5 section five

EPCIS and Its Applications

This article provides an overview of the Electronic Product Code Information Service (EPCIS) and an EPCIS pilot trial for the shipment of goods between Hong Kong to Japan. The article is written in 2 parts: Part 1 describes what is EPCIS, its functions and usage; and Part 2 is a summary of the pilot trial of EPCIS capturing and exchanging real-time data of the movement of goods from China to Hong Kong and then to Japan ports.

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1 What is EPCIS?

"EPCIS" refers to Electronic Product Code Information Service. It is a standard that defines interfaces to enable the sharing of data among trading partners. This sharing of data in the supply chain is aimed at enabling participants in EPCglobal Network to gain real-time visibility into the movement, location and disposition of assets, goods and services throughout the world. EPCIS allows for the seamless secure exchange of data at every point in the lifecycle of goods and services.

The EPCIS approach defines a standard interface to enable Electronic Product Code (EPC) related data to be captured and queried using a defined set of service operations and associated EPC-related data standards, all combined with appropriate security mechanisms that satisfy the needs of user companies. In many or most cases, this will involve the use of one or more persistent databases of EPC-related data, though elements of the Services approach could be used for direct application-to-application sharing without persistent databases.

With or without persistent databases, the EPCIS specification specifies only a standard data sharing interface between applications that capture EPC related data and those that need access to it. It does not specify how the service operations or databases themselves should be implemented. This includes not defining how the EPCIS should acquire and/or compute the data they need, except to the extent the data is captured using the standard EPCIS capture operations. The interfaces are needed for interoperability, while the implementations allow for competition among those providing the technology and EPC Information Service.

EPCIS is therefore a standard that defines the interfaces to enable the sharing of data between trading partners and is not a service. It is a new breakthrough for trading partners to share information as it creates a new dimension in collaboration.

EPCIS is a standard-based approach to securely share product movement information that will provide visibility and improve businesses processes in an unprecedented manner. It is the foundation for increasing visibility, accuracy, and automation throughout the supply chain and is driven by end user needs to share event related information.

EPCIS is industry and application neutral. It is a cross-industry framework with cross-industry and industry-specific vocabularies and extensions. It is user-extensible. It allows each trading partner to keep their data.

EPCIS enables secure information exchange where each company controls their data and shares it only with those partners they choose to share it with. EPCIS leverages on established security mechanisms. Its unique feature is that it is a supplement to and not a replacement for, existing enterprise information systems. It is complementary to EDI.

2 The EPCIS Standard

Product identification that can be captured by EPCIS may come in any of the following formats:

- Passive RFID Tag - UHF Gen 2, HF
- Barcodes - Linear, Data Matrix
- Active RFID Tag
- Human Readable Number
- And more in the future!

The EPCIS specification Version 1.0 is a ratified global standard. It has been widely deployed across industries. Some examples are:

- Retail Supply Chain (RSC) for Promotional Visibility and Electronic Proof of Delivery were successfully implemented in the phase 1 pilot completed in February 2007 from Hong Kong Port to Japan Kobe Port. A total of nine RFID read points in China/Hong Kong and three RFID read points in Japan were deployed with data captured and shared among the trading partners through four EPCIS. For details, please refer to the EPIC pilot described in the second part of this article.

- The second phase of the EPCIS pilot is scheduled for completion in February 2008. It is set to reinforce the EPCIS dimension. Information will be exchanged between potential end users, such as customs administrations for automatic customs clearance. The trade lane to be used in this phase is Shanghai Port to Long Beach Port in California. Both sea and air transportation modes will be used.

- Other areas for deployment of EPCIS are:
  - Healthcare Life Sciences (HLS) for Product Authentication/Pedigree;
  - Transport and Logistics (TLS) in a global pilot; and

- Consumer Electronics for product life cycle management and waste recycle of electrical, electronic equipment (WEEE) management which is mandated in Europe.

GS1 Singapore is an active member in the planning of the above mentioned 2 EPCIS pilots.

- Media and Entertainment use of EPCIS for Value Chain Testing.

An EPCIS Interoperability Event had also been successfully conducted with 12 global participants in July 2006. Samsung was one of the contributing member and participant of this event.

2.1 What is specified in the EPCIS standard?

There are two interfaces and a data model in the EPCIS standard.

