

Mobile and Ubiquitous Computing

RFID: Numbering and Services

RFID Numbering

- Identifiers in RFID
- A brief history of object numbering schemes
- Object identifiers
 - EPCglobal Electronic Product Code
 - Ubiquitous ID
 - Other object numbering schemes
- Addressing objects
- The Internet of Things

Addressing objects

- User-space object ID
 - Generally no additional context data on tag
 - Characteristics
 - Universally unique
 - Sub-domain structure
 - Registrar
 - Ownership
 - Mechanisms for mapping to metadata
 - There are already some candidates!
-

Numbering Systems for Objects

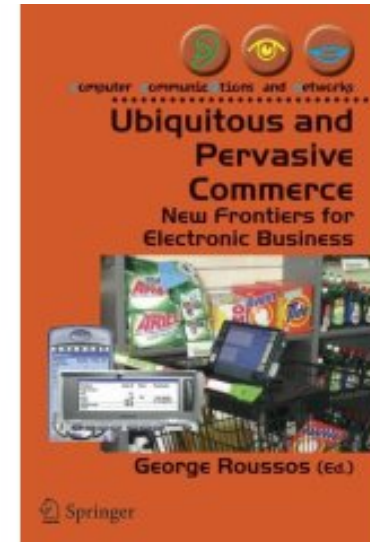
- Barcodes
 - many different types!
- IPv6 addressing
 - too much functionality for objects many cases
 - requires superior processing capability and >100KB stack)
- Internet 0
 - reduced IP stacks with ISO-1800/ IRDA etc link layer
 - Asymmetric, no end-to-end
- Other MAC addresses
 - embedded Zigbee, Bluetooth



UCC/EAN-128, EAN-13, EAN-8, ITF 14.

Multiple identifiers

- Objects can have multiple IDs in different schemes
 - 658.05 UBI (Dewey Classification Scheme)
 - 1846280354 (ISBN)
 - 9781846280351 (EAN)
 - 6602940 (LIBRI)



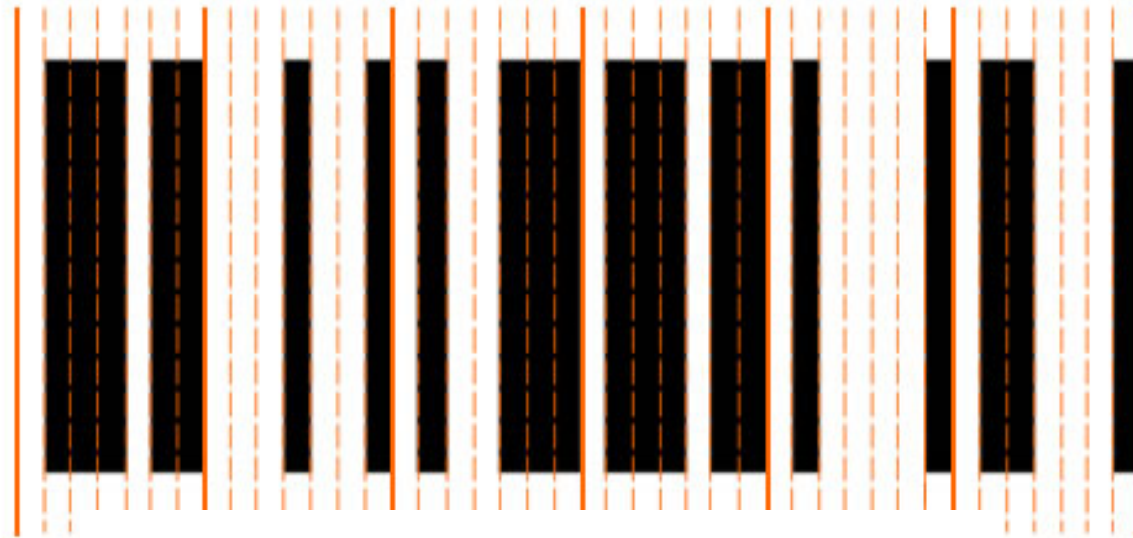
Objects and products

- Object manufacturer well positioned to embed ID
- Has been done before at global scale
- Major perceived business benefits in the supply chain
 - logistics, inventory, anti-counterfeiting, demand forecasting, shrinkage
- Possible consumer applications
 - smart things, smart selves, product recalls
- Major technology investment

