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## **Comparison of the ID@URI (TraSer) approach with other systems**

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-white paper-

## Introduction

In the early 1990s a number of barcode symbologies were standardized by the CEN (Comité Européen de Normalisation). The set included Code 39, Code 128, Interleaved Two of Five (ITF) and EAN-UPC. Later the set was extended with a few two dimensional barcodes (e.g. Data Matrix and PDF417). The CEN standards have now been adopted by ISO/IEC JTC1/SC31 as ISO standards. These symbologies were mainly technologies to print character strings in a machine readable format. However, some of them (notably EAN-UPC and Code128) had application specific features.

To support standardized applications with the symbologies, additional cross-symbology standards were developed. These specifications now also have been published as ISO standards.

They include:

- a specification of a symbology identifier, that is to be added to the data stream by the barcode reader for the application to identify the symbology
- a specification for the format and maintenance of Application Identifiers (AI, for Code 128) and Data Identifiers (DI, for the other symbologies, but mainly for Code 39). AIs and DIs are used to identify the data content of the barcode as specific structures of data elements.
- a specification for a “license plate”, a globally unique identification number for transport units
- a specification for a printed barcode label for shipping purposes.

Data Identifiers are being maintained by ANSI MH10 in the US. Application Identifiers are maintained by GS1. ANSI maintains a cross reference between DIs and AIs. Presently some 320 DIs have been defined and 120 AIs.

The License Plate standard (ISO 15459) includes a numbering system in which issuing organizations may apply for an Issuing Agency Code (IAC) at the ISO 15459 registration authority (presently NEN in the Netherlands). Issuing agencies then assign ranges of numbers to their member organizations that may use them to identify transport units. License Plates may be encoded in various symbologies, including Code 39 and Code 128. GS1 uses the License Plate structure as the basis for a standard called the Serial Shipping Container Code.

RFID standards go a similar path. Obviously the RFID standardization is not as completed as barcode standardization. Many standards are still under development (see Figure 1).

The ISO 18000 series of standards defines the air interface between the transponder and the reader. Various frequency bands have been allocated to be used through this interface. ISO 15962 defines the data protocol and the encoding of data. ISO 15961 defines the data protocol for the application interface. The standard supports ISO 15418 Data Identifiers among other mechanisms. Data Identifiers are converted into Object Identifiers. An Application Family ID defines the services an application may expect from the interface.

