Healthcare Research Initiative
MIT, Cambridge, MA, USA 9 December 2004

The Electronic Product Code (EPC) and Mass-Serialization Issues for Healthcare

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- The Electronic Product Code (EPC)
  - Background and Structure
- The EPC as the key identifier to the whole EPC Network
- The Object Name Service (ONS) and Discovery Services
  - Hierarchical structure of pointers to information
- How is the EPC represented?
  - Encoding/decoding between binary, URIs and legacy codes
- Factors to consider when deciding how to mass-serialize

Structure of the EPC

- The EPC can be thought of as the next generation of the barcode
- The barcode usually only goes as far as identifying product type.
- The EPC goes further and gives each instance of a product a unique serial number

01.0000389.000162.000169740

Header	EPC Manager	Object Class	Serial Number
8 bits	28 bits	24 bits	36 bits

Structure of the EPC

- The EPC is a bit like a unique web address for each object.
- The EPC itself doesn't tell you much about what the object is, but like a web address allows you to find further information about the object using the EPC network (Internet of Things)

01.0000389.000162.000169740

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Structure of the EPC - hierarchical like web addresses

- From the outset, the EPC was designed to be used with the Object Name Service (ONS) to lookup the extra information.
- In order to do lookups in a scalable way, and because ONS is based on the Domain Name Service (DNS), the EPC has always had a hierarchical structure.

01.0000389.000162.000169740

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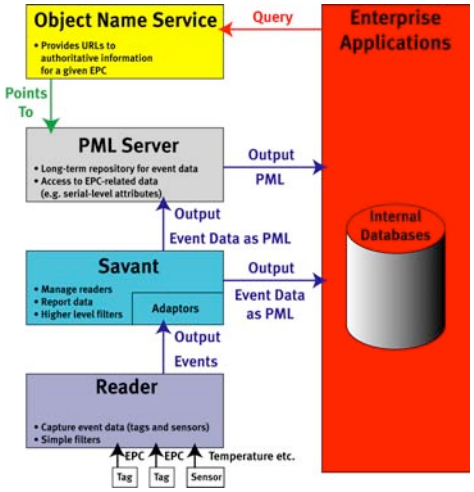
Is a transparently structured EPC appropriate for healthcare?

- In the FMCG retail sector, the hierarchical structure of EPC has followed:

Manufacturer : Product Line : Serial Number

- However, this is pretty transparent - maybe **too** transparent for sensitive products in healthcare - potential for embarrassment or discrimination.
- Barcodes must be scanned with line of sight, whereas RFID tags can be scanned at a distance, potentially without prior notification or consent being given. Identifiers which are OK for coding on barcodes may not be OK for coding on RFID tags.
- We need to think about which AIDC technologies are going to be used at the level of consumer items.
- If RFID tags will be used on consumer items, we need to think about killing tags at point of sale / dispensing - and may need to use a more opaque structure for the EPC mass-serialized identifier.

The EPC Network - 2003
a stack of components



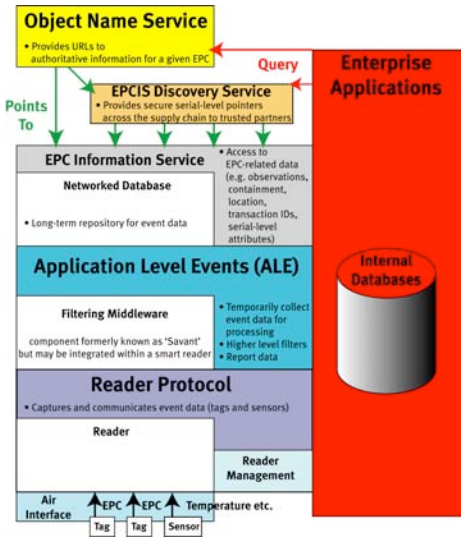
Auto-ID Centre identified a collection of technologies required for the EPC network

However, some of the original concepts

(e.g. PML markup, hierarchical Savant tree)

are now being replaced by alternative approaches

The EPC Network - EPCglobal 2004
well-defined interfaces

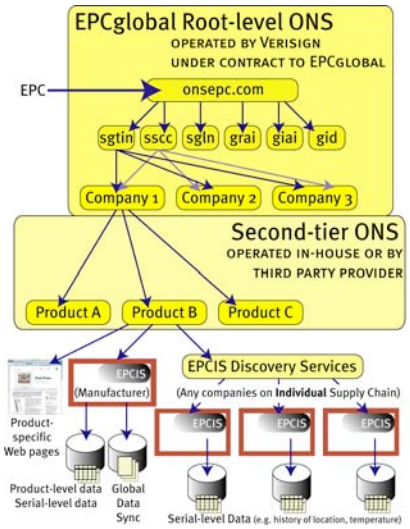


The emphasis is now on well-defined interfaces for the EPCglobal standards

- often using XML schema (XSD) and web service definitions (WSDL)