Barcodes and the SG1 system

- UPC created in 1973 the first American 10-digit barcode standard (uniform and then Universal product code)
- European Article Numbering introduced in 1977 extended the scheme to the needs of a global market
 - first to separate the data from the data carrier
- Two systems became interoperable in 2005 as EAN.UCC and later SG1 (One Global Standard)
- Under SG1 a variety of standardization activity including RFID within EPCglobal
 - ebXML, Global Data Synchronization Network, Global Standards Management Process, Global Product Classification

011101100010010100111011101101000010110001



EPC Identifiers

- A global identifier scheme is needed
 - Address allocation, coordination of address space, address semantics, resolution
- EPC is part of SG1 and so has to accommodate existing EAN and related identifiers
- Management of the scheme is via a SG1 subsidiary called EPCglobal Inc
- Protocols are developed in the Auto-ID network of research laboratories

EPC structure

- EPC tag data standards define “pure identifiers” which are abstract object addresses
 - Pure identifiers are stored following the related “physical realization” and “encoding” protocols on the tag
 - *Header data* identifies the particular scheme employed in a specific EPC and thus the semantics of the digits
 - Current schemes are specific to SG1 and DoD requirements and there is also a general ID
-

Encoding schemes

- General Identifiers (GID-96)
- System Identifiers
 - GS1 Global Trade Item Number (GTIN) SGTIN-96 SGTIN-198
 - GS1 Serial Shipping Container Code (SSCC) SSCC-96
 - GS1 Global Location Number (GLN), SGLN-96 SGLN-195
 - GS1 Global Returnable Asset Identifier (GRAI) GRAI-96 GRAI-170
 - GS1 Global Individual Asset Identifier (GIAI) GIAI-96 GIAI-202
- DoD construct (DoD-96) cf. www.dodrfid.org

Types of data

- Serialized Global Trade Item Number (SGTIN) -On item packaging for items where a serial number is used for the unique identification of trade items worldwide within the UCC.EAN System.
- Global Returnable Asset Identifier (GRAI)-On item packaging for items (reusable package or transport equipment).
- Global Individual Asset Identifier (GIAI) -On item packaging for items (used to uniquely identify an entity that is part of the fixed inventory of a company -GIAI can be used to identify any fixed asset of an organization).
- Serialized Shipment Container Code (SSCC)-Items shipped as either pure or mixed case, pallet, (SSCC can be used by all parties in the supply chain as a reference number to the relevant information held in computer database or file).

Electronic Product Code

016.37000.123456.1000000000			
Header	EPC Manager	Object Class	Serial Number

- *Header*: identifies the length, type, structure, version and generation of EPC
- *Manager Number*: which identifies the company or company entity (today: same as EAN)
- *Object Class*: similar to a stock keeping unit or SKU
- *Serial Number*: which is the specific instance of the Object Class being tagged

ucode

- Not specifically related to supply chain applications
- ucode is a 128-bit number
- It is a meta-ID because it can incorporate other numbering schemes
 - provides bindings for JAN, UPC, EAN.UCC, ISBN
- It can be abbreviated for use with low-capacity carriers
 - uses context code
- Distinct domain levels, managed independently
- Registrar is Ubiquitous ID Centre
 - T-Engine Forum, University of Tokyo

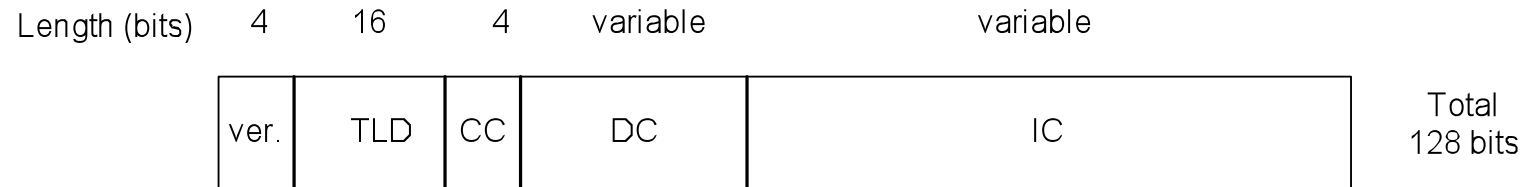
uID technologies

- Defines specific tag classes
 - also incorporates barcodes
 - microwave, HF and UWB tags
- Defines reader device called the uID Communicator
- Defines software platform
 - Based on TRON
- Address resolution points to uTAD record with object details

```
<rdf:RDF
  xmlns:rdf="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:utad="urn:utad:schema:utad:base:0.0.0#"
  xmlns:pc="urn:utad:schema:pc:example:0.0.0#">
  <rdf:Description rdf:about="ucode:0123....cdef">
    <rdf:type rdf:resource="urn:utad:schema:pc:example.0.0.0#pc"/>
    <utad:version>0.0.0</utad:version>
```



unicode structure



- version
- Top Level Domain code
- Class Code specifies the boundary between DC and IC
- Domain Code specifies the type of IC
 - e.g. JAN, ISBN, EPC etc
- Identification Code is the actual object identifier

