The Global Language of Business

GS1 Digital Link: Semantics

Extracting the meaning of identity and data relationships expressed in GS1 Digital Link URI syntax.

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0.2	2020-10-29	Mark Harrison, Phil Archer	Initial addition of S4T terms and all classes and properties related to primary keys. Addition of data types Relationship wth Web Voc and GMD SMG explained
0.3	2020-11-19	Mark Harrison	Updates to flowcharts and tables, addition of a worked example for SSCC and delivery details
0.4	2020-11-19	Phil Archer	Cosmetic updates in prep for comunity review. Addition of Future work section.
0.5	2020-11-23	Mark Harrison	Further additions to the stringSemantics table

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1 Introduction

This section and its subsections are informative

GS1 defines a wide range of identifiers that underpin the supply chain and retail industry across the world. This document assumes the reader is familiar with these and the concept of GS1 Application Identifiers. If not, please see information on [GS1 identification Keys] and the [GENSPECS] for further background.

This work has been motivated by a number of trends. For example: the desire among retailers to move to 2D barcodes that can carry more information than just the GTIN; the problems of multiple barcodes causing scanning errors through conflicts which suggests a need for a single but multipurpose barcode; the growing expectation among consumers that more information is available online about the products they're considering buying; the brand owner concept of the pack as a media channel linking to multimedia experiences, and more.

As a result of GS1 Digital Link, it is possible to represent GS1 identification keys consistently within Web addresses as well as within barcodes containing Web addresses, such that a single identification approach can support both product identification for supply chain applications *and* a link to online material for consumer and business partner interactions. It's this dual functionality and enormous flexibility that is currently not possible when, for example, Brand Owners embed an unstructured Web page address in a QR Code®[1].

The detailed semantics of the GS1 Digital Link system are defined in this document. It represents the GS1 system in terms that can be understood in any context using Linked Data principles [Linked Data]. In particular, how the information encoded within a GS1 Digital Link URI maps to classes and properties defined in the GS1 Web Vocabulary [GS1Voc] and other vocabularies.

1.1 How the GS1 Digital Link standard documents fit together

Rather than one very long document containing every detail, as of version 1.2, the GS1 Digital Link standard comprises 4 discrete documents:

URI syntax

This document provides some of the background to the design of GS1 Digital Link, highlighting existing techniques and practices that underpin the World Wide Web, and applying those to the GS1 system. The normative portions set out the detailed syntax of Web addresses (HTTP URIs) that encode GS1 identifiers with exactly the same precision and expressivity as the AI-based element syntax used across the GS1 system, notably in the GS1 General Specifications. The GS1 Digital Link URI syntax distinguishes between primary keys, such as GTIN and GLN, key qualifiers, such as batch/lot and GLN extension, and attributes such as expiry date and ship to address. The GS1 Digital Link URI syntax is the foundation on which all other aspects of the standard are built.

Compression

A GS1 Digital Link URI that contains a set of identifiers and attributes may exceed the capacity of some data carriers. This document defines a compression/decompression algorithm that minimises the length of those Web URIs while retaining two critical features: 1) that the compressed form is still a URL on the same domain as the uncompressed form, that is, there is no change in ownership of the URL; 2) that it can be decompressed and the GS1 keys extracted *without* an online lookup.

Resolution

A GS1 Digital Link URI is a particular form of URL and *can* be used in exactly same same way as any other URL (this is an important design feature). However, it can also be the gateway to multiple sources of information, both human and machine-readable. This document defines how the keys in a GS1 Digital Link URI can be 'resolved' to those information sources in such a way that information systems and apps can discover them automatically. Resolvers are what makes the standard operational for the GS1 community and the industries served.

[1] Unless otherwise specified, the term 'QR Code®' refers to the widely used *ISO/IEC 18004 QR Code*®, excluding the GS1 QR Code that recognises the FNC1 character. 'QR Code' is a registered trademark of Denso Wave, a subsidiary of Denso Corporation. Both the *ISO/IEC 18004 QR Code*® and GS1 QR Code follow the encoding scheme described in ISO/IEC 18004 Information technology — Automatic identification and data capture techniques — QR Code bar code symbology specification, 3rd edition 2015-02-01.

Semantics (this document)

Devices like scanners and point of sale terminals, PIM systems, product catalogues and more that are designed specifically to work with GS1 identifiers and data carriers, are all programmed to function within that particular framework. GS1 Digital Link puts things like GTINs, SSCCs and GRAIs onto the Web alongside countless other identifiers and ways of working. This document expresses the meaning behind the GS1 Digital Link standard in a way that the Web at large can understand and process. It makes use of, and extends, the GS1 Web Vocabulary.

1.2 Typographical conventions used in this document

This document includes a lot of examples of GS1 Digital Link URIs such as:

`https://example.com/gtin/{gtin} and`

`https://example.org/414/{gln}/254/{glnExtension}`

`https://example.org/01/{gtin}{?exp}`

The use of the monospace font indicates that the text has meaning for computers. Further, these examples follow the convention used in [RFC 6570]. The places where the values of variables should be inserted are written in braces, so, for example, {gtin} means "insert gtin here". All other text in the URI is a literal string to be used as written. As explained in [RFC 2606] and [RFC 6761], the domains example.com, example.org and example.net are second-level domain names reserved by the Internet Assigned Numbers Authority (IANA) for use in documentation. These should be understood as a placeholder for any registered second-level domain name.

2 Definitions and namespaces

This section and its subsections are normative

Throughout this document, the following prefixes and namespaces are used meaning that, for example, `gs1:pip` is equivalent to `https://gs1.org/voc/pip`.

Table 2-1 Prefixes and namespaces used in this document

Prefix	Namespace
gs1	https://gs1.org/voc/
schema	https://schema.org/
dcterms	http://purl.org/dcterms/
skos	http://www.w3.org/2004/02/skos/core#
owl	http://www.w3.org/2002/07/owl#
rdf	http://www.w3.org/1999/02/22-rdf-syntax-ns#
rdfs	http://www.w3.org/2000/01/rdf-schema#
xsd	http://www.w3.org/2001/XMLSchema#

2.1 Conformance to this standard

The GS1 Digital Link standard comprises a number of discrete documents against which conformance can be asserted.

There is no single conformance statement for the entirety of GS1 Digital Link. It is therefore inappropriate to make a formal claim of broad conformance without citing the specific standard with which conformance is claimed.

A data interchange, however that interchange occurs, is conformant with GS1 Digital Link Semantics if:

- it uses terms (classes and properties) in a way consistent with their semantics as declared in this specification;
- it does not use terms from other vocabularies instead of ones defined in this vocabulary that could reasonably be used.

A conforming data interchange

- MAY include terms from other vocabularies;
- MAY use only a subset of GS1 Web Vocabulary terms.

2.2 Relationship with the GS1 Web Vocabulary

The semantics of GS1 Digital Link are expressed using terms defined in the GS1 Web Vocabulary at *https://gs1.org/voc*. Although it is presented there as a human-readable and navigable set of terms, behind the scenes it is driven by a single dataset encoded as RDF [RDF] (it can be accessed as JSON-LD). Where relevant, this includes machine-readable relationships between those terms and external vocabularies.

