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Section Three

# Application of EPCglobal for Container Shipments from Tokyo to Amsterdam

The **GS1 EPCglobal** (TLS: Transport and Logistics Service Industry Action Group) **RFID Pilot Program** was launched to review existing global standards against "real life" transportation and logistics services processes. A primary focus of this activity was to determine if the EPCglobal Gen 2 standards support business objectives as defined by multiple industry participants utilising the Electronic Product Code (EPC) and Radio Frequency Identification (RFID) to create value through increased visibility across stakeholders, countries, and continents.

In 2009, EPCglobal TLS Shipment Program focused on testing out the use of EPCIS to track the progress of physical products in cartons, pallets and containers across the international supply chain from Tokyo to Netherland with 39 sea freight containers.

The challenges for the shipment from Tokyo to Amsterdam are the use of EPCIS which is a fully automated data capturing system and the involvement of Customs authorities.

'The GS1 GSIN' as the Unique Consignment Reference Number was used in order to comply with customs identification requirements for shipments.

The use of active EPC/RFID (Extended Conveyance Asset Tag (XCAT)) and e-seal tags on sea containers as well as the application of active tags on pallet level were tested within the framework of the Program.


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## 1 INTRODUCTION

In the Synthesis Journal 2007, Tan Jin Soon and Dr Shinichi Ishii jointly wrote an article on "EPCIS & Its Applications". It defined what is EPCIS and recorded the pilot trial of EPCIS capturing and exchanging real time data by RFID of the movement of goods from China to Hong Kong and then to Japan Tokyo Port in pilot phase 1 and pilot phase 2, respectively.

In the current article, we are capturing the EPCglobal Transportation and Logistics Pilot Phase 3 with 39 containers shipped by four ocean vessels from Tokyo Port to Amsterdam Port successfully using EPCglobal Gen 2 RFID tags, 433MHz Active tags, Gen 2 electronic seal and EPCIS in capturing and exchanging data in real time on transportation of electronic goods over 13 weeks from 10 December 2008 to 25 February 2009.

**Scope** : The scope of the Pilot Phase 3 is to transport a global brand electronic equipment from its warehouse in Funabashi, Japan to its warehouse in Amsterdam via ocean container vessel in four shipments.

**Time Line** : December 2008 to February 2009

**Participants** : CANON Inc., a global brand electronic shipment manufacturer (Shipper/Consignee)
MISC (Ocean carrier)
NYKTT (Terminal operator in Tokyo)
Ceres Paragon (Terminal Operator in Amsterdam)

**Funding** : Members of EPCglobal Transportation & Logistics Group
METI (Ministry of Economic, Trade & Industry) of Japan.

**Cargo/Freight** : Consumer electronic goods

**Active RF-tags** : NTT (active tags)

**Passive RF-tags** : SATO (NXP)
Toppan Forms (NXP)
Mitsubishi Electric (TORAY, Alien)
Secura Shield

**Reader Providers** : Mitsubishi Electric (IBM Japan)
Mighty Card

**A/P Providers** : Allumis, NEC

**EPCIS Providers** : NEC, GS1 Germany (Oracle)

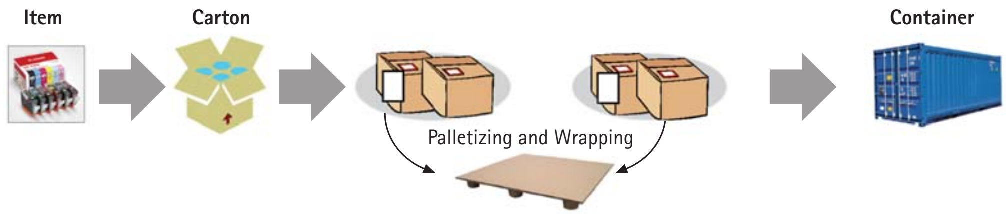
## 1.1 Challenges for Pilot Phase 3

The pilot phase 3 will address:

- Unique identifiers for logistics units; Cargo Layers (Container, Pallet, Carton......).
- Automation (cargo data capturing system and uploading system to EPCIS/data repository).
- Enhanced security.