The **Event Capture interface** enables the loading of business events containing consistent XML data elements into a repository. The business events describe granular product movements in the supply chain e.g. EPC 123 (product) was Received (business step) in Non Sellable condition (disposition) at Distribution Center X (location) yesterday at 2pm EDT (time).

The **Query interfaces** enable internal and external systems to request business events from the repository using a parameterised interface:

- Poll Queries for an immediate response
- Subscription Queries for a triggered response.

The **Data Model** includes the necessary elements to describe product movements in the supply chain:

- EPC, Event Time, Business Step, Disposition, Read Point, Business Location, and Business Transaction. It is readily possible to extend the data model to include other fields. Some extensions for the pilots to-date include Expiration Date, Batch Number, and Temperature.
- EPCIS specification does not define the implementation of the repository. So it is possible to implement the EPCIS interfaces and data model on a database, XML file system, or potentially other structures.

2.2 What is EPCIS Data?

EPC Events answer four questions - **What**, **Where**, **When**, and **Why**.

What	• EPC number (can leverage master data - GTIN) • Manufacturing Data (lot, batch, expiration date) • Transactional Data (PO, Shipment, Invoice)
Where	• Location (can be fixed or moving - leverage master data - GLN)
When	• Event Time • Record Time
Why	• Business Process Step - e.g. Receiving, Shipping • Product State - e.g. Saleable, Active, In Transit • Current Conditions - e.g. Temperature

The EPCIS standard enables extending event data in each direction

2.3 Data Exchange Components

The EPC Event Data consists of the following which is the basis for standardised Data Exchange:

- EPC;
- Time;
- Read Points;
- Business Locations;
- Business Steps;
- Disposition; and
- Business Transaction Type.

Read Points

- Read Points are the very specific place that an RFID read took place. Where the RFID instrument (a reader) captured an event. In some instances this may be very similar if not equivalent to a Business Location.

A *Read Point* answers the question: "Where was the Object seen?"

Business Location

- Business Locations depict the logical place a ***product*** is assumed to be following an RFID read event until a new event takes place.

A *Business Location* answers the question: "Where is the Object assumed to be following the read event?"

Business Step

- Business Step - specifies the business context of an event: What business process step was taking place that caused the event to be captured?

A *Business Step* answers the question: "What business process is being executed at this read point?"
Example would be "Receiving".

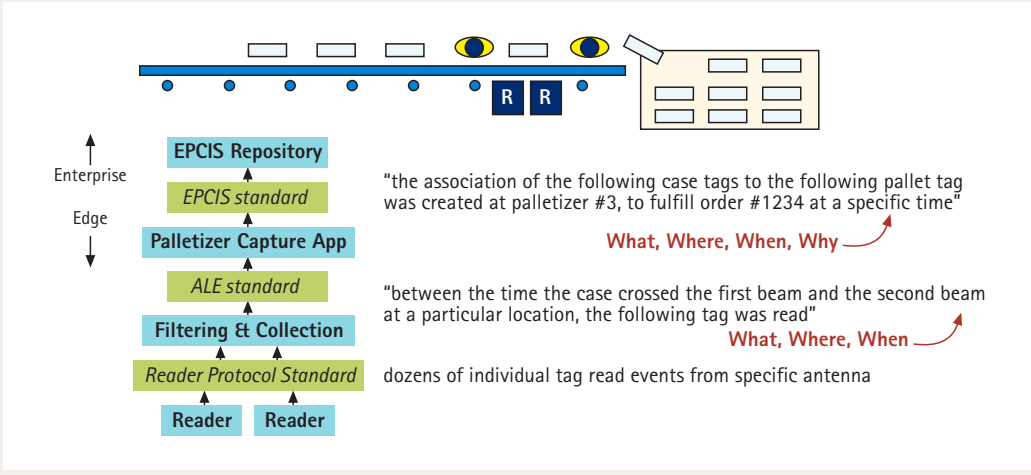


Figure 1: Data Capture Example – Palletizer

2.4 How does EPCIS Data Sharing work?

EPCIS instances at each enterprise communicate via the EPCIS Query Interface.

