



Using external identifiers in the GS1 System

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Contributors

| Name | Organization |
|--------------------------------|-------------------------|
| Andreas Füßler | GS1 Germany |
| Andrew Osborne | GS1 UK |
| Coen Janssen | GS1 Global Office |
| David Buckley | GS1 Global Office |
| Hein Gorter de Vries (lead) | GS1 Nederland |
| Henri Barthel | GS1 Global Office |
| Ken Traub (chapters 2 & 3 & 4) | Ken Traub Consulting |
| Mark Harrison (Appendix D.4) | University of Cambridge |
| Scott Gray | GS1 Global Office |
| Sue Schmid | GS1 Australia |

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1. Background

1.1. Request for finding

In November 2013 the GS1 Transport & Logistics (T&L) MO (Member Organisations) IG (Interest Group) and T&L LT (Leadership Team) submitted a Request For Finding¹ (RFF), asking “how to integrate external identifiers for transport equipment (such as BIC codes (containers) and EVNs (rail vehicles)) in the GS1 System”. Reason is that “*embedding*” of such external codes is recommended in at least one guideline (GS1 in Rail).

The Architecture Group (AG, in telecom on 4 Dec 2013) welcomed the request to provide an opinion:

- AG should address any issues on architectural principles by providing guidelines, in this case on dealing with external identifiers.
- Although the present RFF is related to transport equipment identifiers, it became clear that this topic should be considered from a *general, non-sector specific view*.
- Proprietary, company specific numbering systems will not be considered for integration, only those which are managed by a neutral, independent organisation.

1.2. Problem statement

In several areas of economic activity there is a need for identification of various entities to support business processes. The GS1 System has been created to offer solutions for this in *open* supply chains, so that all companies adhering to the system can benefit from a uniform method of identification. The system proves to be useful in an expanding number of sectors. In some (sub)sectors (not only in T&L) already well established non-GS1 identification schemes are in use. These identifiers are widely used in systems of business partners as well as in (electronic) communication between their systems. If companies from different sectors do business with each other and want to standardise their processes, it can be a challenge to cope with different identification schemes. When GS1 member companies are confronted with alternative schemes from business partners, they would benefit from guidance about how to deal with those. The most straightforward approach is to require the use of only GS1 keys, but that is not realistic if the non-GS1 scheme is well established.

Faced with this reality, some MOs are recommending their users to embed such external identifiers; e.g. in T&L, the embedding of an existing identifier of transport equipment into a GIAI. The GCP is assigned to the operator (owner) of the equipment. However, currently no official guidance is given to MOs, so different implementations may occur. If companies are faced with diverging recommendations, extra costs may be incurred. This risk should be mitigated by offering insight and alternative scenarios and guidelines for choosing one.

1.3. Why is this question relevant?

The **GS1 Policy towards non-GS1 Identification Systems** (“Policy B-12”)² describes the principles to be observed when GS1 considers requests to recognize non-GS1 identification schemes in the GS1 System:

- GS1 should demonstrate an open and objective attitude towards other identification systems and seek mutual benefit.
- GS1’s primary concern will always be the interests of the members of the GS1 member organisations (MOs). Co-operation with third parties must have the aim of extending the usefulness and value of the GS1 System and must not be allowed to compromise the interests

¹ See Appendix E

² See Appendix A

of the MOs' members overall nor generally undermine the benefits they derive from the GS1 standards.

- Willingness of external parties involved to cooperate with GS1 is a prerequisite; this is to be agreed in a formal contract.

Some identifiers from “non-GS1 Identification Systems” are recognised in the GS1 System: some are described in the GS1 General Specifications, with an Application Identifier assigned to them; others are described in the EPC tag data standard.

In the GS1 Architecture a categorisation of identifiers is described, distinguishing 4 classes, where class 1 contains the 11 types of GS1 Identification Keys (in other words, the “core GS1 keys”), which are all created using a GS1 Global Company Prefix³, class 2 and 3 contain some other identifiers recognised by GS1 and class 4 “all others”.

Only the last category is truly “non-GS1” (i.e. “alien” to GS1); identifiers in classes 2 and 3 can be considered as GS1 identifiers, or rather “GS1 recognised identifiers”. In this paper the more neutral wording “external identifiers” is used for identifiers in class 4.

For a further description of the classes, see Appendix B.

1.4. Purpose of this document

The purpose of this document is to give guidance and recommendations regarding request(s) to recognise external identifier(s) in the GS1 System, when used in *open* supply chains, including Guidelines describing the use of the System in specific areas of application. The primary audience is the Standing and Mission Specific Working Groups under the Global Standards Management Process (GSMP), so that they can build standards in line with the GS1 architecture and its principles. It may also be of interest to a broader audience not involved in standards development, from GS1 MOs, user organisations and solution providers interested in this topic.

2. Analysis

This section analyses the general problem of using external identifiers in conjunction with the GS1 System.

2.1. Identify, Capture & Share Applied To External Identifiers

The starting point for a desire to use external identifiers with GS1 standards is an existing system that uses external identifiers without GS1 standards. Such a “non-GS1 system” may include hardware, software, and data components, and may exist within a single organisation or may involve multiple collaborating organisations in an open or closed supply chain.

Generally speaking, the same architectural layering of Identify, Capture, Share that is used to describe the GS1 System, can be recognized in an existing system using external identifiers, too. These layers are:

- *Identify* The existing system uses one or more external identifiers to denote real-world entities. For simplicity, the discussion below illustrates a system using only one type of external identifier, with the obvious generalization to multiple identifier types possible.
- *Capture* The existing system may use AIDC technologies such as bar codes and RFID to physically affix the external identifier to a physical object. These would be non-GS1 data carriers, of which many different types exist.

³ See GS1 General Specifications (version 14 (Jan 2014)), section 1.5.

- One example of particular interest is the Code 128 symbology (ISO 15417) of which GS1-128 is a subset. In this symbology “Function Characters” are used to provide instructions to bar code reading devices regarding the interpretation of the code. By agreement between AIM and GS1, use of FNC1 (Function 1 Symbol Character) in Code 128 Symbols (in the second position after the start character) has been reserved exclusively for the GS1 System.
- Another specific example is an RFID tag according to ISO 16000-63: here a so called toggle bit is used to indicate whether the identifier in the tag is a GS1 key (toggle bit is 0) or not (toggle bit is 1).
- **Share** The existing system may include information systems which process data, where the data uses the external identifiers to reference the corresponding real-world entities. This may take the form of databases, electronic messaging, etc, and may exist within a single organisation or involve sharing across trading partners. There may or may not exist standards (non-GS1) that govern these system components or their interactions.

A specific existing system may not include all of these elements. Without loss of generality, the analysis will illustrate an existing system that includes all three layers, with the obvious generalization to systems that omit parts of the picture.

Conceiving of the existing system in terms of Identify, Capture, Share provides a useful framework to analyse the effect of adding GS1 standards. This is explored in the following sections.

2.2. GS1 Standards Alongside External Identifiers

When we say “use external identifiers with GS1 standards”, what we have primarily in mind is an architectural change to the existing, non-GS1 application in which GS1 standards are added to the Identify/Capture/Share picture, while continuing to utilize external identifiers. In so doing, some of the components of a “non-GS1 application” may be *replaced* by GS1-compliant counterparts, but other components continue to operate using external identifiers.

Also, an external identifier could be complemented with an additional GS1 Key (“dual identifier”). Thirdly, a mix of two (or more) different types of keys could be used, one of them GS1.

If *all* components were replaced with components using only GS1 standards, then we would simply have an ordinary GS1 implementation to which this paper does not apply. However, this paper considers an application which uses both external identifiers and some GS1 standards. As a whole it remains a “non-GS1 application”.

Conversely there can be a situation where the GS1 System is used to a large extent, but where also some external identifiers are to be used in the business processes. In this case, some of the components of the “GS1 application” may be *complemented* by non-GS1-compliant counterparts, while other components continue to operate using GS1 keys.

In all such situations there are several possible architectures in which external identifiers and GS1 standards are mixed. The following taxonomy is helpful to organize the analysis; what follows is a brief outline, expounded in detail afterwards.

