Identifier management architecture

A technical report by *Miguel Pardal*, IST, MIT

Identifiers are the core of GS1's business, so their management is a crucial activity for the organization.

This technical report begins with a brief definition of underlying concepts and then presents a view on the current GS1 identifier management architecture. Finally, it proposes a new architecture that accommodates new business needs, namely the use of GS1 identifiers in mobile commerce applications.

0 - Underlying concepts of identifiers

0.1 - Names, addresses and identifiers
[TanenbaumVanSteen07]

A **name** is a string of bits or characters that is used to refer to an entity. An **entity** is something that can be operated somehow. To operate on an entity, it is necessary to access it, for which we need an **access point**. The name of an access point is called an **address**.

Flat names are unstructured, random bit strings. They don't contain any information on how to locate access point of its associated entity.

Structured names are composed of several parts, which can be represented as a labeled, directed graph. The directory nodes of the graph contain outgoing edges, each labeled with a name part. The leaf nodes have no outgoing edges, represent a named entity and store information about the entity it is representing (typically, its address).

A **namespace** is the set of rules that define the admissible names.

Name resolution is the process of looking up any information stored in the node referred to by that name. Name resolution usually has a partly implicit **closure mechanism** that states how and where to start name resolution.

An **identifier** is a name with the following properties:
1. An identifier refers to at most one entity.
2. Each entity is referred to by at most one identifier.
3. An identifier always refers to the same entity (i.e. it is never reused).

0.2 - Encodings and realizations of identifiers
[EPCglobal08b]

A **pure identity** is the identity associated with a specific physical or logical entity, independent of any particular encoding vehicle such as an RF tag, bar code or database field. As such, a pure identity is an abstract name or number used to identify an entity. A pure identity consists of the information required to uniquely identify a specific entity, and no more.
An **identity URI** is a representation of a pure identity as a Uniform Resource Identifier (URI). A URI is a character string representation that is commonly used to exchange identity data between software components of a larger system.

An **encoding** of a pure identity is the identity value together with additional information such as filter value, rendered into a specific syntax (typically consisting of value fields of

specific sizes). A given pure identity may have a number of possible encodings, such as a Barcode Encoding, various Tag Encodings, and various URI Encodings.

A **physical realization** is an encoding rendered in a concrete implementation suitable for a particular machine-readable form, such as a specific kind of RF tag or specific database field. A given encoding may have a number of possible physical realizations.