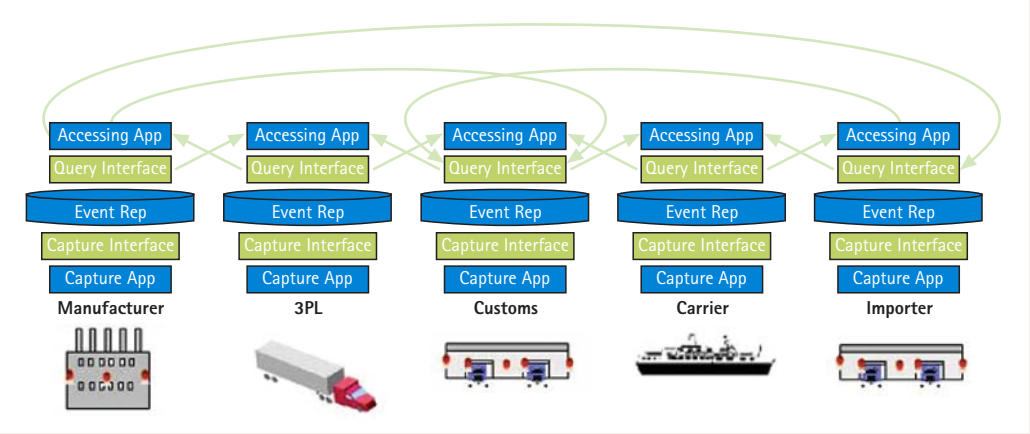


Figure 2: EPCIS data sharing

- Today, trading partners know each other through pre-arrangement.
- Future: "discovery" services to find partners.

3 EPCIS in Action

3.1 Retail Promotions

EPCIS can help measure and drive promotion in retail promotions. It can:

- Track the timeliness of the product: is promotional packaging reaching consumer in time?
- Monitor the effectiveness of the retail promotion: is promotional item selling better?

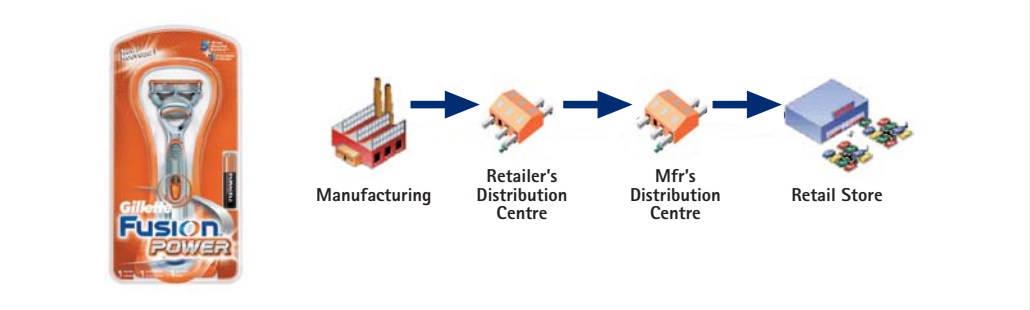


Figure 3: EPCIS in retail promotions

- Give unique EPC to each case of promotion - packaged item, on RFID tag.
- Enables the interaction of RFID tags with RFID readers located at loading lock doors, forklift trucks, retail back-room-door and dumpster.

3.2 Other Uses of EPC are Currently Underway

To improve business processes, EPC is currently used in the following:

- Electronic Proof of Delivery
- Out of Stock
- Chain of Custody Traceability/ePedigree
- Product Authentication
- Returns Management
- Operations Management
- Diversion/Theft Detection
- And more ...

EPCIS supports this variety of use cases because it enables flexible and secure cross-trading partner data sharing.

4 Why is EPCIS valuable?

EPCIS is already in use today in Retail Supply Chain (RSC), Healthcare Life Sciences (HLS) and Transport and Logistics (TLS). It offers various benefits, among which are:

- It provides standard data model, capture, and query interfaces to enable track and trace, product authentication, diversion detection, and other use cases across supply chain partners across multiple industries.
- Security is a core concept - Each trading partner gets to keep their data and partners only move/share data they wish to share on an on-demand basis.

5 The Pilot on Shipments Using EPCIS

The EPCglobal pilots for shipments using EPCIS is funded by the Japanese Government, Ministry of Economy, Trade & Industry (METI) and managed by the pilot Task force team under the EPCglobal Transportation & Logistics Industry Action Group.

