



The GCI Intelligent Tagging Model,
An examination of product and supply chain
opportunities

GCI Intelligent Tagging Working Group

Applying new technologies –
Creating value in supply chains

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THE GLOBAL COMMERCE INITIATIVE

Delivering the goods – creating value

1 BACKGROUND

The Global Commerce Initiative (GCI) was founded in October 1999.

1.1 Our mission

- To enable global commerce providers to continuously improve their ability to satisfy the needs and expectations of consumers around the world
- By ensuring the availability of a sufficient set of consistent and voluntary global supply chain standards

1.2 Our objectives

- To facilitate supply chain effectiveness, efficiency and consumer value creation through global cooperation between manufactures, logistics providers and retailers
- To build a collaborative inter-business process that will create a recommended set of operational standards, enabling technologies and best practices with worldwide application, in order to provide benefits to all users, large and small, wherever they operate
- This global approach will be developed and documented together with international commerce standardisation organisations

1.3 Our commitment

- *We will actively support GCI and its Working Groups.*
- *We are committed to the trial of the GCI Working Groups' recommendations.*
- *We will accept and implement all standards, best practice recommendations and implementation guidelines. Any amendment will be made as a consensus of all GCI members*
- *The GCI recommendations will serve as the platform for communication among contractual partners, within the framework of the organisational design of our operating systems.*
- *We will encourage all our business partners to migrate to the GCI recommended practice.*

1.4 The Global Commerce Initiative - Who are we?

MANUFACTURERS

- Ajinomoto
- Allied Domecq
- Barilla
- BAT
- Coca-Cola
- Danone
- Georgia Pacific
- Gillette
- Henkel
- Johnson & Johnson
- Jusco
- KAO
- Kodak
- Kraft
- L'Oreal
- Mars
- Nestle
- Newell Rubbermaid
- Philips
- Procter and Gamble
- Ralph Lauren
- Sara Lee
- Unilever
- VF Corporation

RETAILERS

- Ahold
- Boots
- Carrefour Promodes
- Casino
- CencoSud (Jumbo)
- Costco
- Dairy Farm
- Target Stores
- Delhaize
- Federated Merchandising
- Home Depot
- Ito Yakado
- Kingfisher
- Marks and Spencer
- Metro
- NTUC Fairprice
- Sadia
- Sears Roebuck
- Shield Buying/Distribution
- Tesco
- Wal-Mart
- Wegman

2 GLOBAL COMMERCE INITIATIVE – INTELLIGENT TAGGING WORKING GROUP (GCI-ITAG)

2.1 GCI-ITAG: Who are our members?

Co-Chairs

Pat Rizzotto

Johnson and Johnson
New Brunswick, NJ, USA

Dr. Gerd Wolfram

Metro
Germany

Project Editors

Alistair McArthur

Allied Domecq
UK

Kevin Faulkner

Tesco Stores
UK

Dick Cantwell

Gillette Company
USA

Alan Reynolds

Marks and Spencer
UK

2.2 What is our deliverable?

PHOEBE, the key deliverable of GCI-ITAG, is

- *The assessment and evaluation of the functions involved with the Supply Chain dynamics that would benefit from the implementation of Radio based solutions.*

Product Handling Operation Environment Business Evaluation

PHOEBE is divided into four supply chain elements

- Manufacturing
- Fulfilment (Distribution)
- Store
- Consumer

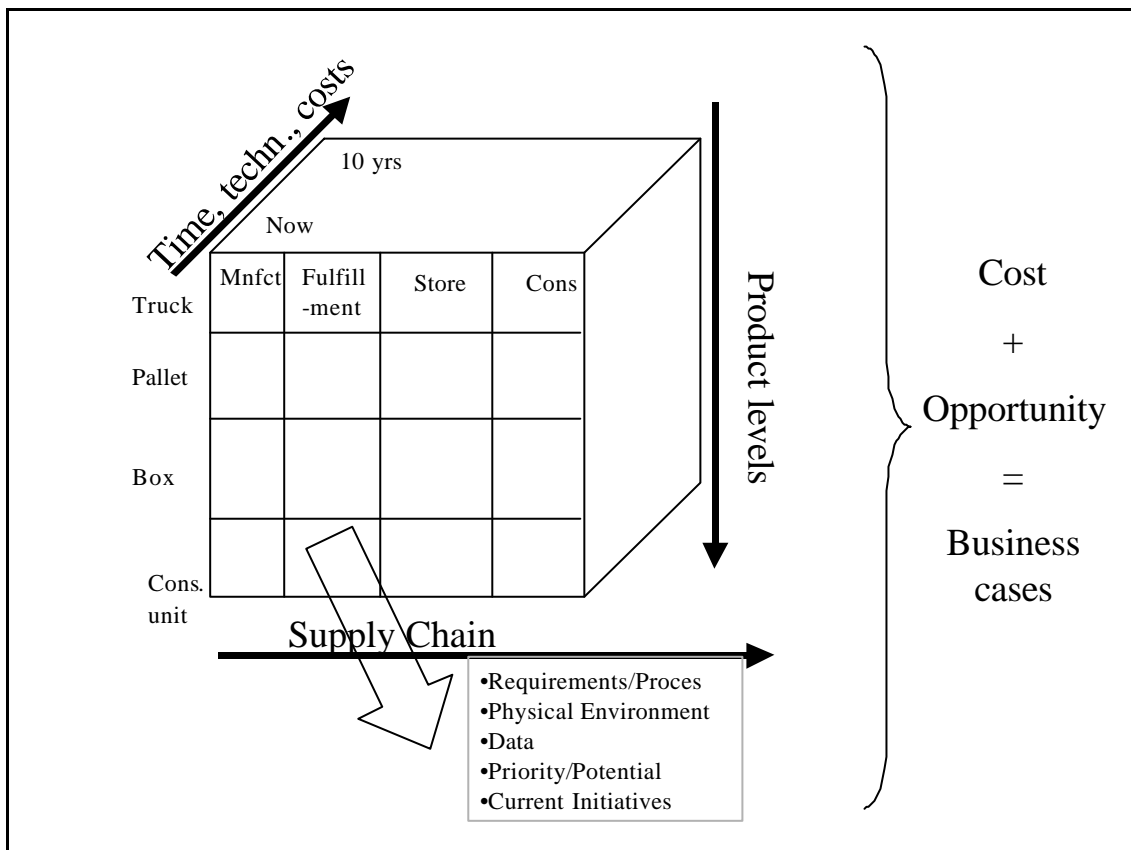
The GCI-ITAG work programme will develop models to illustrate generic applications in each of these elements.

Each model will provide a description of the following components

- Functionality of the process or application
- Technical requirements
- Operating conditions
- Ergonomic conditions
- Data required
- Benefits

Four delivery modes will be considered

- Truckload
- Pallet
- Box
- Consumer unit



The PHOEBE model

GCI-ITAG will consider three types of RFID applications: Generic, Sectoral and Advanced.