The Web Vocabulary is managed by the *Global Master Data Standards Maintenance Group* on behalf of the wider community, not just that working specifically on GS1 Digital Link. Therefore terms 'defined' in this standard must be seen as proposals for inclusion. In case of any discrepancy between this document's use of a term and its definition within the Web Vocabulary, the latter is authoritative.

A copy of the vocabulary is maintained on GS1's GitHub site at *https://github.com/gs1/WebVoc*. This is where new terms can be suggested and developed for later inclusion in the formally published vocabulary.

As a result of new GS1 Application Identifiers introduced in the GS1 General Specifications v21 and this standard to provide a semantic interpretation of GS1 Digital Link URIs, some additional terms will need to be added to the GS1 Web vocabulary. These include new properties to connect a Logistic Unit to a ship-to/deliver-to Postal Address or to a return-to Postal Address, as well as additional properties within gs1:PostalAddress to express a suburb or to express line 2 of a street address. Some additional classes and properties may also be needed for completeness, to support semantic expression of all GS1 Application Identifiers.

3 Semantics of GS1 Digital Link URIs

This section and all its subsections are normative unless flagged otherwise.

3.1 Exposing GS1 Digital Link semantics to the outside world

This subsection is informative

The GS1 community is very familiar with the meaning of things like GTINs, SSCCs, expiry dates and so on. However, there is a great deal of background knowledge that a human uses to interpret the GS1 system. GS1 Digital Link operates within and outside the GS1 community and so needs to be much more precise if information is to be exchanged accurately between non-specialist people and, even more critically in this context, non-specialist information systems. Therefore we must add precise detail concerning what is expressed using GS1 Digital Link URIs, the relationships between related GS1 Digital Link URIs and also how we can express facts about things that are identified using them, not only as human-readable Web pages that include tables of information, but also as structured data that can be automatically interpreted by computer software.

The GS1 Digital Link URI syntax is just a way of expressing a set of one or more GS1 element strings in a Web-friendly format that looks like a Web address or URL and functions as a Web address, in the sense that a Web request (HTTP / HTTPS GET request) can return relevant data.

GS1 Digital Link supports all fundamental GS1 identification keys (e.g. GTIN, SSCC, GRAI, GIAI, GSRN etc.) as well as appropriate qualifiers (e.g Consumer Product Variant, Batch/Lot Number, Serial Number, GLN extension, CPID Serial Number) that can be used to form compound identification keys that enable identification at a finer granularity, such as a specific batch of products or even an individual product instance. Additionally, the GS1 Digital Link URI syntax also supports the expression of data attributes for which corresponding GS1 Application Identifiers are defined. These include data attributes such as net weight, gross weight, expiry date, date of production, dimensions, country of origin, etc.

The good news is that Semantic Web/Linked Data technology provides an effective, standardised way to exchange factual data about data attributes and their values without the need to exchange long GS1 Digital Link URIs. This chapter explains how that technology works and how it can be used to exchange factual data about things so that the meaning can be automatically interpreted by computer software within and beyond the GS1 information ecosystem.

3.2 Equivalence

The GS1 Digital Link URI syntax has been developed with the practical realities of the supply chain and commercial worlds very much in mind. This is the thinking behind some key features, notably:

- domain name neutrality (you can create a conformant GS1 Digital Link URI using any domain name);
- the definition of developer-friendly short alpha codes, like ‘gtin’ and ‘cpv’ as equivalents of their numeric GS1 application identifiers, so that:
  `https://example.com/foo/gtin/9520123456788/cpv/2A`
  `https://id.example.org/gtin/9520123456788/cpv/2A`
  `https://example.example/01/9520123456788/22/2A`
  `https://id.gs1.org/01/9520123456788/cpv/2A`
  `https://id.gs1.org/gtin/9520123456788/22/2A`
  are all equivalent in terms of the information they carry and the items they identify.

Fulfilling these needs comes at a cost since it is clear that there can be an infinite number of conformant GS1 Digital Link URIs that identify the same thing. Whilst this does not go against the Architecture of the World Wide Web [WebArch], it does mean that further clarity is required so that conformant GS1 Digital Link URIs can be used with confidence in Semantic Web and Linked Data environments.

Non-unique naming is commonplace in Linked Data but the fact that two URIs identify the same resource will often need to be recognised, and in some cases explicitly declared, in information processing systems. In this context, it is worth noting two similar but distinct relationships that occur commonly.

Starting from a GS1 Digital Link URI:

- The correct relationship with another URI that identifies the same item, or class of items, is `owl:sameAs`, the definition of which is "indicates that two URI references actually refer to the same thing: the individuals have the same *identity*". This relationship type is very specific and should be used with care. It is, however, the correct relationship between the URIs listed above.
- It is anticipated that the more common case will be a link to information describing the item, particularly a product information page. That is, the identified item and the description of it are two distinct concepts and therefore `owl:sameAs` is not applicable. The correct relationship in this case is likely to be `gs1:pip`, `gs1:smpc` etc.

See section GS1 Digital Link: Resolution [DL-resolution] for more on relationship types.

3.3 Information encoded within the URI

There is a feature of the GS1 Digital Link URI syntax that goes directly against W3C's Web architecture principles [WebArch], namely *URI Opacity,* which states that:

> *Agents making use of URIs SHOULD NOT attempt to infer properties of the referenced resource.*

GS1 recognises this conflict, however, it is overridden by the need to meet two requirements:

- that a Web address directly related to a product can be encoded in its entirety in a data carrier on the pack (in a QR Code®, NFC tag, digital watermark or similar) such that a generic application with no special software can directly extract the entire URL and follow the link, without the need to further construct the URL;
- that critical applications within the supply chain do not need to dereference the GS1 Digital Link URI in real time to extract the GS1 keys and key values; they can instead extract the GS1 keys and key values using translation software that requires no real-time online connectivity.

GS1 further notes the definition of SHOULD NOT from [RFC 2119]:

> *... there may exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.*

With these factors in mind, it is important to note that the semantics of a GS1 Digital Link URI can only be inferred within the specific context of a GS1-aware system. This means that, in addition to normal error handling, any application attempting to infer semantics from a GS1 Digital Link URI SHALL first check that:

- it is conformant to the standard, including validity of the keys and key values;
- where multiple keys are included in the URI that the combination is itself valid, see section 4.14 of the GS1 general Specifications [GENSPECS].

Furthermore, the development of a URI syntax that is independent of any internet domain name goes directly against *URI Design and Ownership* [BCP190], the abstract of which includes:

> *… the structure of a URI is defined by its scheme. While it is common for schemes to further delegate their substructure to the URI's owner, publishing independent standards that mandate particular forms of URI substructure is inappropriate, because that essentially usurps ownership.*

It is recognised that GS1 Digital Link goes against this by defining a a URI substructure but notes that this standard *requires* that all conformant resolvers SHALL publish a resolver description file at /.well-known/gs1resolver that asserts its independent control of its URI space. This includes

information about whether the resolver handles all or only a subset of the GS1 identifier system, support for any extensions, the supported value space(s), if any, for the context keyword and more.

Therefore, each resolver/internet domain remains sovereign over its URI space and the BCP is not contravened.

3.4 Trailing slashes

Where a GS1 Digital Link URI resolves to a directory on a server, it will typically be appended with a trailing slash automatically. Thus our example

`https://example.com/gtin/9520123456788/cpv/2A`

might be seen in the address bar of a browser as

`https://example.com/gtin/9520123456788/cpv/2A/`

This is **not** conformant, however, it is likely to be common and therefore resolvers SHOULD be tolerant of it.