- **Without GS1 Keys** Here, certain GS1 *technical* standards are introduced but only external identifiers are used, not GS1 Keys. See further § 2.3.
- **With GS1 Keys** Here, real-world entities formerly identified only by an external identifier are now identified by both an external identifier *and* a GS1 key. There are several possible approaches to this, which break down as follows:
 - **Dual Identifier** Here, each real-world entity identified by an external key is also assigned a GS1 key. The GS1 key is assigned arbitrarily, meaning that the characters comprising the GS1 key are not related to the characters comprising the external key. With no *a priori* relationship between the two identifiers, the system must have a way to maintain the relationship. Two possible approaches are considered here:

- *Use Both Identifiers Together* (see § 2.4.1.1);
- *Associate the Identifiers in a Database* (see § 2.4.1.2).
- **Embedded Identifier** Here, the GS1 key corresponding to an external key is constructed by embedding the external key into a GS1 key structure. In broad strokes, this entails combining a prefix (GS1 Prefix or GS1 Company Prefix) with the external key to arrive at the corresponding GS1 key. This can only be done if the external key fits within the constraints of the chosen GS1 key (length, format, meaning). Such approaches can be further distinguished as:
 - *Embedded External Identifier Using a Fixed GS1 Prefix*
External identifiers are preceded by a GS1 prefix, allocated to a 3rd party; the resulting codes in GS1 format are to be used by individual companies, under control of that 3rd party. See § 0.
 - *Embedded External Identifier Using Individual Companies' GCPs*
External identifiers are preceded by a GS1 company prefix, where the external identifiers are issued under the control of a third party, but are assigned by the respective company, using its GCP. See § 2.4.2.2.
 - *Embedded External Identifier Using Individual Companies' GCPs with Dedicated AI*
Each existing GS1 Key is identified by an AI / EPC header / EDI data element code. By adding specific AIs for Keys in which external identifiers are embedded, while sticking to the original key definition (format, length, meaning), such external identifiers can be extracted. In § 2.4.2.3 arguments in favour and against such approach are given. This option is currently not used nor recommended and the conclusion is that this should not be changed.

Mixed Identifiers. Here, companies use both external identifiers and GS1 keys to identify entities, but not in the Dual Identifier approach mentioned above, hence neither together nor in association. In other words, some entities are (still) only identified with an external identifier, while others (already) have been assigned a GS1 key. This means that either key is an *alternative* to the other. It requires that both identifiers can be used by all parties involved, in data capture as well as in data share.

This is not a future proof approach, since this would imply that all companies in the business community would have to continue to use two (or perhaps even more) numbering systems. For the shorter term, when migrating to a one system approach, the options mentioned above under “dual identifier” can be used. The success of the GS1 system is based upon the use of one consistent set of identifiers. Hence this option is not elaborated hereafter.

The following sections expand on each of these possibilities in detail.

2.3. External Identifiers Without GS1 Keys

In this architecture, the external identifier continues to be the sole means of identifying real-world entities, but certain GS1 technical standards are utilized as part of the architecture⁴. This is possible in the following situations:

- When the GS1 technical standard is completely agnostic to the type of identifier to be used.

⁴ Note: in section 2.1 examples are given regarding technical data carrier standards, defined by ISO, which encompass specific options for the use of GS1 keys, but which can also be used for other identifiers. In this section some technical standards are referred to, which are defined by GS1 and can be used by external identifiers. In other words, in these cases corresponding technical ISO standards do not exist and the standards are managed by GS1.

- For example, the GS1 Low-Level Reader Protocol (LLRP) standard specifies an interface to RFID readers but places no constraint at all on the data content. LLRP may be used in a system where the RFID tags contain external identifiers (Class 4 keys⁵).
- When the GS1 technical standard makes a specific provision for an external identifier in the form of a Class 3 key.
 - For example, the GS1 EPC Tag Data Standard provides for URI and binary representations of ATA SPEC 2000 identifiers (known as ADI in the EPC Tag Data Standard), which in turn allows their use in UHF Gen 2 RFID tags (with the “toggle” bit set to 0 to indicate the use of GS1 standards) and in EPCIS.

This mode of using GS1 standards with external identifiers fits entirely within the intended use of the GS1 technical standard in question, and so there is no architectural difficulty. However, this mode is limited insofar as it is only possible for the specific GS1 standards that provide for such use.

2.4. External Identifiers With Corresponding GS1 Keys

In this approach, a GS1 Key is created as an *alternative* identifier for the real-world entity identified by the external identifier. Within the solution architecture, both the external identifier and the corresponding GS1 Key are used. Motivations for also using a GS1 Key include:

- To gain the benefits of *all* GS1 standards for the application. For example, an asset tracking system may use an external identifier to track physical assets of an organisation in a database. By assigning a corresponding GS1 Key, the system may now benefit from (a) using bar codes, available in many symbologies (GS1 DataMatrix, GS1 DataBar, etc) and unambiguously decodable thanks to FNC1; (b) using ISO 18000-63 compliant RFID tags with an EPC toggle bit set to zero; (c) having EPCIS as a means to exchange tracking data; etc. Only some of these benefits are available if the Class 3 key approach (§ 2.3) is adopted, and none at all if the external identifier is not at least one recognized as a Class 3 key.
- To interoperate in settings where a GS1 Key is already expected. For example, a large company has an internal system for coding physical locations that is used extensively within internal business processes. They enter into trading relationships which require them to define GLNs for these locations, register them into a GLN registry, and use the GLNs in various electronic messages (eCom) with trading partners. It may be impractical to eliminate the use of the company specific identifiers in the internal systems, resulting in both the company specific identifier and GLN being used in the company’s systems, while externally only the GLN is used.

Balancing these benefits are significant issues of interoperability where one component of the system which expects the external identifier interfaces to another component that uses the GS1 Key, and vice versa. This leads to several possible approaches, discussed in the following sections, which can be characterized by how this issue of translation between the external identifier and the GS1 Key is handled.

In addition, each solution must consider the process whereby GS1 Keys are *assigned* to real-world entities: the rules regarding when to assign a new code must be identical for both the external identifier and the GS1 Key. See also § 2.4.3 about Allocation Rules.

2.4.1. Dual Identifier Approach

A straightforward approach is simply to assign a GS1 Key in the ordinary way to each real-world entity that has an external identifier. “In the ordinary way” simply means that the GS1 Key is assigned without regard to the content of the external identifier – it is assigned as though only GS1 Keys are being used. This results in each real-world entity having both an external identifier and a GS1 Key, but where it is not possible to deduce the value of one by looking at the other. This means that the system must

⁵ For some remarks on the GS1 Key Classes concept, see Appendix B

maintain the association between the two identifiers. Two approaches to maintaining this association are described in the following sections.

2.4.1.1. Use Both Identifiers Together

One way to maintain the association is to use both identifiers throughout the system. A number of cases can be distinguished.

First regarding **data carriers**, (barcodes and RF tags), on real-world entities. If its identity is marked with one bar code (i.e one symbol) that bar code could contain both the external identifier and the GS1 Key. If the external identifier is recognised by GS1, there would be an AI defined, implying that a GS1 symbology can be used (e.g. GS1 128 or DataBar).

Otherwise the GS1 Key would have to be represented by a non-GS1 symbol, or two different symbologies should be used (a GS1 symbol for the GS1 Key and some other symbology for the non-GS1 identifier).

It should be noted that from visual (human) inspection it is not always obvious which symbology uses GS1 encoding; in other words, there are non-GS1 symbologies that are visually indistinguishable from GS1 symbologies.

Secondly, if an **electronic message** is delivered between trading partners, it would include both the external identifier and the GS1 Key, as separate data elements within the same message. If the message is a GS1 standard, this would require that the external identifier is recognised by GS1. In e.g. EANCOM there are facilities to use external identifiers in addition to GS1 keys. In this way, any system component that relies on one identifier or the other will have access to the identifier it needs.