Generic: Applications that are common core activities, shared by all organisations.

- *It is important to define these applications so that brand owners, retailers, standard organisations and technology providers can develop medium and long term solutions to help automate operations in world wide open markets where anyone with the right IT and telecommunications systems, equipment and processes can join in and participate - as they can today if they choose to run, e.g., retail point of sale systems using bar code).*

Sector, industry or company applications - customised to address particular requirements

- *Customised solutions are being developed and applied now to meet the needs of Government and business - and are often 'proprietary' solutions used in defined, closed loop applications controlled by the organisations directly involved, e.g., tag and trace returnable containers, facilitate automatic road tolls, tag and track livestock.*

Advanced applications – “blue sky”, leading edge, visionary.

- *Advanced applications may be concepts for which technical solutions are not yet available - they may be dependent upon open market solutions where standards, RFID technology, IT and communications technologies and investment by many partners is required before critical mass can be achieved and solutions become available, e.g., solutions to run retail point of sale systems to sell fast moving consumer goods in the open market automatically as a development of the bar code without the need for direct line of sight to read and process the items.*

The objective of this paper is to develop generic application models: future publications will consider sectoral and advanced applications of RFID.

3 THE GENERIC APPLICATION MODEL FOR MANUFACTURING

Intelligent RFID tags will be part of a hierarchy of methods used together to enable automation of business systems.

The hierarchy begins with the human readable printed label and leads on to the use of UCC*EAN bar codes essential for automated data capture from consumer units and traded units. Almost all manufacturers already operate at this level of the hierarchy

More sophisticated businesses able to identify rapid return on investment are likely to be the early adopters of emerging Auto ID technologies, in particular RFID. The user and application base will then broaden as costs fall and a fuller understanding of the benefits of the technology develops.

Intelligent RFID tags are presently constrained to niche ‘closed loop’ high value applications. This situation will continue until the delivery of device and data interoperability through global and industry sector standardisation opens the market for high volume / low unit value applications.

Manufacturers have a vital role to play in the successful operation of supply chains. Effective source marking of consumer units, traded units and shipping units, using labels, bar codes and RFID tags as appropriate, enables the automation of production, storage and distribution activities. Source marking, especially where EAS/EAC functionality can be embedded, also provides significant value to both the retail sector and their customers as a result of lower costs and improved service

Source marking is not cost free, and it is vital that customers provide the signals and incentives to their suppliers necessary to encourage them to continue to develop and implement new identification technologies and applications.

Human intervention in data capture processes is costly and prone to error. RFID tagging offers the prospect of zero human intervention, with large volumes of data being captured reliably and at low cost every time an operation takes place.

The increased quality and quantity of data captured will enable greater capability in logistics, ERP and Sales and Operational planning systems software.

Benefits

The benefits will include

- Reduced inventory costs
- Improved service levels
- Faster – and more accurate - Business processes
- Enabling of ‘Just in Time’ activities as ‘Real Time’ and ‘Near Real Time’ decision-making improves.
- Reduced waste with improved process compliance and elimination of surplus and overage stock.

3.1 Functionality

The key stages of the manufacturing process model are listed below, together with a brief description of the functional, process or application components. A RFID implementation must support all the stages, and enhance the operation of the majority. The four delivery modes for inbound and outbound logistics are covered in the Fulfilment section, as is a more detailed consideration of materials handling.

In bound delivery management

- Placing an order accurately and JIT on supplier's systems
- Delivery (JIT)
- Authorising access for the delivery vehicle (security)
- Routing for delivery vehicle to correct unloading point
- Receipt of goods at unloading point
- Counting/checking of goods against Advance Shipping Note (ASN)
- Capture of data on host systems in real time
- Authorisation of documentation and administrative processes, including payment
- Management of Returnable Trade Items (RTI), e.g. reusable crates / pallets)
- Handling rejected items / returns to supplier

Storage

- Allocation to storage location
- Stock rotation (FIFO / Date Related management)
- Cross docking and transfers to other locations
- Picking of material for production
- Counting / stock control as material is consumed for production, including ERP links
- Recording data describing suppliers Lot Number / Batch / Code and linking data to manufactured goods Lot Number / Batch / Code for product records, traceability and authenticity
- Monitoring key characteristics such as temperature and vibration/shock
- Monitoring usage to identify and reduce waste of material
- Managing waste disposal by material category, e.g.. Pre-assembled component, ingredient, packaging (glass, paper, plastic (by type), metal)

Production Process

- Monitoring and control of assembly of components / ingredients / packaging
- Monitoring and control of packing processes - consumer, traded, shipping unit
- Capturing license plate and fixed attributes of items produced and packed by traded unit / pallet, weight, dimensions, temperature etc.
- Application of variable attribute information e.g.. Lot number / batch /best before date / customer destination
- Automatic counting of finished goods volume and input to host systems
- Allocation of storage locations / destination (EAN / UCC traded unit / pallet labelling applied, with data input to data carrier and capture by host system
- Measurement / control of components / ingredients / packaging materials / part finished goods, including items returned to store or disposed to waste.

Storage and Despatch of Finished Goods

- Automated put away processes to manufacturer's store
- Automated picking and retrieval for despatch to customer or intermediary
- Management of full, mixed and part pallets
- Transfer of logistics data to shipping unit or RTI
- Automatic inventory control to provide real time asset management
- Invoicing
- Advance shipping advice to customer
- Electronic seal for despatch vehicle / container to enhance security
- Management of exceptions (damaged goods)

Reverse Distribution

- Receipt of returned goods (misdelivered / out of condition / customer returns)
- Allocation of storage location (for resale)
- Allocation to re-work for re-processing or destruction
- Administration (credit and customer management)
- Returns analysis and prevention

E Commerce

- Receipt of order from customer
- Advance Shipping Notice
- Demand led forecasting and production planning through real time access to customer inventory and usage
- Sales ledger

Product Authentication and Traceability

- Reverse traceability of stock by customer shipment
- Product recall by customer shipment for due diligence and Major Incident Management
- Product authentication and Brand protection
- Detection of unauthorised distribution channels

Asset Management

- Control of owned reusable asset inventory by location and type, e.g. containers, crates, pallets, roll cages, keg, gas cylinders, etc
- Control of rented assets by location and type, e.g. containers, crates, pallets, roll cages, keg, gas cylinders, etc
- Maintenance history, e.g. hours run, repairs made

Security

- Control of access by vehicles and people
- Asset control
- Electronic security seals

3.2 Technical Requirements

The exact technical requirements are dependent on the standard system specified, e.g., by the GTAG process. The following general capabilities must be present

- Ability to store UCC*EAN data structures.
- Memory size and configuration (WORM, R/W)
- Standard communications protocols
- Interoperability with other data carriers
- Effective anti collision protocols
- Cohabitation with other radio spectrum users, e.g. radio LAN's, RFDC, GSM, Bluetooth
- Ability to discriminate tag signal from electrically noisy background
- Compliance with local radio regulations regarding frequency, power emitted, etc
- Compliance with health and safety requirements in relation to energy absorption and induction in human tissue.