3.5 The identified resource and the applicability of attributes

Historically at least, the basis of the GS1 System is the provision of identifiers for physical things. Therefore, GS1 Digital Link URIs also identify physical things, not information resources that describe them. Making that statement does, inevitably, lead to the potential problem of dereferencing the URI for a physical product to discover the obvious nonsense that it has a media type of text/html and a size of 13.4 kilobytes. This is a very old and well known problem [URIDoc] [HR14] but it is one that presents few practical problems in the real world where the assumption that the identifier is for the physical object is usually safe.

Nevertheless, it is important to think carefully about what we really mean by identifiers - and to carefully distinguish between a class of objects and an individual instance within that class.

The GS1 Glossary defines a class as "A class describes a set of objects that share the same attributes, relationships and semantics." The GS1 Glossary does not currently provide a definition for instance, nor does the GS1 System Architecture [Arch] - although the concept of instance-level identification and instance-level data is discussed throughout the GS1 System Architecture document, e.g. in sections 6.1.1.1 and 6.2.

We are familiar with products that carry a GTIN barcode. In everyday language, we might say that the GTIN identifies the product. However, we also recognise that in practice there are multiple copies (instances) of the same mass-produced product, each sharing the same GTIN barcode.

The GTIN is not sufficiently specific to identify each individual product instance; for that we need to combine the GTIN with a Serial Number that is unique within the GTIN class and which is different for each instance, i.e. no two instances of the same product would be allowed to have the same combination of GTIN and Serial Number. This combination of GTIN + Serial Number is noted in the GS1 System Architecture, see Table 4-1 within section 4.2.

We therefore conclude that the familiar GTIN barcode identifies the product class, rather than the individual product instance.

The GTIN is still useful for retrieving product master data defined for that product class, such as the ingredients or material composition, net weight etc. However, other data, such as traceability data, physical event data or transactional data may be concerned with that individual product instance, such as its date of manufacture, date of expiry or date of purchase.

In situations where the individual product instance is not uniquely identified, we may still want to express factual statements such as:

- 'this instance of the product with GTIN 01234567890128 was manufactured / packed on date 2018-04-02'
- 'this instance of the product with GTIN 01234567890128 was sold on date 2018-06-07'
- 'this instance of the product with GTIN 01234567890128 has an expiry date 2018-07-21'

We also understand that these factual statements only apply to *this instance* of the product, not to all replica instances that share the same GTIN'.

We may want to express such factual statements in a machine-interpretable way using Linked Data technology. In situations where the instance of a product does not have a data carrier that identifies its GTIN and its Serial Number, then Linked Data technology provides the concept of a 'blank node', which simply means 'this thing with no globally-unambiguous URI name'.

A blank node identifier is often written as _:1, _:2 etc., where underscore (_) just indicates a local namespace with no specific mapping to a global URI. Blank node identifiers are useful because we can write multiple factual statements that share the same Subject or Value or where the Value within one statement is the Subject of another statement, even when no globally-unambiguous URI is available for these things.

In the examples above, we could write (in Turtle syntax):

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix schema: <http://schema.org/> .
@prefix gs1: <https://gs1.org/voc/> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .


_:1  rdf:type schema:Product .
_:1  gs1:gtin  "01234567890128" .
_:1  gs1:productionDate  "2018-04-02"^^xsd:date .
_:1  gs1:expirationDate  "2018-07-21"^^xsd:date .
```

In JSON-LD, this looks like:

```
{
  "@context": {
    "gs1": "https://gs1.org/voc/",
    "rdf": "http://www.w3.org/1999/02/22-rdf-syntax-ns#",
    "rdfs": "http://www.w3.org/2000/01/rdf-schema#",
    "schema": "http://schema.org/",
    "xsd": "http://www.w3.org/2001/XMLSchema#"
  },
  "@id": "_:f2c87b45989c249c0873cfc3aa6b79948b1",
  "@type": "schema:Product",
  "gs1:expirationDate": {
    "@type": "xsd:date",
    "@value": "2018-07-21"
  },
  "gs1:productionDate ": {
    "@type": "xsd:date",
    "@value": "2018-04-02"
  },
  "gs1:gtin": "01234567890128"
}
```

In plain English, these statements express the following:

- 'this thing is a product'
- 'this thing has a GTIN value 01234567890128'
- 'this thing was manufactured on 2nd April 2018'
- 'this thing has an expiry date of 21st July 2018'

Note that the GTIN 01234567890128 is not the Subject of these factual assertions.

The reason is that we do NOT want to say the following:

- 'EVERY instance of the product with GTIN value 01234567890128 was manufactured on 2nd April 2018'
- 'EVERY instance of the product with GTIN value 01234567890128 was purchased on 7th June 2018'
- 'EVERY instance of the product with GTIN value 01234567890128 expired on 21st July 2018'

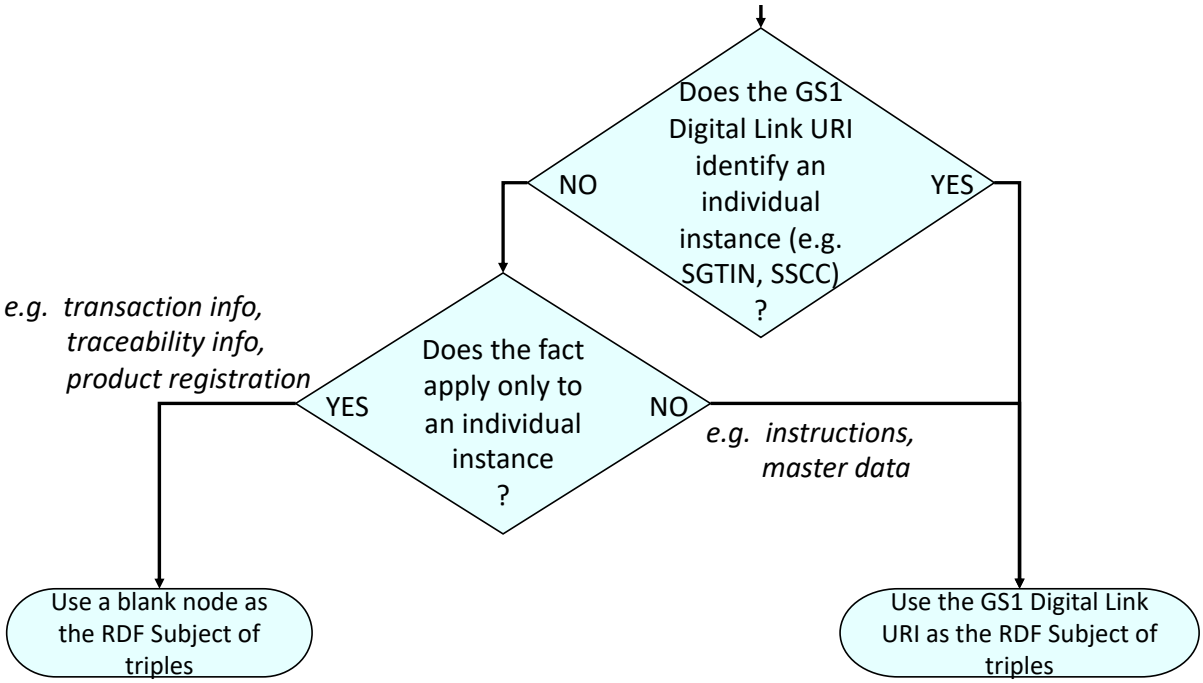
By using a blank node to make statements about 'this thing', we avoid making invalid statements that would otherwise apply too broadly to all instances of the same product.

When a GS1 Digital Link URI identifies a maximum of one object in the world, e.g. a unique combination of GTIN and Serial Number (or other individual instance identifiers for things that are not products), then it is correct to use the GS1 Digital Link URI as the subject of factual statements that are specific to the instance (such as any facts relating to the traceability or transaction history of the individual instance).

It is also correct to use the GS1 Digital Link URI as the Subject of facts that are defined at class-level (GTIN granularity) or sub-class granularity (e.g. GTIN+Batch/Lot or GTIN+CPV) and always apply to all instances within that class or subclass.

If the individual object does not carry a globally unique instance identifier (GTIN + Serial Number unique within that GTIN), then Linked Data applications SHALL instead use a blank node as the subject of any factual statements about the traceability data or transaction history of that specific instance of a product.

Figure 3-1 Decision tree for whether to use the GS1 Digital Link URI or a blank node as the subject of triples expressing facts about the identified item



The flowchart above attempts to provide some guidance about when to use the GS1 Digital Link URI as the subject of Linked Data triples (factual assertions) and when it is more appropriate to instead use a blank node that has no globally unambiguous URI name - only a local name for combining related facts and referencing them from other facts.