As mentioned above, certain GS1 Standards already provide for this paradigm. For example, there are Application Identifiers⁶ defined for Additional Product Identification (AI 240), National Health Reimbursement Number (NHRN – AIs 710, 711, etc); these allow an external identifier to accompany a GS1 Key in a GS1 bar code or a RFID tag. Likewise, some eCom standards include a field AdditionalTradeItemIdentification by which an external identifier for a trade item can accompany a GTIN.

A disadvantage of this approach is the need to ensure that *all* interconnections between system components must carry *both* identifiers, except perhaps in portions of the system known in advance to require only one or the other. This can be burdensome, and introduces more opportunity for error if the association is not correctly maintained. The problem here is that one party doesn't necessarily know which identifier is used by other parties; hence both codes must *always* be used in external communications as well as in data carriers on physical entities.

2.4.1.2. Associate the Identifiers in a Database

An alternative approach is to establish a system of record such as a database which maintains the definitive association between each external identifier and the corresponding GS1 Key. In this approach, only one identifier need be carried between system components. If a component requires the other identifier, it consults the system of record to translate the one identifier to its counterpart.

This approach helps overcome the difficulties of having to carry both identifiers throughout the system. This is especially helpful if there are parts of the system that cannot be modified to include the second identifier. The cost, however, is that system components that receive one identifier but require the other must have access to the system of record in order to carry out the translation.

2.4.2. Embedding Identifier Approach

The difficulties of the “dual identifier” approach, whether the “carry both together” or “associate in a database” variation is used, lead some to consider a different approach based on *embedding* the

⁶ For some remarks on the GS1 Application Identifier Standard, see Appendix C

external identifier in the GS1 Key structure. As in the dual identifier approach, a GS1 Key is assigned to each real-world entity having an external identifier, but in this approach the value of the GS1 Key is derived in an algorithmic way from the value of the external identifier.

To illustrate, suppose a system has a six-character external identifier for an asset, where each character is either a digit or an uppercase letter; for example, ABC123. A corresponding GS1 Global Individual Asset Identifier (GIAI) can be derived by combining a unique GS1 prefix (GS1 Prefix or GS1 Company Prefix – see below for more on this point) with the external identifier; for example:

GIAI for asset = 0614141 + (six character external identifier)

So in this example, external identifier ABC123 corresponds to GIAI 0614141ABC123.

Depending on the external identifier and the GS1 Key structure chosen, the details might be more complex. For example, to embed an external identifier into the GTIN structure requires dealing with the GTIN's indicator digit and check digit, plus a length and character (only numeric) limitation. The external identifier might also undergo some transformation; e.g., to remove a redundant check digit from the external identifier prior to embedding into a GS1 Key structure that already has a check digit, to convert characters that cannot be included directly into the chosen GS1 Key structure, etc. These details are omitted here for the sake of brevity.

When just embedding an external identifier in a GS1 identifier, an application receiving the GS1 identifier has no explicit way to recognize whether or not an external identification scheme is being applied (and if so, which one). This can lead to processing issues upon capture or communication of the key, unless further measures are taken. Therefore several options are considered below in the following three subsections.

Regardless of the details, it is clear that there is a fundamental constraint that the numbering capacity of the GS1 Key structure, considering only the characters remaining after the prefix is accounted for, must be at least as large as the numbering capacity of the external identifier. For example, it is impossible to embed a 10-digit external identifier into a GTIN using a 7-digit fixed prefix, as there are simply not enough digits remaining (assuming that all possible values of the 10-digit external identifier are permitted).

The nature of the embedding approach depends critically on what prefix is chosen. Three possibilities are discussed below.

2.4.2.1. Embedded External Identifiers Using a Fixed GS1 Prefix

The main purpose of the GS1 Prefix is to allow decentralisation of the administration of identification numbers. To this end GS1 Prefixes are allocated by GS1 Global Office to GS1 Member Organisations, while others are used for Restricted Circulation Numbers⁷.

However, a GS1 Prefix can also be assigned to be the prefix for all external identifiers of a given type, regardless of what organisation issues the particular external identifier.

In the GS1 General Specifications two such applications are mentioned:

- **ISSN**: the international standard serial number for serial publications, which can be presented as a GTIN (following applicable formatting rules (described elsewhere)).
- **ISBN**: the international standard book number, which can be presented as a GTIN, if preceded by Prefix 978, with the following formatting: 978 + (10 digit ISBN minus its check digit) + GS1 Check Digit⁸.

The external identifiers are controlled by their respective organisations, outside GS1. Companies using the GTIN representation of such codes do not need to register with a GS1 MO. Since the structure of the nine digits between the 3 digit prefix, which has been assigned by GS1 global, and the Check Digit is entirely under the control of ISSN and ISBN, respectively, the 13-digit GS1 Key form is considered a Class 2 Key within the GS1 System Architecture.

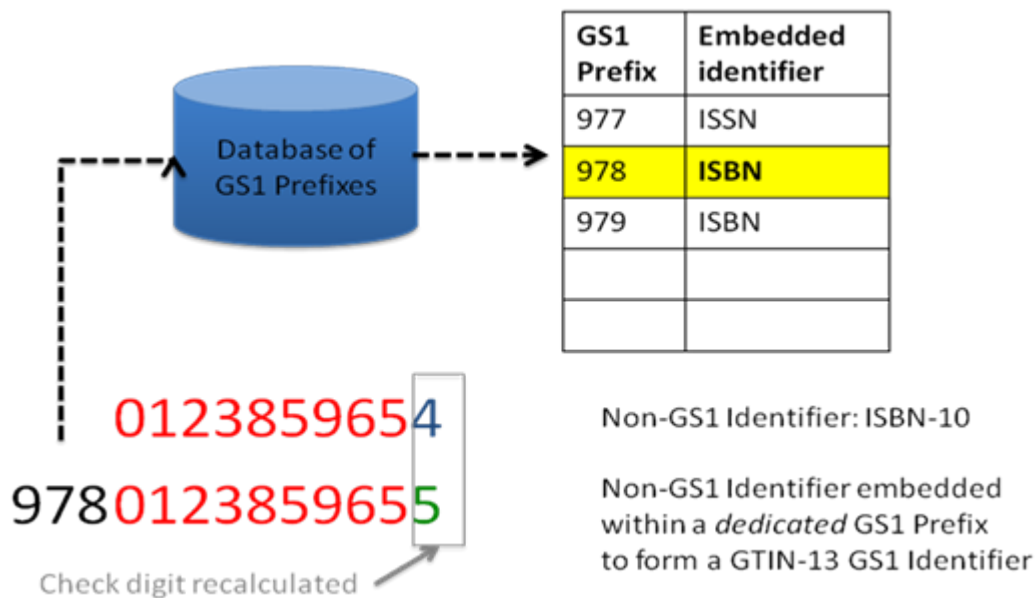


Figure 1: ISBN-10 numbers and their GS1 GTIN-13 equivalent (see also note 8)

⁷ See also GS1 General Specifications, section 1.4.2

⁸ It should be noted that initially, when the 10-digit ISBN was preceded by a 3 digit GS1 prefix (978), the ISBN was really embedded. Later on the capacity of the 10 digit number range became too small, so extra numbering capacity was needed. This was achieved by adding a new GS1 prefix (979). The consequence of this is, that it is no longer possible to decode a 10 digit ISBN from the 13 digit key, since this increasingly will result in ambiguity, as more numbers are allocated from the “second slot of numbers”. Hence there is *no longer* a 10-digit ISBN *embedded* in a GS1 Key; only the full 13-digit key is unique. The difference with “regular” GS1 class 1 keys is only the assignment process (GS1 MO vs the ISBN organisation).

Some MOs reserve a GS1 prefix, which has been allocated to the MO, to embed external identifiers. An example is the following:

- US National Drug Code (**NDC**) as a GTIN-12 = 3 + (10 digit NDC) + Check Digit

In the case of the **NDC**, the 10 digit NDC consists of a 4- or 5-digit labeller code assigned by the US Food and Drug Administration (FDA) to a drug manufacturer, who assigns the remaining digits to a specific drug. But in order to use the GTIN-12 form, GS1 US requires the drug manufacturer to register the combination of digit “3” plus the 4- or 5-digit labeller code as a GS1 U.P.C. Prefix, which essentially is a 5- or 6-digit GS1 Global Company Prefix, allocated by GS1 US, using the NDC determined labeller code.

