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Building on RFID with the EPC Network

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EPCglobal Network Components

- The EPC itself
- ONS
- Filtering layer
- EPCIS



EPCglobal Network Components





The electronic product code (EPC)



- The EPC can be thought of as the next generation barcode
- The barcode usually only identifies product type
- The EPC also includes a unique serial number

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Header 8 bits indicates partitioning scheme 256 EPC Manager 28 bits indicates company (manufacturer) >268 million

Object Class 24 bits indicates product -type ('SKU') > 16 million Serial Number 36 bits unique for each instance of a product > 68 billion

- An additional field indicates object 'type'
 - E.g. item, inner pack, case, pallet
- This speeds up identification with RFID
 - Can specify types of interest and ignore others
 - Reduces/eliminates dwell times, improves reliability
- NB some contention over the type categories

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Header Filter EPC Manager Object Class Serial Number

- Clear need to support existing numbering systems
 - In addition to original 'universal identifier' format
- Still need to support different tag sizes
- EPC supports serialised encoding of
 - Global Trade Item Number (GTIN)
 - used for trade items (item, case, pallet)
 - Serial Shipping Container Code (SSCC)
 - used for tracking logistics units for transport or storage
 - Global Location Number (GLN)
 - used for physical, functional or legal entities



•EPC supports serialised encoding of

- -Global Returnable Asset Identifier (GRAI)
 - used for individual returnable assets rented or loaned (e.g. pallets, barrels, gas cylinders, freight containers, beer kegs, trailers, vehicles, pallets)
- -Global Individual Asset Identifier (GIAI)
 - used for individual assets usually high-value / long-lived



Object Name Service (ONS)



Object Name Service (ONS)

- Why we need ONS
- The simple approach
 - Static ONS
- More sophistication
 - 'dynamic' ONS /'discovery service'



The Object Name Service – why do we need it?

- Information about objects is stored in a database
 EPC is purely a key into that database
- Just one database is not adequate
 - Too much information
 - Too many requests
- Need to find the right database for a given EPC
 - This is what ONS does



The Object Name Service – what does it provide?

- A global service to translate an EPC into URL(s)
 - Where further information on the object may be found
- URLs may identify different services and resources
 EPC Information Service, website, internet resources





- Assumes that there is one database for each object
 - Given EPC always resolves to same URL(s)
 - Typically provides pointer to relevant manufacturer





- A given manufacturer may have several databases
- ONS can be used hierarchically
 - Root ONS server points to manufacturer
 - Manufacturer has own ONS server(s) to indicate which particular database
- ONS caching possible
 - Reduce need to query global ONS for each object
 - Certain EPC/location information stored in cache
 - Provides first port of call for ONS queries



Object Name Service (ONS)

- Why we need ONS
- The simple approach
 - Static ONS
- More sophistication
 - 'dynamic' ONS or 'discovery service'

- Assumes that there is one database for each object
 - Given EPC always resolves to same URL
- In reality information will be distributed
 - More than 1 database with information about each item
 - Information created by different people
- Want to know the sequence of custodians
 - To enable a number of envisaged applications
- Need to locate all relevant databases
 - Ideally need to know which one(s) relevant



Limitations of Static ONS





- Registry to point to multiple databases
 - Supports a sequence of custodians through the supply chain
 - Several information stores within an organisation





• The registry is updated by each custodian on handover, with serial-level EPC lookup

- We need to update the EPC discovery service about
 - Change of custodian (arrival / departure)
 - Change of EPC to track upon aggregation into a container
 - Change of EPC to track upon re-packaging
 - whether the particular EPC is marked for recall
- We can query the EPC discovery service to
 - Find and query the current custodian
 - Find and query all custodians who have handled the object
- Need to maintain security and consistency
 - Robustness, access control, non-repudiation



Object Name Service (ONS)

- Why we need ONS
- The simple approach
 - Static ONS
- More sophistication
 - Dynamic ONS 'discovery service'