3.3 Operating Conditions

The operating environment will vary significantly by location. Consideration will be given to the following parameter set as applied to the total supply chain.

- Maximum and minimum temperatures + 40°C to - 30°C. 80°C during cleaning.
- Humidity 80%
- Warehouse construction, including racking
- Transportation mode
- Speed and direction of movement of tag relative to reader
- Orientation of tag to reader i.e. controlled or random
- Read distance
- Write distance (if applicable)
- Electro-magnetic interference from motors, fluorescent lights, other spectrum users
- Electro-magnetic characteristics of the packaging and contents of the tagged item
- Shape and size constraints on antenna, and any requirement to decouple antenna from tagged item
- Form factor constraints in terms of size, shape, resistance to pressure, temperature, moisture, cleaning and contaminants (dust, oil (natural food, petroleum and synthetic), acids and alkalis
- Method of attachment of form factor
- Resistance of readers to heat, moisture, impact damage.

3.4 Ergonomics

In general, zero human intervention operation (ØHIO) is a target requirement of RFID implementations, and ergonomic considerations should be minimal, with fixed head readers being the norm. Where hand held terminals are required, either as part of a RFID enabled functionality, or as a consequence of RFID being integrated with bar code, consideration must be given to ease of use/lack of complexity of the terminal, and to the placement of the tag on the tagged item.

3.5 Data Content

The data required to track and trace consignments through the “typical” Supply Chain may be drawn from the ECR publication “Unit Load Identification and Tracking” UCC*EAN data content and structures will be used to ensure interoperability and unambiguous interpretation of the data carried.

Interoperability has three aspects

- Interoperability with trading partners
- Interoperability with other data carriers
- Interoperability with legacy databases.

The volume of data transmitted should be kept to a minimum to ensure that a scanning transaction can be completed in the minimum time. This is particularly important where the tagged item moves rapidly past the reader, or where a large number of tags must be read simultaneously. The minimum data is normally a licence plate.

Additional data would be written to the Tag to meet the following circumstances

- It is a “Legal Requirement” imposed by external authorities.
- It is the only way that key performance criteria can be met.
- If the overall system performance exceeds our requirement, added value might be achieved by writing additional data to the Tag.

Certain classes of RFID tags offer the ability to configure on-board memory as read-write, as opposed to fixed or write once-read many times (WORM). Writing to the tag enables the data carried to be updated after the initial data upload, e.g. to incorporate delivery address into a shipping unit tag.

Writing introduces a number of issues

- Write range is generally much shorter than read range
- Write speed is generally much slower than reading.
- Access to the tag data must be controlled to prevent unauthorised updates, e.g. perishability dates
- Procedures must be in place to prevent erroneous data being loaded into the tag

In general, licence plates and look-up functionality to on-line catalogues will be used to ensure speed, accuracy and auditability of item attribute transactions. EAS flags are a separate case.

3.6 Industry sector and advanced application issues for manufacturing

One or more flagship projects, agreed between key supply chain partners in the FMCG sector, must be implemented to create the critical mass needed for more widespread adoption of emerging auto ID technologies.

Many higher value, ‘closed loop’ applications will be conceived and implemented anyway - reflecting the benefits that can be obtained by one organisation or a limited number of committed partners. These are the ‘customised’ solutions.

The vast majority of data capture events in FMCG are made up of low value transactions. These will only migrate to RFID or chipless tag solutions if the cost of the tag drops to a very low level, perhaps as low as 1 US cent per tag, and this cost can be shared equitably between the supply chain partners.

Current supply chain systems are capable of achieving 98-99% reliability at the back door. However, on shelf availability may drop to 88-92% for promotional items, with standard lines suffering the same problem at peak demand periods.

If out of stock events could be reduced by half - say by 4% to 6 % at peak times - consumer satisfaction would rise substantially, choice would be preserved and additional profit would flow through to the net profit line with minimal additional direct costs.

The ideal leading edge application for Intelligent Tagging would achieve this objective by facilitating the wider implementation of existing auto identification systems such as EAN128 and RSS, but would also introduce electronic article control to the retail environment. This would enable better forecasting that will drive a more efficient production and supply chain process with sharply reduced out of stocks.

3.7 CASE STUDY: Spirit Industry Sector Applications:

A non exclusive list of possible spirits sector applications include:

- Tag casks of maturing spirit (replacing the industry bar code standard system with RFID) and beer kegs during delivery and returns cycles
- Tag containers of stock in transit (security seals that can be read by Customs or Police to verify contents / Excise Duty status vs. pre advised data / routing to reduce fraud / theft)
- Authentication of original documentation (to reduce the risk of fraud)
- Authentication of product (to reduce the risk of counterfeit)
- Replacement of EAS security tagging (to facilitate retail security systems and reduce theft)
- Tag specialised packaging formats (promotional packs / display pallets to reduce theft)

GENERIC APPLICATION MODEL FOR FULFILMENT

4.1 Delivery Mode Definition

The delivery modes defined by GCI-ITAG are

- Truckload** includes ISO Containers, Airline ULD's, and Railcars
- Pallet** represents a Handling Unit or Shipping Unit and may include dollies, roll cages, IBC's etc
- Box** In FMCG supply chains, this is generally synonymous with traded unit, and includes one-way cases and reusable totes

Note:

These modes may require the tracking of both the movement of the product and a reusable asset carrying the product to the customer.

- *The returnable asset may be owned by the user or a supplier or by a third party provider such as Chep or GE Capital*
- *The asset may consist of a number of separate components i.e. box and lid, cage and detachable shelves that are not permanently fixed together.*

GCI-ITAG is investigating the concepts needed to bi-directionally map a number of individually identifiable assets to an assembly of these units into a single handling module, and similarly to map the contents of these handling devices.

4.2 Consumer Unit

In most cases within the fulfilment sector, consumer units do not need to be tracked as separate entities. For example, it is unlikely that we would wish to monitor the movement of individual pots of yoghurt.

However there are many cases where the consumer unit, traded unit and shipping unit are the same item. Refrigerators and washing machines exemplify this in the white goods sector, and hanging garments such as coats and dresses in retail Apparel supply chains.

GCI-ITAG in collaboration with the UCC*EAN GTAG project is considering the issues of identifying levels of trade in an RFID enabled supply chain. The bar code solutions of differing symbologies, auto-discriminating readers, and physical barriers to show through are not in practice transferable to RFID.

Within the Supply Chain much of the data will be hierarchical in its structure, Items will be consolidated into Boxes, Boxes will be placed onto Pallets, Pallets will be carried on Trucks. Optimum performance may be achieved by a “Russian Doll” approach that rolls up the data to the level above.