Drug manufacturers using such a GCP can also base other GS1 keys, e.g. GLNs or SSCCs, on the GCP⁹. This is not allowed for publishers using the ISSN / ISBN prefixes mentioned above. If they would want to do so, they should register with an MO and obtain a separate GCP.

At the system level, it is now possible to transmit either the external identifier or the GS1 Key, and have any given system component recover the form it needs (Note that this no longer possible with ISBN). Given a GS1 Key, it can be recognized as carrying an external identifier by the presence of the designated prefix, and the external identifier recovered by removing the prefix (and inverting any other transformations regarding check digits, etc). Conversely, the GS1 Key can be obtained from the external identifier by adding the prefix.

It should be noted that this approach can only be applied where the format and length of the external identifier fit in the definition of the GS1 Key (in the examples above the external identifiers must be numeric and no longer than $12 - 3 = 9$ digits long, excluding the check digit).

This approach requires that the external identifier is recognized by GS1 global office so that a prefix may be issued. Two other variations of the embedded identifier approach avoid this requirement (see next subsections).

2.4.2.2. **Embedded External Identifiers Using Individual Companies' GCPs**

A GS1 Company Prefix cannot be used as the basis to embed an external identifier that is issued by many organisations. However, obtaining a GS1 Prefix from GS1, as in the examples of ISSN, ISBN or NDC, may be insurmountably difficult.

An alternative approach is to have each organisation use their own GS1 Company Prefix to embed their external identifiers, being managed by a 3rd party, into a GS1 Key structure. For example, suppose that many different companies assign BIC codes to shipping containers. Some issuing agency other than GS1 is responsible for coordinating this assignment so that each organisation's BIC codes are unique. Each organisation could create a GIAI for its own BIC codes in the following manner:

BIC as GIAI = (GS1 Company Prefix of individual organisation) + (BIC code)

This approach does not violate GS1's licensing terms for GS1 Company Prefixes. However, translation between external identifier and GS1 Key is not straightforward.

To translate from the external identifier to the GS1 Key, a system component must know the correct GS1 Company Prefix to use. This may be straightforward for the organisation to whom the specific external identifier belongs, but difficult or impossible for other parties in the supply chain.

To translate from the GS1 Key to the external identifier, an application system component must be able to do two things:

⁹ It is debatable whether a NDC GCP is Class 1 or Class 2, because the GTIN allocation is not controlled by GS1 US, but by the FDA; however, all other GS1 keys based on a NDC GCP are class 1.

- Identify whether the GS1 Company Prefix of the GS1 Key is a prefix used to embed external identifiers; in other words, whether the given GS1 Key actually embeds an external identifier or not, and, if more than one type of external identifier is used, which one (cf figure 2)
- Know the length of the GS1 Company Prefix, so that the correct characters of the external identifier may be extracted. This is easy if the external identifier is of fixed length, but not if the external identifier is of variable length.

A table maintained at GS1 or elsewhere indicates which GS1 Company Prefixes *of individual companies* are being used in conjunction with external identifiers in order to construct specific GS1 keys, such as GIAI

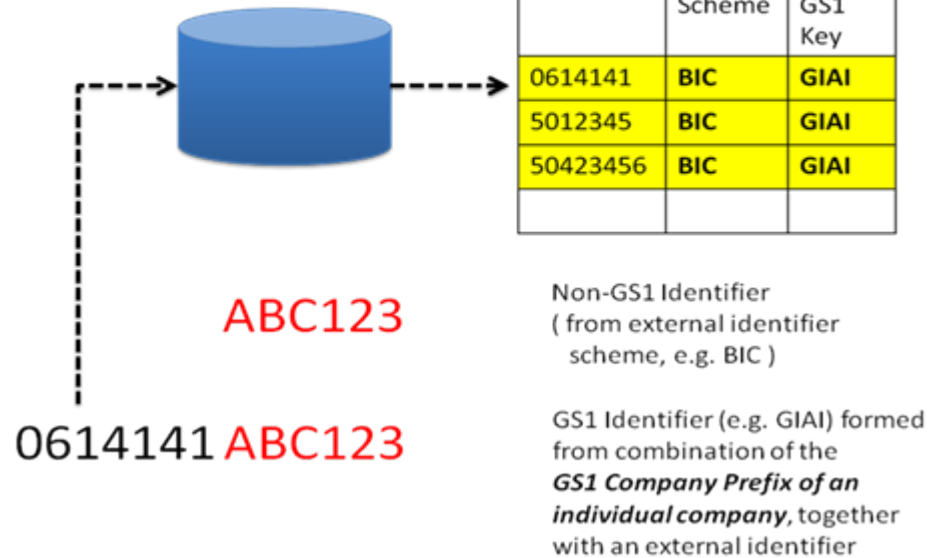


Figure 2: Embedded external identifiers using individual companies' prefixes

One possible solution to this problem is if the organisations involved share a database where GCPs used to embed external keys are registered (cf figure 2). A given GS1 Key can be compared to the registered GCPs to determine if the GCP is indeed a prefix used to embed the external identifier, and in that case the length of the GCP is available from the registry as well. However, the need to consult a registry in some respects negates the original motivation for embedding, which was to be able to translate between the GS1 Key and external identifier without requiring access to a distant information system. However, managing a registry of GCPs may be easier than managing a registry of individual identifiers (as required by the “dual identifier” approach), especially if the list of GCPs is small and/or slowly changing. Also, by locally storing in cache memory the need to access the registry will decrease over time.

2.4.2.3. Embedded External Identifiers Using Individual Companies' GCPs with Dedicated AI

In the current GS1 Standard each existing GS1 Key is identified by an AI (in bar codes like GS1 128 and GS1 DataBar), an EPC header (in RFID tags) or an EDI data element code (in EANCOM and GS1 XML messages). One might consider to add specific AIs, dedicated to a specific, recognised 3rd party organisation, for GS1 Keys in which external identifiers are embedded, while sticking to the original key definition (format, length, meaning). In this approach such external identifiers can be extracted. This option is currently not used nor recommended.

Consider the same example as above, regarding the BIC. Many different companies assign BIC codes to shipping containers, but only one 3rd party controls the BIC. If this issuing agency would be assigned

a specific AI for GIAIs it can assign BIC codes to containers like they do now, while companies, by using the “BIC GIAI AI”, can code their containers in the GS1 GIAI format, while, by using the designated AI for the GIAI, giving certainty to other companies that the GIAI indeed contains a BIC. The GIAI would look like mentioned on the previous page. But instead of using AI 8004 (or the corresponding EPC headers), a different AI or EPC header would be used.

In evaluating this option the following arguments can be considered:

- In favour of this approach is the fact that determining whether a GIAI embeds an external identifier is easy to determine by recognizing the special AI (or EPC header).
- The corresponding disadvantage is that this approach requires modification to GS1 Standards to introduce the new AI and/or EPC headers.
- If the external identifier is of variable length, an external registry of GCPs would still be required to parse the external identifier out of the GIAI, for an application which receives the GIAI but needs the external identifier.
- Any system that expected to treat all GIAIs uniformly must now be enhanced to recognize both AI 8004 (or the corresponding EPC headers) as well as the new AI (or headers) introduced.
- Any system that records the GIAI in a database and later communicates this GIAI to another system component must be enhanced to also record which AI was used, so that the proper AI can be used when communicating downstream.

Conclusion: because of all of the difficulties described above, this option is not recommended.

2.4.3. Allocation Rule Clashes

In using an external identifier and a GS1 Key to identify the same item, a problem arises if the allocation rules of the external identification system differ from those of the GS1 System.

For example, suppose a given trade item class is identified both by a GTIN and an identifier assigned within some external identification system. Further suppose that the external identification system stipulates that if the weight of the trade item changes by 30% the external identifier should *not* change, whereas the GTIN allocation rules specify that the GTIN *must* change.