Table 4-1 of the GS1 System Architecture document [Arch] identifies the following compound keys that identify individual instances of things. That table is repeated below for convenience, with the addition of mappings to current or draft terms within the GS1 Web vocabulary.

Table 3-1 Combinations of common AIs that identify instance-level items

Entity	Physical / Digital / Abstract	Candidate key
Trade Item (product) Instance (gs1:Product)	Physical or Digital	GTIN + AI 21 (compound) = 01 & 21 (gs1:gtin + gs1:hasSerialNumber)
Returnable asset instance (gs1:ReturnableAsset)	Physical	GRAI including serial number component = 8003 (gs1:grai)
Individual asset instance (gs1:IndividualAsset)	Physical	GIAI including serial number component = 8004 (gs1:giai)
Document instance (gs1:Document)	Physical or Digital	GDTI including serial number component = 253 (gs1:gdti)
Coupon instance (gs1:Coupon)	Physical or Digital	GCN including serial number component = 255 (gs1:gcn)
Component/part instance (gs1:Component)	Physical	CPID + AI 8011 (compound) = 8010 + 8011 (gs1:cpid + gs1:hasCPIDSerialNumber)
Unit Pack Unique Identifier (upUI) (gs1:Product)	Physical (restricted use for compliance with regulations)	= GTIN + AI 235 (compound) = 01 & 235 (gs1:gtin + gs1:hasThirdPartyControlledSerialNumber)

3.6 Subclass relationship

The structure of a GS1 Web URI is such that:

- identifiers, including identifier qualifiers used to form compound identification keys, are expressed in the URI path information and attributes in the URI query string;
- identifiers are increasingly specific as you move from left to right within the URI path information.

It follows that `https://example.com/gtin/9520123456788/cpv/2A` identifies a subclass of `https://example.com/gtin/9520123456788`. Semantic applications SHOULD infer this relationship for class-level, i.e. not instance-level items (see section *3.7.4*).

3.7 Interpreting the URI query string

The query string in a conformant GS1 Digital Link URI, if present, may contain facts about the identified resource and/or key=value pairs that provide processing instructions for resolvers or for target URLs accessed following redirection from a resolver. The query string does not contain identifiers for the item itself (these are in the URI path information). Therefore, when interpreting the URI to extract facts, the query string SHALL NOT be used as the subject of the derived triples in whole or in part.

Where an attribute key within the URI query string is a defined GS1 attribute AI, such as an expiry date or measured weight, these SHALL be interpreted as facts about the identified instance or class. The GS1 Web vocabulary [GS1Voc] provides properties for all GS1 attribute AIs.