4.3 Functionality

The key stages of the fulfilment process model for the four defined delivery modes are listed below, together with a brief description of the functional, process or application components. A RFID implementation must support all the stages, and enhance the operation of the majority.

Truck: Receiving a Truck for immediate unloading of merchandise:

- Arrival at check in point for the Depot (Guard House)
- Check in, validate shipment, seals, driver etc
- Assign unloading location
- Move to unloading location
- Check in/cross check with Guard House, “break seals”
- Unload consignment (this may include empty Re-usable Transport Items, i.e. pallets, boxes.)
- Return to Guard House
- Security check, seal Truck
- Leave Depot

Truck: Receiving a “Drop Shipment”, i.e. a Truck for non-immediate unloading of merchandise:

- Arrival at check in point for the Depot (Guard House)
- Check in, validate shipment, seals, driver etc
- Assign parking location
- Assign unloading location
- Check seals
- Move to unloading location
- Check in/cross check with Guard House, “break seals”
- Unload consignment (this may include empty Re-usable Transport Items, i.e. pallets, boxes.)
- Move to parking location
- Collect from parking location
- Return to Guard House
- Security check, seal Truck
- Leave the Depot

Truck: Loading a shipment from a Depot:

- Move truck to loading point
- Cross check Truck identity to shipment / route
- Load with merchandise, check correct quantity and destination during loading or before (usually at Unit of Delivery Level)
- Seal Truck
- Move Truck from loading point
- Move Truck to parking location (optional)
- Arrival at check out point for the Depot (Guard House)
- Validate shipment, seals, driver etc
- Leave the Depot

Pallet: Receiving a Pallet:

- Pallet unloaded from truck
- Move to accumulation point (optional)
- Pallet/contents checked against consignment note
- Check for damage
- Move to further processing, defined as one of the following:
 - Cross Docking, direct transfer to an outgoing delivery vehicle.
 - Identify pallet as having specific onward destination
 - Move pallet to outloading point
 - Validate pallet against vehicle loading list
 - Load to outgoing vehicle
 - Move to picking location
 - Determine picking location
 - Label pallet with picking location
 - Move to location
 - Move to Storage location
 - Determine storage location
 - Label pallet with storage location
 - Move to location
 - Depalletise load
 - Move to work area
 - Unload boxes from pallet (some or all)
 - Re-label pallet or discard if empty
 - Return balance if any to storage/pick location

Pallet: loading a Pallet:

- Empty pallet identified/labelled with destination/consignment
- Loaded with Boxes picked to satisfy consignment
- Moved to load assembly area
- Destination consignment details on pallet checked against truck manifest
- Pallet loaded onto vehicle

Box: Receiving a box

- Box unloaded from Truck (loose loaded) or from pallet
- Move to accumulation point (optional)
- Box/contents checked against consignment note
- Check for damage
- Move to further processing, defined as one of the following:
 - Cross Docking, direct transfer to an outgoing delivery vehicle.
 - Identify box as having specific onward destination
 - Move box to outloading point or accumulate onto designated pallet
 - Validate box or pallet when fully loaded, against vehicle loading list
 - Load to outgoing vehicle
 - Move to picking location
 - Determine picking location
 - Label box with picking location
 - Move to location
 - Move to Storage location
 - Determine storage location
 - Label box with storage location
 - Move to location
 - Debox Items
 - Move to work area
 - Unload items from box (some or all)
 - Re-label box or discard if empty
 - Return balance if any to storage/pick location

Technical Requirements

The exact technical requirements are dependent on the standard system specified, e.g., by the GTAG process. The following general capabilities must be present

- Ability to store UCC*EAN data structures.
- Memory size and configuration (WORM, R/W)
- Standard communications protocols
- Interoperability with other data carriers
- Effective anti collision protocols.
- Cohabitation with other radio spectrum users, e.g. radio LAN's, RFDC, GSM, Bluetooth
- Ability to discriminate tag signal from electrically noisy background
- Compliance with local radio regulations regarding frequency, power emitted, etc
- Compliance with health and safety requirements in relation to energy absorption and induction in human tissue.

Added value may be provided by recording temperature within a cold chain environment for example, thereby providing evidence of due diligence. Vibration sensors may provide similar added value where fragile goods are shipped.

4.5 Operating Conditions

The operating environment will vary significantly by location. Consideration will be given to the following general parameter set. Values relate to the movement of FMCG through the “A” core Supply Chain.

- Maximum and minimum temperatures + 40°C to - 30°C. 80°C during cleaning.
- Humidity 80%
- Warehouse construction, including racking
- Transportation mode
- Speed and direction of movement of tag relative to reader
- Orientation of tag to reader i.e. controlled or random
- Read distance
- Write distance (if applicable)
- Electro-magnetic interference from motors, fluorescent lights, other spectrum users
- Electro-magnetic characteristics of the packaging and contents of the tagged item
- Shape and size constraints on antenna, and any requirement to decouple antenna from tagged item
- Form factor constraints in terms of size, shape, resistance to pressure, temperature, moisture, cleaning and contaminants (dust, oil (natural food, petroleum and synthetic), acids and alkalis
- Method of attachment of form factor
- Resistance of readers to heat, moisture, impact damage
- Health and Safety regulations

4.6 Operational parameters

Truck: Read range and Portal size

The operating range and portal size for this class of delivery mode is highly variable and has not yet been defined. The operating environment may encompass unloading from vessels in the Rotterdam Container Port, handling modules at Chicago O’Hare or monitoring parked vehicles.

Pallet: Read range and Portal size

The following examples represent the acceptable gateways through which a range of handling units would pass. The optimum is unrestricted movement of two pallets through a loading dock portal

- | | | |
|-------------------------------|-------------------|----------------------------------|
| • <i>Loading dock portal:</i> | <i>4 metres</i> | <i>Vehicle width: 2.6 metres</i> |
| • <i>Pallet “tunnel”:</i> | <i>1.5 metres</i> | <i>Pallet: 1200mm x 1000mm</i> |
| • <i>Dolly/cage “tunnel”:</i> | <i>1 metre</i> | <i>Dolly: 800mm x 600 mm</i> |

Pallet: Speed of movement past reader

The following examples illustrate the maximum and typical speed of movement of a pallet using different handling methods. The optimum would be the uninterrupted movement of the handling units onto and off from a vehicle.

