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Building on RFID with the EPC Network

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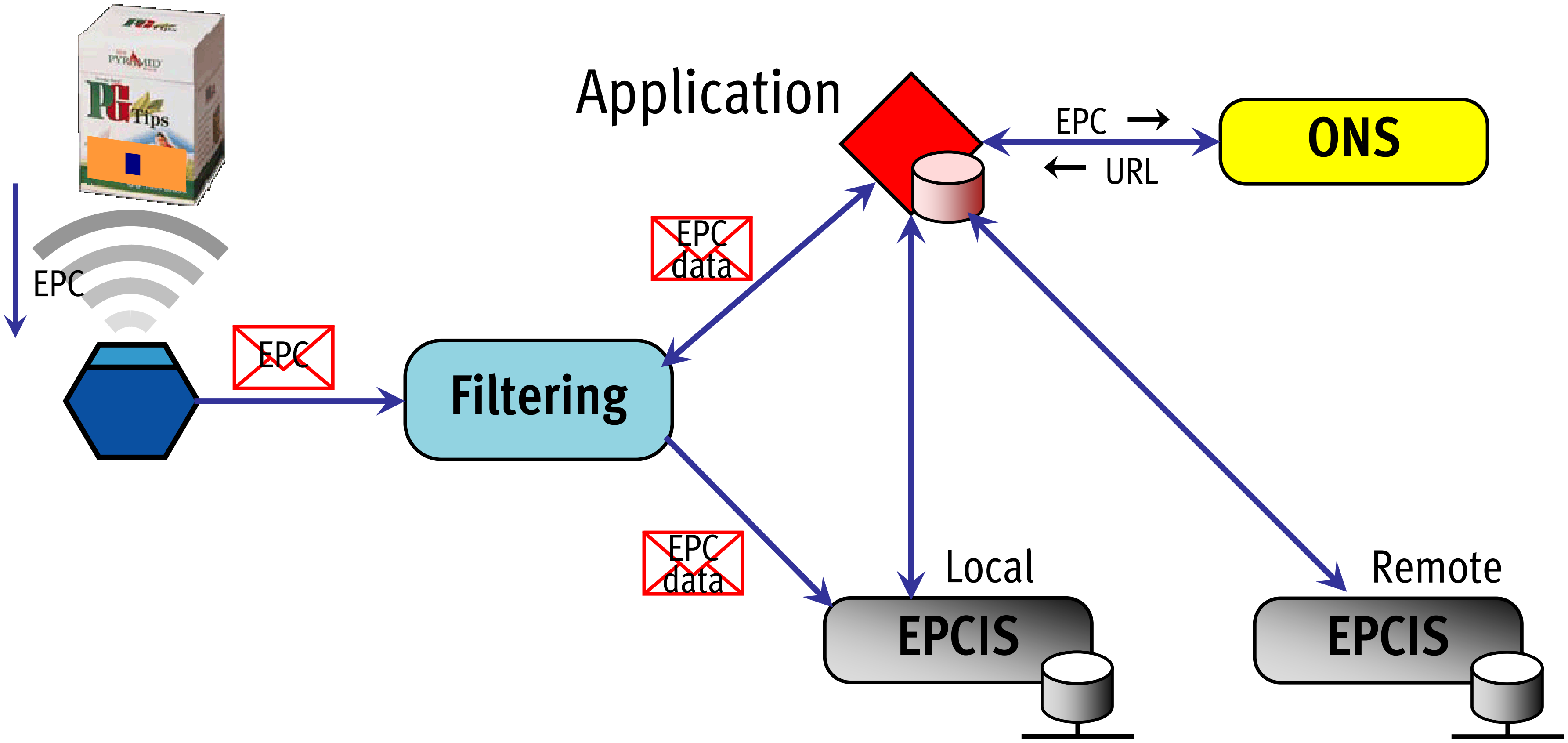
Presentation prepared by EasyEPC