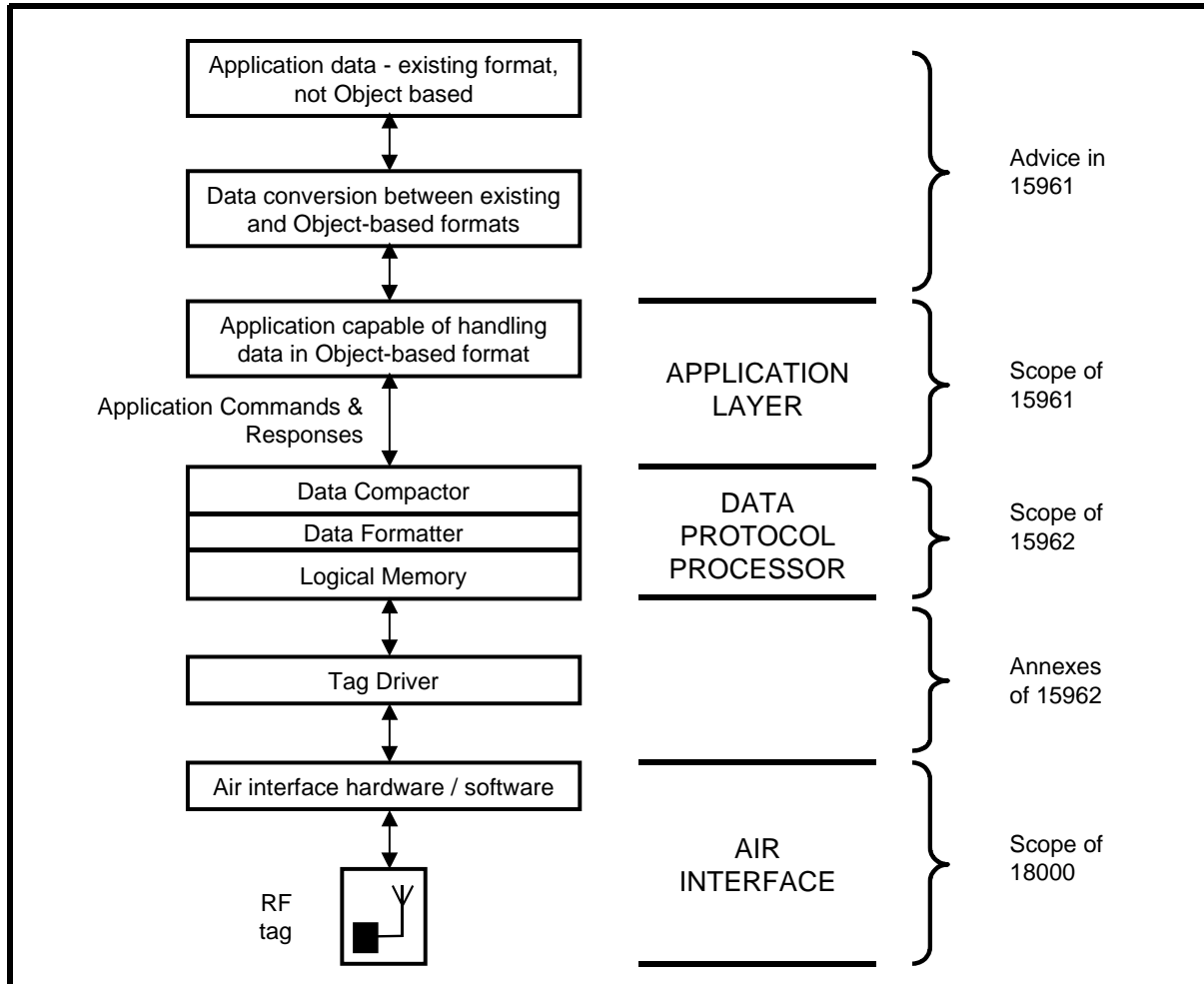


Figure 1. RFID standards

RFID transponders may get a built-in unique identification number. ISO 15963 describes the structure of that number and the mechanism to guarantee uniqueness. The number is prefixed by an Allocation Class (AC). Presently 4 organisations have been assigned such AC (See Figure 2). APACS holds a register of microchip manufacturers who may apply for a UID issuer Registration Number. GS1 issues Issuer Registration Numbers for use in the EPC Global system. NEN holds a register of owners of freight containers. INCITS is the US committee that gives input to ISO JTC1.

AC Value	Class	UID issuer identifier size	Serial Number size	Registration authority (of "UID issuer Registration Number")
'11100000'	7816-6	8 bits	48 bits	APACS (ISO/IEC 7816-6 registration authority)
'11100001'	14816	per NEN	per NEN	NEN (ISO 14816 registration authority)
'11100010'	GS1	per GS1	per GS1	GS1
000xxxxx	INCITS 256	per ANS INCITS 256	per ANS INCITS 256	ANSI ASC INCITS T6
'11100011' to '11101111'	RFU	N/A	N/A	Reserved for future use by ISO

Figure 2. RFID allocation classes.

Both barcode license plates and radio frequency identification thus make use of the same mechanism to guarantee uniqueness of identification numbers. An ISO appointed registration authority issues codes to a limited number of issuing organizations, that allocate number ranges to be used by their members. A similar mechanism is the one used to assign Uniform Resource Identifiers (URI). URIs are not defined in an ISO standard, but in an RFC of the Internet Engineering Task Force. Similar to ISO registration authorities there exists a body (the Internet Corporation for Assigned Names and Numbers, ICANN) that assigns domains of identifiers, either directly to user organizations or via intermediates, such as national bodies.

A completely different mechanism is employed for the production of UUIDs. A Universally Unique Identifier (UUID) is an identifier standard used in software construction, standardized by the Open Software Foundation (OSF) as part of the Distributed Computing Environment (DCE). The intent of UUIDs is to enable distributed systems to uniquely identify information without significant central coordination. Thus, anyone can create a UUID and use it to identify something with reasonable confidence that the identifier will never be unintentionally used by anyone for anything else. Information labelled with UUIDs can therefore be later combined into a single database without needing to resolve name conflicts.

## **Numbering Standards of EAN.UCC**

To obtain an identification number to be used in bar codes one must join either EAN Int. or UCC. As a result, one gets a 6- to 10-digit company prefix, which is globally unique and independent of sector of industry. The following 1- to 6-digit code makes the item reference number. At the end, there is always a check digit, which is calculated from the other digits.