3.7.1 Determine if the RDF Subject is a unique instance identifier

Table S1 provides a list of GS1 Application Identifiers of primary GS1 identification keys that may correspond to unique instance identifiers themselves or as compound keys in combination with additional GS1 Application Identifiers.

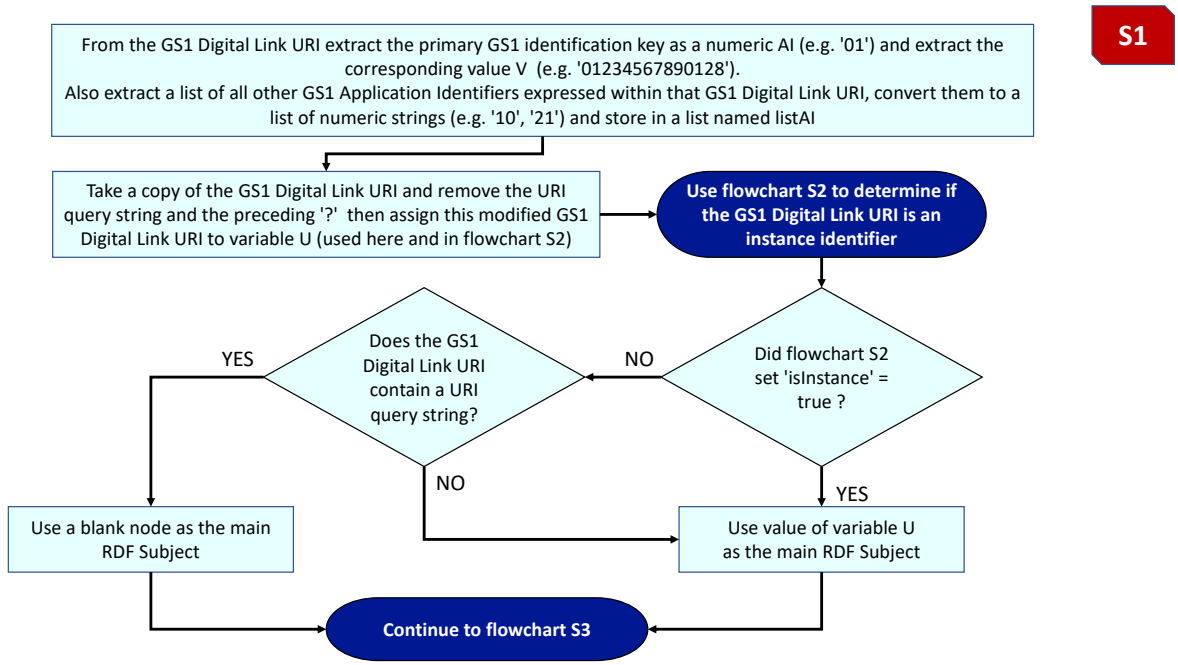
Where the second column, 'requires' is null, the primary identification key already identifies a unique instance. Where the second column shows a list of additional AI values, a unique instance exists provided that one of those additional AIs is specified, together with a value.

The third column indicates a 'mininum length'. For a GS1 primary identification key in Table S1, if a minimum length is indicated in the third column and its value is equal or greater than the minimum length, a unique instance exists. This is to support GS1 Application Identifiers that have optional serial components or serial references.

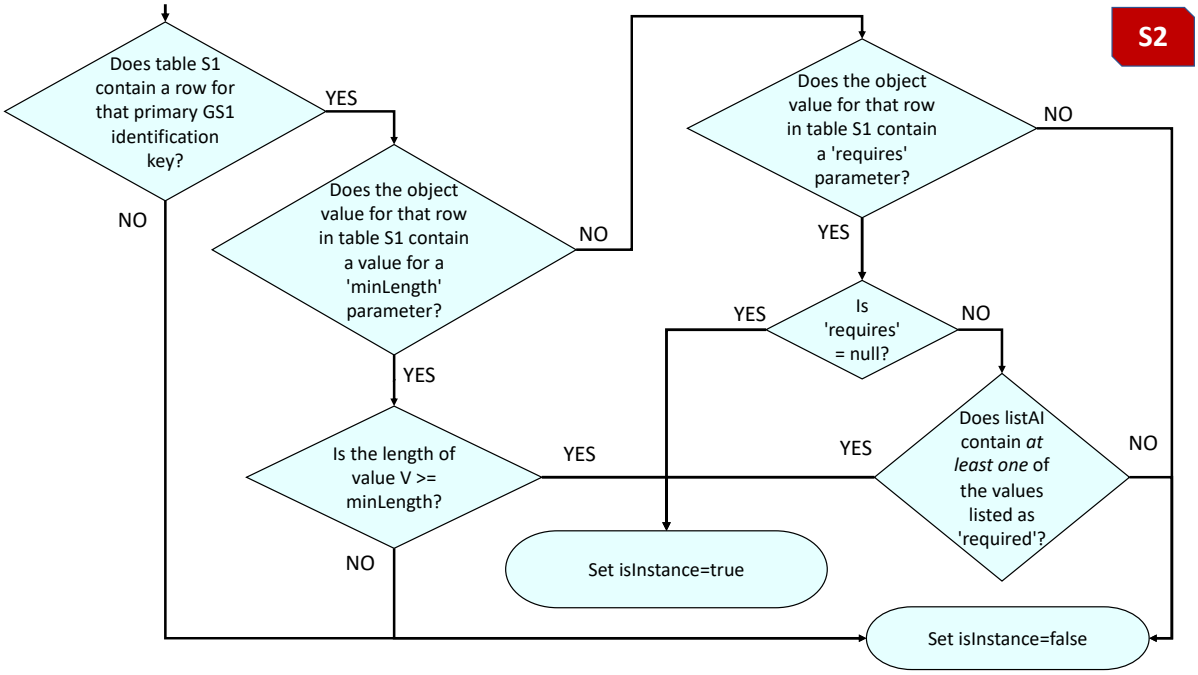
Table S1 - Primary Identification Keys, or key + key qualifers, that correspond to instance identifiers.

AI of GS1 Primary ID key	Requires additional AIs	Minimum Length
01	21, 235	
00	null	
253		14
414	null	
8003		15
8004	null	
8006	21	
8010	8011	

Flowchart S1 expresses the high-level logic for determining whether the GS1 Digital Link URI identifies an individual instance or a class of things.



Flowchart S2 expresses the detailed logic for determining whether or not the GS1 Digital Link URI identifies an individual instance or only a class of things.



3.7.2 Determine class relationships that can be inferred

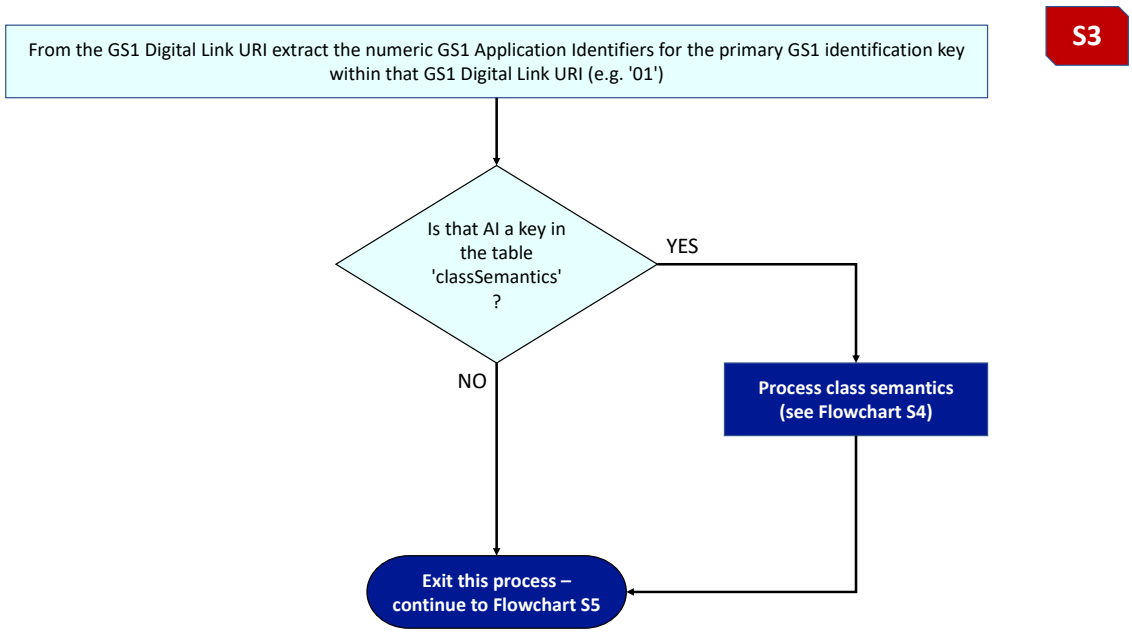
Table 'classSemantics' shows relationships between GS1 Application Identifiers of primary GS1 identification keys and corresponding semantic classes that can be inferred for such AIs.

Table 'classSemantics' – GS1 Application Identifiers and their associated properties for which a domain is declared and therefore from which the class of the identified item can be inferred

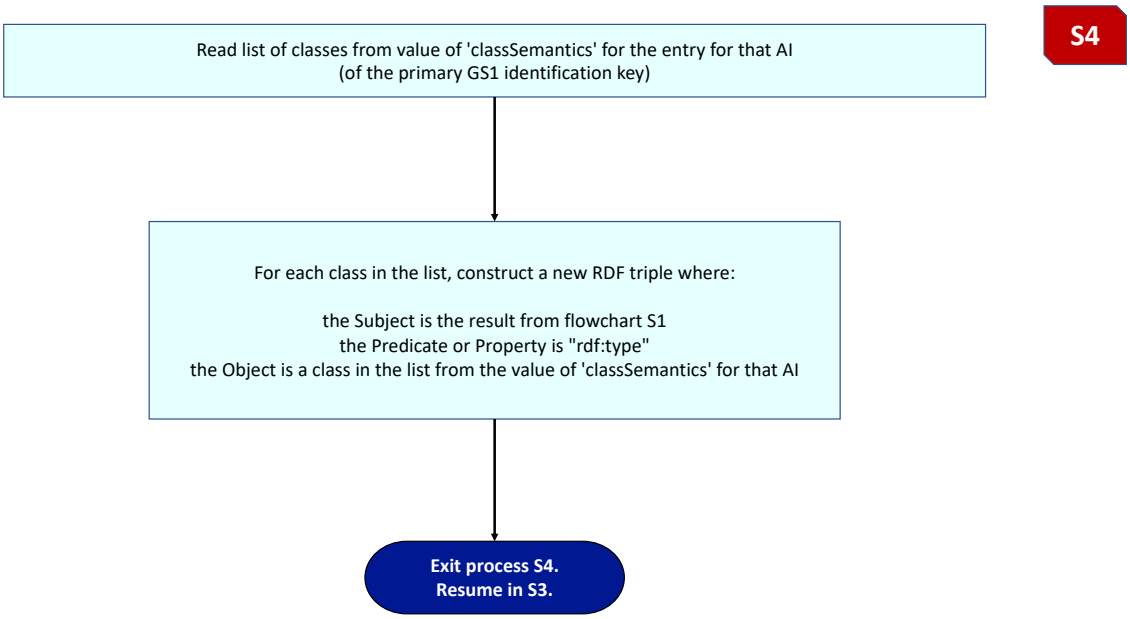
AI of GS1 Primary ID key	Inferred class
00 (gs1:sscc)	gs1:LogisticUnit
01 (gs1:gtin)	gs1:Product , schema:Product
253(gs1:gdti)	gs1:Document, foaf:Document, schema:CreativeWork
255(gs1:gcn)	gs1:Coupon
401 (gs1:ginc)	gs1:Consignment
402 (gs1:gsin)	gs1:Shipment
414 (gs1:locationGLN)	gs1:Place , schema:Place
417 (gs1:partyGLN)	gs1:Organization, schema:Organization
8003 (gs1:grai)	gs1:ReturnableAsset
8004 (gs1:giai)	gs1:IndividualAsset
8006 (gs1:itip)	gs1:IndividualTradeItemPiece
8010 (gs1:cpid)	gs1:Component
8013 (gs1:gmn)	gs1:ProductModel
8017 (gs1:gsrnp)	gs1:ServiceProvider~~, gs1:ServiceInstance~~
8018 (gs1:gsrn)	gs1:ServiceRecipient~~, gs1:ServiceInstance~~
8019 (gs1:srin)	gs1:ServiceInstance