EPCglobal Network Components

- The EPC itself
- ONS
- Filtering layer
- EPCIS

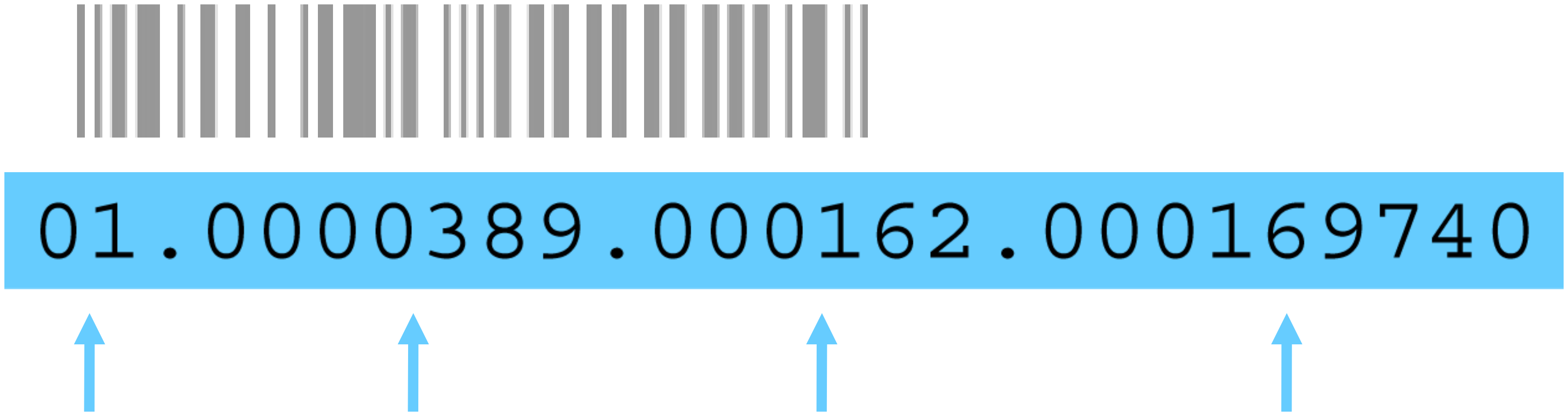
EPCglobal Network Components



The electronic product code (EPC)

Original EPC structure

- 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



01.0000389.000162.000169740

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

Addition of ‘fast filtering’

- 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

Addition of ‘legacy support’

- 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

Addition of ‘legacy support’

- 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)

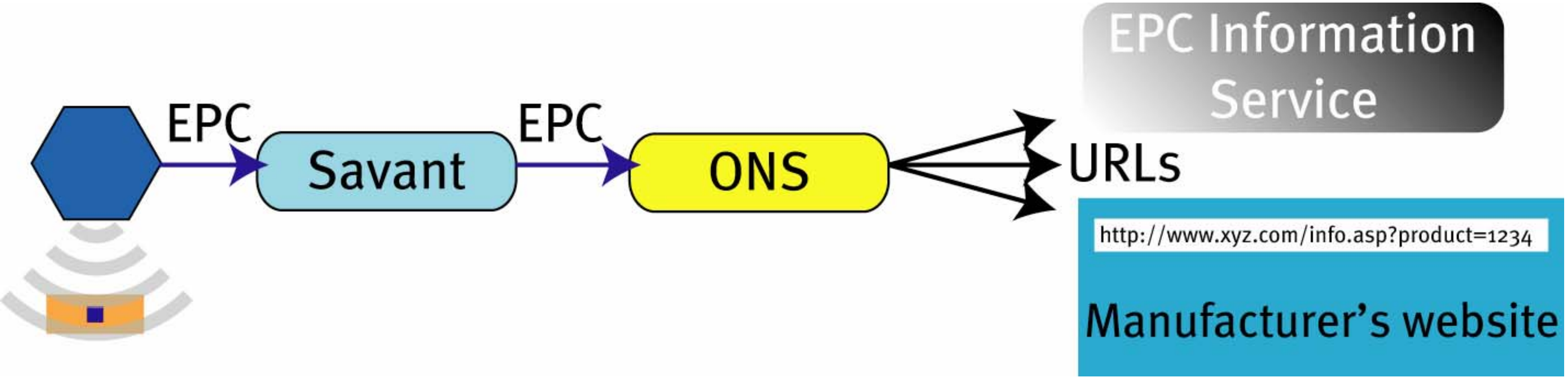
- Why we need ONS
- The simple approach
  - Static ONS
- More sophistication
  - ‘dynamic’ ONS /‘discovery service’

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

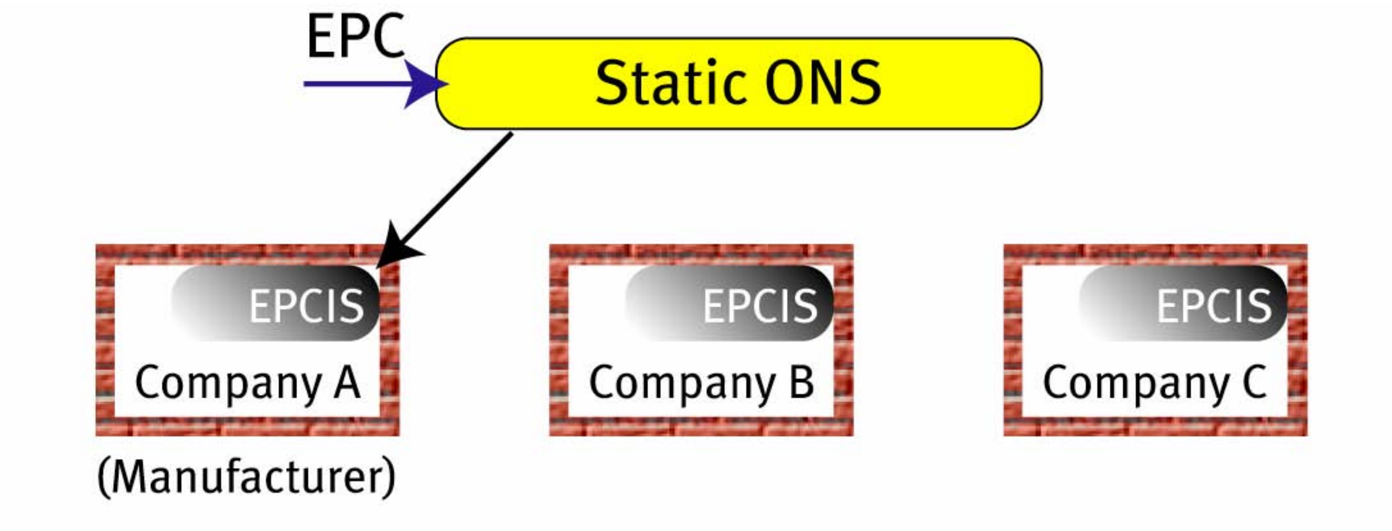
The Object Name Service – what does it provide?