Components may implement or understand multiple interfaces

The Object Name Service (ONS) hierarchy



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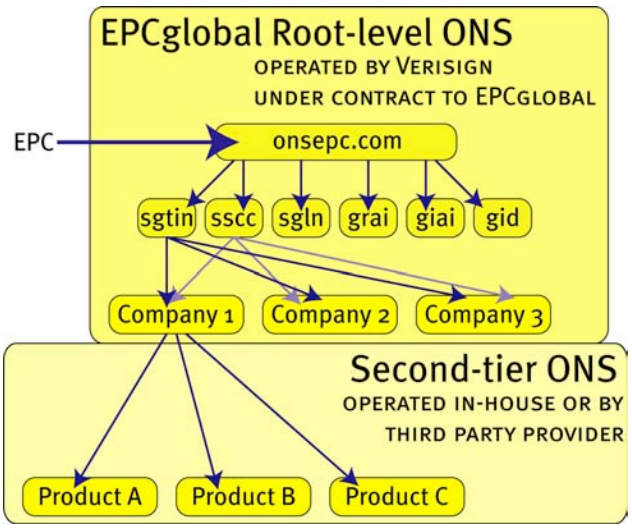

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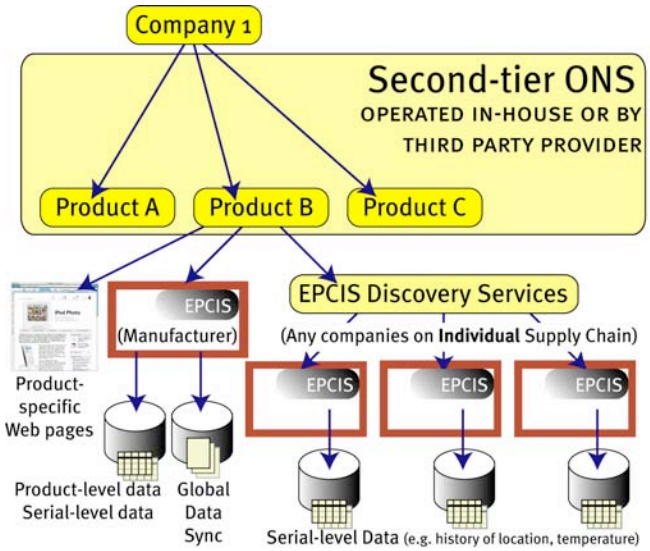
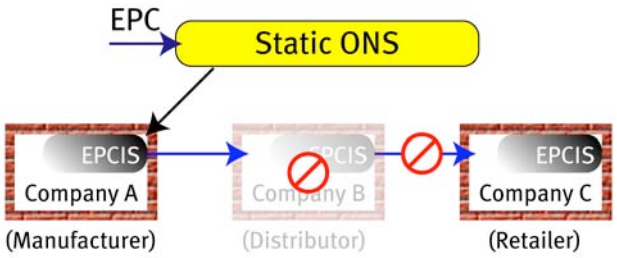


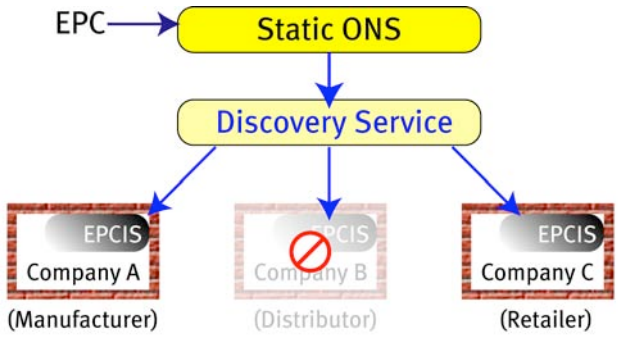
Beyond static ONS v1.0

- The link approach (forward/reverse links) may fail if any link on the daisychain fails to respond or cooperate at a critical time - redundancy is necessary