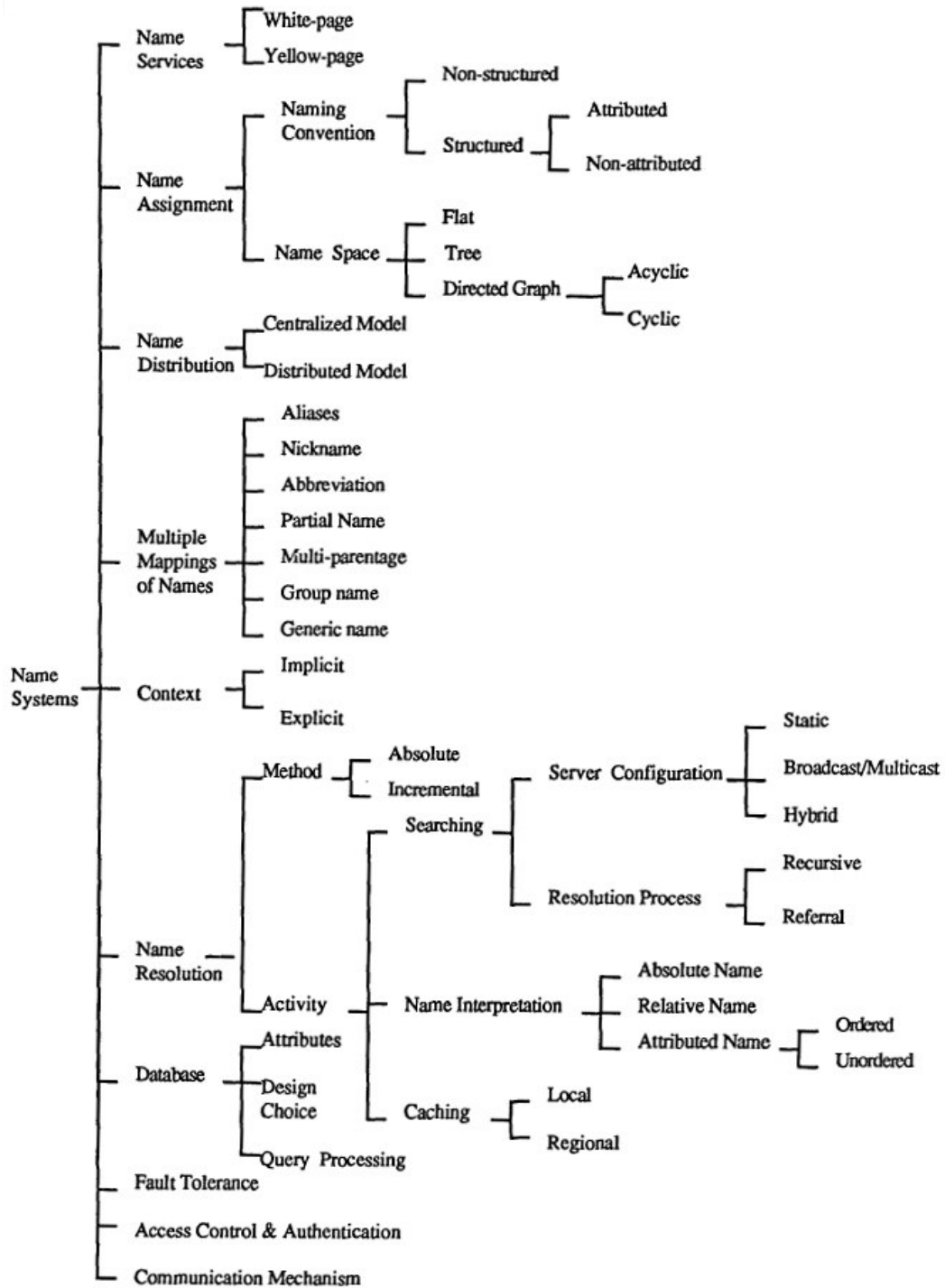The following figure shows the layered construction of identifiers in practical use.
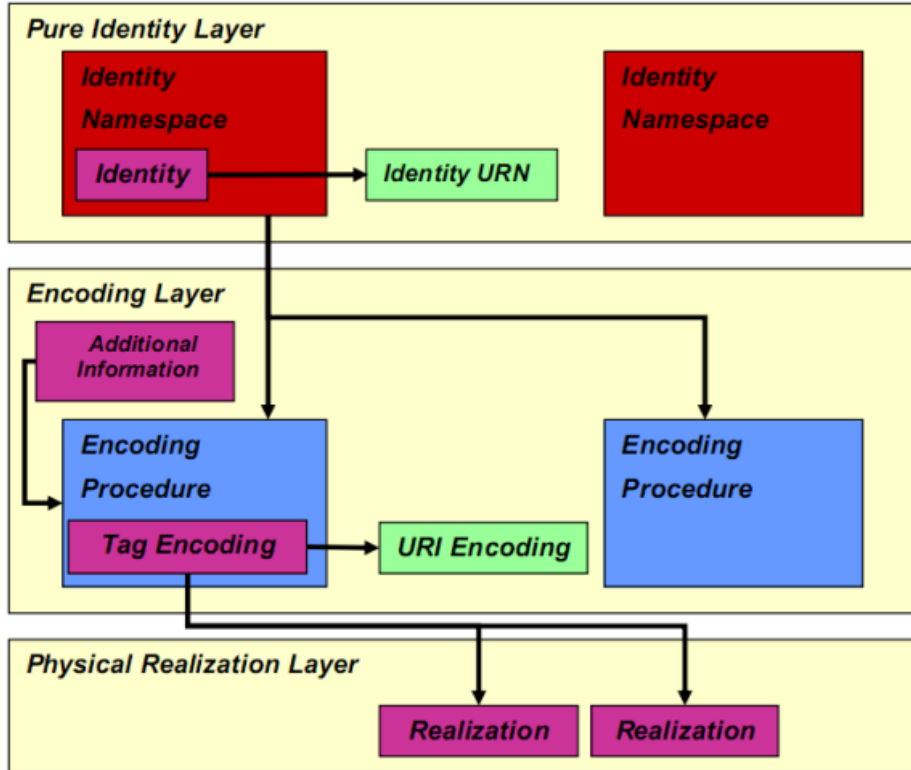
[EPCglobal08b]