The problem here is that the association between the external identifier must change from the first GTIN to the second. This can cause havoc for systems that expect a permanent correspondence between identifiers in the two systems.

This problem exists both in the Dual Identifier approach and the Embedding approach. It may not be as difficult in the Dual Identifier approach, because the Dual Identifier approach gives the flexibility to have the association between the two identifiers change over time. But the treatment of historical data would have to be treated very carefully. In the Embedding approach, a clash in allocation rules is fatal because it is impossible to change the embedded identifier without also changing the GS1 Key, and vice versa.

2.5. Summary of Challenges in Using GS1 Standards Alongside External Identifiers

The following table summarizes the challenges that arise in using each of the approaches of using GS1 Standards alongside external identifiers:

| Approach | Variation | Sub-variation | Challenges |
|----------------------------|-----------------------------|---|--|
| Without GS1 Keys (§2.3) | | | Limited to those GS1 standards that are identifier-agnostic, or to those GS1 standards that accommodate Class 3 keys but then only for those external identifiers that have a Class 3 counterpart. Because of these limitations, does not provide the opportunity to benefit from the full GS1 System |
| With GS1 Keys (§2.4) | Dual Identifier (§2.4.1) | | In all sub-variations: Extra work required to maintain the use of two identifiers for the same real-world entity, also implying extra opportunity for error. Could be divergences between the rules for allocating the identifiers |
| | | Carry Both Identifiers (§2.4.1.1) | All interfaces must be extended to accommodate both identifiers Not all GS1 Standards provide a means to do this in all circumstances Existing systems may be difficult to modify to accommodate the GS1 Key in parallel |
| | | With Translation Database (§2.4.1.2) | Need to create and maintain the translation database Every system component that might need to translate must have reliable access to the translation database |
| | Embedding (§2.4.2) | | In all sub-variations: Subject to capacity limitation: there must be sufficient capacity in the chosen GS1 Key structure, after accounting for the prefix, to accommodate all possible values of the external identifier. Is at odds with GS1's principle of non-significance. |
| | | Using fixed GS1 Prefix (§0) | Requires recognition by GS1 for a Class 2 key or a means to manage as a Class 1 key (the latter generally requiring an MO to agree to issue GCPs whose digits correspond to external identifier blocks) A Class 2 approach usually is limited to a single GS1 Key type, so does not provide opportunity to benefit from the full GS1 System |

| Approach | Variation | Sub-variation | Challenges |
|----------|-----------|--|--|
| | | Using individual companies' GCPs (§2.4.2.2) | Requires a registry of GCPs to reliably translate between the GS1 Key and the external identifier Lacking such a registry, it is difficult for a party other than the issuer of an external identifier to know what prefix to use to translate to the corresponding GS1 key, and conversely it is difficult to know whether a given GS1 key actually embeds an external identifier. If the external identifier is of variable length, it may also be difficult to know how to separate the prefix from the external identifier. |
| | | Using individual companies' GCPs plus dedicated AI (§2.4.2.3) | Requires that the 3 rd party is recognised by GS1, with assignment of dedicated AI(s) for the GS1 Keys to be used. Still requires a registry of GCPs to translate between the GS1 Key and the external identifier, if the external identifier is of variable length. Extra work for applications to process multiple AIs, and to keep track of which AI is used. This approach is currently not used and would require explicit consideration and decision. Advice: refrain from this option. |

It should be noted that quite complex situations can arise in these approaches, especially if they are combined. For example, if for one asset type the dual identifier approach is used, while for another asset type an embedding approach is used, it will be hard to interpret the different approaches correctly. Hence such situations should not be allowed.

3. Adoption Scenarios

The previous section considered the various methods of using GS1 Standards alongside external identifiers, and identified challenges that are inherent to each possible approach. To fully assess the most appropriate method for a given situation, it is also useful to identify the intended scenario for adoption of GS1 Standards into the existing system. There may be additional aspects, which, from an overall system point of view, should be taken into account as well. Three possible scenarios are:

- **Non-migration** The intent is to use the *external identifier* as the *primary identifier*. Use of GS1 standards is only done to leverage certain GS1 *technical* standards (Gen 2 RFID Tags, GS1 DataMatrix, EPCIS, etc.) but those are only considered to be a means to convey the external identifier. The external identifier is used in perpetuity, and the practitioners don't intend to migrate to the full GS1 System
- **Co-exist** The intent is to use the *external identifier* in *some contexts*, the *GS1 Key* counterpart in *other contexts*. Both identifiers will be *used in parallel* in perpetuity in various parts of the architecture. The external identifier might be used in a narrow context, the GS1 counterpart in a broader context which could include other objects outside the narrow context which still use GS1 keys.
- **Migration** The intent is to use the *GS1 Key exclusively* some day; one of the approaches from the previous section is used as a way to transition existing objects and information systems onto that track rather than require instantaneous replacement all use of the external identifier. At some point, the *external identifier* is intended to be *retired*. If an embedding approach was used, the fact that some GS1 Keys happen to have older external identifiers embedded becomes a point of historical significance only.

Also combinations of the above are possible. For example, the BIC is embedded in a GIAI but other assets are identified by the same organisation with "pure" GIAIs.

Understanding the intended scenario is very important in selecting an appropriate approach. For example, if it is clear that the intended scenario is one of gap filling, considerations about whether the approach allows for expansion to full use of the GS1 System become less important. Likewise, if migration is the intended scenario, then certain challenges may be easier to accept given that they disappear once the migration is complete, compared to a dual identity scenario where such challenges will persist indefinitely. In the next chapter the following framework will be used to evaluate the approaches in each of the scenarios.

| | Scenarios | | |
|---------------------------------------|---|---|---|
| Approach towards external identifiers | <i>Non-migration</i> (stick to external ID as primary identifier) | <i>Co-exist</i> (use both ext ID and GS1) | <i>Migration</i> (to GS1; retire external ID) |
| Without GS1 Key | | | |
| With GS1 keys | | | |
| - Dual Identifier | | | |
| - Embedding | | | |

4. Conclusions

4.1. General Guidelines for Choosing an Approach

Putting together the material from the previous sections, we can make some general observations about which approaches are more appropriate in which scenarios. In the following scheme the three rows summarize the solutions as described above in section 2.4, while the columns represent the three scenarios which can be applied. With the colours guidance is given, for each solution, as to whether a scenario is more or less preferable:

- Green means good / recommendable.
- Yellow means reasonable, which implies “be certain that the inherent difficulties are well understood, acceptable and properly documented, with clear management approval regarding long term consequences”.
- Red means “not reasonable”, which implies “avoid unless absolutely no other choice is applicable and the implications are well understood, acceptable and properly documented, with clear management approval regarding long term consequences”.
- Black means “not applicable”.

| Approach towards external identifiers | Scenarios | | |
|---------------------------------------|---|---|--|
| | <i>Non-migration</i> (stick to external ID as primary identifier) | <i>Co-exist</i> (use both ext ID and GS1) | <i>Migration</i> (to GS1; retire external ID) |
| Without GS1 Key (§2.3) | Good, if feasible given limitations of this approach | Not applicable, by definition | Not applicable, by definition |
| | GS1 adoption scenarios | | |
| With corresponding GS1 keys | <i>Non-migration</i> | <i>Co-exist</i> | <i>Migration</i> |
| - Dual Identifier (§2.4.1) | Reasonable, if difficulties inherent in the approach are acceptable, well described in a guideline and properly managed | Reasonable, if difficulties inherent in the approach are acceptable, well described in a guideline and properly managed | Good, as this leads to the cleanest situation once migration is complete (i.e. when external identifier is no longer used) |
| - Embedding (§2.4.2) | Reasonable, if difficulties inherent in the approach are acceptable, well described in a guideline and properly managed | Poor choice, as the difficulties of embedding (such as the problems of non-significance) persist on top of the difficulties of managing dual identifiers. | Good, assuming the migration period is short (and certain). May offer an easier migration than dual identifier as it avoids assigning completely new identifiers to entities that already have the legacy external identifier. |