GS1 Singapore, GS1 Hong Kong and GS1 Japan are active members of this working group and have actively participated in this pilot together with shippers, importers, logistics providers, forwarders and shipping companies.

The objectives of the Phase 1 and Phase 2 Pilots are as follows:

Phase 1 Pilot

- Demonstrate how EPC/RFID and EPCIS can be applied in transportation and logistics from HK to Japan port.
- Interoperability among multiple trading partners and service providers.

- Proof of concept using active RFID technologies serving as foundation for Phase 2 Pilot.
- Prepare and investigate shipment info used for import/export declaration.
- **Only Ocean Transport.**

Phase 2 Pilot

- Utilise EPC/RFID and EPCIS technology components and EPCglobal standards.
- Enable visibility at critical events in the supply chain.
- Test and develop requirements for Active RFID and integration with associated technologies.
- Identify standards opportunities for transportation and logistics providers.
- Open results and information sharing for the EPCglobal member community.
- **Both Air and Ocean transport.**

5.1 Report on the Pilot

In May 2006, EPCglobal TLS IAG (Transport and Logistics Service Industry Action Group) formed the Pilot Use Case to evaluate existing EPCglobal GEN 2 standard to investigate and verify EPCIS as it is being developed by a group of user companies.

The Japanese Government, Ministry of Economy, Trade and Industry (METI), proposed to EPCglobal TLS IAG to conduct such a pilot project. The TLS agreed and discussed about how to demonstrate interoperability among multiple trading partners and service providers in a global supply chain:

- Utilise EPC/RFID technology components and EPCglobal standards;
- Enable visibility at critical events in the supply chain;
- Test and develop requirements for Active RFID and integration with associated technologies;
- Identify standards opportunities for transportation and logistics providers; and
- Open results and information sharing for the EPCglobal member community.

The Working Group decided to take a phased approach and divided the project into two phases. The first phase is a pilot shipment from Hong Kong port to port of Tokyo in Japan. The second phase is to use the experiences gained in the first phase to conduct a pilot shipment from Shanghai, China to Los Angeles, USA.

Phase 1 of the pilot, which was extensively supported by the Japanese Government, Ministry of Economics, Trade and Industry (METI), assessed the user of both passive and active EPC tags for sea shipment of cartons and containers. The pilot addressed specific business needs of the partners, such as matching tagged products with purchase orders.

EPCIS pilot participants include several hardware and software companies, government bodies, and global supply chain providers including METI, Maersk/Maersk Logistics, Schneider National, Inc, APL, DHL, NYK logistics, GS1 Hong Kong, IBM, BEM Systems, WhereNet, Symbol, Toppan Printing, Toppan Forms, Savi, Allumis, NRI, Oracle, IIJ, NTT COMWARE, Monohakobi Technology Institute, VeriSign and Schenker.

This multi-industry, multi-stakeholder initiative extensively tested EPCglobal standards developed in response to specific user requirements. Through the use of the EPC Information Services (EPCIS) standard in particular, true visibility at critical junctions throughout the global supply chain was achieved.

5. 2 Objectives of Phase 1 Pilot

Let us review the objectives again. We demonstrated how EPC/RFID can be applied in transportation and logistics from HK to Japan port.

1) Demonstrate interoperability among multiple trading partners and service providers in a global supply chain using EPC/RFID and EPCIS technology and GS1 standards.

2) Provide the foundation and proof of concept for the larger Global Transportation and Logistics BAG Pilot (Shanghai - Los Angeles) using active RFID technologies.

3) EPC/RFID and shipment info used in transportation and logistics in apparel and footwear.

4) Prepare and investigate shipment info used for import/export declaration.

Under the Phase 1 Pilot with shipments of goods from Hong Kong to Japan, EPC data were exchanged and events were queried.

The graphic set-up of Japan EPCIS and the Hong Kong EPC Network is shown in Figure 4.