0.3 - Taxonomy of issues in identifier systems

[Yeo93]

Naming systems presents the following taxonomy of issues in name systems design and implementation:

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Name Systems
├─ Name Services
│   ├─ White-page
│   └─ Yellow-page
├─ Name Assignment
│   ├─ Naming Convention
│   │   ├─ Non-structured
│   │   └─ Structured
│   │       ├─ Attributed
│   │       └─ Non-attributed
│   └─ Name Space
│       ├─ Flat
│       ├─ Tree
│       └─ Directed Graph
│           ├─ Acyclic
│           └─ Cyclic
├─ Name Distribution
│   ├─ Centralized Model
│   └─ Distributed Model
├─ Multiple Mappings of Names
│   ├─ Aliases
│   ├─ Nickname
│   ├─ Abbreviation
│   ├─ Partial Name
│   ├─ Multi-parentage
│   ├─ Group name
│   └─ Generic name
├─ Context
│   ├─ Implicit
│   └─ Explicit
├─ Name Resolution
│   ├─ Method
│   │   ├─ Absolute
│   │   └─ Incremental
│   └─ Activity
│       ├─ Searching
│       │   ├─ Server Configuration
│       │   │   ├─ Static
│       │   │   ├─ Broadcast/Multicast
│       │   │   └─ Hybrid
│       │   └─ Resolution Process
│       │       ├─ Recursive
│       │       └─ Referral
│       ├─ Name Interpretation
│       │   ├─ Absolute Name
│       │   ├─ Relative Name
│       │   └─ Attributed Name
│       │       ├─ Ordered
│       │       └─ Unordered
│       └─ Caching
│           ├─ Local
│           └─ Regional
├─ Database
│   ├─ Attributes
│   ├─ Design Choice
│   └─ Query Processing
├─ Fault Tolerance
├─ Access Control & Authentication
└─ Communication Mechanism
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[Yeo93]

(…)

1 - Current architecture

This section presents a view of the current GS1 identifier management architecture, starting with the identifier namespace and then describing the existing management processes.

1.1 - Identifier namespace

GS1 defines the identifiers listed in the following index.

GS1 Country or Special Code

GS1 defines a 3 digit code that can be used as a country code or as a special code.

Example country code prefixes:
- 000 - 019 USA and Canada
- 060 – 099 U.S. and Canada
- 100 – 139 U.S. (reserved for later use)
- 300 – 379 France and Monaco
- ...
- 400 – 440 Germany
- 450 – 459 Japan
- 460 – 469 Russia
- ...
- 490 – 499 Japan
- 500 – 509 United Kingdom
- ...
- 560 Portugal
- ...
- 690 – 695 China, The People's Republic
- ...
- 754 – 755 Canada
- ...
- 759 Venezuela
- 760 – 769 Switzerland and Liechtenstein
- ...
- 789 – 790 Brazil
- 800 – 839 Italy, San Marino and Vatican City
- 840 – 849 Spain and Andorra
- 850 Cuba
- ...
- 867 North Korea
- 868 – 869 Turkey
- 870 – 879 Netherlands
- 880 South Korea
- ...
- 890 India
- ...
- 900 – 919 Austria
- 930 – 939 Australia
- 940 – 949 New Zealand
- ...
- 958 Macau

Every country in Europe is now on the GS1 system. There are around 200 countries in the world, but the free number ranges are enough for the countries still missing.