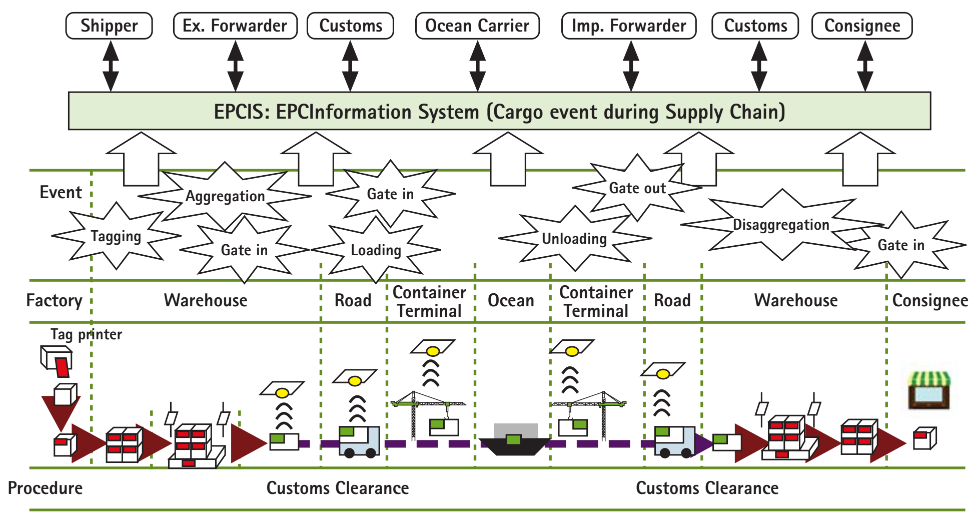
## 1.2 Physical Cargo Identifier

There is strong need to acquire visibility information even under container level. Details are illustrated below.




| | Item Level | Carton Level | Pallet Level | Container Level | Consignment Level |
|---|---|---|---|---|---|
| **Identifier in the current process** | Serial number | (D/O number) | (D/O number) | Container number | - |
| **Identifier in the pilot** | - | SSCC<br>- Child | SSCC<br>- Parent | GIAI | GSIN (UCR) |
| **Length** | - | 96 bit | 96 bit | 202 bit | 21 digits |

In the supply chain, the enhanced global supply chain visibility is achieved via leveraging RFID and EPCIS as shown below.



## 1.3 UCR

- The world customs organization (WCO) has published guidelines for the **unique consignment reference (UCR) in 2004**. These guidelines require the sender (consignor/shipper) of goods to identify physical grouping of several transport or logistic units to be identified with a single UCR.

- UCR has to identify **several transport or logistic units that travel under one single customs declaration (or dispatch advice)**.

- The only GS1 Application Identifier that meets the WCO requirements is **AI 402**. This would become **Global Shipment Identification Number (GSIN)**.

## 1.4 What is GSIN?

- The Global Shipment Identification Number is a number assigned by a consignor (seller/shipper) of goods. It provides **a globally unique number that identifies a logical grouping of logistic units under one dispatch advice for the purpose of a transport shipment from that consignor (seller) to the consignee (buyer)**.

- It may be **used by all parties in the transport chain as a communication reference**, for example, in Electronic Data Interchange (EDI) messages where it can be **used as a shipment reference number**. The **GSIN fulfils the requirements of the UCR of the WCO**.

## 1.5 Expected Definition of GSIN

- What is identified for:
  - **A logical grouping of logistic units from consignor (shipper) to consignee under one single dispatch advice**.
  - **One single customs declaration** (required by WCO standard).
  - Its unit equals to, or is more than one invoice number.

- Who is a issuer of GSIN:
  - **Consignor (Shipper)**

- Who can see GSIN visibility:
  - It includes **parties who are involved into the shipment from shipper to consignee**.
  - The candidates would be forwarder, transport carrier, terminal operator, and customs offices.

- When is GSIN issued:
  - It is when cargos that consignee ordered under one single delivery order are stuffed into a logical grouping of logistics units at origin.
  - In other words, it is **when delivery order information actually matches with the physical event that the container related to the shipment is assigned by shipping line OR the goods concerned are stuffed into container**.

