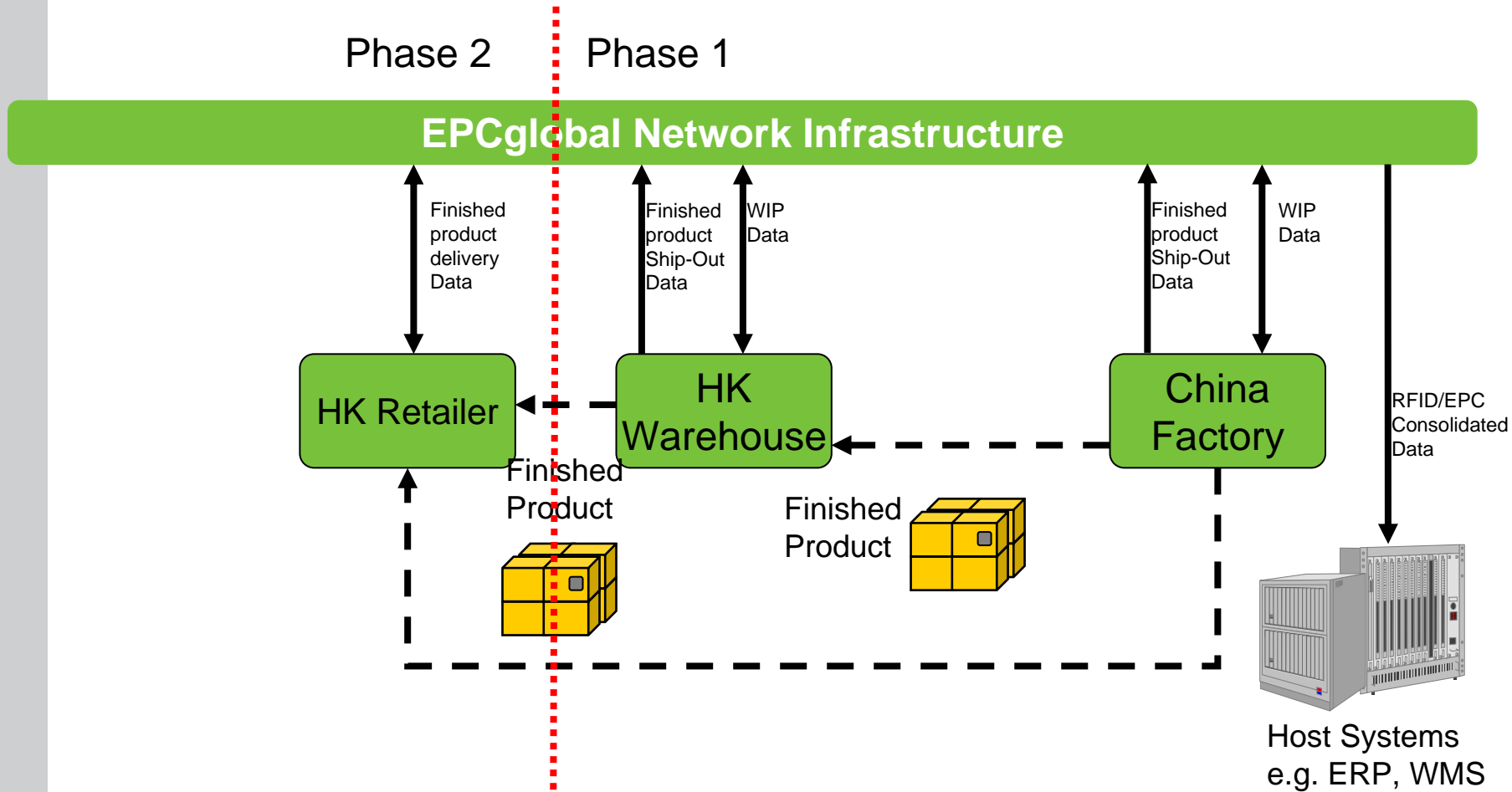# Esquel Pilot

RFID Readers and Antennas

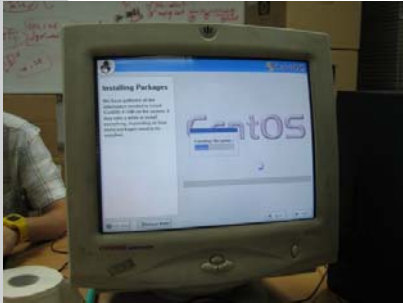

UHF RFID tags for the plastic boxes

The Hong Kong EPCnetwork Infrastructure Project

China/HK Pilot 2 – Group Sense Ltd.

Phase 2 | Phase 1

EPCglobal Network Infrastructure

Finished product delivery Data

Finished product Ship-Out Data

WIP Data

Finished product Ship-Out Data

WIP Data

RFID/EPC Consolidated Data

HK Retailer

HK Warehouse

China Factory

Finished Product

Finished Product

Host Systems e.g. ERP, WMS

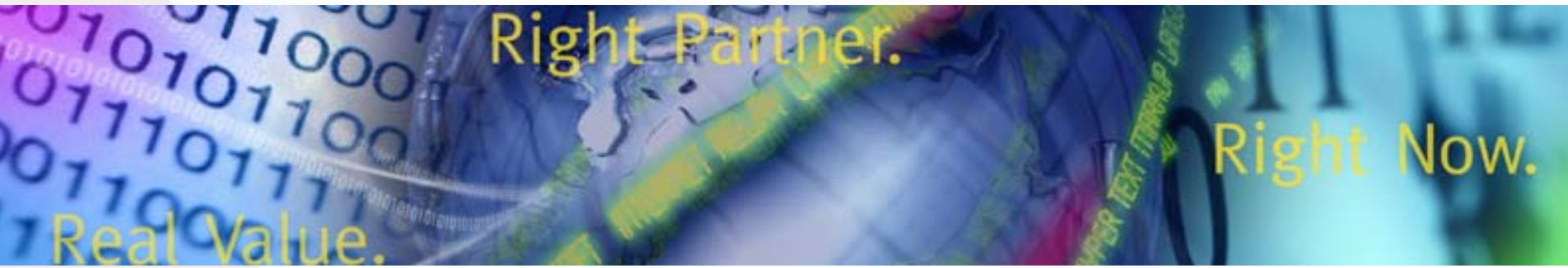GS1 EPCglobal

GSL Pilot

Label commissioning and print tags

RFID equipment installed in the warehouse

Thank You !