Special ranges prefixes:
- 020 - 029 Restricted distribution (GS1 MO defined)
- 030 – 039 U.S. drugs (see U.S. National Drug Code)
- 040 - 049 Restricted distribution (GS1 MO defined)
- 050 - 059 Coupons
- 200 - 299 Restricted distribution (GS1 MO defined)
- 950 Head Office - is used for several special applications and bi-lateral agreements. As an example prefix 9509999 has been allocated by GS1 to the United Nations International Drug Control Programme UNDCP in 1995.
- 977 Serial publications International Standard Serial Number (ISSN)
- 978 - 979 Bookland International Standard Book Number (ISBN)
- 9790 International Standard Music Number (ISMN)
- 980 Refund receipts
- 981 - 982 Common Currency Coupons
- 990 - 999 Coupons

GS1 Company Prefix

All GS1 identifiers use the same GS1 Company Prefix assigned to the company or organization.

The GS1 Company Prefix provides a way for GS1 Member Companies to uniquely and globally identify things like trade items, logistic units, locations, parties, and assets.

The Company Prefix has varying length. In the barcodes it appears with usually 4 or 5 digits. For RF tags it can range from 6 to 12 digits.

A UPC company prefix can be converted to a GS1 Company Prefix by adding a leading zero.

GTIN - Global Trade Item Number

For *trade items*: products and services upon which there is a need to retrieve pre-defined information at any point in the supply chain.

A Global Trade Item Number (GTIN) is used to identify any item upon which there is a need to retrieve pre-defined information and that may be priced or ordered or invoiced at any point in any supply chain.

A separate unique GTIN is required whenever any of the pre-defined characteristics of an item are different in any way that is relevant to the trading process. The guiding principle is if the customer is expected to distinguish a new trade item from an old trade item and purchase accordingly, a new GTIN should be assigned.

GTINs have four numbering structures: GTIN-8, GTIN-12, GTIN-13 and GTIN-14. All GTIN can be formatted using 14 digits and leading zeros. **The last digit is always used as a check digit.**

Numbering structures	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14
GTIN-8	0	0	0	0	0	0	N1	N2	N3	N4	N5	N6	N7	*N8*
GTIN-12	0	0	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	*N12*
GTIN-13	0	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12	*N13*
GTIN-14	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12	N13	*N14*

http://www.gs1.org/productssolutions/barcodes/technical/idkeys/gtin.html

SGTIN - Serialized GTIN

The combination of GTIN and a unique serial number is called a Serialized GTIN (SGTIN). To create a unique identifier for individual objects, the GTIN is augmented with a serial number, which the managing entity is responsible for assigning uniquely to individual object classes.


[EPCglobal08b]
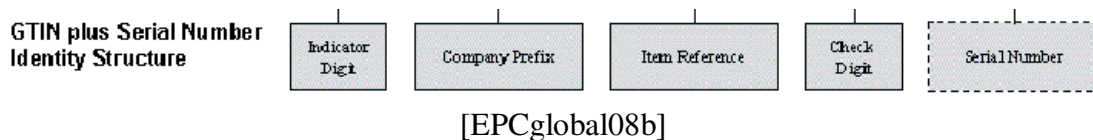
GLN - Global Location Number

For *locations*: physical, functional or legal entities requiring a permanent identification, such as a company, department, or warehouse.