<i>Gas Powered counter balance Forklift</i>	<i>max speed</i>	<i>16 km/hr – 4.44m/sec</i>
<i>Sit-on Powered Pallet Truck:</i>	<i>max speed</i>	<i>10 km/hr – 2.77m/sec</i>
	<i>Load/unload</i>	<i>8 km/hr – 2.22m/sec</i>
<i>Pedestrian Operated Pallet truck:</i>	<i>max speed</i>	<i>6 km/hr – 1.67m/sec</i>
	<i>Load/unload</i>	<i>6 km/hr – 1.67m/sec</i>
<i>Pedestrian:</i>	<i>max speed</i>	<i>5 km/hr – 1.38m/sec</i>
	<i>Load/unload</i>	<i>5 km/hr – 1.38m/sec</i>
<i>Conveyor:</i>	<i>op. speed</i>	<i>7 km/hr – 1.94m/sec</i>

Pallet: payloads

These are the typical payloads, expressed in Handling Units, of the different movement methods. Where more than one unit is carried, they may be arranged either in line with the direction of travel, or across the direction of travel in the case of clamp trucks

<i>Gas Powered counter balance Forklift</i>	<i>1 x 1200 mm x 1000 mm pallet</i>
<i>Sit-on Powered Pallet Truck:</i>	<i>2 x 1200 mm x 1000 mm pallets</i>
	<i>3 x 800 mm x 600 mm dollies</i>
<i>Pedestrian Operated Pallet truck:</i>	<i>1 x 1200 mm x 1000 mm pallet</i>
<i>Pedestrian:</i>	<i>1 x 800 mm x 600 mm dolly/cage</i>
<i>Conveyor:</i>	<i>single crate @ 6,000 crates per hour</i>

Pallet: number of tags

The number of tagged items per pallet will vary considerably.

Typical Scenarios for Re-usable plastic crates expressed as the number of crates per Handling Unit or Unit of Delivery (UOD): -

- *Empty crates on a 1200 mm x 1000 mm pallet (a nested crate is 40mm high, 2 metres stack height = 50/stack)*
600 mm x 400mm crates = 5 stacks = 250 crates
400 mm x 300mm crates = 10 stacks = 500 crates
- *Empty Crates on an 800 mm x 600 mm Dolly: -*
600 mm x 400mm crates = 2 stacks = 100 crates
400 mm x 300mm crates = 4 stacks = 200 crates
- *Full Crates on a 1200 mm x 1000 mm pallet (160 mm height per crate, 2 metres stack height = 12/stack)*
600 mm x 400 mm crates = 5 stacks = 60
400 mm x 300 mm crates = 10 stacks = 120

- *Full Crates on an 800 mm x 600 mm Dolly:* -
 $600 \text{ mm} \times 400 \text{ mm} = 24$
 $400 \text{ mm} \times 300 \text{ mm} = 48$

By combining speed of movement, payload and number of tags on the pallet, the optimum performance can be calculated.

E.g.

The optimum performance for a Sit-on Powered Pallet Truck moving two pallets loaded with empty 400 mm x 300 mm plastic trays onto a vehicle would require 1000 tags to be read in 1 second as it passes through a 4 metre portal.

Note: this is an arithmetical result, and does not take account of screening and absorption issues.

Similarly for a conveyor operation, consider 600 mm x 400 mm crates moving at 1.94m per second with a gap between the individual crates of 600 mm, this would provide a time window of approximately 0.6 of a second to read the tag.

4.7 Pallet: Tag orientation

It should be assumed that the handling operation cannot predict the orientation of the individual cartons / crates when stacked onto the Handling Units because of the unpredictable nature of mixed loads, and the multiple case orientation on homogenous pallet configurations.

A 300 mm x 100 mm box would palletise at 32 boxes per layer (40 per layer in the case of a 1200 mm x 1000 mm pallet): this may result in a typical consignment of between 300-400 cases.

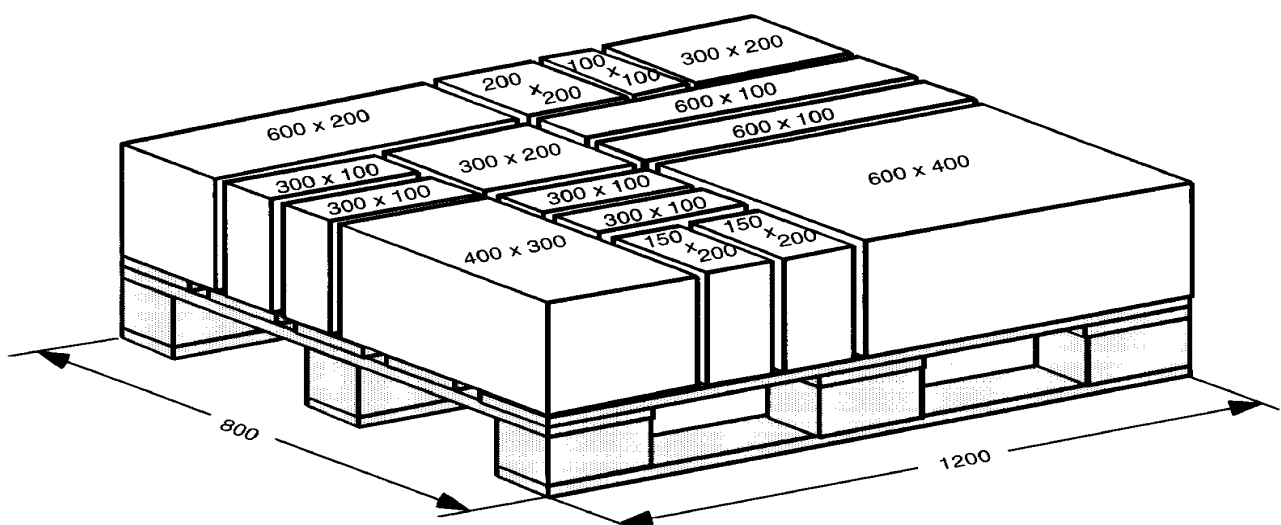


Illustration of standard “euro” pallet demonstrating a typical configuration of mixed boxes in a single layer

4.8 Packaging Material

A wide range of packaging material is utilised in the FMCG sector to encapsulate and protect the consumer units when in transit:

- Cardboard Boxes
- Re-usable Plastic Crates
- Shrink-wrapped display trays
- Consumer units may be metal cans or contain metal foil barrier layers
- Many products have a high liquid content
- Pallets may be metal cages

4.9 Shock Loads and Abrasions

Typically the various handling units are subject to shock loads during the handling process, trailer coupling, shunting, ISO container handling etc. Forklift trucks drop pallets and other Units of Delivery onto concrete floors from a height of a few inches; boxes are dropped from waist height onto the Delivery Unit or concrete floor.

Abrasion will take place between boxes on adjacent Delivery units during the loading/unloading process and during the actual journey.

Pallets may be stacked.

4.10 Ergonomic issues

In general, zero human intervention operation (ØHIO) is a target requirement of RFID implementations, and ergonomic considerations should be minimal, with fixed head readers being the norm. Where hand held terminals are required, either as part of a RFID enabled functionality, or as a consequence of RFID being integrated with bar code, consideration must be given to ease of use/lack of complexity of the terminal, and to the placement of the tag on the tagged item.

4.11 Recyclability/reuse

Tags attached to the reusable handling items, such as roll cages or beer kegs, will be continuously used throughout the life of the asset, typically ten years.