- When GSIN validity ends:
  - It is when cargos that consignee ordered under one single dispatch advice are delivered to destination.
  - In other word, it is **when delivery order information actually matches with the physical event that the goods concerned are unstuffed**.

- Where is GSIN issued:
  - **The place shipper instructs at origin**.

## 1.6 Additional Requirement

- In order to qualify for UCR, AI 402 needs to be unique for at least 10 years. This is a requirement for Customs Authorities on import shipments. The shipment reference is assigned by the consignor. In order to fulfil the requirements of the WCO UCR, a GSIN has to be unique and not to be re-used with a period of 10 years.

- It is suggested to include the wording in the appropriate section of the General Specifications dealing with Key Allocation Rules.

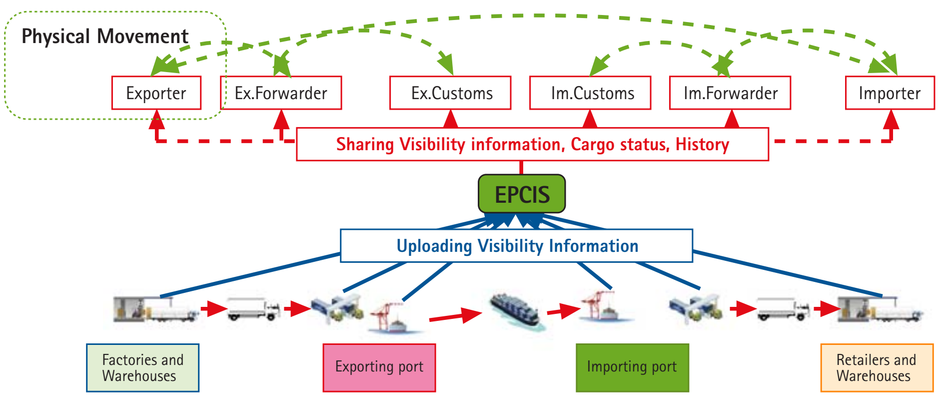
| Application Identifier | | | Shipment Identification Number | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | GS1 Company Prefix | | | | | | | | Shipper Reference | | | | | | | | Check Digit |
| 4 | 0 | 2 | N1 | N2 | N3 | N4 | N5 | N6 | N7 | N8 | N9 | NID | N11 | N12 | N13 | N14 | N15 | N16 | N17 |

*Note: N9 can be used as company prefix extension too.*

## 2 KEY CHALLENGES: VISIBILITY BY CONSIGNMENT

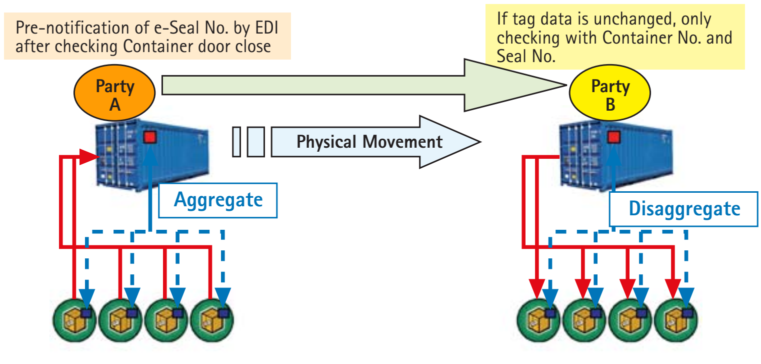
'Clearance information submitted by EDI' and 'cargo movement information with bonded site gate-in by RFID' can be obtained at the same time.

Visibility is required not only for every consignment but for every transport unit as illustrated below.




The security for the pilot phase 3 is enhanced by Passive e-Seal. The frequency chosen is UHF 860 - 960 MHz band so it can be used internationally without radio frequency issues. The e-Seal is EPC Gen 2 compliant so the e-Seal can be read with any EPC compliant reader.