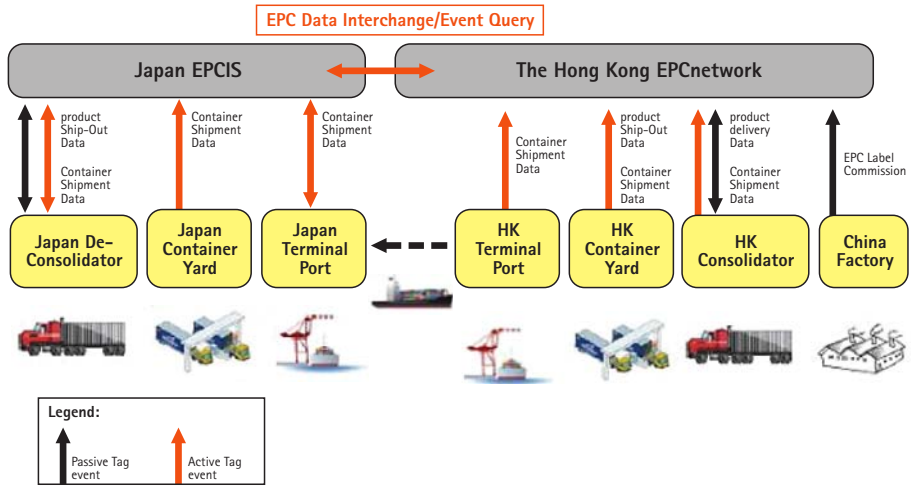


Figure 4: Japan Global Pilot Phase 1 (Hong Kong to Japan)

The GS1 Identification key layers used in Phase 1 Pilot included Global Location Number (GLN), Global Returnable Asset Identifier (GRAI) and Serial Shipping Container Code (SSCC). Details are shown in Figure 5.

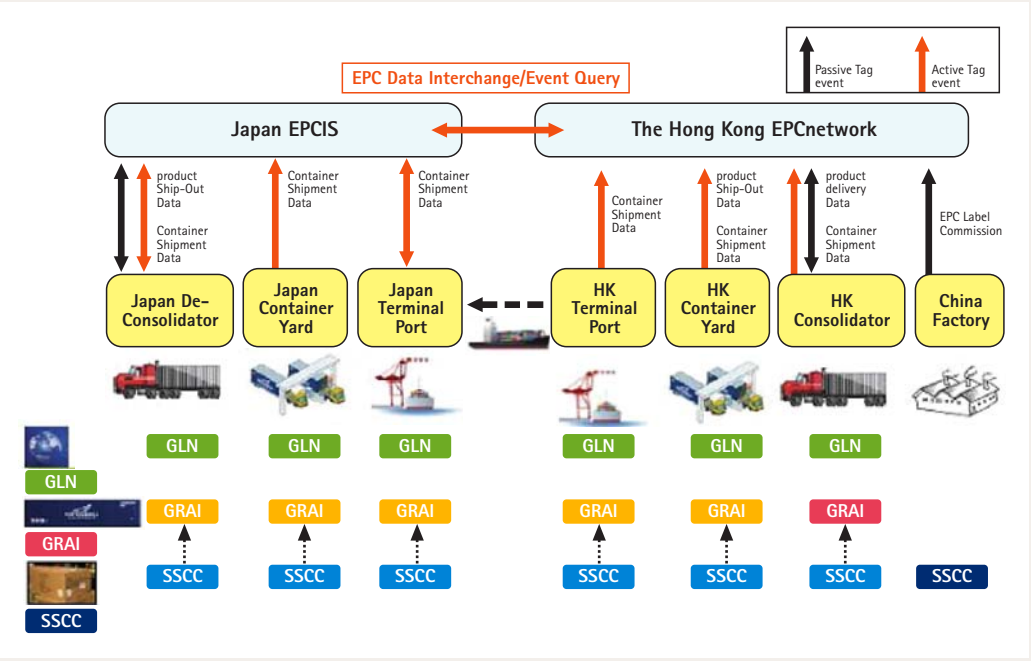


Figure 5: GS1 Identification key layers in Phase 1

5.3 Process Flow

At the time of the implementation of the Phase 1 Pilot, the RFID spectrum for UHF in China was not finalised. (It has since been finalised and announced on 20 April 2007). Due to the lack of UHF frequency availability in China at that time, all the work of initiating and commissioning data on the EPCglobal Gen2 tags need to be done in Hong Kong instead of in China. In the case of empty containers, the active RFID tags were attached at the empty container yard in Hong Kong and the data was read. The consecutive application and reading of active tags at the empty container yard were defined as R1 "Commission Container Tag". For this project, to evaluate the efficiencies of different active tags; two different brands of active tags were used. One brand of active tags was made in Japan and the other brand of active tags was made in USA. The Japan brand active tag stored serial number, temperature data and vibration data inside the tag and other data such as GRAI, GLN were stored in EPCIS through the middleware. The USA brand active tag stored GRAI and temperature data inside the tag and other data such as GLN inside EPCIS.