### **Global Trade Item Number (GTIN)**

GTIN is a 14-digit code system, and it can be combined with other data in a Code-128 bar code symbol. Most commonly used GTINs are the EAN-13 symbol and its US counterpart Universal Product Code (UPC), which are meant to identify product types. There are also two other data structure possibilities: EAN-8 and EAN-14. EAN-14 is also known as the Shipping Container Code (SCC), which is used to mark a transport unit (e.g. a container) that contains only one type of products. As can be noticed, the codes do not necessarily identify individual product items as such; they can also identify product types or large amounts of products.

One can create a GTIN from each of the codes mentioned by right-justifying them in a 13- digit field, and by adding enough zeros to fill the empty digits on the left, as shown in the Figure 3. The fourteenth digit is always reserved to be a check digit, which will be calculated from the previous digits. The translation for TraSer can be done by using the bits in the company prefix in the formation of the URI, and the item reference number in the formation of the product identity.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
UCC - 12	0	0	X	X	X	X	X	X	X	X	X	X	X	C
EAN/UCC - 13	0	X	X	X	X	X	X	X	X	X	X	X	X	C
EAN/UCC - 8	0	0	0	0	0	0	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

Figure 3: GTINs created from different data structures by right justifying them and adding zeros to left to fill the empty digits. The last digit is a check digit that is calculated from the other digits.

### Global Location Number (GLN)

The Global Location Number (GLN) is another EAN.UCC system. It provides all legal entities, trading parties and locations with a unique identification number to support the requirements of electronic commerce. GLN can be used to identify both functional and physical entities. This means that it can be used to identify a fixed checkpoint location, as well as a delivery handling division of a company. GLN consist of 13 digits from which the first three digits are the EAN.UCC prefix, which is followed by nine-digit company prefix and location number (see Figure 4). The last one is a check digit.

1	2	3	4	5	6	7	8	9	10	11	12	13
N	N	N	N	N	N	N	N	N	N	N	N	C

Figure 4: GLN consist of 13 digits, from which the last one is a check digit.

### Serial Shipping Container Code (SSCC)

The Serial Shipping Container Code (SSCC) is meant to ease tracking of a shipment of products and handling of them in shipping and receiving. SSCC is a sort of licence plate for a container of products. It has been designed to ease moving of products from the supplier to his customer, and to make handling of the shipment and delivery quicker.

The code consists of 18 digits. The first one is an extension digit, which can be used by a member company as it sees appropriate (or useful). Next 16 digits are the actual code, with first the company prefix assigned by EAN or UCC and then the actual serial reference of a product. The last digit is a check digit. All these can be seen in the Figure 5.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
E	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	C

Figure 5: First digit is an extension for the company to use as desired, then the company prefix followed by the product code and a check digit.

## Code-128

Code-128 is a high-density alphanumeric bar code system. It will take the least amount of space of one dimensional bar code structures for data with six or more characters. Its length is not restricted, so the symbol can be as long as desired. The name comes from the amount of 128 ASCII characters one can inclusively code with it to a bar code, in accordance with ISO 646. Other characters, with ASCII codes between 128 and 255, may also be encoded.

## EPC vs. ID@URI

The EPC network approach defines standard interfaces for related information systems that associate the product item with serial-level product information in backend systems. The product item is uniquely identified by its EPC (Electronic Product Code), which is a flexible identifier framework that allows a number of existing product identifiers (such as the GTIN) to be embedded. The ID@URI approach also uses existing product identifiers (item-level or not) and explicitly expresses, where product information can be accessed in backend systems<sup>i</sup>.

## EPC Network Approach

The electronic product code (EPC) is one approach for creating references between product items and the product agent or backend information services (see Figure 6). EPC identifiers are Uniform Resource Names (URN) that uniquely name objects. The EPC URN naming scheme is a ratified, published open standard, known as the 'EPC Tag Data Standard', which describes how a number of existing product identifiers may be formatted as a URN for use in the EPC network. These existing product identifiers include serialized versions of the global trade item number (GTIN), which is related to the UPC-12/EAN-13 barcodes already found on many products. When the EPC URN identifier is stored on passive RFID tags, a very compact binary format is used, requiring a minimum of only 64 or 96 bits of tag memory to store a wide range and large number of identifiers. This is achieved by not encoding the URN into binary as 8-bit bytes per character—but instead encoding various identifier fields as binary-encoded integers and replacing the URN prefix with a compact 8-bit 'header' code.