Identifiers in a Gen2 tag

- Tag identification (TID) memory bank
 - An 8-bit ISO 15963 allocation class identifier
 - For EPCglobal Tags it is 0xE2
 - A 12-bit Tag mask-designer ID
 - A 12-bit Tag model number.
 - Manufacturers can also include other information if required e.g. tag serial number
- EPC in EPC memory bank
- User memory bank may contain additional application specific IDs

ISO 14443 IDs

- ISO 14443-A requires fixed Card Identifier (CID)
- CID uniquely related to tag chip
 - Application Family Identifier (AFI) defines separate spaces for CID
- Used by reader to address a specific card
 - Also used in groups to keep specific cards in a particular state
- In ISO 14443-B can be pseudo –random number
- Application layer identifiers are contained in user data space
 - e.g. Oyster card customer number different from ISO ID

OID (ISO/IEC 15459)

1.0.15961.12.1. 1234567890

{iso(1) standard(0) rfid-data-protocol(15961) iata(12) 1}

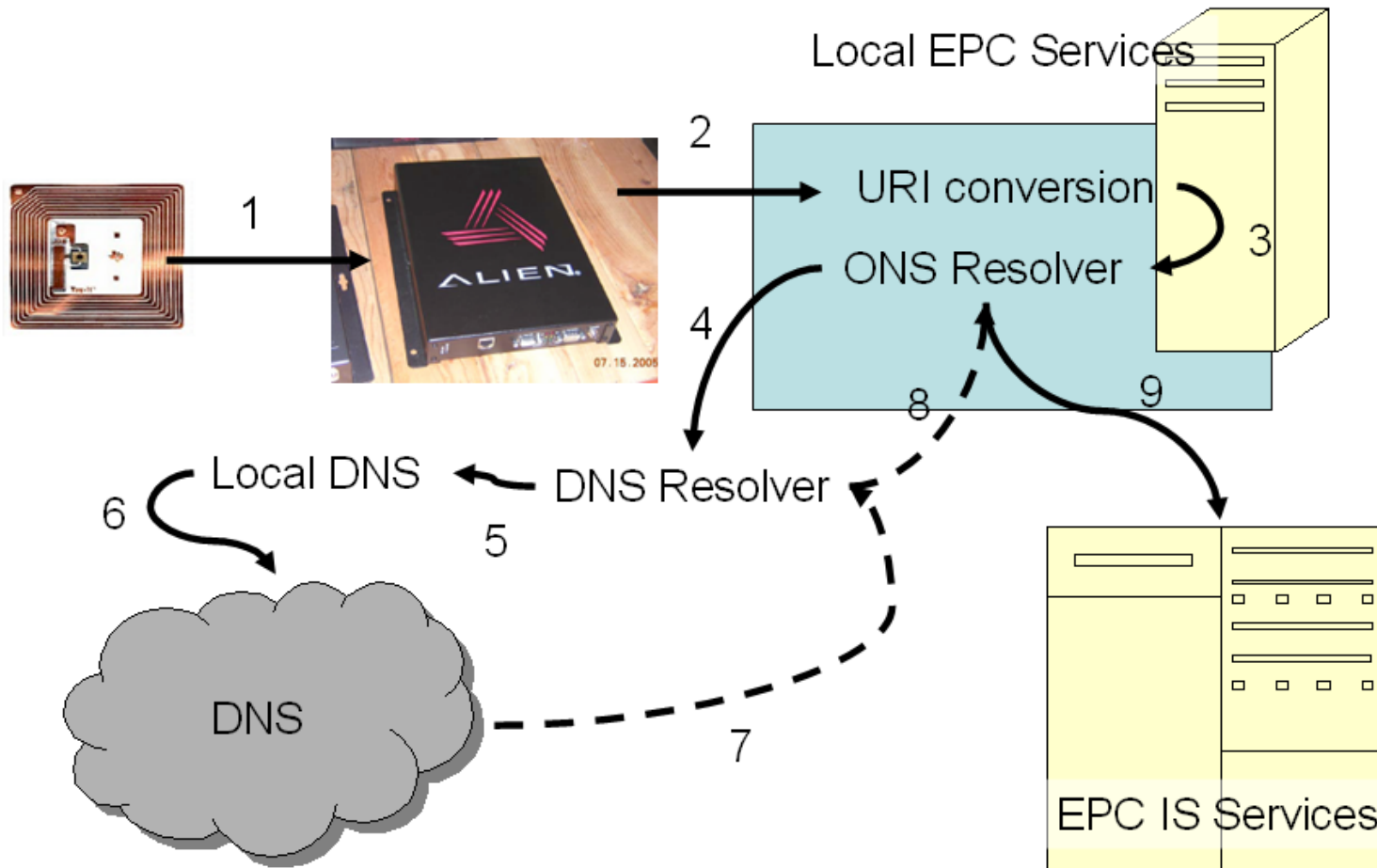
1.0.15459. 4. OD.A1B2.A1B2C3D4E5

IAC supply chain management code
Defined in ISO/IEC 15459-4:2004, clause 4
Issuing agency code

ONS lookups

- Using the usual DNS tools
 - Two types of DNS resource records
 - NAPTR for EPC codes
 - TXT for company code tables
 - Translating the ID into a DNS query
 - Follows path to (local to authoritative) onsepc.com through DNS
 - Follows path within onsepc.com from root to ID custodian local server
-

Query sequence



Translation

EPC 64-bit Format:

[10 000 00000000000000 00000000000000011000 0000000000000000110010000]

Step 1: Reader captures and sends to EPC event manager

10 000 00000000000000 00000000000000011000 0000000000000000110010000

Step 2: EPC EM creates URI following Tag Data Standard:

urn:epc:id:sgtin:0614141.000024.400

Step 3: To local ONS resolver:

urn:epc:id:sgtin:0614141.000024.400

Step 4: ONS resolver converts the URI to the equivalent DNS NAPTR query

000024.0614141.sgtin.id.onsepc.com