- 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



Static ONS

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



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Static ONS hierarchy and caching

- 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

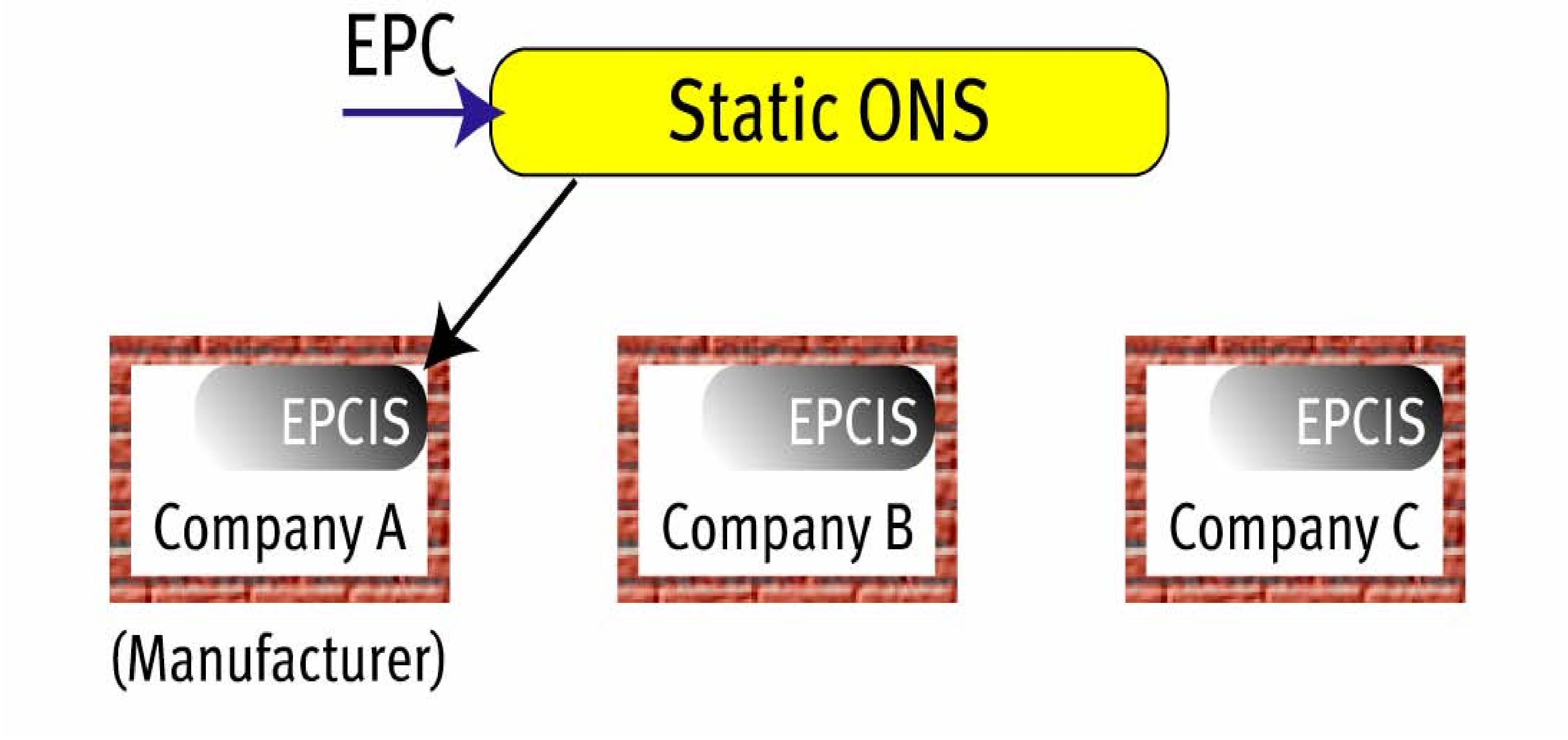
Object Name Service (ONS)