Tags attached to “one-way” handling items may be used to facilitate the recycling of these items, e.g. by holding information on plastic type, and then be reused themselves if this is economically viable.

4.12 DATA

The data required to track and trace consignments through the “typical” Supply Chain can be drawn from the ECR publication “Unit Load Identification and Tracking” UCC*EAN data content and structures will be used to ensure interoperability and unambiguous interpretation of the data carried.

Interoperability has three aspects

- Interoperability with trading partners
- Interoperability with other data carriers
- Interoperability with legacy databases.

The volume of data transmitted will be kept to a minimum to ensure that a scanning transaction can be completed in the minimum time. This is particularly important where the tagged item moves rapidly past the reader, or where a large number of tags must be read simultaneously. The minimum data is normally a licence plate.

Additional data would be written to the Tag to meet the following circumstances:

- It is a “Legal Requirement” imposed by external authorities.
- It is the only way that key performance criteria can be met.
- If the overall system performance exceeds our requirement, added value might be achieved by writing additional data to the Tag.

Certain classes of RFID tags offer the ability to configure on-board memory as read-write, as opposed to fixed or write once-read many times (WORM). Writing to the tag enables the data carried to be updated after the initial data upload, e.g. to incorporate delivery address into a shipping unit tag.

Writing introduces a number of issues

- Write range is generally much shorter than read range
- Write speed is generally much less than reading.
- Access to the tag data must be controlled to prevent unauthorised updates, e.g. perishability dates
- Procedures must be in place to prevent erroneous data being loaded into the tag

In general, licence plates and look-up functionality to on-line catalogues will be used to ensure speed, accuracy and auditability of item attribute transactions. EAS flags are a separate case. Consignments passing through Customs / Tariff barriers will need to satisfy the conditions imposed by the relevant authorities.

4.13 Data errors

It is unacceptable to have an unknown incidence of non-scans. Tag failures must be detected as and when they occur in order that remedial action can be taken.

5 GENERIC APPLICATION MODEL FOR STORE

5.1 Delivery Mode Definition

The four delivery modes specified at the start of the Fulfilment section still apply to the Store model. However there is a significant shift of focus onto tracking Consumer Units.

Within a security application, (EAS), the role of a consumer unit tag could be limited to describing its state as active or de-activated. However, for most supply chain processes, the prime deliverable of a tag is to identify the product, i.e., a licence plate. This does not preclude other data being on the tag, merely that there is no generic data model that could cover all of the application possibilities. There is little benefit - and great difficulty - in describing all the potential data that may be required.

We have also assumed that the Truck / Pallet / Case / Consumer Item relationship is hierarchic - the 'Russian Doll' - albeit dynamic, and that therefore it will be possible to track back from the Consumer Unit to the Truck, and *vice versa*. This relationship will change within the Store, as cases move onto different pallets or cases are emptied onto shelves. It will be necessary to define the hierarchy in relation to time or static process points, e.g., when the Truck arrives at the Store, in order to preserve the bi-directional mapping essential for product traceability.

When a reusable transport item is unloaded, the relationship with its load must be broken. There is a need for a mechanism or procedure to terminate such a relationship.

In addition to the above, it will be necessary to specifically identify empty cartons or pallets.

5.2 Functionality

The key stages for the Store model are listed below, together with a brief description of the functional, process or application components.

Receive: Manage Goods in to Store

Applies to Truck / Pallet / Case. Where Consumer Units are being delivered individually, they should be tagged as Cases.

- Arrival at check in point
- Validate shipment / driver etc.
- Move to unloading location
- Remove security seals
- Unload
- Check Order against delivery note
- Check for damage
- Check / Activate EAS

Put Away: Store product

Applies to Pallet / Case.

- Breakdown incoming pallet/case and reform into optimum replenishment order
- Determine whether product is for shop floor or put away
- Move to assigned location / general storage area

Pick: Find product in the Backroom

Applies to Pallet / Case.

- Confirm stock should be present
- Check assigned location
- Check backup location
- Remove from backroom stock and transfer to sales floor

Merchandise: Layout sales floor

Applies to Item.

- Generate Planogram / manage change
- Maintain / record shelf space
- Generate Shelf Edge Labels
- Display price / manage price changes

Replenish: Display product for sale

Applies to Pallet / Case / Consumer Unit.

- Request for replenishment generated / scheduled
- Move stock from backroom to designated location on shop floor
- Rotate stock, check for Out of Code product
- Check product location & point of sale information
- Check for multiple product locations
- Return overstock to backroom (where sales location full)

Control Inventory: Recognise and track stock levels

Applies to Consumer Unit.

- Count stock held on shelf, (multiple locations)
- Count stock held in backroom
- Record wasted product
- Record product transferred in/out (exceptional movements, e.g. moving product to the staff restaurant / to another store)
- Record Out of Stocks / Face overs or other actions
- Manage abandoned product

Manage Returns: Product and Reusable Transit Packaging

Applies from Consumer Unit upwards.

- Separate returns from waste
- Stack empty trays / dollies
- Load returns to cage / dolly / pallet and store
- Secure and identify the pallet load
- Load returns to Truck
- Complete returns paperwork, including...
 - *Transfers to another store*
 - *Return to DC stock*
 - *Return to DC for recycling / destruction*
 - *Vendor notification*

Reorder: Manage the reordering of product

Applies to Consumer Unit.

- Forecast demand
- Check inventory
- Order stock

Buy: Customer actions in the Store

Applies to Consumer Unit only.

- Find product
- View product attributes, e.g., contains nuts
- View product alternatives, e.g., bigger size / alternate brand
- Find associated products, e.g., BBQ tools & BBQ food, lifestyle choices, etc.
- Find special offers - reductions & promotions)
- Order unavailable product
- Collect specially ordered product
- Return product

Sell: Charge customer for product

Applies to Consumer Unit.

- Scan products to produce barcode
- Scan products at point of sale
- Manage unidentified product
- Replace / remove damaged product from basket
- Deactivate EAS
- Charge customers & receive payment
- Process discount vouchers / special offers

Customer Service Desk: Manage customer returns & complaints

Applies to Consumer Unit.

- Record products & reasons for return
- Identify replacement / alternative products & their locations.
- Move returned product to recycling / returns area
- Reactivate EAS

Other Issues: Maintenance of Cold Chain

Within all of the above functions there is a requirement to store product at prescribed temperatures. Products may be held for a limited time outside of these limits, e.g. when in transit between the backroom freezer and shop floor freezer.

Other Issues: Security

Applies at all levels, but primarily Consumer Unit.