Step 5: DNS returns result set (redirect to manager domain)

ONS Resolver

- Remove URI pre-fix

urn:epc:id:sgtin:0614141.000024.400 → 0614141.000024.400

- Remove Serial Number

0614141.000024.400 → 0614141.000024

- Invert

0614141.000024 → 000024.0614141

- Append ONS root

000024.0614141 → 000024.0614141. sgtin.id.onsepc.com

- Issue DNS query e.g.

nslookup 000024.0614141. sgtin.id.onsepc.com (set type=NAPTR)

```
ictx.getAttributes(epcDomainName, new String[]{"NAPTR"});  
(javax.naming)
```

NAPTR

- Naming Authority Pointer (NAPTR) is a type of DNS Resource Record (RFC 2915)
- Designed for Dynamic Delegation Discovery System (DDDS) applications (RFC 3401, 3401, 3403, 3404)
 - Lazy binding of strings to data
 - Supports dynamically configured delegation
- Uses regular expressions to specify a delegation point within some other namespace
- e.g. used to locate SIP users
\$ORIGIN 3.8.0.0.6.9.2.3.6.1.4.4.e164.arpa.
NAPTR 10 100 "u" "E2U+sip" "!^.*\$!sip:info@example.com!" .

ONS Result Set

- NAPTR fields:
 - **Order** And **Pref** show priority of this result within the set
 - **Flags** when set to “u” means regular expression containing URI
 - **Service** designates different types of services. The format of this field is EPC+service_name where service_name can be pml, html, xmlrpc, and ws
 - **Regexp** specifies a URI for the service being described (for ONS currently it is hostname and additional path information)
 - **Replacement** specifies the replacement portion of the rewrite expression (not used in ONS)

ONS Result Set Example

Orders	Pref	Flags	Service	Regexp	Replacement
0	0	u	EPC+pml	^.*\$ http://www.epc.dcs.bbk.ac.uk/cgi-bin/epcpml.php	.
0	0	u	EPC+html	^.*\$ http://www.epc.dcs.bbk.ac.uk/epcpml.jsp	.
0	0	u	EPC+xmlrpc	^.*\$ http://www.epc.dcs.bbk.ac.uk/exist/epc	.
0	0	u	EPC+epcis	^.*\$ http://www.epc.dcs.bbk.ac.uk/epc	.
0	0	u	EPC+ws	^.*\$ http://www.epc.dcs.bbk.ac.uk/ws/epc.wsdl	.