    14 digits
        company prefix
        location reference
        1 check digit
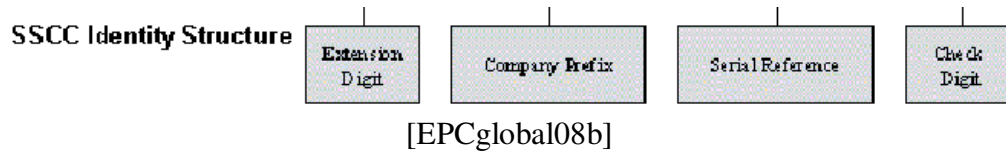
SGLN - Serialized GLN

Within the GS1 system, high capacity data carriers use Application Identifiers (AI) to distinguish data elements encoded within a single data carrier. The GLN can be associated with many AI's including physical location, ship to location, invoice to location etc.

The EPC SGLN (serialized GLN) represents only the physical location sub-type of GLN AI (414). The serial component is represented by the GLN Extension AI (254).
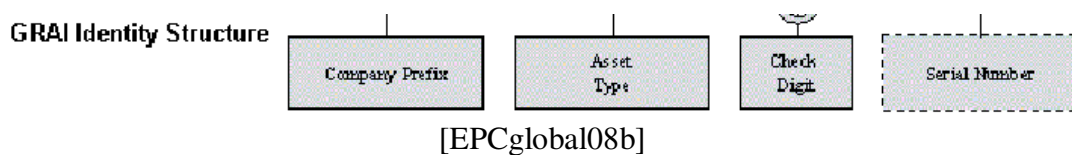

[EPCglobal08b]
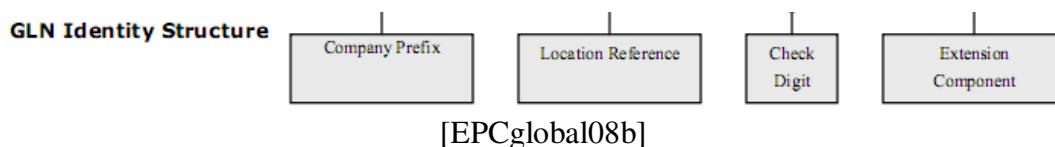
SSCC - Serial Shipping Container Code

For *logistic units*: physical units established for transport and storage of products of any kind that need to be tracked and traced individually in a supply chain.
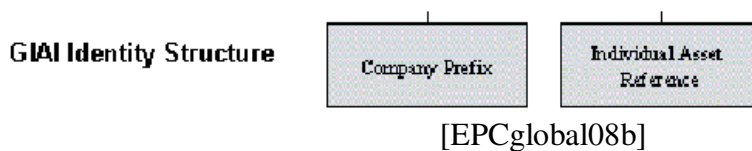
SSCC Identity Structure | Extension Digit | Company Prefix | Serial Reference | Check Digit

[EPCglobal08b]

GRAI - Global Returnable Asset Identifier

For returnable *assets*.

GRAI Identity Structure | Company Prefix | Asset Type | Check Digit | Serial Number

[EPCglobal08b]

GIAI - Global Individual Asset Identifier

For fixed *assets*.

GIAI Identity Structure | Company Prefix | Individual Asset Reference
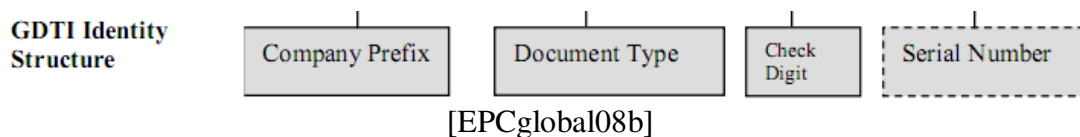
[EPCglobal08b]

GSRN - Global Service Relation Number

For *service relations*: public or private service provider to track any entity's service requirements and needs over a continuing relationship.