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

Limitations of Static ONS

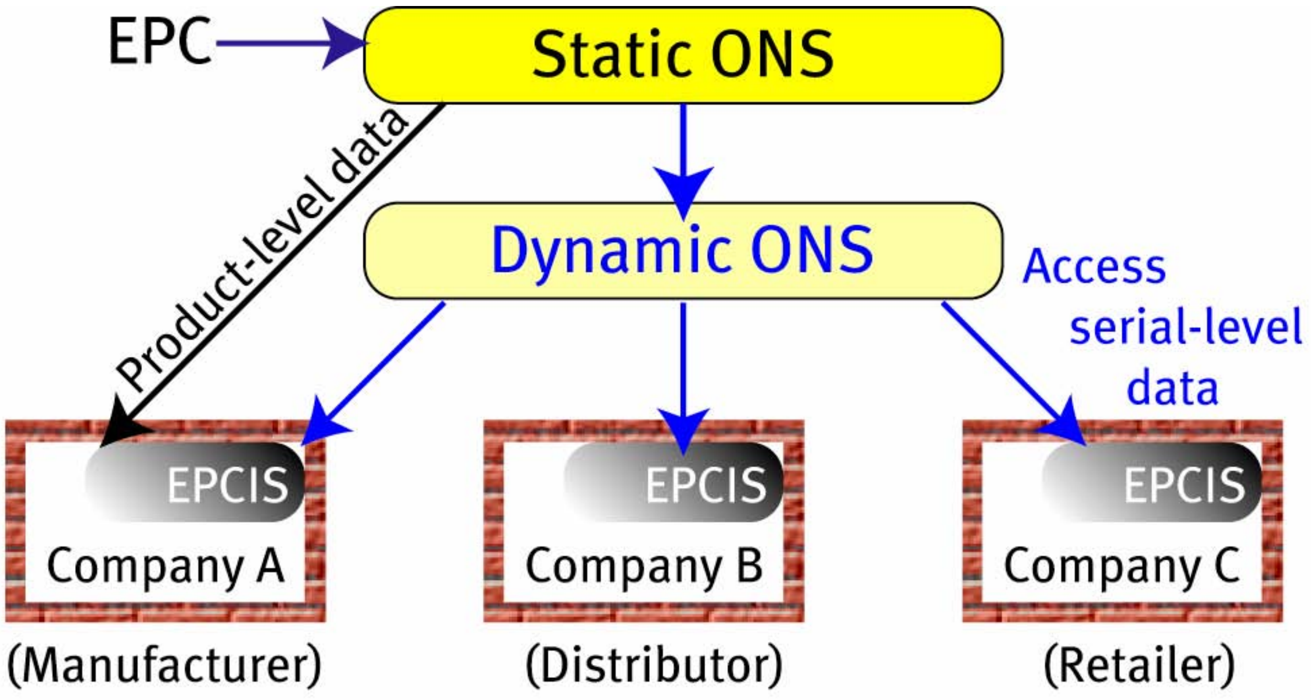
- Assumes that there is one database for each object
  - Given EPC always resolves to same URL
- In reality information will be distributed
  - More than 1 database with information about each item
  - Information created by different people
- Want to know the sequence of custodians
  - To enable a number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