Flowcharts S3 and S4 explain the logic for inferring semantic classes and how to construct the associated RDF triples [RDF], with reference to Table 'classSemantics'.

Flowchart S3 checks whether the table 'classSemantics' has an entry for the primary GS1 identification key, then references Flowchart S4 for construction of RDF triples.



Flowchart S4 explains how to construct RDF triples that express what class of thing is identified by the GS1 Digital Link URI, e.g. is it a gs1:Product, a gs1:Shipment, a gs1:Party etc.?

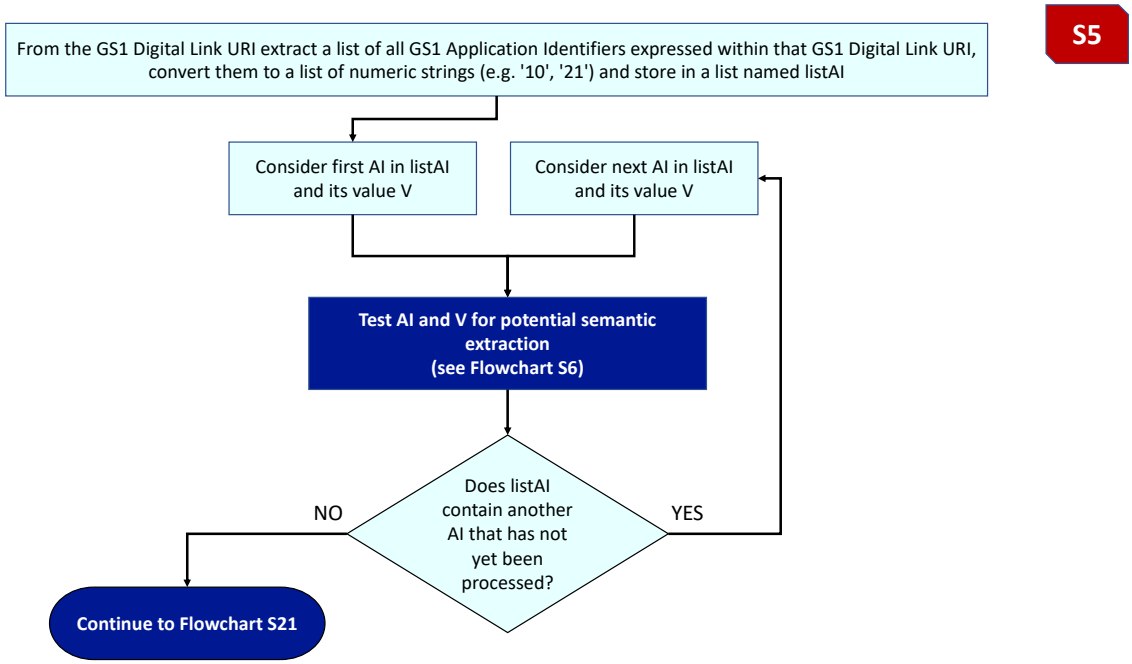


3.7.3 Extract further relationships expecting data values

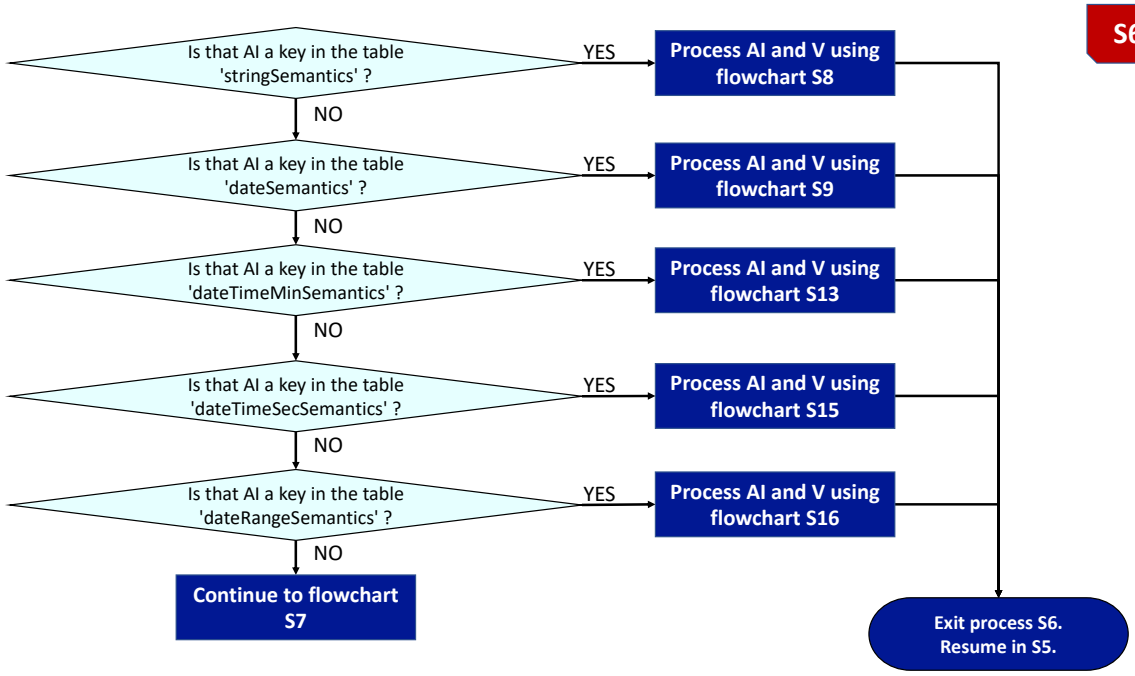
Many GS1 Application Identifiers express data values about specific identified things. These include data such as net weight, gross weight, dimensions, date of production, expiry date etc. The following subsections explain how to extract further semantic relationships from such AIs, depending on the type and format of their value.

As shown in Flowchart S5, the first step is to convert a GS1 Digital Link URI into a table that maps each GS1 Application Identifier present within the GS1 Digital Link URI to its value, then use Flowchart S6 and its dependent flowcharts (S7 to S20) to perform appropriate reformatting of the value so that it is in a suitable format for use in a Linked Data RDF triple for expressing the semantic relationship.

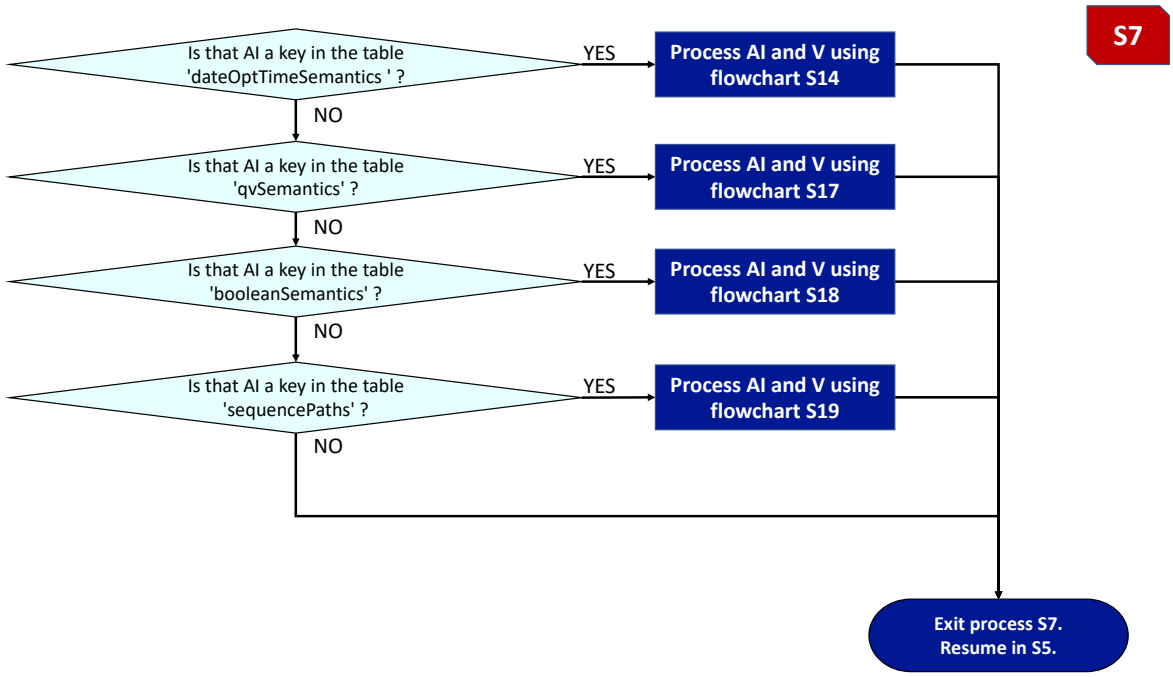
Flowchart S5 represents the main processing loop for semantic interpretation of a set of GS1 Application Identifiers and their values, referencing Flowchart S6 and its dependents for further details.



Flowchart S6 references other flowcharts to prepare RDF triples for GS1 Application Identifiers whose values correspond to specific data types



Flowchart S7 is a continuation of Flowchart S6 and references other flowcharts to handle data types not already handled in Flowchart S6



3.7.3.1 Properties expecting string values

Table 'stringSemantics' provides mappings between GS1 Application Identifiers that expect a plain string value, usually an alpha-numeric identifier, and corresponding existing (and future) properties in the GS1 Web vocabulary that also expect an xsd:string value.

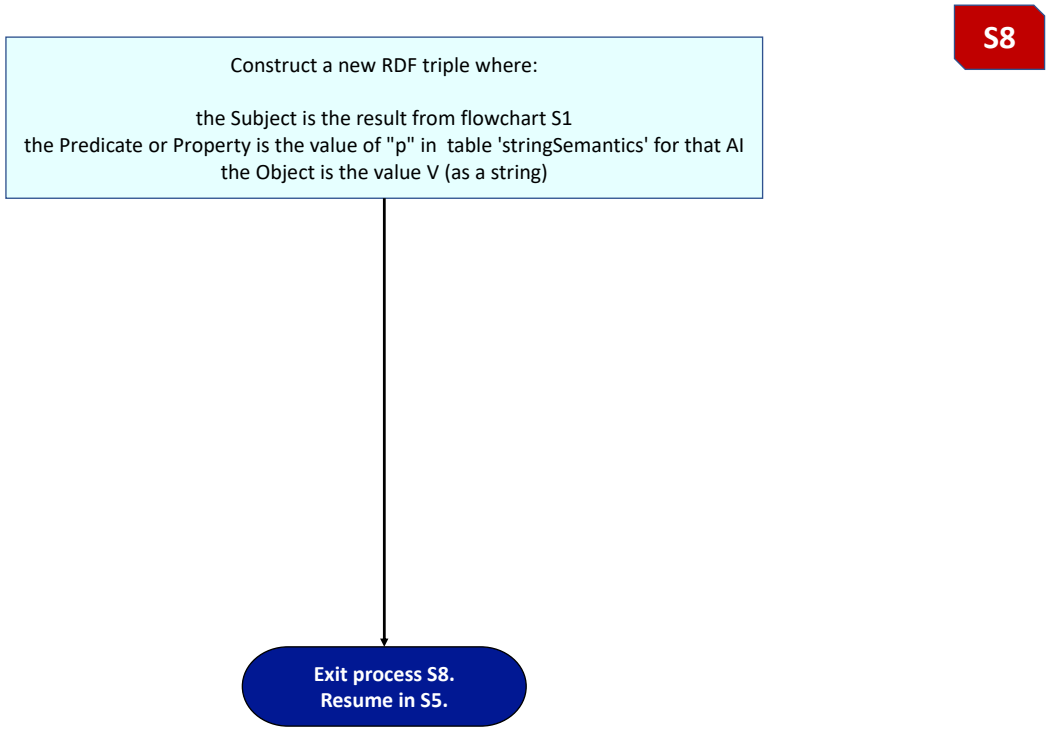
Table 'stringSemantics' – GS1 Application Identifiers and their corresponding properties that expect a plain string value

GS1 Application Identifier	Corresponding property	Explanation
00	`gs1:sscc`	Serial Shipping Container Code
01	`gs1:gtin , schema:gtin`	Global Trade Item Number
10	`gs1:hasBatchLotNumber`	Batch or Lot Number
21	`gs1:hasSerialNumber`	Serial Number for GTIN (manufacturer-assigned)
22	`gs1:consumerProductVariant`	Consumer Product Variant (CPV)