Service codes:

EPC+pml: Product Markup Language document

EPC+html: Web page description

EPC+xmlrpc: XML Remote Procedure Call interface

EPC+ws: Web Service interface (WSDL)

EPC+epcis: Authoritative EPC IS server

Example

Solaris 10
nslookup

Set DNS record
type to NAPTR

ONS reply



```
hermes.dcs.bbk.ac.uk - PuTTY
hermes(113)% /usr/sbin/nslookup
*** Can't find server name for address 193.61.29.197: Non-existent host/domain
Default Server:  loki.dcs.bbk.ac.uk
Address:  193.61.29.134

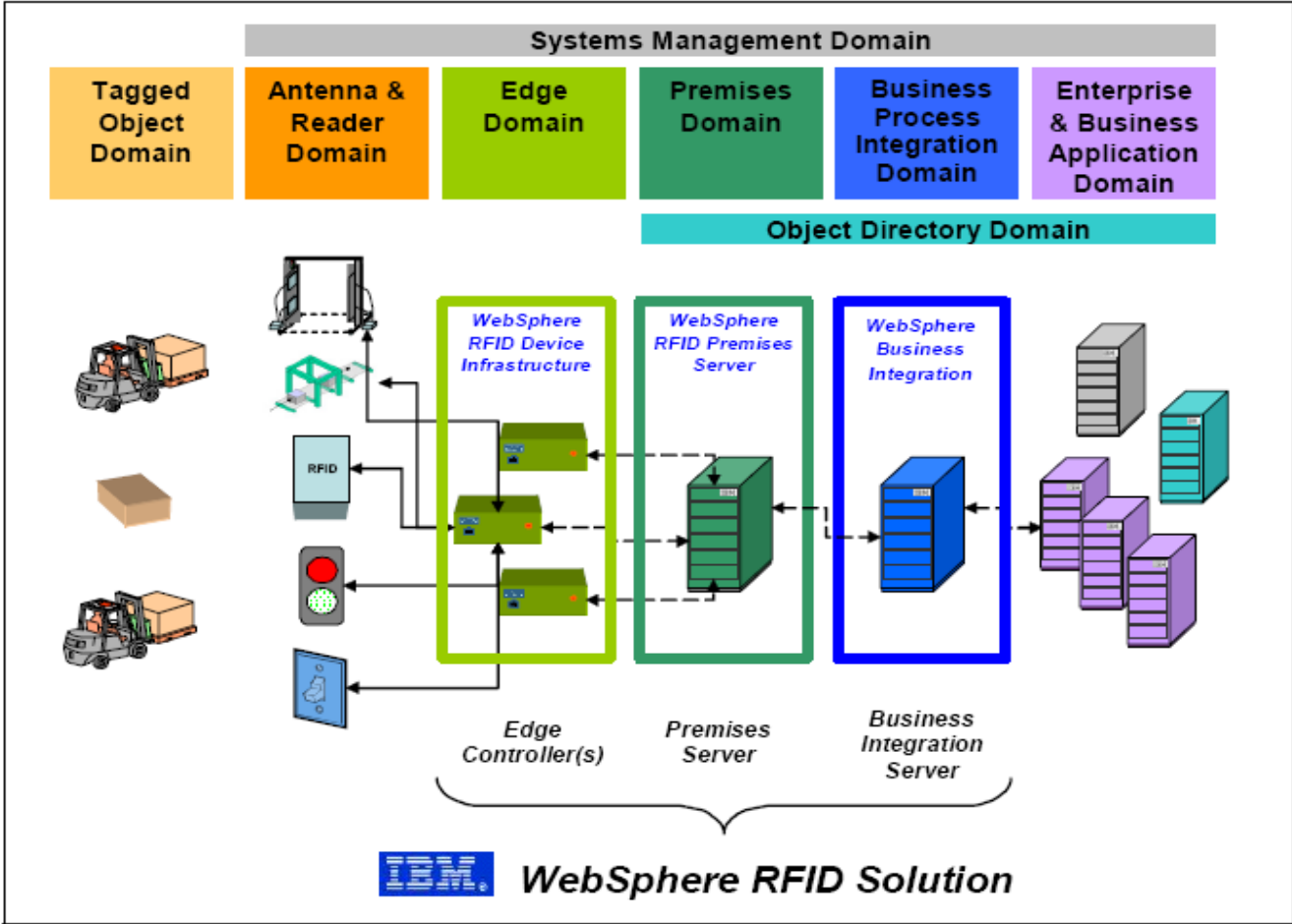
> set type=NAPTR
> 075861.0434687.sgtin.id.onstest.com
Server:  loki.dcs.bbk.ac.uk
Address:  193.61.29.134

Non-authoritative answer:
075861.0434687.sgtin.id.onstest.com      order = 1, preference = 1
    flags = "u"
    services = "EPC+EPCIS"
    rule = "!^.*$!http://reference.verisignepctest.com!"
    replacement = (root)

>
```

Try test ONS server at epc.dcs.bbk.ac.uk

RFID System



Event Manager Internals