GSRN Identity Structure | Company Prefix | Service Reference | Check Digit

[EPCglobal08b]
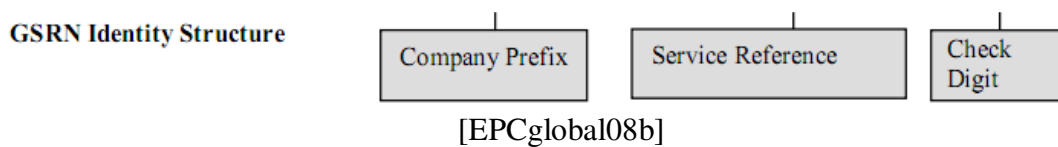
GDTI - Global Document Type Identifier

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GDTI Identity Structure | Company Prefix | Document Type | Check Digit | Serial Number

[EPCglobal08b]

EPC-GID - Electronic Product Code - Generic Identifier

General Identifier (GID-96) is independent of any known, existing specifications or identity schemes.

The General Identifier is composed of three fields - the General Manager Number, Object Class and Serial Number.

The General Manager Number identifies an organizational entity (essentially a company, manager or other organization) that is responsible for maintaining the numbers in subsequent fields – Object Class and Serial Number. EPCglobal assigns the General Manager Number to an entity, and ensures that each General Manager Number is unique.

The Object Class is used by an EPC managing entity to identify a class or "type" of thing. These object class numbers, of course, must be unique within each General Manager Number domain.

Finally, the Serial Number code, or serial number, is unique within each object class. In other words, the managing entity is responsible for assigning unique, non-repeating serial numbers for every instance within each object class.

Encodings of the GID include a fourth field, the header, to guarantee uniqueness in the EPC namespace. There are currently no standard barcode encodings for GID.

1.1.1 - Barcode encodings

GTIN-8
GTIN-8s are normally assigned one-by-one.

A GTIN-8 is encoded in an EAN-8 bar code; introduced mainly to use on small packages where an EAN-13 barcode is impractical.

EAN-8 structure
   8 digits
      7 digits
         2 or 3 - country code
         5 or 4 - item reference
      1 check digit
      EAN stands for European Article Number

Graphical example:

<9638 5074>

GTIN-12

May be encoded in UPC-A, UPC-E, ITF-14, or GS1-128 bar codes.

UPC-A structure
   12 digits
      11 digits
         1 digit prefix
            "0", "1", "6", "7", "8", or "9" - most products
            "2" - reserved for local use (store/warehouse), variable weight items
            "3" - drugs by National Drug Code number
            "4" - reserved for local use (store/warehouse), loyalty cards or store coupons
            "5" - coupons
         10 digits
           company prefix
           item reference
      1 check digit

Graphical example:

UPC-E structure
   6 digits
      if last digit is "0", "1" or "2"
         2 digits for manufacturer code
         3 digits for product code
      if last digit is "3"
         3 digits for manufacturer code
         2 digits for product code
      if last digit is "4"
         4 digits for manufacturer code
         1 digits for product code
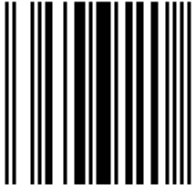   if last digit is "5", "6", "7", "8" or "9"
         5 digits for manufacturer code
   no check digit, parity check embedded in coding
   convertible to UPC-A using a conversion table

Graphical example:

ITF-14 structure
    Interleaved 2 of 5 bar code
    14 digits
       2 digits? - leading zeros
       12 digits? - see UPC-A structure

Graphical example:

GS1-128 structure
    Function Code "FNC1"
    Application Identifier "01" for GTIN
    GTIN digits

Graphical example:

GTIN-13
May be encoded in EAN-13, ITF-14 or GS1-128 bar codes

EAN-13 structure
    13 digits
       7 digits
          2 or 3 digits - country or special code
          5 or 4 digits - company code
       5 digits - product code
       1 check digit
    Superset of UPC-A (an UPC-A is converted to an EAN-13 by adding a leading "0")
    EAN-13 is the same as JAN (Japanese Article Number)

