Basics of EPC

Training
Introduction

Objectives:

- Create awareness of the concepts
- Develop technical knowledge
- Show benefits of implementation
- Explain 5 steps of Implementation
Programme

- Introduction
- What is EPC?
- Benefits of the EPC Applications
- Technical Information
- Implementation
What is EPC?

The global language of business
What is EPC?
EPC is one of GS1 Products

- Global standards for automatic identification
  Rapid and accurate item, asset or location identification

- Global standards for electronic business messaging
  Rapid, efficient and accurate business data exchange

- The environment for global data synchronisation
  Standardised, reliable data for effective business transactions

- Global standards for RFID-based identification
  More accurate, immediate and cost effective visibility of information
What is EPC?

GS1 Solutions:

GS1 TRACEABILITY
What is EPC?

GS1 Solutions:
Patient Safety & Healthcare
The EPC Concepts
The EPC Concepts

Exchange

Capture

Identify

The Basic Needs of the Supply Chain
The EPC Concepts

Basic needs: identification
The EPC Concepts

Basic needs:
Data Capture
The EPC Concepts

Basic needs:
Data Exchange
The EPC Concepts

Solution to the basic needs:
The EPC Concepts

Solution to identification

EPC = Electronic Product Code.

The EPC identifies each single item.
The EPC Concepts

Solution to DATA CAPTURE

The EPC, is captured using RFID

RADIO FREQUENCY IDENTIFICATION
The EPC Concepts

Solution to Data Exchange

EPC is a System that allows the trading partners to capture and share information about the items in an automated way.

EPCglobal Network provides real-time information about each item.
The development process of the standards starts with gathering user requirements.

The standards are then developed based on these user requirements, by technical experts from solution providers.

These will be open standards.
Summary

This topic presented the three major concepts of identification, data capture and data exchange and how EPCglobal Inc has provided solutions to these key questions:

- the Electronic Product Code (EPC) to identify items
- RFID to capture information
- the EPCglobal Network to exchange data
Identification Keys
GS1 Identification Keys

Definition

• GS1 Identification Keys provide access to database information relevant to trading partners.

Objectives

• A single, open, business led, integrated system of identification for effective supply chain management in any company, in any industry, anywhere in the world.
• Relevant and applicable to any supply chain, independent of who assigns, receives, and processes them.
• Enable only one way to achieve a given, global, identification requirement.
• Fixed attributes (master data) of an item or service should be looked up from a database by entering GS1 identification key.

GS1 Keys (GTIN, GLN, EPC, SSCC, GRAI, GIAI, GSRN & GDTI)
What do GS1 identification keys identify?

**Trade items:** Any item (product or service) upon which there is a need to retrieve predefined information and that may be priced or ordered or invoiced at any point in the supply chain.

**Logistic units:** An item of any composition established for transport and/or storage which needs to be managed though the supply chain.
What do GS1 identification keys identify?

**Locations:** Physical or legal entities requiring a permanent identification (company, department, warehouse, ...).

**Assets, Service Relationships, Coupons,**

*(similar principles apply)*
Trade Items
GTIN is a GS1 Identification Key

- Unique
- Non-significant numbering structure
- International
- Secure
- Foundational

GTIN provides access to information held in computer files
Allocating the Numbers

It is the responsibility of GS1 Member Organisations to administer number allocation and set the rules in their territory.

THESE RULES MUST COMPLY WITH THE GS1 GENERAL SPECIFICATIONS
Global Trade Item Numbers (GTIN)

- **GTIN-14 data structure**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>GTIN of the items contained (without check digit)</th>
<th>Check Digit</th>
</tr>
</thead>
<tbody>
<tr>
<td>N_1</td>
<td>N_2  N_3  N_4  N_5  N_6  N_7  N_8  N_9  N_{10}  N_{11}  N_{12}  N_{13}</td>
<td>N_{14}</td>
</tr>
</tbody>
</table>

- **GTIN-13 data structure**

<table>
<thead>
<tr>
<th>GS1 Company Prefix</th>
<th>Item reference</th>
<th>Check Digit</th>
</tr>
</thead>
<tbody>
<tr>
<td>N_1  N_2  N_3  N_4  N_5  N_6  N_7  N_8  N_9  N_{10}  N_{11}  N_{12}</td>
<td></td>
<td>N_{13}</td>
</tr>
</tbody>
</table>
Allocating GTINs ...