4.2. Recommendations

One of the strengths of the GS1 System is that it offers a limited set of non-significant keys to manage all kinds of supply chain complexities. Nevertheless, it is recognized that when the GS1 System is contemplated for use in a certain sector, where in existing systems there may already be other “external” identifiers, guidance for the use of external identifiers in conjunction with the GS1 System is needed. The following recommendations are made:

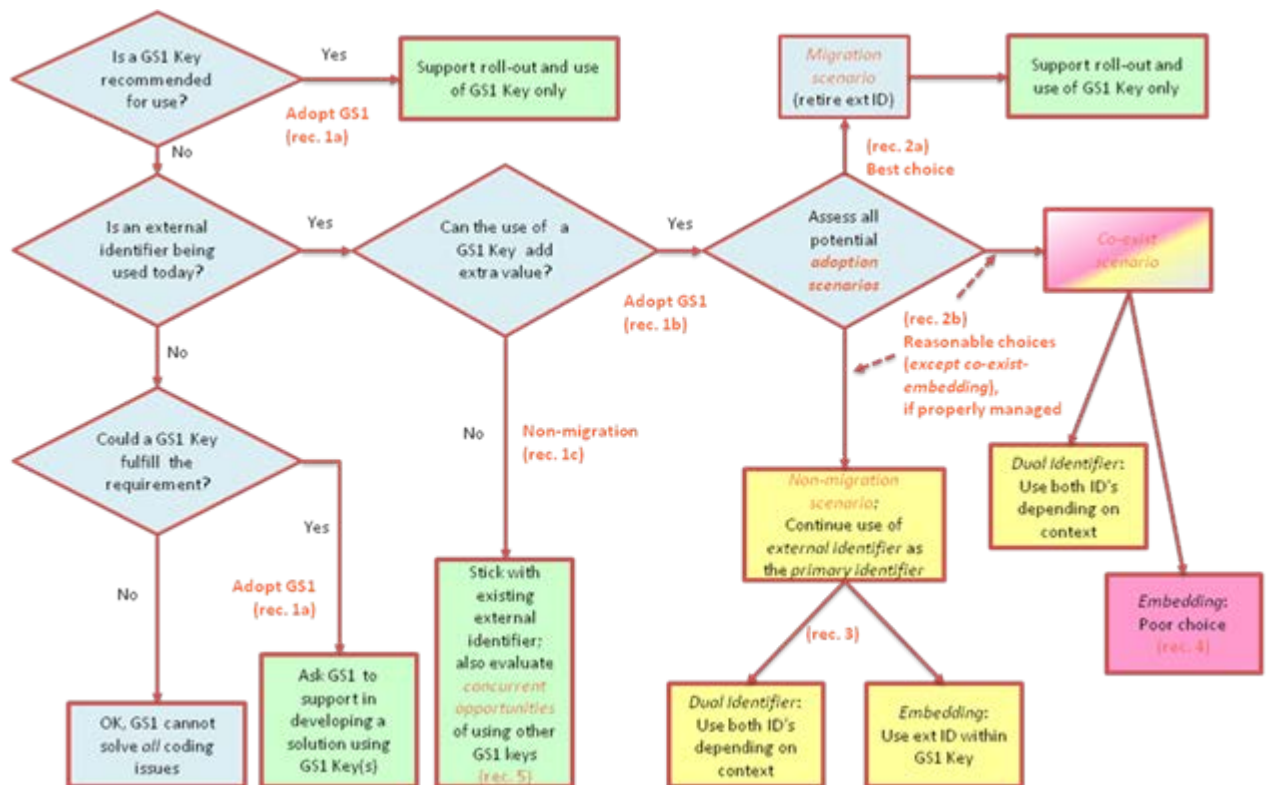
1. *Use a GS1 Class 1 Key (utilizing GS1 Company Prefix).*
 - a. The best way to avoid problems in using external identifiers in conjunction with GS1 Keys is simply to use a GS1 Key *instead* of the external identifier.

However, if the external identifier is widely used, a full understanding of the complexities of managing external identifiers together with GS1 Keys is required, leading to a choice: two alternative conclusions can be drawn regarding the best approach:

- b. *Adopt the use of a GS1 Key.* Given the fact that this, normally speaking, cannot be done “overnight”, an adoption scenario should be determined. See recommendation 2.
 - c. *Stick with the existing external identifier* (don’t adopt a corresponding GS1 key). In this case recommendation 5 could also be considered.
2. *Understand the Adoption Scenarios Before Choosing a Solution.* Section 3 outlines three different *adoption scenarios* under which a GS1 Key could be adopted in an existing system that uses an external identifier: Non-migration, Co-exist and Migration. As summarised in Section 3.2 the suitability of different solution approaches hinges critically on which adoption scenario is intended. Therefore, this should be understood first. There are *two main alternatives* to choose from:
 - a. In working with the users of an existing system, it is worth investing effort to see if the “*Migration*” adoption scenario (i.e. replacing the external identifier by a corresponding GS1 key) is possible, as this offers a better way forward than the other two scenarios. This is the preferred approach.
 - b. However, if this is not considered feasible, “*Non-migration*” and “*Co-exist*” should be evaluated. Regarding the latter see also recommendation 4.
3. *In a “Non-migration” Adoption Scenario both Embedding and Dual Identifier Solutions are Reasonable*, i.e. if the use of external identifiers is to be continued, in conjunction with GS1 keys. Both may be manageable in a “Non-Migration” adoption scenario especially if the identifier is confined to a low level of the system (e.g., at the data carrier level). However, in the case of embedding the consequences for decoding must be stipulated very clearly in guidelines, while both user companies and the external organisation which manages the external identifier system, must express their understanding and commitment.
4. *In a “Co-exist” Adoption Scenario Avoid Embedding as a Solution.* Embedding an external identifier in a GS1 Key has a number of difficulties, including limitations on syntax and capacity, the need to have compatible allocation rules, etc. These are especially troublesome in a “Co-exist” adoption scenario where these difficulties not only persist indefinitely but also pervade all layers of the solution architecture (hence, this combination is coloured red in the table in Section 3.2). In the “Co-exist” scenario only the Dual Identifier approach is considered to be a reasonable choice, though this scenario, like the two Non-migration scenarios, is not preferable compared to the Migration scenario (see also recommendation 2.a. above).

Additionally, if for some identification purposes the use of external identifiers is warranted, the use of GS1 Keys for other identification purposes could be considered, to take wider advantage of using the GS1 System.

- Consider Concurrent Opportunities.** In many existing systems where an entrenched external identifier necessitates the use of one of the approaches outlined in this paper, there will be other parts of the system that offer an opportunity for straightforward adoption of GS1 Keys or other parts of the GS1 System. An example would be introducing asset tracking to a system where there is already an external identifier for the assets but there is no established identifier for locations. In this example, while the existing asset identifier might be embedded within or used alongside a GIAI, there is an opportunity to introduce the GLN as the location identifier “cleanly,” without making any compromises. Such opportunities may mitigate the undesirability of the mixed solution, and also help lead the existing application towards a Migration adoption scenario for the external identifier.



Appendices

A. GS1 Policy towards non-GS1 Identification Systems

1. Introduction

GS1 provides a coherent system of interrelated standards for identification, automatic data capture and data exchange. The GS1 identification standards are the foundation of the system.

The GS1 identification system has a broad variety of applications and can be used by any sector in any country. GS1 acknowledges that there are many more identification systems, managed by other organisations, many of which have strong appeal.

GS1's policy towards identification systems managed by other organisations is described in this document.

2. Principles

The principles to be observed when GS1 considers requests to recognize non-GS1 identification schemes in the GS1 system are:

- GS1 should demonstrate an open and objective attitude towards other identification systems and seek mutual benefit
- GS1's primary concern will always be the interests of the members of the GS1 member organisations (MOs). Co-operation with third parties must have the aim of extending the usefulness and value of the GS1 system and must not be allowed to compromise the interests of the MOs' members overall nor generally undermine the benefits they derive from the GS1 standards.