The Object Name Service (ONS) is the lookup mechanism used to obtain one or more URLs where authoritative information can be obtained for a given EPC. ONS is an extended implementation of the

Domain Name System (DNS), using NAPTR (Naming Authority Pointer) DNS records. ONS provides a scalable hierarchical lookup system, re-using existing DNS tools and protocols to perform the lookup. The root-level of ONS has been operational for over two years and resolves the Manager ID (usually points to the manufacturer of the product). The root-level is administered by EPCglobal Inc., and the operation of the root-level servers is currently subcontracted to Verisign Corporation. The second tier of ONS provides for resolution of different product classes within a company. It may be implemented using an in-house DNS name server. Entries in the root-level ONS lookup system are currently only provided for subscribers of EPCglobal Inc.

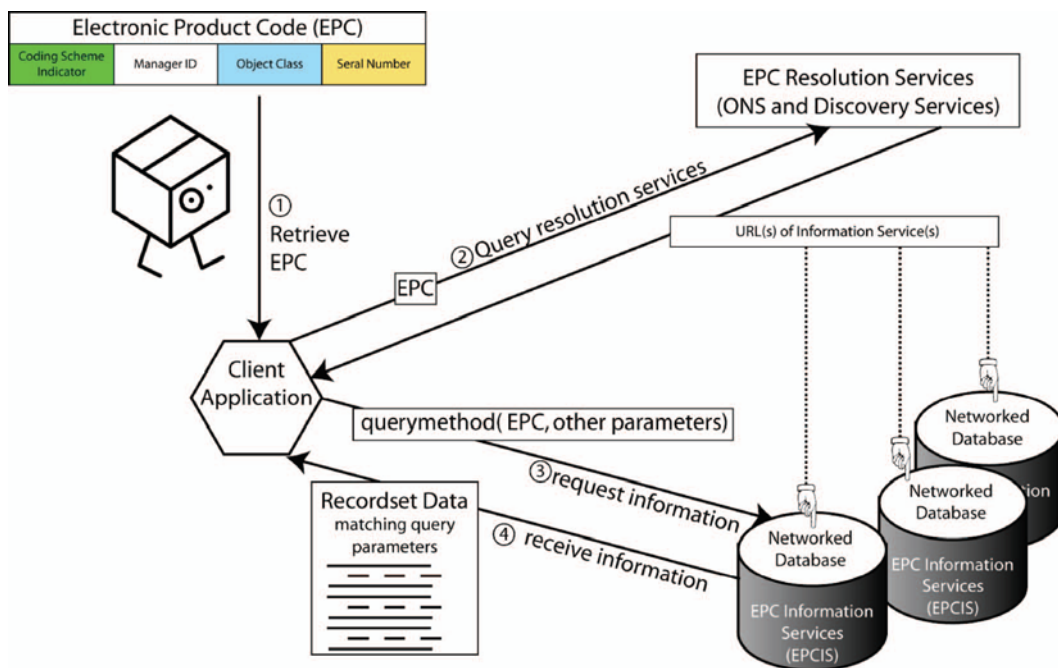


Figure 6. Product information lookup with EPC Network approach. The system uses an ONS-service to find the information database, and then requests for the wanted information from the database.

To date, EPCglobal have not yet chartered a work group to standardize discovery services, although there are several technology vendors currently providing implementations of discovery services, albeit with no guarantee of a standard API among their implementations.

### ID@URI Approach

In the TraSer approach (see Figure 7), an ID@URI notation is used for creating a GUPI (Globally Unique Product Identifier), where the ID part identifies the product item at the URI (Uniform Resource Identifier). If the URI is a Uniform Resource Locator (URL), it is straightforward to link to a product agent or backend information services so no ONS-type approach is needed. The uniqueness of a URL is guaranteed by the DNS infrastructure. For an ID@URI to be a GUPI, the ID part should be unique for the corresponding URI. At the minimal level the ID@URI reference can be embedded as a barcode or using a passive RFID tag.

Since the URI part uses existing standards and since many possible standards exist for the ID part, this approach does not need any new identifier standards. Examples of usable standards for the ID are the EPC, well-known industrial standards such as GTIN, SSCC GRAI etc., as well as ordinary serial numbers that are typically designed to be unique by product manufacturers.