Using GTIN-13 Data Structure:
The exact structure is left to the discretion of every Member Organisation. The main methods are:

<table>
<thead>
<tr>
<th>GS1 Prefix</th>
<th>Company number</th>
<th>Item number</th>
<th>Check Digit</th>
</tr>
</thead>
<tbody>
<tr>
<td>P₁ P₂ P₃</td>
<td>M₁ M₂ M₃ M₄ M₅</td>
<td>I₁ I₂ I₃ I₄</td>
<td>C</td>
</tr>
<tr>
<td>P₁ P₂ P₃</td>
<td>M₁ M₂ M₃ M₄ M₅ M₆</td>
<td>I₁ I₂ I₃</td>
<td>C</td>
</tr>
<tr>
<td>P₁ P₂</td>
<td>M₁ M₂ M₃ M₄ M₅ M₆ M₇</td>
<td>I₁ I₂ I₃</td>
<td>C</td>
</tr>
</tbody>
</table>
Global Trade Item Numbers (GTIN)

- **GTIN-12 data structure**

  - GS1 Company Prefix
  - Item reference
  - Check Digit

  \[ N_1 \rightarrow N_2 \rightarrow N_3 \rightarrow N_4 \rightarrow N_5 \rightarrow N_6 \rightarrow N_7 \rightarrow N_8 \rightarrow N_9 \rightarrow N_{10} \rightarrow N_{11} \rightarrow N_{12} \]

- **GTIN-8 data structure**

  - GTIN-8 Prefix
  - Item reference
  - Check Digit

  \[ N_1 \rightarrow N_2 \rightarrow N_3 \rightarrow N_4 \rightarrow N_5 \rightarrow N_6 \rightarrow N_7 \rightarrow N_8 \]
1 product = 1 GTIN
1 GTIN = 1 product
The GTIN identifies the lowest level

Product identification

The GTIN identifies the lowest level.
Significant numbering

Strongly not advisable

Product ID
1

Accessories department

Product ID
2

Leather-goods department

1 = leather
2 = vinyl
3 = fabric

Article Number

1 = leather
2 = vinyl
3 = fabric

Colour number

01 = black
02 = burgundy
03 = blue
04 = white

Fabric number

Color number
The GLN can be used to identify:

- physical locations and legal entities where there is a need to retrieve pre-defined information

Global Location Numbers are a prerequisite for GS1 eCOM message or to access Global Data Synchronisation Network.

The GLN is constructed as:
Logistic units: SSCC – Serial Shipping Container Code

• GS1 Identification Key for an item of any composition established for transport and/or storage which needs to be managed through the supply chain.
• Assigned for the life time of the transport item
• Mandatory element on the GS1 Logistic Label using Application Identifier (00)
• The SSCC is constructed as:

![Diagram of SSCC structure]

- Extension Digit
- GS1 Company Prefix
- Serial reference
- Check Digit

N₁ = N₂ N₃ N₄ N₅ N₆ N₇ N₈ N₉ N₁₀ N₁₁ N₁₂ N₁₃ N₁₄ N₁₅ N₁₆ N₁₇ N₁₈
The Other GS1 Identification Keys

GRAI, GIAI, GSRN, …:

- Users need a GS1 Company Prefix to generate any GS1 Identification Key
- The assigned GS1 Company Prefix gives users access to all GS1 Identification Numbers
Summary of GS1 Identification Keys

Once assigned GS1 Identification Keys are GLOBAL and acceptable everywhere
What is the Electronic Product Code?
What is the Electronic Product Code?

UNIQUE ITEM IDENTIFIER
POINTER TO INFORMATION
What is the Electronic Product Code?