3. Criteria

The incorporation of existing numbering schemes into the GS1 System will be considered providing all the following criteria have been met:

1. The identification scheme shall be managed by a recognized not-for-profit organisation that has a proven record of being responsible for the management of its numbering system.
2. The identification scheme shall be either used globally or be an established system, recognized internationally and widely used, that addresses the need of an important economic community.
3. The organisation managing the identification scheme commits to encourage the concerned User organisations to join GS1 Member Organisations in order to benefit from the use of the GS1 system, its products and services.
4. The incorporation of the identification scheme brings benefits to GS1 member companies, for example through broadening the GS1 scope of application.
5. There must be a formal contract between the managing organisation and GS1 or an MO.

This contract must specify, at minimum, the following:

- GS1 System components that can be used with the key
- Any restrictions that may apply,
- Financial considerations
- Allocation and lifecycle rules
- Validation rules
- The business service levels that apply, e.g. participation in GSMP
- The technical service levels that apply, e.g. ONS support of class 3 key
- Use of GS1 trade names and logos and the way in which the relationship may be portrayed
- Compatibility with class 1 key function and syntax for example:
 - Will this class 2 key work with GDSN validation rules
 - Will this class 2 key support ONS
 - etc...
- Restrictions on reciprocity (e.g. national or currency zones)

*Update approved by the General Assembly on 18 May 2011
Approved by the General Assembly on 21 May 2008*

B. Background: GS1 Key Classes

As described in the *GS1 System Architecture*¹⁰ (section 4.3), GS1 distinguishes four *classes of keys*:

- Class 1: Keys administered by GS1 and fully under its control
- Class 2: Keys whose framework is controlled by GS1 by means of portion of the GS1 numbering capacity that is allocated for an identification scheme administered by an external agency
- Class 3: Keys fully administered and controlled outside GS1 but which are supported in some part or parts of the GS1 System
- Class 4: Keys that are entirely outside the GS1 System, i.e. all identifiers that meet the definition of “key” (*also provided in the Architecture (section 4.1.3)*), but at are not in the first three classes

The *GS1 General Specifications*¹¹ (§2.1.1) stipulate, at least for trade items (identified with a GTIN), that organisations should process GS1 ID keys in their *entirety* with *no attempt to extract parts of the code*. There is no reason why this would be different for other GS1 keys.

According to the *GS1 General Specifications* (§1.3.2) “*non-GS1 identifiers may only be used with GS1 standards as additional identifiers (not alternates). Implementations using non-GS1 identifiers as primary identifiers are not compliant with GS1 standards.*” To this should be added that implementations using non-GS1 identifiers as primary identifiers *can* be compliant with GS1 *technical* standards (e.g., any use of Class 3 keys).

Applying the Gen Specs standard rule mentioned above on the four key classes means:

- a. Numbering systems which are recognised in *class 2*, are treated as if they are class 1 keys.
- b. Numbering systems which are recognised in *class 3* are *supported* in some GS1 *technical* standards (currently EPC tag data standard), but remain *external identifiers*. “Class 3” keys are not required to obey the Gen Specs additional identifier rule mentioned above.
- c. Some identification systems are recognised as an *attribute to a GS1 “class 1 key”*. Such external keys are *not part of the GS1 standard and fall under “class 4”* (see also appendix A.2 of this paper).
- d. In the GS1 in Rail guideline it is recommended to *embed* external keys in a larger GS1 key. This means that a company, using its GS1 prefix, creates GS1 keys by using the *external key in the item reference part of the GS1 key*. Such external keys are not part of the GS1 standard and hence fall under “*class 4*”, but the full key is a GS1 key under “*class 1*”.

¹⁰ See http://www.gs1.org/docs/gsmpr/architecture/GS1_System_Architecture.pdf

¹¹ See <http://www.gs1.org/genspecs>

C. Background: GS1 AI (Application Identifier) standard

In the GS1 General Specifications a description of the GS1 AI standard is provided. Essentially this is a methodology to distinguish data elements when represented on a data carrier (barcode, RF tag), where the AI has the same role as a data qualifier in electronic messages (EANCOM, GS1 XML). In consequence, the following statements could be analogously applied to the EDI environment, in particular when taking best practices into account in which only a GS1 Key is encoded in the data carrier and where all related attribute information which has been communicated via electronic data interchange beforehand, is retrieved from databases using the GS1 identifier as a key.

The following types of data elements exist:

1. GS1 keys (class 1 and class 2; this distinction is not mentioned in the Gen Specs, however)
2. Attributes:
 - GS1 attributes (e.g. various numbers, dates, measurements, etc.)
 - GS1 key qualifiers (e.g. serial number AI 21, batch/lot number AI 10, etc)
 - External keys

Apart from distinguishing between key classes, in several cases a *dedicated AI* (application identifier) for an external key has been defined, to enable recognition in the GS1 data capture standards (barcodes and RFID). These keys are “class 4”.

Note: the (current) class 3 keys are not part of the AI standard (they are not to be printed as a barcode).

An *external key* is to be *linked as an attribute to a GS1 key* (cf Gen Specs §1.3.2). Examples (of keys that are all to be linked to a GTIN (AI01)):

- Additional product identification assigned by manufacturer (AI240),
- Customer part number (AI241),
- NHRN (National Healthcare Reimbursement Number, AI 710-713)
(here legal / regulatory requirements require the use of external codes),
- NSN (NATO Stock Number; AI7001).

(Note: other external keys may be linked to other GS1 keys.)

These external keys are “class 4” keys.

It should be noted that in the Architecture, no mention is made of external keys, which are part of the AI standard. Conversely, none of the class 4 key examples in the Architecture are part of the AI standard.

D. Specific considerations regarding T & L

D.1. User requirements referred to in RFF

There is a need to track Transport & Logistics assets such as containers, wagons, semi-trailers, etc. (*in practice several (non-GS1) coding systems are widely used, which often are physically marked on the transport assets*). Also there is a need to associate shipments / logistic units (*often identified with GS1 codes*) with such assets, which requires alignment of respective identification systems.

Current recommendations:

- **Rail vehicles** In the GS1 in Europe Rail guideline, in section 3.1, it is recommended “to have the 12 digit *EVN as part of GIAI (Individual Asset Reference)*. ... The involved parties (train operator as well as system developers) shall be aware that GIAs from other implementations with a different application objective may be attached to or be on the vehicle not using any significance.”
- **Containers (BIC)**, swap bodies and semi-trailers (ILU) and IATA ULDs: No provisions in GS1 guidelines (nor user requirements known) (except a mention of BIC in the GS1 Guideline on GS1 keys in Transport & Logistics (slide 18)).

D.2. Identifiers in T&L

1. For Transport & Logistics assets several specific (non-GS1) coding schemes are used:
 - For containers the BIC code, managed by the “Bureau International des Containers et du Transport Intermodal”.
 - For rail vehicles the EVN: Article 33 of EU Directive 2008/57/EC mandates that all rail vehicles placed into service are allocated a numeric identification code (the European vehicle number (EVN)), which are registered in the Rolling Stock Library (RSL).
 - For locomotives the UIC code of the Union International des Chemins-de-fer, as required by the EU ERA (European Railway Agency)
 - For air freight the IATA ULD code for “unit load devices”.
 - For “intermodal loading units” (e.g. swap-bodies, semi-trailers) the ILU code, managed by UIRR (International Union of combined Road-Rail transport companies).
 - And no doubt (many) others.
2. GS1 offers an integral identification system, including shipping containers (SSCC), shipments (GSIN) and (Transport & Logistics and other) assets (GIAI and GRAI).
3. What do the **GS1 General Specifications** (version 14, Jan 2014) state about identification of ((returnable) transport) assets?

*Section 4.5.1: GS1 System asset identifiers can be used to identify **any fixed assets** of a company. It is left to the discretion of the issuer to determine whether the Global Returnable Asset Identifier (GRAI), AI (8003), or Global Individual Asset Identifier (GIAI), AI (8004), is more suitable for the application concerned.*

4. What does the **GS1 Guideline on GS1 keys in Transport & Logistics** (issue 1, June 2013) state about identification of ((returnable) transport) assets?