The followings are description of process flow and read events in the use case of Phase 1 Pilot, confirming a location of each read event (Table 1).

READ EVENT	DESCRIPTION
R1 <Active Tag>	Commission container tagged at empty container pool
R2 <Active Tag>	Container arrived at Hong Kong Warehouse (Location A)
R3 <Passive Tag>	Commission carton tag at a shipper's factory in China
R4 <Passive Tag>	Cartons arrived at Hong Kong warehouse (Location A)
R5 <Passive Tag>	Cartons loaded into the container at Hong Kong warehouse (Location A)
R6 <Active Tag>	Cartons aggregated/associated to the container (Location A)
R6A <Active Tag>	Container closed (Location A)
R7 <Active Tag>	Loaded container departed Hong Kong warehouse (Location A)
R8 <Active Tag>	Container arrived at Hong Kong container terminal In Gate Modern Terminal (Location B)
R9 <Active Tag>	Container arrived at Japan container terminal Quay Tokyo Container Terminal (Location C)
R10 <Active Tag>	Container departed Tokyo container terminal (Location C)
R11 <Active Tag>	Container arrived at Japan Brand Owner warehouse in Kawasaki (Location D)
R12 <Active Tag>	Container opened at Japan Brand Owner warehouse (Location D)

Table 1: Process flow and read events in the use case of Phase 1 Pilot

In this Phase 1 Pilot, there were eight RFID read points in China and Hong Kong (R1 to R8) and four RFID read points in Japan (R9 to R12).

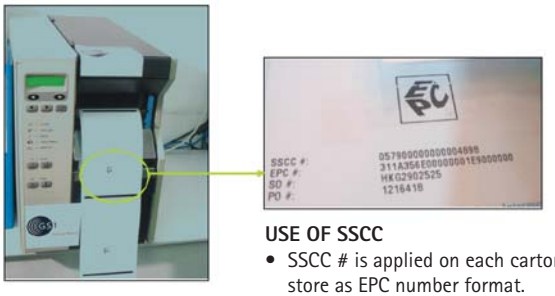
Figure 6: Detail Read Point (Hong Kong)

Similarly in Japan, there were three RFID read points (R10 to R13).

Figure 7: Detail Read Point (Japan)

The unique feature of the Phase 1 Pilot is the successful usage of GS1 Keys - SSCC, GLN and GRAI in the project.

SSCC is Serial Shipping Container Code and it is a candidate as the content of Unique Consignment Reference Number (UCR) proposed by the World Customs Organization's (WCO).



USE OF SSCC

- SSCC # is applied on each carton box tagging, it is translated and store as EPC number format.
- World Customs Organization (WCO) has approved the use of SSCC as the content for WCO's Unique Consignment Reference Number (UCR) and in this pilot.

Figure 8: Use of SSCC

GLN is Global Location Number and it is used in Phase 1 Pilot to identify the RFID read points.

USE OF GLN

- GLN # of consolidators, Deconsolidator, Terminal ports in both Hong Kong and Japan are assigned. It is used to EPCIS query and EPC biz location identification.

ATL Logistics Centre (Hong Kong)
urn:epcglobal:tls:loc :4899940303007

NYK Tokyo Container Terminal
urn:epcglobal:tls:loc :2022222220019

Maersk Logistics Warehouse (Hong Kong)
urn:epcglobal:tls:loc :5790000000012

Consignee Warehouse (Japan)
urn:epcglobal:tls:loc :2011111110012

Figure 9: Use of GLN

The GRAI is Global Returnable Asset Identifier and it is used in this pilot to identify the containers.

USE OF GRAI

- GRAI # is used for container level tagging. ISO container # is translated into GRAI 170 format and store as EPC number format.

urn:epc:id:grai:579000.999999.NYKU5850310

Figure 10: Use of GRAI

The key highlight of the Phase 1 Pilot is the successful linkages of the EPCIS in Hong Kong with three separate EPCIS in Japan and the successful exchanged of all vital data among the four EPCIS.