The e-Seal has been demonstrated with many security pilot around the world. In line with the standard using EPCglobal Gen 2 passive frequency, EPCglobal TLS has demonstrated how to ensure security by using e-Seal, Active tag and permanent tag (Passive). Details are illustrated below.




## 3 KPI MEASUREMENT AND RESULT

### 3.1 KPI Result – Container Tag

Some of the container tag is not functioning when it arrived at Amsterdam. Total 36 out of 39 container tags are functioned properly to send out active RF signal in Amsterdam side.

### 3.2 433MHz Radio Detected Rate

| | Total container tag | Reading in JP | Reading in NL |
|---|---|---|---|
| 1st shipment | 3 | 3 tags read | 3 tags read |
| 2nd shipment | 10 | 10 tags read | 8 tags read |
| 3rd shipment | 6 | 6 tags read | 6 tags read |
| 4th shipment | 20 | 18 tags read | 19 tags read |
| **Total** | **39** | **37 tags read** | **36 tags read** |

Most of tags were read both in Japan and in the NL, we thus concluded that active container tag could be one of the solutions to get container visibility.

### 3.3 Container Tag Reading Failures

- Mechanical Problems:
  - Open/Close status switch could not function properly.
  - Four tags died during the long ocean transportation period, because of the tough condition.

- Operational Problems:
  - Difficult for reader to read container tags during short time with interfering radio with illegal trucks communication radio in Japan.
  - Short cycle of beacon rate is essential to read tags at check-points, but it would become battery consuming. We actually failed at the Land Mark for example.

### 3.4 Possible Cause affecting Container tag reading

- In Japan, several container tags could not be detected at NYTT in-gate because of interference by illegal radio wave of truck driver's communications.

- In the 1st shipment in NL, all three container tags could not be read at Ceres Terminal when they were returned to Landmark. Most suspicious reason is that the containers is moving in a relatively high speed when passing through the reader, thus reader do not have sufficient time to detect the signal. However, this can be improved from a technical perspective.

- When a container truck, CAXU8145914 in fact, arrived at Canon warehouse, a part of X-CAT, tag IC part was found to have dropped off. Thus, X-CAT signal failed to send out upon arriving.

### 3.5 KPI Result – Pallet Active Tag

Some of the Pallet tag signals cannot be captured in Canon EU Warehouse. All together 1,831 out of 1,909 Active Pallet tags signal are properly detected in Canon EU warehouse.

| | Total | Tokyo side | EU side |
|---|---|---|---|
| 1st shipment | 148 | 148 tags | 148 tags |
| 2nd shipment | 497 | 497 tags | 449 tags |
| 3rd shipment | 296 | 295 tags | 296 tags |
| 4th shipment | 968 | 967 tags | 961 tags |
| **Total** | **1,909 tags** | **1,907 tags** | **1,831 tags** |

| Japan Side | 1st | 2nd | 3rd | 4th | Total |
|---|---|---|---|---|---|
| Total | 148 | 497 | 296 | 968 | 1,909 |
| Tag Reading* | 148 (100.00%) | 497 (100.00%) | 295 (99.66%) | 967 (99.90%) | 1,907 (99.90%) |
| Aggregation Failure* | 0 (0.00%) | 2 (0.40%) | 4 (1.36%) | 65 (6.72%) | 71 (3.72%) |

| NL Side | 1st | 2nd | 3rd | 4th | Total |
|---|---|---|---|---|---|
| Total | 148 | 497 | 296 | 968 | 1,909 |
| Tag Reading* | 125 (84.46%) | 449 (90.34%) | 296 (100.00%) | 961 (99.28%) | 1,831 (95.91%) |
| Disaggregation Failure* | 21 (16.80%) | 90 (20.04%) | 58 (19.59%) | 220 (22.89%) | 389 (21.25%) |

**This statistics does NOT count tags which had not been working from the beginning: As a result of our analysis, we found 13 dead tags.*

### 3.6 KPI Result – Pallet Active Tag Reading in Japan

We achieved 99.9% reading at the warehouse in Japan. Only two small readers covered the warehouse, and the active tags were able to be read without disturbing the warehouse operation. We, therefore, concluded that active tagging at pallet level had great potential.