Section 4: The recommended use of either GRAI or GIAI is based on the asset type and business application. Assets may be classified as either individual or returnable based on definitions, described in section 4.1. For several types of transport equipment (trailers, rail wagons & intermodal containers) a GIAI is recommended; regarding containers the BIC is mentioned, without suggesting to embed a BIC code into the GIAI (see section 4.3.3). No reference is made to the use of other external codes.

5. BIC & EVN are examples of class 4 keys: they are not accommodated by any GS1 standard and there is no interoperability with the GS1 System.
6. In the **GS1 guideline for RFID in Rail of GS1 in Europe** it is recommended to *embed* the EVN, an external asset code, into a GIAI. This implies that, in a pragmatic manner, some interoperability would exist.
7. The risk of embedding is that *deriving an external code* from a GIAI can be hampered by the fact that there is no explicit way to recognize in the code whether an external code is applied and if so, which one. This risk is referred to in the GS1 EU Rail guideline:
- Section 1.2 “EVN is only unique within the context of rail registers”
 - Section 3.5, last sentence “it is a disadvantage ... that a system may incorrectly believe that an EVN is encoded”.
 - However, there are no comments about potential consequences (how serious is the risk, how to avoid, area of application).
 - New Section D.4 (based on comment on the right) proposes some approaches to mitigate the risk of extracting a non-GS1 code from a GS1 key.
8. The RFF is asking “how to integrate external identifiers for transport equipment in the GS1 System”, in other words how keys such as BIC codes should be represented in the GS1 System. From the key classes framework it follows that:
- If such external codes are to be formally represented in the GS1 System, they could be added to the AI standard (several external codes are part of this standard), though not as GS1 keys, but rather as attributes to GS1 keys. Alternatively, they could be positioned in class 2 (or 3) (depending on requirements).
 - Following the GS1 Policy towards external Identification Systems acknowledging an external key in the AI standard should be based upon a formal agreement with the respective authority which assigns the external codes.
 - The recommendation to embed such codes into e.g. a GIAI without such positioning has no formal relevance, since the external code cannot be formally extracted from the GS1 code. However, it can be used in a pragmatic manner, as long as the risks are understood and accepted.
 - For an in-depth analysis, see sections 2 and 3 of this paper.

D.3. Specific remarks regarding the GS1 in Europe Rail guideline

The recommendation in the GS1 in Europe Rail guideline to identify rail vehicles by GIAIs with embedded EVNs is an example of the “Embedding – Non-migration” scenario (cf section 3.2). It is recommended that further explanation is added regarding the consequences and limitations regarding decoding.

Also, a formal agreement with the organisation managing the EVN should be made, because the soundness of the GS1 recommendation to embed depends on the quality of the assignment of unique numbers to rail vehicles.

D.4. Mitigation of risk when extracting a non-GS1 code from a GS1 key.

In Section 2.4.2.3 of this document, each organisation may choose to use their own GS1 Company Prefix to embed their external identifiers, managed by a 3rd party, into a GS1 Key structure, for example embedding an EVN code into a GIAI.

If multiple organisations within an industry sector adopt this procedure in a mutually consistent approach, then there is an opportunity for that sector (e.g. a rail industry sector body) to support its members by compiling and maintaining a whitelist database of GS1 Company Prefixes of organisations who are constructing some of their GS1 Keys in this way.

Any other organisation that encounters a GS1 Key (such as GIAI) and expects that it contains an embedded external code (such as an EVN), could consult the whitelist database (or their own previously cached copy of it) to check whether the GS1 Company Prefix appearing within the GS1 Key (e.g. within the GIAI) is a GS1 Company Prefix that also appears within the whitelist database. If so, then they can have higher confidence about the likelihood that the other code extracted from the GS1 Key corresponds to a specific external code (e.g. an EVN).

Of course, the same companies leasing those GCPs as well as other companies may use them to construct other GIAs attached to stationary assets (for example containers on a freight vehicle) and this should not pose a conflict unless those stationary assets are being transported by rail and capable of being read together with the rail asset identified by a GIAI in which the EVN was embedded. This is why in the Rail Guideline a filter value in the tag identifying the vehicle is proposed.¹² This is only applicable for tags, not for barcodes or eCom messages.

Additionally, if the external code (e.g. EVN) has its own check digit *and* if this digit is preserved intact when embedding within the GS1 Key, then following extraction from the GS1 Key, the extracted code can be checked to see whether its check digit is in agreement with the rules for calculating the check digit of the external code. If the check digit for the external code appears to be correct, this also provides a user with greater confidence that the extracted external code has the intended meaning.

Finally, the most robust way to determine the meaning of an identifier is if master data about that identifier can be easily retrieved by a well-defined mechanism and if the master data explicitly states what kind of thing is being identified, as well as an explicit assertion about the correspondence to a specific external identifier. For example, master data about a GIAI may indicate that the type of object is a rail vehicle and that is externally identified by a specific EVN.

If this master data is retrieved and cached by parties who encounter these GIAI-identified assets, then they can use that internal cache as a whitelist for GIAs that they have been confirmed as embedding an EVN. Even in the absence of a shared whitelist of GS1 Company Prefixes maintained by an industry sector body, an individual company might not only maintain its internal whitelist cache of GIAs that have been confirmed to contain specific EVNs; it might also use this internal whitelist cache to infer that other GIAs derived from the same GS1 Company Prefixes are likely to also contain EVNs, subject to additional checks on the plausibility of the format and check digit etc.

An approach to achieve this, which does not require access to a database, is to use a dedicated AI, indicating that the asset is a rail vehicle, of which the number is managed by a 3rd party. This is described in section 2.4.2.4.

¹² This is described as follows in the GS1 in Europe RFID in Rail Guideline, version 1.0 (Jan 2013):

Page 11: Implementers should be aware that a tag filter value may be allocated by GS1 to minimise the possibility of interference from other tags. If a filter value is agreed then it will be important for all vehicle tags to use the agreed filter value. Implementers should therefore check for the latest information about the filter value from GS1 before rolling out large numbers of tags. In the meantime this guideline will minimise readability issues at high speeds.

Page 23: *At present, this Filter value is still under development.*

E. The Request For Finding

Request for Finding – Brief Summary (one phrase or sentence)

How to integrate external identifiers for transport equipment, such as Intermodal Containers (BIC), swap bodies and semi-trailers (e.g. ILU), wagons (e.g. EVN), ULDs (IATA) in the GS1 System.

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| Submitter Name | Coen Janssen on behalf of the Transport & Logistics Leadership team and the Transport & Logistics MO Interest Group |
| Submitter Company | GS1 |
| GS1 Member Organisation of submitter | |
| Submitter e-Mail | coen.janssen@gs1.org |
| Submitter Telephone | +32 (2) 788 78 38 |

Statement of Question or Concern

In Transport & Logistics processes there is a need for identification and tracking of transport equipment. This enables better asset management and also can be used to enhance supply chain visibility, by linking shipments (GSIN) or logistic units (SSCC) or trade items (GTIN) to the transport equipment. For some types of transport equipment very well established non-GS1 identification schemes exist. These identifiers are physically marked on the equipment, and widely used in systems of operators, shippers and logistic service providers.

Faced with this reality, some MOs are recommending their users to *embed such external keys in a GIAI*. The GCP is assigned to the operator (owner) of the equipment. Currently no official guidance is given to MOs, so different implementations may occur.

One could argue that the existence of several external keys for transport equipment, some of them regional, are a valid reason for embedding these in a more generic GS1 identification scheme, and that the GIAI is a good fit since it is a very flexible format. Counter argument could be that by embedding an external identifier in a generic GS1 identifier, there is *no explicit way to recognize whether an external identification scheme is being applied* (and which one), which could lead to processing issues upon capture or communication of the key.

The Transport & Logistics leadership team would like to ask the Architecture Team for their opinion on this topic, and for guidance on further steps in formalizing and aligning the MO policies.

Relevant GS1 Standards or other GS1 System Components

GIAI, GRAI, EPC/RFID, EPCIS, GS1 Bar Codes and GS1 eCom