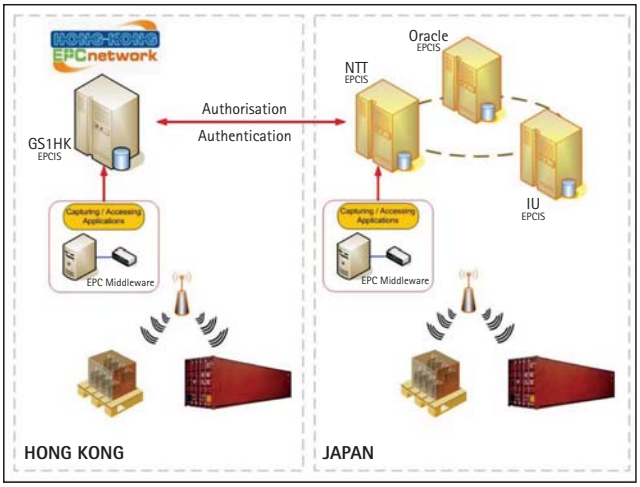


Figure 11: Use of EPCglobal Network

5.3 Phase 2 Pilot

The Phase 2 Pilot is currently being planned and organised. It will involve the shipment of goods by sea and air from Shanghai, China to Los Angeles, USA. EPCIS in China and EPCIS in USA will be interconnected to conduct real-time exchange of data capture by RFID read points.

6 Conclusion

6.1 Benefits of Phase 1 Pilot

The Phase 1 Pilot validated the value of EPC standards and technology. It demonstrated how organisations across a global supply chain can exchange real-time event data and track shipments from point of manufacture through the final point of distribution with EPCIS. Supply chain partners will have real-time access to information about products and shipments as they travel along the supply chain.

Seen from shipper and consignee, most important benefits of the Phase 1 is that EPC/RFID technology and GS1 identification keys enables logistics management by unit of P/O (carton level in the Phase 1). Logistics providers, forwarder, and 3PL provider would obtain this benefit, specifically:

- Improvements in P/O level logistics management (For example, enables to identify and replenish cargo by carton level to the final consignee);
- Decrease of cargo shrinkage such as lack and stolen during the transport by means of carton level tracking and tracing from the beginning to the end (Actually the shipper have such kind of problem especially from China factories to the destination.);
- Decrease of labour force and lead-time for checking number of cargoes and inspection; and
- Improvements in visibility of consolidation by means of matching P/O (carton SSCC level) with container GRAI level (This expands the possibility of making manifest information for consolidation automatically).

From ocean liner perspective, the benefits in Phase 1 are an improvement in visibility of container transportation, which is already provided by themselves as a service to some extent, and a further clarification of transport responsibility, especially about the timing of handing cargo over to the next entity in the whole supply chain.

In terms of 4 walls (Warehouses and Container Yards) management benefits in phase 1, it appeared that un-matching P/O with actual cargoes would be decreased through improving visibility of P/O level movement. Of course, as described in the above, decrease of labour force and lead-time for checking number of cargoes and inspection are highly expected. Improvements in utilisation of warehouse assets would also be possible as a result of decreasing the number of stocks in the whole supply chain.

6.2 Potential Benefits of EPCIS

The EPC standards and EPC/RFID technology including EPCIS would further expand the improvement of Transport & Logistics Services. Main assumed benefits are as follows:

Trade Procedures Improvement

- Automatic custom clearance in co-operation with EPCIS and the Custom's EDI system (At the present, forwarder only can start import custom clearance when terminal operator completes cargo acceptance procedures to NACCS in Japan).

Logistics Vendor Management

- To be possible to evaluate logistics vendor (For example, truck company would be evaluated in terms of time gaps between getting the tender and reaching the warehouse and transport quality such as damage and losing cargo).

4 Walls Management

- Making CLP (Container Load Plan) safely and automatically with maximising consolidation.

These benefits are to be verified by the Phase 2 Pilot with shipments from Shanghai, China to Los Angeles, USA using both air and sea transport.

Figure 12: RFID (Passive/Active) demonstration in Kobe in January 2006

Figure 13: Whole picture of Process Flow in Japan

7 Acknowledgement

We would like to thank Mr Bernie Hogan of EPCglobal for supplying the latest version of EPCIS Standard to facilitate the enhancement of this article.