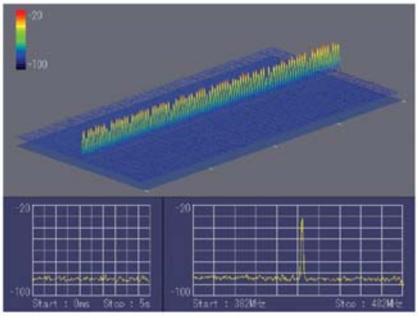
### 3.7 Possible Cause affecting Pallet tag reading

- **Firmware of tag**
  - The 1st shipment used 152 pallet tags. 4 out of 152 tags did not work from the beginning. The 2nd shipment used 504 pallet tags. 10 out of 504 tags did not work from the beginning, or the UHF beacon could not be detected at one of reading point.
  - The cause would be firmware logic of pallet tag, and be final inspection process after manufacturing at EMS. The firmware is revised for the 2nd shipment.

- **Fail to read because of radio wave collision**
  - In 1st shipment in NL, there were 22 out of 104 pallet tags that could not be detected. Two main reasons could come from the interference, namely the collision. Firstly, there is a material handling equipment next to the truck dock that uses 434MHz. This could significantly interfere with the transaction among both of container and pallet active tags and the reader.
  - Second, these active tags does not have any function in the firmware that change the duty cycle randomly though they have a carrier-sense function. This resulted in the collision status not only between the equipment and the tags but also among the tags themselves.

## 3.8 KPI Result – Pallet Active Tag Reading in NL

Having carrier-sense function, we achieved 95.9% read rate without interfering data transaction of existing other equipment, even though the material handling equipment next to the truck dock was transmitting almost 100% duty 434MHz radio.




## 3.9 KPI – Aggregation of Pallet to Container (Japan Side)

- Total correct aggregation over detected tags: 1700 / 1785
- Total fail aggregation over detected tags: 85 / 1785

## 4 IMPORTANT ISSUES FOUND IN THE EXECUTION (CONTAINER X-CAT TAG)

- **Deficit in controlling open/close status function**
  - From 2nd shipment in Japan, NTT changed firmware logic of X-CAT. It caused the trouble that X-CAT could not control container status information, including the container closing status especially. This also led the problem that the aggregation event between container and pallets could not be made because the capturing application logic used this closing status of X-CAT to create the event.
  - In the 1st shipment in NL, one container, CAIU8093465, the active tag reader at Canon EU could not detect the close status signal from container tag. To create the disaggregation event, three status signals are required, thus first the close status signal, second the open status signal, and the close one again. On the other hand, the first signal that the reader actually detected was the open status. The prime suspicious reasons are collision with Daifuku sorter and with other active tags themselves.

- **Fail to read at some choke points**
  - In Japan, several container tags could not be detected at NYTT in-gate because of interference by illegal radio wave of truck driver's communications.
  - In the 1st shipment in NL, all of container tags could not be read at Ceres Terminal when they were returned to Landmark. Most suspicious reason is that the containers is moving in a relatively high speed when passing through the reader, thus reader do not have sufficient time to detects the signal. However, this can be improved from a technical perspective.

- **Discrepancy between the tag detected time and the actual event time**
  - The container loading event on the vessel was created before the actual loading process. The reason would be that the containers concerned entered into the read distance by chance.
  - This is a physical limitation that the pilot team is not allowed to set up the reader at every quay crane.
  - We have to come up with idea to get container status info by using different auto ID technology for data capturing into EPCIS in real world. Eg Optical Reading, etc.

- **Theft of Tag**
  - When a container truck, CAXU8145914 in fact, arrived at Canon warehouse, a part of X-CAT, tag IC part actually, was already fallen due to some reason. Thus, there was no X-CAT on arrival.