Event filtering

Basic Problem

- When the vision becomes reality, there's a *lot* of data
 - Item level detection for literally billions of items
 - Many detection locations
 - Unique identification
 - Licence-plate only
- To make this work we need to
 - Minimise the amount of data communicated
 - Make communications as efficient as possible
 - Make the system robust to communications outages / changes

- Basic concept is to use a single filtering layer
 - At a low level in the architecture
 - Generic enough to support different readers
 - Generic enough to support different application needs
 - Returns information in a standard format
- Focus on standardized interface (API) for client applications
 - ALE application level events
 - Events defined in terms of read cycles and event cycles
 - Applications all make requests to filtering layer
 - Filtering layer subsequently provides reports back



Summary of filtering layer



Example applications – DVD tagging

- 'Live-display' application
- Replenishment application

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The EPC information service (EPCIS)



EPC information service – the 'network database'



- Provides information about an EPC-tagged object
 - EPC is used as a database lookup key
- Really only provides the *interface* to this information
 - May interface to existing databases, apps & information systems
 - May provide its own persistent data storage
- Two-way data flow
 - Raw data sent to EPCIS for storage
 - Queries sent to EPCIS for information retrieval



Categories of data which may be accessible through EPCIS

'EPC-Related' data						
Timestamped historical data	Attribute data (often static)					
Observations (Tag readings)	Attributes defined at serial level					
Measurements (sensor data)	e.g. date of manufacture, expiry					
Symbolic Location/Containment	Attributes defined at product level,					
EPC <-> Transaction ID	e.g. mass, dimensions					

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- What sort of questions may be asked?
 - "Where is the nearest red sweater in a size 4?"
 - "Where are the 5 CDs that were supposed to be in the last order?"
 - "This case of meat is tainted. Which items crossed paths with it?"
- Data required is available, but need to retrieve it!
 - Queries are complex
 - May involve sophisticated data storage and processing
 - May require data from multiple EPCIS's and other applications



- Need to break down complex queries
 - EPCIS will only handle queries which it can answer directly
 - BIS applications responsible for managing complex que





Coping with different EPCIS abilities and requirements

• Modular design for EPCIS specification:



- Registered interface descriptions for each method or capability
 - specifies function names, input parameters, return values
 - probably in terms of WSDL files
- ONS
- Savant
- EPCIS



The Elements of the EPC Network

- The EPC itself
- ONS
- Savant
- EPCIS



EPCIS worked example



"Where is the nearest red sweater of size 4?"

- Resolve any linguistic ambiguities
 e.g. Does 'nearest' mean 'shortest distance' or 'quickest time'?
- Tell me all EPCs on local EPCIS subject to:
 static attributes: Colour = red (from product data) Size=4

dynamic attributes: (from inventory/sales data) In Stock = yes Already Sold = no

=> list of EPCs or EPC classes, {e}



"Where is the nearest red sweater of size 4?"

- 3. For each of these EPCs, tell me which readers have seen it in the last hour? SELECT * FROM Reader_data WHERE tagEPC = e AND TIMESTAMP > (NOW - 3600000) => list of readerEPCs, {r}
- 4. For each of these reader EPCs, tell me your current (x,y,z) location

static attributes: Cartesian Location (from location data)

=> hash-table mapping an (x,y,z) for each readerEPC r



"Where is the nearest red sweater of size 4?"

- 5. For each of these (x,y,z) co-ordinates, sort in order of increasing distance from my position at (x_o, y_o, z_o)
 ORDER BY (x-x_o)*(x-x_o) + (y-y_o)*(y-y_o) + (z-z_o)*(z-z_o) ASC => ordered list of readerEPCs, {r} nearest first
- 6. For the nearest n readers r, obtain human-readable location static attributes: Human-Readable Location (from location data) => "Aisle 5; shelf 3 from the top" etc.