Limitations of Static ONS



Dynamic ONS/EPC discovery service

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



Discovery service – example

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

Implementing discovery service – updates and queries

- 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

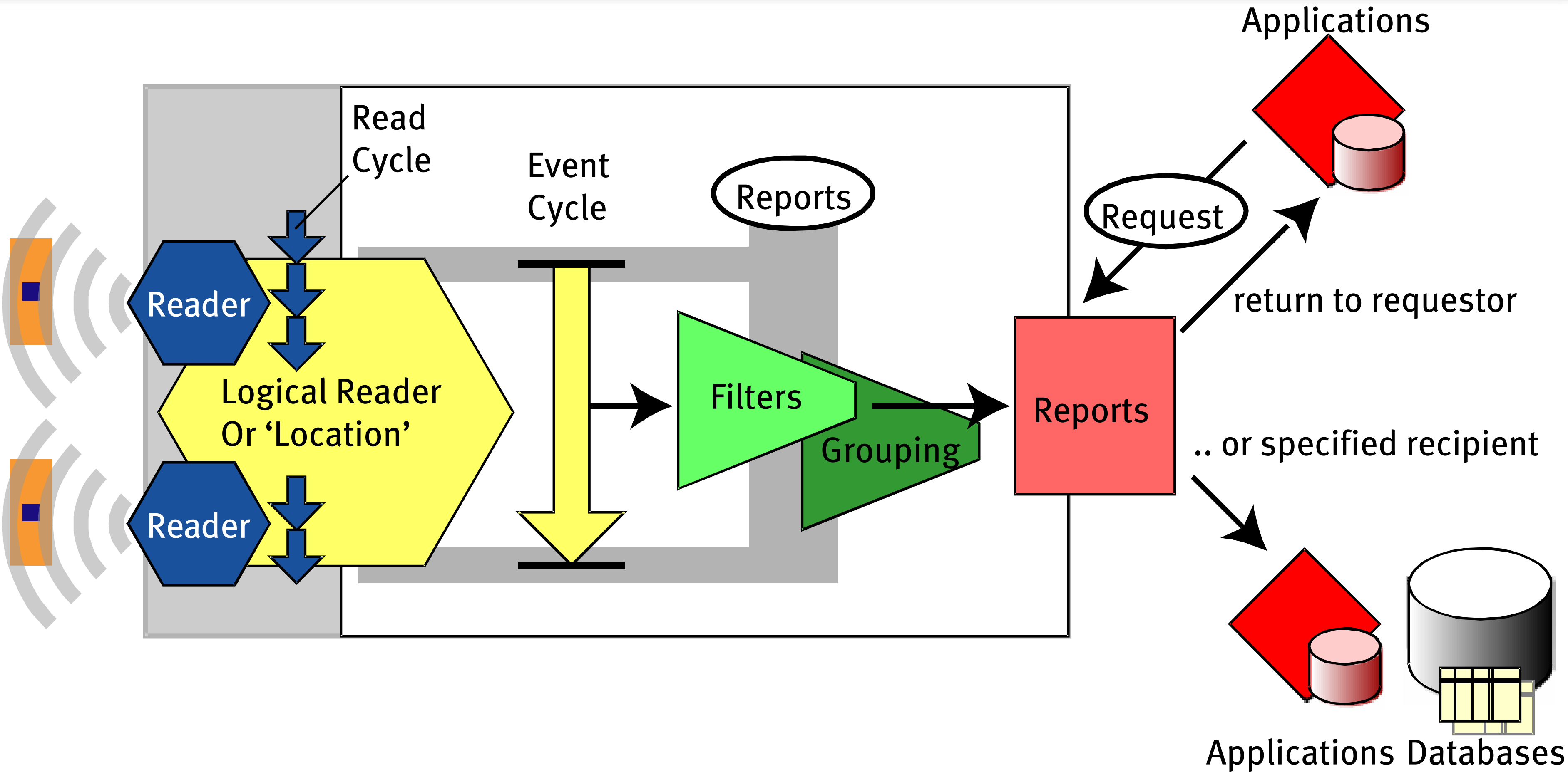
Basic Problem

- 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

Solution: event filtering

- 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



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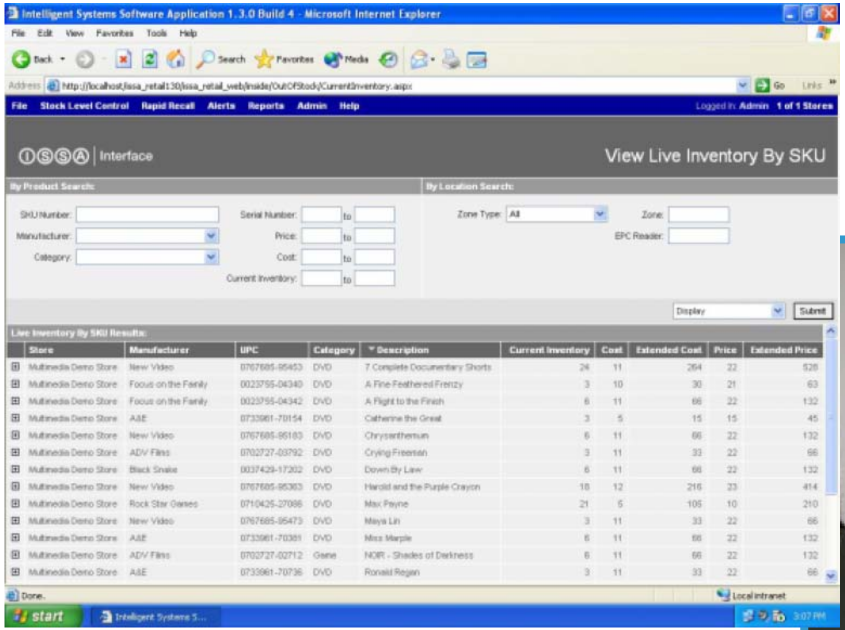
Example applications – DVD tagging

- ‘Live-display’ application
- Replenishment application


Intelligent Systems Software Application 1.3.0 Build 4 - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://localhost/issa_retail130/issa_retail_web/inside/OutOfStock/CurrentInventory.aspx
Go Links
File Stock Level Control Rapid Recall Alerts Reports Admin Help
Logged In: Admin 1 of 1 Stores
ⒾⓈⓈⒶ Interface
Display
Submit
Done.
Local intranet
start
Intelligent Systems S...
3:07 PM