### (i) Lessons learned from this project

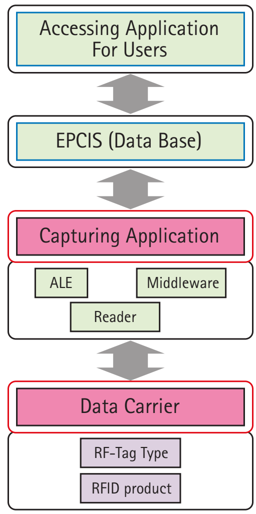
- We have learned many things from this pilot phase 3 project. Firstly, in this pilot phase 3 project, we tried to apply RFID/EPC technology into real life logistics operation. In real life, there were much more different environment than we thought with Frequency collision (probably generated by illegal users), physical layout problem for association between cargo and transport equipments (current warehouses are not suitable for automatic association for RFID, Tags and Cargos) and special environment for ocean transport with conditions depending on weather and temperature.

**(ii) Areas where further investigation / development in standards**

- In standards developments, we have focused on RFID product and Information system for sharing information (Database) by using EPC networks through the pilot demonstration. It is verification and reviewing process for standard development.

- However we found that there are missing standard development areas. We used standardised Frequency (Gen2) and developing standard frequency of 433MHz. By using these tags and readers, we had to develop specific capturing application for the communication between Tags and readers for this pilot. Some part of capturing application are standardised with ALE (Application level Events) and middle wares, but we needed to consider data format, length and data structure in the EPCIS for better communication among supply chain partners. The same issues were raised by application software that enable supply chain partners to share cargo visibility data through EPCIS.

- Other important issue we experienced through this pilot is that we need to consider to integrate existing hardware and software such as barcode technology, OCR (Optical Character Recognition system) and GPS that are already very common among ocean transport including terminal operation. The basic concept of EPCIS is device independent. It does not matter which ever devices are used for capturing cargo visibility. We have to consider harmonisation with these existing data carrier and devices.




### (iii) What's next

Based on these analysis and review of this pilot phase 3 from Tokyo (JP) to Amsterdam (NL), we are restarting the discussion about basic scheme for supply chain partners to share the information through RFID/EPC technology. In compliance with industries and authorities requirement for cargo visibility, we conclude the basic cargo visibility platform standard is the most important issues we have to develop as soon as possible. In the process of reviewing and summarising last three pilot demonstrations by EPCglobal, we now decide to develop 'implementation guideline' which includes lessons learned from the three pilots (phase 1, phase 2 and phase 3). We are looking for an opportunity as a phase four pilot. In the phase four pilot, we are trying to find an opportunity to implement EPCglobal using EPCIS for shipments between two countries. This is especially important because after the successful execution of the three pilots (phase 1, phase 2 and phase 3), we could not get shippers to adopt although we know that there are such potentials and opportunities to apply RFID/EPC to international transport and logistics. We are now in the developing stage for the implementation of RFID/EPC technology. We hope to have pilot phase four commencing late 2009 or early 2010.

## 5 ACKNOWLEDGEMENTS

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He has been actively involved in the manufacturing, distribution, marketing and procurement of consumer products in Singapore and Malaysia during the past 40 years. He was a member of Food & Beverage Advisory Committee of the Singapore Trade Development Board during 1992 to 1995.

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Dr Ishii, Senior Management Consultant for Transportation Industry of Nomura Research Institute has a professional experience of 20 years and has been involved in transport and logistics planning, business development Strategy for transport & Logistics Industry, trade facilitation programme with B2G, ICT programme for both public and private sectors.

He has participated in Trade Facilitation and Electronic Data Interchange Project since 1998 through participation on UN/EDIFACT Working Group for Transport (TBG3 Group). He has been a member of committees on Inter-modal transport between maritime and land transport Project conducted by the Ministry of Transport in Japan and also a committee member of Traceability, Transportation and Logistics Industry, conducted by Ministry of Economy, Trade and Industry in Japan. He has been a Japanese delegate for ISO TC204 Working Group 7 (General Fleet Management and Commercial Freight Operation) since autumn 2002.

He joined EPCglobal activity for Transport and Logistics Business Action Group from the beginning in spring 2005. He was a member of import/export working group and is now a Co-Chair of chain of custody task force group of EPCglobal Transport and Logistics Service Industry Action Group.