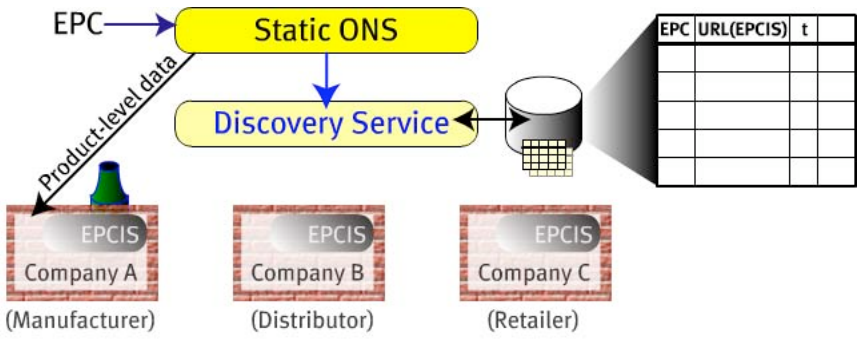
Beyond static ONS v1.0

- The EPCIS Discovery Service should be more robust - i.e. can still navigate beyond the failed link



EPC Discovery Service - example

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



Discovery Service - Updates

We may want to update the EPCIS Discovery Service about:

- change of custodian (arrival / departure)
- change of EPC to track
  - upon aggregation into a container
  - upon re-tagging / re-packaging
- whether the particular EPC is marked for recall

Discovery Service - Queries

We can query the EPCIS Discovery Service to:

- track forwards to the current custodian
  - to get current information about location/status
  - to determine who to contact about a product recall
- trace backwards to find all custodians which have handled the object and may hold some data on it

Discovery Service and Electronic Pedigree Record

- The EPCIS Discovery Service is a useful tool for obtaining real-time serial-level pointers to the individual supply chain path followed by each individual object
- However, it may not be sufficient proof from a legal perspective.
- Most likely, we will need complementary approaches including:
- An electronic pedigree document, complete with digital signatures proving the custody trail from cradle to grave
+ Something like a discovery service to be able to rapidly connect together the fragmented information services which may all hold some relevant data when performing a recall or analyzing why a problem occurred

How will the EPC be transmitted? Converting the EPC into URI format

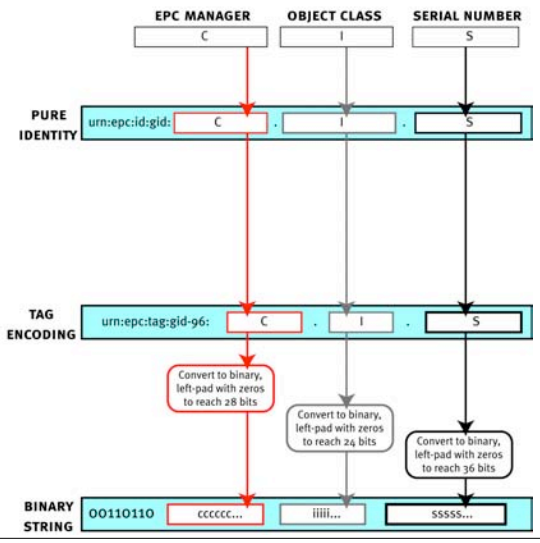
- Originally, the EPC was assumed to be just a binary string [0,1] or more compactly expressed in hexadecimal [base 16 - digits 0-9, A-F]
- The Object Name Service (ONS) v1.0 specification now assumes that the EPC will be communicated in URI format where the fields are expressed as decimal values [digits 0-9 only] separated by dots.
- The filtering layer interface (Application Level Events [ALE]) also uses the URI patterns to define high-level filters about which EPC codes to include/exclude in the reported filtered data.
- URI formats are formulated for pure identities and also to express tag-encoding of the binary number actually stored on the tag.

Pure identities vs Tag-encoding

Pure Identity	Tag-encoding
Used by high-level & legacy applications	Used by low-level applications e.g. for programming tags or filtering
Says nothing about tag length or filter value	Indicates length of tag (64-bit or 96-bit)
Often just consists of: • Company Prefix • Item Reference / Location Ref. • Serial Number	May include filter values for fast filtering on e.g. packaging type (item/case/pallet) physical locations vs companies
urn:epc:id:sgtin:0037000.163903.40932601	urn:epc:tag:sgtin-96:3.0037000.163903.40932601

The original EPC general identifier – encoding in a 96-bit tag

GID-96 Encoding



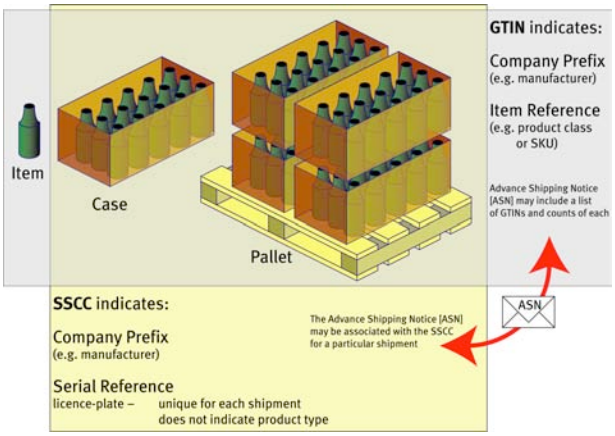
Global trade item number (GTIN)