View Live Inventory By SKU

By Product Search:

SKU Number:

Manufacturer:

Category:

Serial Number: to

Price: to

Cost: to

Current Inventory: to

By Location Search:

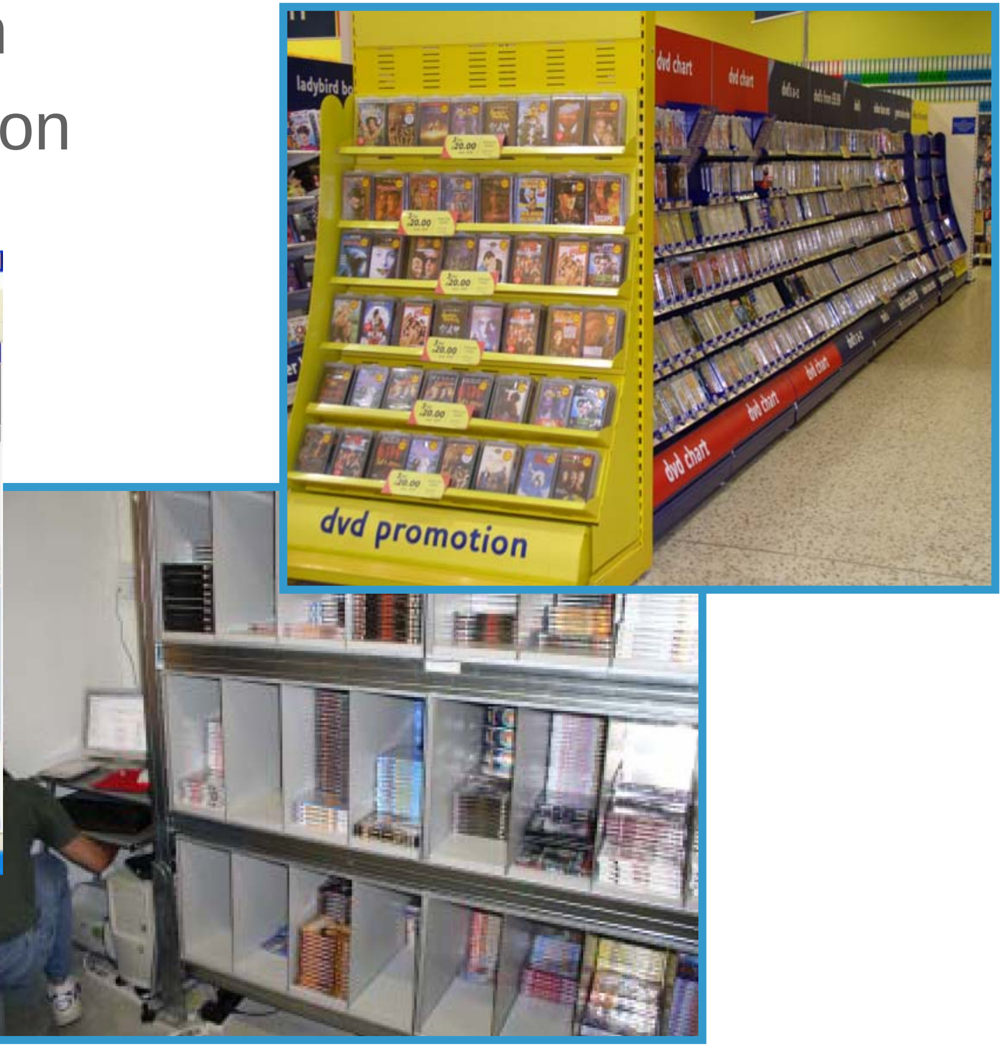
Zone Type: All

Zone:

EPC Reader:

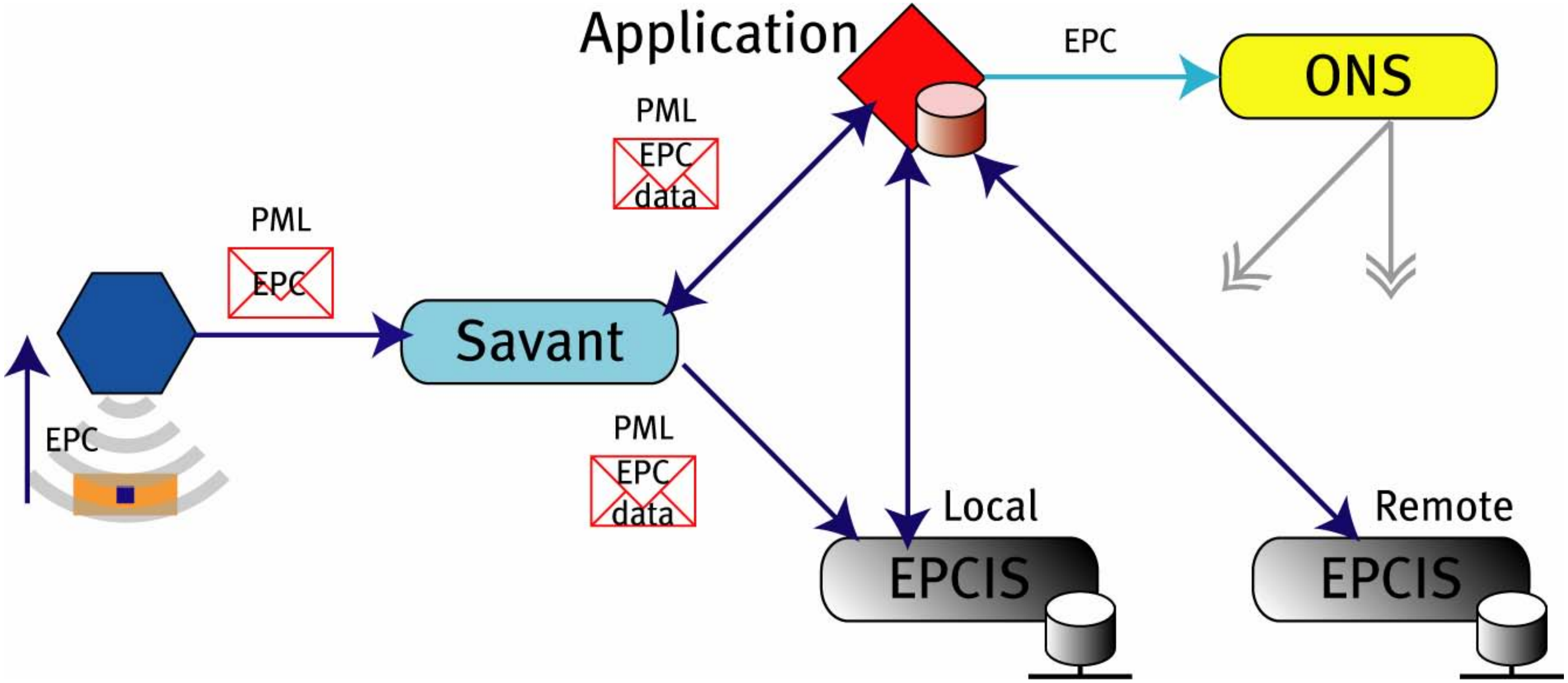
Live Inventory By SKU Results:

Store	Manufacturer	UPC	Category	Description	Current Inventory	Cost	Extended Cost	Price	Extended Price
Multimedia Demo Store	New Video	0767685-95453	DVD	7 Complete Documentary Shorts	24	11	264	22	528
Multimedia Demo Store	Focus on the Family	0023755-04340	DVD	A Fine Feathered Frenzy	3	10	30	21	63
Multimedia Demo Store	Focus on the Family	0023755-04342	DVD	A Flight to the Finish	6	11	66	22	132
Multimedia Demo Store	A&E	0733961-70154	DVD	Catherine the Great	3	5	15	15	45
Multimedia Demo Store	New Video	0767685-95183	DVD	Chrysanthemum	6	11	66	22	132
Multimedia Demo Store	ADV Films	0702727-03792	DVD	Crying Freeman	3	11	33	22	66
Multimedia Demo Store	Black Snake	0037429-17202	DVD	Down By Law	6	11	66	22	132
Multimedia Demo Store	New Video	0767685-95363	DVD	Harold and the Purple Crayon	18	12	216	23	414
Multimedia Demo Store	Rock Star Games	0710425-27086	DVD	Max Payne	21	5	105	10	210
Multimedia Demo Store	New Video	0767685-95473	DVD	Maya Lin	3	11	33	22	66
Multimedia Demo Store	A&E	0733961-70381	DVD	Miss Marple	6	11	66	22	132
Multimedia Demo Store	ADV Films	0702727-02712	Game	NOIR - Shades of Darkness	6	11	66	22	132
Multimedia Demo Store	A&E	0733961-70736	DVD	Ronald Regan	3	11	33	22	66



The EPC information service (EPCIS)

EPC information service
– the ‘network database’