Graphical example:

5 901234 123457 >

GTIN-14
May be encoded in ITF-14 or GS1-128 bar codes

GTIN-14 structure
   14 digits
      1 digit - indicator - "0" to "8" packaging level[1], "9" variable measure item
      13 digits - see EAN-13 structure

See GS1-128 structure

SSCC GS1-128 structure
   Code 128 Function Code "FNC1" for GS1-128
   Application Identifier "00" for SSCC
   18 digits - SSCC
      1 extension digit
      16 digits
         company code
         serial reference
      1 check digit

GS1-128 structure for GRAI
   Code 128 Function Code "FNC1" for GS1-128
   Application Identifier "8003" for SSCC
    "0"
     12 digits
       company prefix
       asset reference
     1 check digit
     1 to 16 digits - serial number (optional)

GS1-128 structure for GIAI
   Code 128 Function Code "FNC1" for GS1-128
   Application Identifier "8004" for SSCC
   company prefix
   individual asset reference

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[1] There is however, no world-wide consensus on which number indicates which packaging level and in some countries (Germany) a leading zero is used independently from item hierarchy.

GS1-128 structure for GSRN
   Code 128 Function Code "FNC1" for GS1-128
   Application Identifier "8018" for SSCC
   company prefix
   service reference
   1 check digit

1.1.2 - RFID tag encodings

(…)

1.1.3 - URI encoding

(…)

1.2 - Identifier management processes

The identifier management processes are described using the following template:

Process number - template title
Actors -
Summary -
Inputs -
Outputs -
Non-functional requirements -
Open questions -

Processes are sequences of activities that cross-cut organization units and boundaries. The actors are the abstract organizational units that participate directly in the process. The process takes inputs and produces outputs. A process can also have non-functional requirements. A process may not be fully understood having open questions.

Processes are labeled AS-IS if they are a description of the current implementation or TO-BE if they are either a significant modification of an existing process or a new process.

Processes are referred to by "P" followed by its number. Open questions are also numbered and can be referred to by "P" + process number + "-" + question number + "?".

Process index:

Process 1 - Issue a Company Prefix (AS-IS)

Actors - GS1 MO, Trading Partner

Summary -
"GS1 Global Office assigns GS1 Prefixes to GS1 MOs;
GS1 MOs then assign a GS1 Company Prefix to GS1 Members;
GS1 Member Companies then combine their GS1 Company Prefix with GS1 defined reference numbers to identify things they sell, ship, or own."

A trading partner sends its data and a payment certificate to an MO.
The MO validates the input, checks the payment and registers the trading partner as a GS1 Member.
A company prefix is assigned to the new member using a still unused prefix from the provided by GO before this process instance.

Inputs - Trading Partner data, Payment certificate

Outputs - Company Prefix

Non-functional requirements - Authentication of communicating parties; trusted payment certificate

Open questions:
1? When is this new company prefix sent to GS1 GO?

2 - New architecture

2.1 - New requirements

2.1.1 - Mobile commerce defined

"Mobile Commerce is any transaction, involving the transfer of ownership or rights to use goods and services, which is initiated and/or completed by using mobile access to computer-mediated networks with the help of an electronic device."
[TiwariBuse07]

"Mobile Commerce is the ability to conduct commerce, using a mobile device."
http://en.wikipedia.org/wiki/Mobile_commerce

2.1.2 - Mobile commerce applications

Products and services:
- Mobile ticketing
- Mobile vouchers, coupons and loyalty cards
- Content purchase and delivery
- Location-based services
- Information services
- Mobile banking
- Mobile brokerage
- Auctions
- Mobile purchase
- Mobile marketing and advertising

2.2 - Identifiers

2.3 - Processes