Trade Item A
31234567 89012 0000000123456

Trade Item A
31234567 89012 0000000123459
What is the Electronic Product Code?
What is the Electronic Product Code?

Illustrative example

<table>
<thead>
<tr>
<th>GTIN</th>
<th>0 1 2 3 4 5 6 7</th>
<th>8 9 0 1 2 8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7</td>
<td>8 9 0 1 2</td>
</tr>
</tbody>
</table>

**EPC**

<table>
<thead>
<tr>
<th>3</th>
<th>1 2 3 4 5 6 7</th>
<th>0 8 9 0 1 2</th>
<th>0000000123456</th>
</tr>
</thead>
<tbody>
<tr>
<td>Header</td>
<td>EPC Manager Number</td>
<td>Object Class Number</td>
<td>Serial Number</td>
</tr>
</tbody>
</table>
What is the Electronic Product Code?

The EPCglobal Network
What is the EPC?

EPC Unique Identifier
EPC pointer to information
EPC and EPCglobal Network serial level identification
The Secrets of RFID

Why was RFID developed?

How does RFID work?

Compare RFID with other technologies
The Secrets of RFID
The Secrets of RFID

R.F.I.D.

= Radio Frequency IDentification
The Secrets of RFID

1. The reader sends energy and data in the form of radio waves to the tag;
2. The tag transmits its identity back;
3. The reader receives and decodes.
The Secrets of RFID
The Secrets of RFID

RFID Tag components:
The Secrets of RFID

Components of a reader:

- Module (transmit /receive)
- Control Unit
- Antenna
The Secrets of RFID

Summary:

RFID reader and tag work together to transmit information

Components of the tag

Components of the reader
What is EPC? - Summary:

EPC is the Code for Identification
RFID for Data Capture
EPCglobal Network for data exchange
Benefits of EPC Applications
Benefits of EPC Applications

EPC applications are built upon RFID technology. RFID has multiple advantages such as:

• No line of sight required
• Multiple object read simultaneously
• Capture of product information at low cost
Benefits of EPC Applications

RFID requires no line of sight between the reader and the tag(s)

Scanning Bar Codes

Scanning EPC Tags
RFID readers can capture up to several hundreds of tags per second.
Benefits of EPC Applications

EPC enables the capture of a lot of information at low cost.
This topic explained the benefits RFID brings to data capture:

- No requirement for positioning of tags in front or close to the reader;
- Simultaneous reads;
- Lot of simultaneous reads.
RFID EPC standard coding scheme

- standard coding schemes
- compatibility with current GS1 coding schemes
RFID EPC standard coding scheme

Trade Item A
31234567 89012 0000000123456

Trade Item A
31234567 89012 0000000123459

© Jean-Pierre Attal
GS1 codes such as serialised GTINs, SSCCs, can be embedded in EPCs: No migration to a new coding scheme necessary.
Summary

- RFID EPC standard coding scheme
- Standard coding scheme
- Guarantees the uniqueness of codes allocated by a company
- Existing GS1 codes can be re-used
EPCglobal Network with RFID
EPCglobal Network with RFID

EPC and RFID

Track & Trace

Product Recall

Anti-Counterfeiting Applications
EPCglobal Network with RFID

Tracking:

the ability to know where an item is located.

Tracing:

the ability to know the history of an item.
EPCglobal Network with RFID
EPCglobal Network with RFID

Product recall

products in the supply chain cannot be consumed because of errors during production, storage, or even transport. They have to be returned to the retailer or manufacturer.
EPCglobal Network with RFID

Anti-counterfeiting applications

Counterfeits are products that have been copied illegally without manufacturer's knowledge and approval.

The EPCglobal Network combined with RFID gives the possibility to inquire about the origin of products. Moreover, counterfeited products do not have EPCs or have invalid EPCs or EPCs that are duplicates of authentic products.
EPCglobal Network with RFID

New applications

The management of books in a bookshop.

Each book is equipped with an EPC tag.

Tags are read and the location of books can be provided.