- GTIN unifies UPC-12 and EAN-13 barcodes for trade items into a 14 digit format by left-padding with zeros:

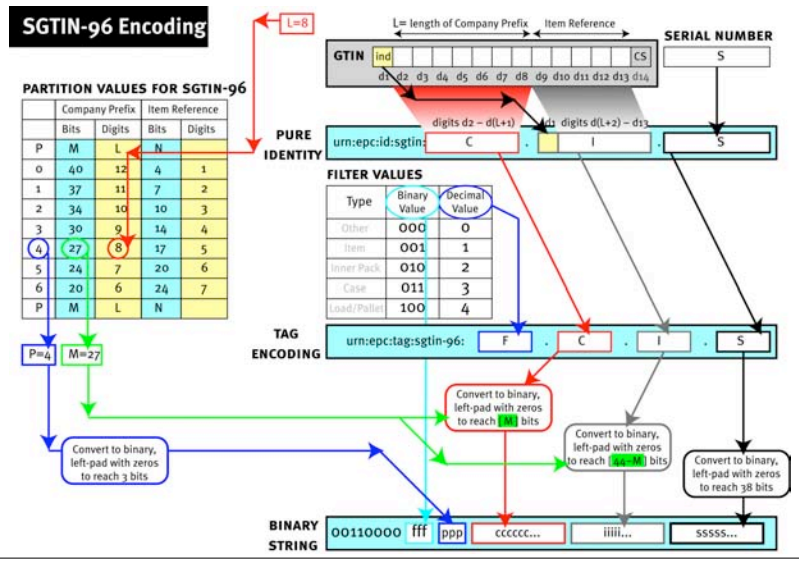
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
EAN/UCC-12	O	O	X	X	X	X	X	X	X	X	X	X	X	C
EAN/UCC-13	O	X	X	X	X	X	X	X	X	X	X	X	X	C
EAN/UCC-8	O	O	O	O	O	O	X	X	X	X	X	X	X	C
EAN/UCC-14	X	X	X	X	X	X	X	X	X	X	X	X	X	C

C = check digit

EAN.UCC Keys - GTIN and SSCC



Serialized GTIN (SGTIN) – encoding in a 96-bit tag

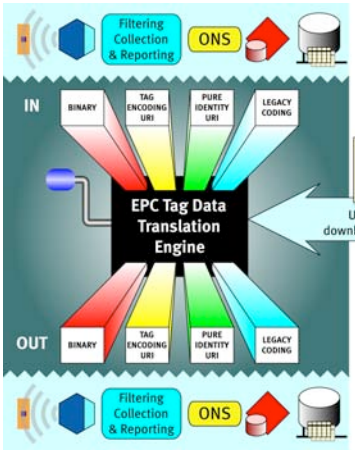


Complexity of encoding/decoding

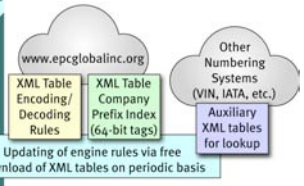
- The original EPC did not try to embed existing numbering schemes such as EAN.UCC into the identifier. The mapping process was therefore very simple.
- However, FMCG end users (and perhaps also EAN.UCC) wanted the existing legacy codes (GTIN, SSCC etc.) embedded in the EPC. This however, makes the encoding/decoding process much more complicated than it needed to be.
- How complicated do **you** want it to be?
- Just what information do you need to be able to read from the RFID tag? - and what can more safely be left on the barcode?

Tag Data Translation Tool

http://www.autoidlabs.org/Cambridge/TDS



EPC Tag Data Translation WG



- Automatic
- Extensible
- Usable at any point of the EPC Network Technology Stack

Tag Data Translation Tool

http://www.autoidlabs.org/Cambridge/TDS

[Web Page Demo]

Factors to consider

- Healthcare does not have to follow the same path as FMCG!
- It must make an informed choice, basing its own decisions on:
- Life-critical Real-time readability needs
- What data needs to be read from a barcode or RFID tag when either the external network or internal LAN network connections fail
- Redundancy requirements - local pre-positioning and caching of data
- Privacy concerns - especially for RFID tags on consumer items
- Computational performance/time needed to decode tags
- Which ID to store on RFID tags vs which ID to store on barcodes
- What information belongs in the identifier for life-long traceability and what belongs in 'user memory' of tags as attributes