- Apply / activate security tags
- Identify products leaving the store

5.3 Data Capture

Data Capture – Trailer

Trailer information

- Seal number
- Delivery day and time
- Bill of lading information

PO/Store Manifest (DCI) information

- Items
- Code
- Cost/Retail
- Units
- Price Change notification

Data Capture – Pallet

Pick Label information

- EAN/UPC
- Store
- Store zone (area of the store)
- Contents
- Case information
- Planogram location
- Case Quantity / unit or pack size

PO/Store Manifest (DCI) information

- Items
- Code
- Cost/Retail
- Units
- Price Change notification

Stockroom location

Pallet label information

- EAN/UPC
- Store
- Contents
- Quantity

Data Capture – Case

Pick Label information

- EAN/UPC
- Store zone (area of the store)
- Contents
- Case information
- Planogram location
- Case Quantity / unit or pack size

PO/Store Manifest (DCI) information

- Items
- Code
- Cost/Retail
- Units
- Price Change notification

Stockroom location

Chargeback disposition

Data Capture – Item

Pick Label information

- EAN/UPC
- Store zone (area of the store)
- Contents
- Case information
- Planogram location
- Case Quantity / unit or pack size

PO/Store Manifest (DCI) information

- Items
- Code
- Cost/Retail
- Units
- Price Change notification

Price Change information

- Counts and on hands
- Pricing

Stockroom location

Sales & Returns

- EAN/UPC
- Quantity
- Disposition
- Serial number
- Autofill information (Sales generating replenishment based on presentation minimums)

Research information

- EAN/UPC
- On hands
- Stockroom location
- Quantity

5.4 Technical Requirements

The technical requirements for the Store model are as specified in the Fulfilment Model.

5.5 Operating Conditions

Conditions applying to Truck / Pallet / Case have been specified in the Fulfilment Model.

- Ambient to -25C (frozen foods only)
- Tag applied to glass, cardboard, plastic, metal, etc.
- Needs to be hidden and not easy to "kill" for fraudulent purposes, e.g., by scratching, shielding or magnetic field.

Must be a small enough form factor to hide and/or apply to small items without spoiling packaging aesthetics or obscuring wording.

5.6 RF Environment

Current

- Frequency hopping spread spectrum communications at 2.45 GHz/2 Mbs utilised for phones/PDT's/ self-scanning /mobile tills/potentially also pagers and scales.
- EAS: Sensormatic 400 MHz. Shopping cart control may also use 400 MHz.
- Electronic Shelf Edge Labelling (ESEL) at 880 MHz
- Customers may bring in a range of other devices to the store: EAS from other stores//personal hi-fi/phones/pagers/ parcels with postal RF tags/etc.

Future

- [Bluetooth](#)
- [IEEE 802.11 WLAN](#)

5.7 Tag Performance

For Consumer Unit tags in the Store Model, the following should be considered

- Reading by hand held or automatically through portals up to 1.5m wide.
- Many different tags in field at one time
- Could be surrounded by metal (other products/ shopping cart)
- Barcode replacement would necessitate 100% performance
- Auto discrimination/anti collision
- Multiple reads on metal surrounded by metal
- Convergence with EAS necessitating non duplicate correction within the multiple tag read window

5.8 Applications and Benefits for Store

There are significant benefits to be realised in the Store environment. The ultimate challenge is the unmanned checkouts, however there are a number of steps towards that goal that are described below.

The steps towards that goal are described below:

- **Automated receiving**
 - Reduces manual intervention at the backdoor. Provides for identification of product required for immediate replenishment.
- **Backroom stock control**
 - Being able to locate product allows for targeted replenishment, thereby improving availability. Identifying product location also provides increased customer service.
- **Replenishment Control**
 - Ensures correct cycling of short life product.
- **Identification of overage product**
 - Could provide cold chain conformance warnings.
- **Returns Control**
 - Provide a tracing method for products being returned. Also facilitates better product recall processes.

All of these will enable an automated inventory management system, with total visibility of stock allowing store management to control stock by exception.

The other major area of opportunity is in Security.

- **Security (EAS)**
 - Control shrink, improve availability. Additional benefits if Tag contains product identification, allowing targeting of vulnerable / high-risk products.

Tags containing unique ID would provide the authenticity & product traceability data to enable the Customer Service Desk to check that the product was sold by their store and to which customer.

6 GENERIC APPLICATION MODEL FOR CONSUMER

6.1 Introduction

“The most important applications of any breakthrough technology are not only unknown, they are *unknowable*” Clayton M. Christensen, ‘The Innovators’ Dilemma’, Harvard 1997

When Personal Computers were first developed during the 1970’s, no one had any idea why they might be useful in the home, yet today many consumers find them indispensable.

In the case of intelligent tagging technology, we can foresee many convincing B2B applications in the areas such as inventory reduction, fresh food supply chain management and loss prevention.

Truly convincing consumer uses require even more foresight. This does not mean that there are fewer consumer applications: just that we don’t yet know what they are.

We offer speculation in four areas where consumers could see benefits:

- Purchase decision-making
- Usage and repurchase
- Telemetry and sensing
- Environmental

Each of these areas requires intelligent tagging technology to be increasingly ubiquitous. Purchase process improvements can be gained if only a small percentage of items contain intelligent tags, while environmental applications need intelligent tags in almost all items. As a result, purchase process improvements may be the first area where consumers will benefit, and environmental benefits may not be seen for many years.

6.2 Purchase decision-making

Many of the mainly B2B benefits of intelligent tagging will have a positive effect on consumers’ lives. The consumer is the supply chain’s ultimate customer, so any true supply chain improvement should be beneficial, whether from reduced cost or increased efficiency. The impact of this on the consumer should not be underestimated.

For example:

- Counterfeit items, from pharmaceuticals to fragrances to spare aircraft parts, can cause consumer injury or death
- Stock-outs can lead to inconvenience such as having to shave with a dull blade, or extreme disappointment, e.g. no Buzz Lightyear for Christmas
- The inconvenience at the checkout counter is the thing consumers dislike the most about shopping

Intelligent tagging technology will improve all these areas, reducing the number of counterfeit items sold, increasing the availability of items through better information, and possibly one day improving the efficiency of checkout counter.

Some of these changes will go unnoticed by the consumer. Others can be a source of competitive advantage for those retailers and manufacturers who are fastest and smartest at adopting and using intelligent tagging.

A list of possible applications for intelligent tagging during the shopping and purchasing process would include:

- Product description, contents, specifications, manufacturer information (in multiple languages)
- Selling information and promotional offers (including performance offers, special pricing, coupons, etc.)
- Authentication
- Gift registry/shopping list
- Warnings/restrictions

6.3 Usage and repurchase

It is widely held that the next generation of consumer appliances will be computerized and networked (or ‘smart’). What is less clear is why this will be useful. One currently available smart washing machine, for example, offers only specialist benefits, such as the ability to monitor and log statistics such as water usage and temperature profiles, and request maintenance – visit www.margherita2000.com

What limits these technologies most is the same thing that limits almost all other computer systems: their inability to identify objects in the world around them.

If a washing machine is truly smart, then surely it should know what clothes it contains, as well as what detergent it is using. It should be able to spot a red sock in the white wash and not turn the clothes pink or – even better – sort clothes into colours, whites, and delicates itself; or maybe wash items one at a time so they last much longer without fading or damage.