This provides a better service to the consumer.
Summary: EPCglobal Network with RFID

Are tools to set efficient systems for applications such as:

- Track and trace
- Product recall
- Anticounterfeiting
- New applications
Summary

• Benefits of EPC Applications
• Easy and efficient operations
• Uniqueness of codes
• Track and trace, product recall, anticounterfeiting
• Benefits to the end consumer
Consumer Benefits

Track retail trade items

Fight counterfeiting

Higher levels of food safety, produce freshness and product safety in general
Consumer Benefits

- Better information
- Better after-sales services
- Improved shopping experience
- Improved availability of products
- Customer service
- Improve the supply chain efficiency
- Instrumental in reducing waste and energy consumption
Technical information

• EPC number

• Explain the structure of the code

• Explain every part of the structure and who is responsible for the different parts
Technical Information

EPC Building Blocks

- **Header**
  - Assigned by EPCglobal

- **EPC Manager Number**
  - Assigned by EPC Manager Owner

- **Object Class**

- **Serial Number**
Technical Information

Defines the type of code scheme being used

- Header
- EPC Manager Number
- Object Class
- Serial Number

Assigned by EPCglobal
Assigned by EPC Manager Owner
Technical Information

- Header
- EPC Manager Number
- Object Class
- Serial Number

- Allocated to a company that assigns and maintains EPC's

Assigned by EPCglobal
Assigned by EPC Manager Owner
**Technical Information**

The image illustrates a diagram explaining the structure of a technical code used to identify a class or type of items. The code is composed of several sections:

- **Header**
- **EPC Manager Number**
- **Object Class**
- **Serial Number**

Each section is assigned by different entities:

- **Header**: Assigned by EPCglobal
- **EPC Manager Number** and **Serial Number**: Assigned by the EPC Manager Owner

Additional notes:

- The **number 3** is part of the header.
- The **number 1234567** is the EPC Manager Number.
- The **number 89012** is the Serial Number.
Technical Information

Identifies each occurrence of an Object Class

3
1234567
89012
0000000123456

Header
EPC Manager Number
Object Class
Serial Number

Assigned by EPCglobal
Assigned by EPC Manager Owner
# Technical Information

<table>
<thead>
<tr>
<th>Type of identity</th>
<th>GS1 code</th>
<th>EPC(URI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGTIN</td>
<td>GTIN: 80652642000311</td>
<td>0652642.800031.400</td>
</tr>
<tr>
<td></td>
<td>Serial number: 400</td>
<td></td>
</tr>
<tr>
<td>SGLN</td>
<td>GLN: 0652642123458</td>
<td>0652642.12345.40</td>
</tr>
<tr>
<td></td>
<td>serial number: 40</td>
<td></td>
</tr>
<tr>
<td>GRAI</td>
<td>006526421234581234</td>
<td>0652642.12345.1234</td>
</tr>
<tr>
<td>GIAI</td>
<td>0652642123456</td>
<td>0652642.12345.1234</td>
</tr>
<tr>
<td>SSCC</td>
<td>006526421234567896</td>
<td>0652642.0123456789</td>
</tr>
</tbody>
</table>
Summary

EPC number

EPC is composed of two building blocks

Defined by EPCglobal: type of code and EPC manager number

Assigned by the user company: code of the class (type) of items and serialized number
Technical Information – RFID Tags

RFID TAGS

Explain the tag and its parts

Explain 3 different kinds of tags and their usage
Technical Information – RFID Tags

- chip
- antenna
- substrate
Three kinds of tags

- Passive tags;
- Semi-passive tags;
- Active tags.
Technical Information – RFID Tags

Passive Tag
Technical Information – RFID Tags

Semi-Passive Tag
Technical Information – RFID Tags

Active Tag
# Technical Information – RFID Tags

<table>
<thead>
<tr>
<th>Type of tag</th>
<th>Typical usage</th>
<th>Typical environment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PASSIVE</strong></td>
<td>Object identification, process automation, Retail, maintenance and authentication</td>
<td>Retail sales, Warehouse and freight management, Logistics, Manufacturing and Supply chain management, Agriculture</td>
</tr>
<tr>
<td><strong>ACTIVE</strong></td>
<td>Position tracking, location-based computing, Aware systems that react to specified physical signals, constant monitoring with the use of active sensor</td>
<td>Hospitals and healthcare facilities, Warehouses</td>
</tr>
<tr>
<td><strong>battery powered</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SUMMARY