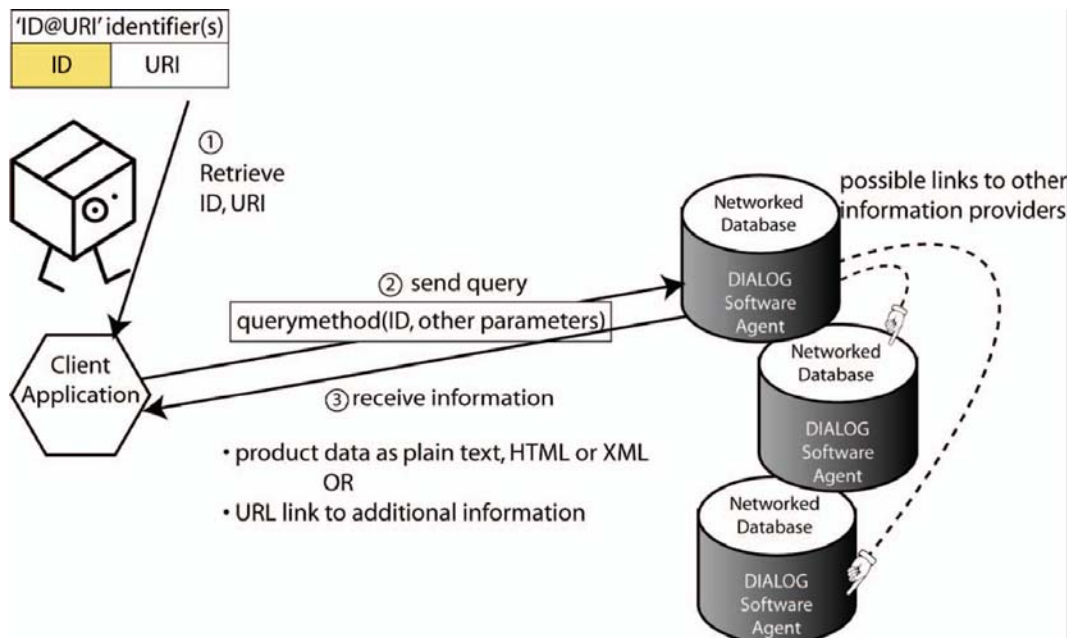


Figure 7. Product information lookup with ID@URI. Within TraSer-system, the database is found by using the URI, and the wanted information by using the product identity (ID). In case of external identifiers (such as GTIN), a translation to ID@URI is first performed.

## Conclusion

A typical TraSer use process begins with a reading device reading a bar code or an RFID tag. Out of this information, client software will sort out URI and identification number of the object. If both data are read correctly, the client software will create a connection with the server at the network location defined by URI and fetch the data. As mentioned earlier, if the identity is already in the form of ID@URI, no ONS-type lookup is required.

In the case where a URI cannot be retrieved from the item itself, at least the following approaches can be used:

1. **Static URI**: send ID to a backend service that takes care of message forwarding if it is needed. An example where this approach can be used is where an organisation has some existing infrastructure, e.g. DHL, Itella etc. and can resolve the needed URIs in their backend systems

2. Local mapping of e.g. company prefix in GTIN or SSCC code to a corresponding URI. This is feasible in cases where only items from a limited number of organisations can occur, e.g. in an ordinary supply chain where business relationships do not change too often.
3. Using the identifier as a key to some global lookup mechanism that returns the corresponding URI. ONS or some yet-to-define Web Service solution could be used for this. The main challenges with this approach is e.g. that no such infrastructure yet exists, that it would need to be failure-tolerant and that the cost of using it would not become excessive.
4. Any combination of these. Retrieving the URI from the item itself is the quickest way, while the solutions 1-3 can be successively used as backups for each other in such a way that a corresponding URI can be retrieved to a sufficient degree of certainty.

The ID@URI concept is really an information access method in a distributed system, not another new numbering scheme. Any existing numbering method (e.g. GTIN) is used simply by making a translation into ID@URI and then using this identification throughout the TraSer system. This has the advantage that the system is numbering scheme independent.

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<sup>1</sup> K. Främling, M. Harrison, J. Brusey and J. Petrow: *Requirements on unique identifiers for managing product lifecycle information: comparison of alternative approaches*, forthcoming article in International Journal of Computer Integrated Manufacturing.