The same is true of other household appliances such as ovens able to identify that they were cooking a turkey, find out how much it weighed, how fresh it was, and adjust cooking time, and refrigerators able to reorder or at least warn about essential items such as milk, eggs, beer.

It also applies to other electronics rich consumer products, such as cars, which could know what tyres they are running on, or how old their brake pads are; and to items with today have no electronics, such as medicine cabinets, which could check that medicine was being taken properly, and also warn of possible drug interactions.

Interaction with home appliances as well as consumable goods is an area where we may see benefits that are hard to imagine today, as well as the emergence of luxuries that soon become essentials. The microwave that cooks food without being programmed

may quickly become as common and apparently indispensable as a remote control for the television set.

Here are some examples of how the interaction between intelligent tags and consumer products would enhance the usage experience or facilitate repurchase:

- Recall and returns
- Compliance
 - *Health-related (e.g. medicines)*
 - *Misuse/malfunction/lifecycle maintenance*
 - *Emergency (e.g. poison control centre)*
- Ordering replacement parts
- Smart products ('things talking to things')
- Consumer storage
- Product source communications (with manufacturer)
 - *Q&A*
 - *Usage information (e.g. recipes)*
 - *Product lifetime analysis*
 - *Video instructions*
- Product reference communications (with other consumers who own product)
- Web-served repurchasing (consumer-initiated, from shopping list, etc.)
- Auto-replenishment (via sensing capability to initiate...e.g. intelligent refrigerator, wastebasket, medicine cabinet, etc)
- Auto-measurement of home stock level
- One-to-one consumer relationship marketing (e.g. name/address) for marketing purposes
 - *New product development*
 - *Customized products*
 - *Special offers*
 - *Consumer profiling*
 - *Forecasting*

6.4 Telemetry and sensing

In addition to knowing what something is, it is sometimes useful to also know what state it is in – i.e. how hot or worn it is.

Intelligent tagging is an essential infrastructure for sensing data of this kind – knowing something is cold is not useful unless you also know what it is.

Intelligent tagging technology also allows for the communication and standardized sensed data - telemetry - via specialized sensors embedded in either items or readers as appropriate.

When used in conjunction with intelligent tagging telemetry can deliver potentially interesting consumer benefits

- Knowing that fresh products are spoiling based on sensory data such as stored temperature, rather than using time-based general estimates
- Identifying that a tyre has punctured, and calculating how long before it deflates
- Knowing that a vital part has become worn and will soon break
- Temperature conservation
- Monitoring and tracking of perishable products
- Post sales warranty
 - *Auto-identify problem*
 - *Auto-evaluate cause*
 - *Auto-initiate service*

6.5 Environmental benefits

One of the most exciting benefits of intelligent tagging is the ability to greatly improve the recycling and reuse of post-consumer waste.

Identification is the problem that prevents most waste from being recycled; instead it is dumped into landfill sites at cost to the taxpayer and the environment. Where identification and sorting of waste does take place today, it is most often the responsibility of the consumer, e.g., to sort glass and paper, either voluntarily, or in order to comply with local regulation.

A world where identification, sorting and recycling is made easier by the use of intelligent tagging at the recycling station, could yield a surprising number of consumer benefits, including:

- Reduced prices as more packaging is reused and recycled
- Greater convenience as consumers can dispose of waste without sorting
- Reduced concern about damage to the environment from landfill
- More efficient use of natural resources

6.6 Functionality

The operating conditions required for these consumer applications would be similar to B2B applications earlier in the supply chain. The tags should be able to be read within a reasonable distance, withstand a range of temperature variation, e.g., from frozen foods to extreme heat from an oven. They should operate within a store or household environment with competing radio signals generated from various electronic devices normally in use.

Since more and more consumer uses for intelligent tags will be developed as the technology for B2B applications is identified, it is premature to define specific functional requirements at this time. Suffice it to say that with common standards for all tags/operating environments, consumer applications can be developed.

6.7 MIT Program

The MIT Auto-ID Center is researching the physical and virtual data carrier issues of mass applications of emerging auto identification techniques.

The Auto-ID Center mission is to merge the physical world with the information world to form a single, seamless network, using the latest technology developments embracing electro-magnetic identification, computer modelling, and networking.

Research is focussed primarily on creating an open architecture for embedding ID technology in everyday items. The Center works in collaboration with the global standards bodies and the auto-ID industry to help specify how items will communicate in a standard environment.

The technologies currently being developed by the Center include

- Electronic Product Code: *identifies the product*

ePC is a numbering scheme that can provide unique identification for physical objects assemblies and systems. The ePC provides a pointer or address to information held in databases sitting on local networks or the Internet.

ePC has two parameters in its design. Firstly, the number of bits necessary to provide unique identity for any product in the global supply chain. Secondly, bit partitioning to speed up the search routine.

There is a trade off partitioning for speed and bit length for numbering capacity, identical to the issues of structured item numbering in conventional bar code numbers.

- Product mark-up language: *describes the product*

PML is a standard language for describing physical objects, and is based on the extensible Mark-up Language XML.

- PML will contain or translate static data such as dosage, expiry date, recycling.
- PML will provide instructions to machines that handle the product such a microwave ovens, machine tools and laundry appliances.
- PML will offer the ability to communicate dynamic data which alters as a product ages or is consumed.
- PML may contain applets, e.g. to describe how the product may deteriorate with use.

PML should allow distributed management of product information at central locations such as a factory, warehouse or store. Software changes can be simultaneously and immediately, ensuring that products are linked with the latest most up-to-date information. Real-time access to critical information, e.g. in the case of breakdowns, becomes possible.

- Object Naming Service: *links ePC and PML together*
 - ONS tells computer systems where to locate information on the Internet about any object that carries an ePC.
 - ONS is very similar in concept to DNS, but will be many times larger and have to operate at very much higher speeds.

The MIT work will be vital in providing the data management structures necessary to effectively exploit the emerging very low cost, short range auto ID technologies needed for low level item identification.

7 Global Commerce Initiative – *the way forward*

7.1 Conclusions

The initial focus of GCI-ITAG will be in realising the potential benefits of RFID applications in B2B relationships, where existing and emerging technologies have demonstrated that rapid returns in investment are possible.

As RFID technology matures, with the possibility of ultra low cost devices becoming available, and the capacity and capability of existing numbering systems are expanded, intelligent tagging will undoubtedly extend its scope to encompass the B2C relationship.

While the consumer benefits of intelligent tagging are inevitably speculative at this early stage, we confidently predict that they will have a significant and very positive impact on the way we do business, and that the areas outlined above will only be the beginning.

Indeed, the most important intelligent tagging applications may still be completely unknown. RFID is an immensely powerful enabling tool for Global Commerce, with only our imagination as a constraint.

Your input to our Initiative is needed and most welcome.

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