• RFID tags
• Antenna has to be chosen based on the intended usage of the tag and the read range of the application
• Three types of tags
Technical Information – Readers

• Readers

• Reader and its elements

• Different types of readers depending on the usage
Technical Information – Readers
Technical Information – Readers

• The following criteria will have an impact on your choice:

  • the placement of the antenna;
  • number of items to be read simultaneously;
  • product type to be read (boxes, pallets, individual items).
SUMMARY

• Readers

• Different components of a reader

• Critical element of a reader: antenna
Technical Information – Frequencies

• Frequencies

• Study the frequency component of RFID
Technical Information – Frequencies

Amplitude

Amplitude

Time

Time
Technical Information – Frequencies

<table>
<thead>
<tr>
<th>Band designation</th>
<th>LF</th>
<th>MF</th>
<th>HF</th>
<th>VHF</th>
<th>UHF</th>
<th>SHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>30kHz - 300kHz</td>
<td>300 kHz - 3MHz</td>
<td>3MHz - 30MHz</td>
<td>30MHz - 300MHz</td>
<td>300MHz - 3GHz</td>
<td>3GHz - 30GHz</td>
</tr>
<tr>
<td>Wavelength</td>
<td>1km - 10km</td>
<td>1000m - 100m</td>
<td>100m - 10m</td>
<td>10m - 1m</td>
<td>1m - 0.1m</td>
<td>0.1m - 0.01m</td>
</tr>
</tbody>
</table>
# Technical Information – Frequencies

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Capabilities</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>125 kHz</td>
<td>Read Range - up to 5.50 metres</td>
<td>Pallet/container, RPC</td>
</tr>
<tr>
<td></td>
<td>Good in Moist Environments</td>
<td>v/Windshield decal, Label inserts, Credit card</td>
</tr>
<tr>
<td></td>
<td>Slow Data Range</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Costly Tags</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No Anticollision</td>
<td></td>
</tr>
<tr>
<td>13.56 MHz</td>
<td>Read Range - up to 0.91 metre</td>
<td>Pallet/container, RPC</td>
</tr>
<tr>
<td></td>
<td>Good Penetration in Moist Environments</td>
<td>v/Windshield decal, Label inserts, Credit card</td>
</tr>
<tr>
<td></td>
<td>Poor Performance in Metal Environments</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Many Standards in Financial Market</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anticollision (10-40 tags / sec)</td>
<td></td>
</tr>
<tr>
<td>862-928 MHz</td>
<td>Read Ranges up to 4.5 metres</td>
<td>Metal mount, Label inserts</td>
</tr>
<tr>
<td></td>
<td>Fast Data Rates</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Good Performance in Metal Environment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anticollision (50 tags / sec)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Many Standards in Logistics / Supply Chain</td>
<td></td>
</tr>
<tr>
<td>2.45 GHz</td>
<td>Read Range - up to 0.91 metre</td>
<td>Metal mount, Label inserts</td>
</tr>
<tr>
<td></td>
<td>Good Performance in Metal Environment</td>
<td>Hardened tag format, Reusable form factor</td>
</tr>
<tr>
<td></td>
<td>Poor Performance in Moist Environments</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fast Data Rates</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anticollision (50 tags / sec)</td>
<td></td>
</tr>
</tbody>
</table>
Technical Information – Frequencies

Frequencies are assigned at global level by ITU, the International Telecommunication Union.
SUMMARY

• Frequencies

• 3 different bands are available for RFID

• Frequencies are allocated at global level by ITU
Technical Information – EPCglobal Network

EPCglobal Network

The three most important and most visible elements
Technical Information – EPCglobal Network

Application Level Events

A standard interface to filter the collected data from the tag
Technical Information – EPCglobal Network

EPCIS
To manage the storage and exchange of information between the trading partners:

- Product data
- Quantity information
- Transaction event
Technical Information – EPCglobal Network

Discovery Services
Enable users to find data related to a specific EPC.