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

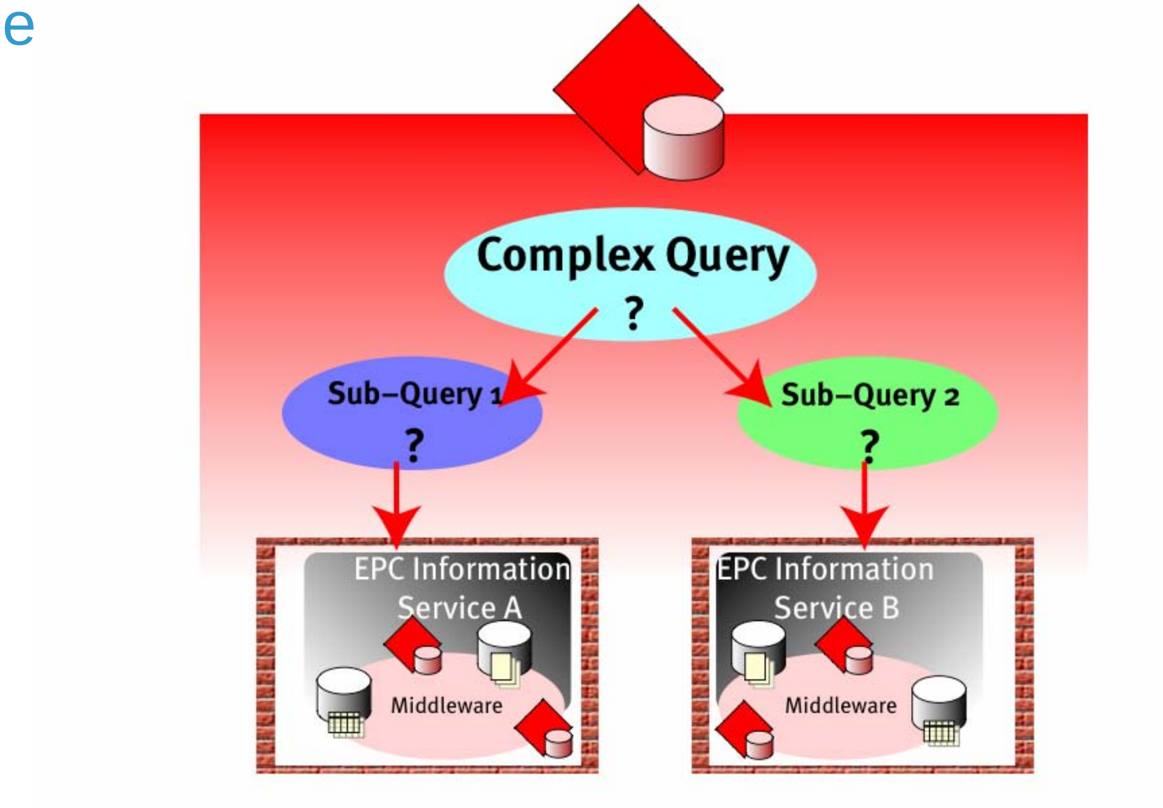
‘EPC-Related’ data	
Timestamped historical data	**Attribute data (often static)**
Observations (Tag readings)	Attributes defined at serial level e.g. date of manufacture, expiry
Measurements (sensor data)	
Symbolic Location/Containment	Attributes defined at product level, e.g. mass, dimensions
EPC <–>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

How can the data be turned into useful information?

- 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

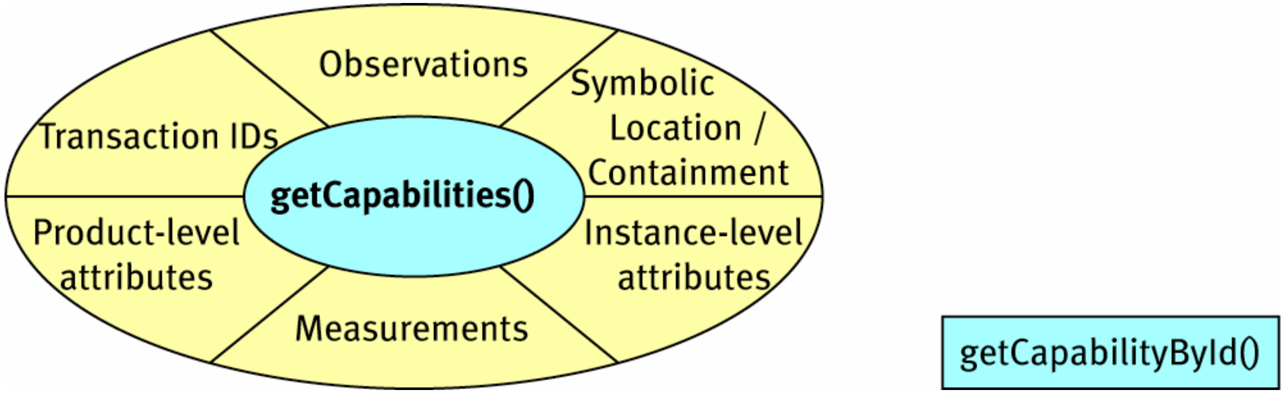
Data from multiple EPCIS’s

- 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

Complex Query Example

“Where is the nearest red sweater of size 4?”

1. Resolve any linguistic ambiguities
   e.g. Does ‘nearest’ mean ‘shortest distance’ or ‘quickest time’?

2. Tell me all EPCs on local EPCIS subject to:

static attributes:
(from product data)
	Colour = red
	Size=4

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

=› list of EPCs or EPC classes, {e}

Complex Query Example

“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

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Complex Query Example

“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.