Returns links to the EPCIS services (or other places) where the data is stored.

Make it possible for companies to retrieve information on all the events of a specific item.
SUMMARY

EPCglobal Network

3 major components of the EPCglobal Network:

- ALE
- EPCIS
- Discovery Services
This chapter explained in more detail the technical aspects of EPCglobal applications:

- How the EPCs are created;
- The importance of the antenna for tags and readers;
- Why frequencies have to be taken into account;
- The key components of the EPCglobal Network (ALE, EPCIS and Discovery Services) and how they interact.
Implementation - How to lead an EPC project

- How to lead an EPC project
- Different steps to implementation
Implementation - How to lead an EPC project

Different reasons to implement:

• Efficiency
• Customer mandate
• Legislation
Implementation - How to lead an EPC project

Five steps of an EPC Project:

• Investigate
• Experiment
• Trial
• Pilot
• Deploy
Implementation - How to lead an EPC project

Investigation step

The purpose of the investigation step is to develop the RFID/EPC knowledge.

The investigation step comprises 4 actions to be taken.

In the next screens we will explain these steps.
Implementation - How to lead an EPC project

Investigation step

- Learn the technology
- Understand the business drivers
- Secure sponsorship and funding
- Identify the relevant use cases
- Learn about the available resources
Implementation - How to lead an EPC project

Experiment step

• Understand the technology and information flow
• Identify baseline work process and key measurements or Key Performance Indicators
• Conduct tag placement analysis
• Identify technology partners and test products
Implementation - How to lead an EPC project

Trial step

• Define and map the supply chain processes and examine process and environmental related issues

• Document EPC/RFID impacts to business processes and define testing success criteria

• EPC system/data architecture and the EPC numbering scheme and obtain EPC manager numbers

• Identify cost drivers and develop communication plan
Implementation - How to lead an EPC project

Pilot step

- Verify the adoption strategy and cost items
- Decide which EPC reading to be added
- Analyse the in-process data and validate performance
- Coordinate testing with trading partners
Implementation - How to lead an EPC project

Deploy step

• Develop a scoreboard of metrics

• Measure and track improvements

• Refine business cases

• Collaborate on process and data flow improvement
SUMMARY

Implementing an EPC project

• Investigate
• Experiment
• Trial
• Pilot
• Deploy
Implementation – Examples of Projects

Examples of projects

• Baggage

• Food traceability

• High value products

• Healthcare
Implementation - Examples of Projects

Hong Kong international airport

System to tag and read tags on luggage.
17 million items are tagged yearly.

The primary objectives:
-improve operational efficiency
-improve customer service.

On average, a lost bag costs $100.
Currently 2 per cent of all baggage is lost each year.
The system directs the right piece of luggage to the right direction automatically instead of manually.
A RFID label is attached to the regular baggage label and is read on conveyor lines.
Implementation - Examples of Projects

Food traceability

The Ministry of Agriculture in Japan has developed a project to tag fruit and vegetables.

Primary objectives:

- to ascertain the country of origin of the products
- to trace the items that are coming from contaminated regions.
Implementation - Examples of Projects

High Value Products

1. RFID installation at 1 distribution centre

2. ... and 2 stores (inbound)

3. RFID tags to be placed manually on trays and dollies (plus barcode)

4. 2-sided and 4-sided roll cages

5. Develop a web-based reporting tool to report RFID read events to HQ

6. Device monitoring capability (Reader 'Missing in Action' reports to HQ)
Implementation - Examples of Projects

Healthcare

drugs are tagged in order to prevent counterfeiting
SUMMARY

• Examples of projects
• 4 implementation cases of RFID
• 4 different sectors
Implementation

- the steps that user companies follow to conduct an EPC project
- 4 successful RFID projects for several different applications