235	`gs1:hasThirdPartyControlledSerialNumber`	Third-party controlled serialised extension to GTIN (assigned by third party)

GS1 Application Identifier	Corresponding property	Explanation
253	**gs1:gdti**	Global Document Type Identifier (GDTI)
254	**gs1:hasGLNextension**	Global Location Number extension component
255	**gs1:gcn**	Global Coupon Number (GCN)
401	**gs1:ginc**	Global Identification Number for Consignment (GINC)
402	**gs1:gsin**	Global Shipment Identification Number (GSIN)
403	**gs1:routingCode**	Routing Code
414	**gs1:locationGLN**	Global Location Number for a physical location
417	**gs1:partyGLN**	Global Location Number for a party or organization
4320	**gs1:serviceCodeDescription**	Service Code Description
8003	**gs1:grai**	Global Returnable Asset Identifier (GRAI)
8004	**gs1:giai**	Global Individual Asset Identifier (GIAI)
8006	**gs1:itip**	Identification of an individual trade item piece (ITIP)
8010	**gs1:cpid**	Component/part identifier (CPID)
8011	**gs1:hasCPIDSerialNumber**	Component/Part Identifier serial number
8013	**gs1:gmn**	Global Model Number (GMN)
8017	**gs1:gsrnp**	Global Service Relation Number – Provider (GSRN-P)
8018	**gs1:gsrn**	Global Service Relation Number – Recipient (GSRN)

GS1 Application Identifier	Corresponding property	Explanation
8019	`gs1:srin`	Service Relation Instance Number (SRIN)

Flowchart S8 explains how to construct RDF triples for properties that expect a string value



3.7.3.2 Properties expecting date values

Table 'dateSemantics' provides mappings between GS1 Application Identifiers that expect a date value formatted as YYMMDD and corresponding (future) properties in the GS1 Web vocabulary that expect a value cast as an xsd:date.

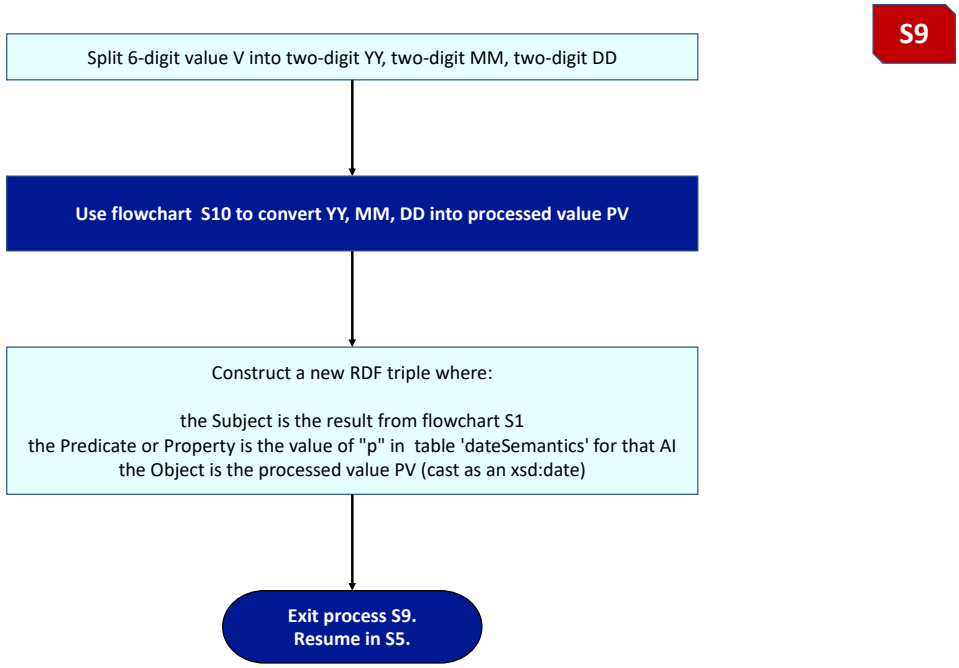
Table 'dateSemantics' – GS1 Application Identifiers and their corresponding properties that expect a date value

GS1 Application Identifier	Corresponding property	Explanation
11	gs1:productionDate	Date of Production
12	gs1:dueDate	Due date (for payment of invoice)
13	gs1:packagingDate	Packaging date
15	gs1:bestBeforeDate	Best before date
16	gs1:sellByDate	Sell by date
17	gs1:expirationDate	Expiration date
4325	gs1:releaseDate	Release date

GS1 Application Identifier	Corresponding property	Explanation
7006	gs1:firstFreezeDate	First freeze date

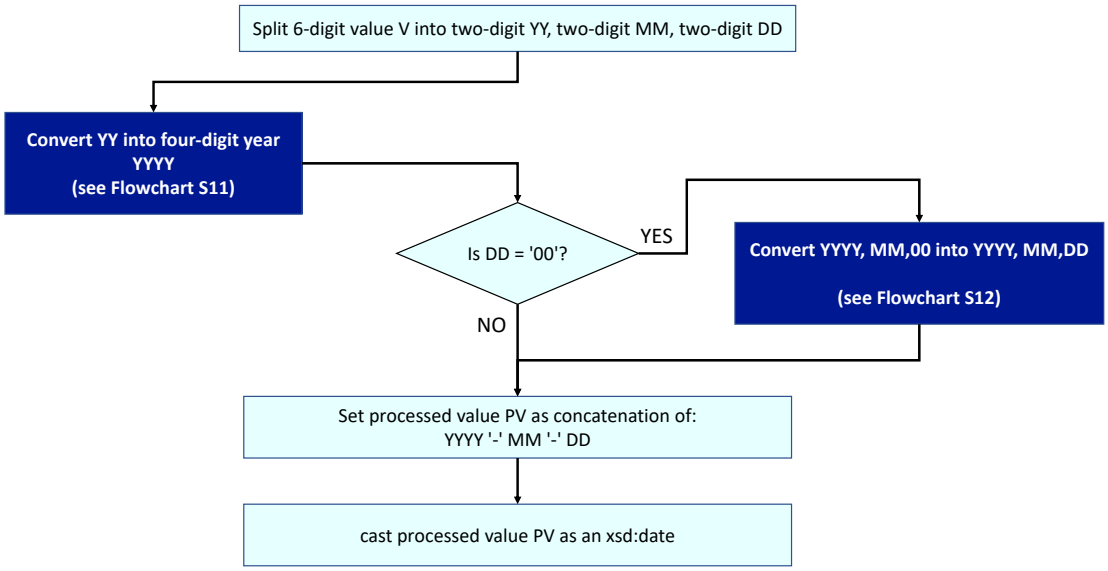
Flowcharts S9, S10, S11 and S12 explain the logic for reformatting a date from format YYMMDD into an xsd:date value. Flowchart S11 handles correct conversion of a two-digit year YY into a four-digit YYYY value. Flowchart S12 handles conversion of a two-digit date expressed as '00' to mean "last day of the month" to the corresponding actual DD, considering the values of MM and YYYY.

Flowchart S9 explains how to construct RDF triples for YYMMDD date values that correspond to xsd:date values



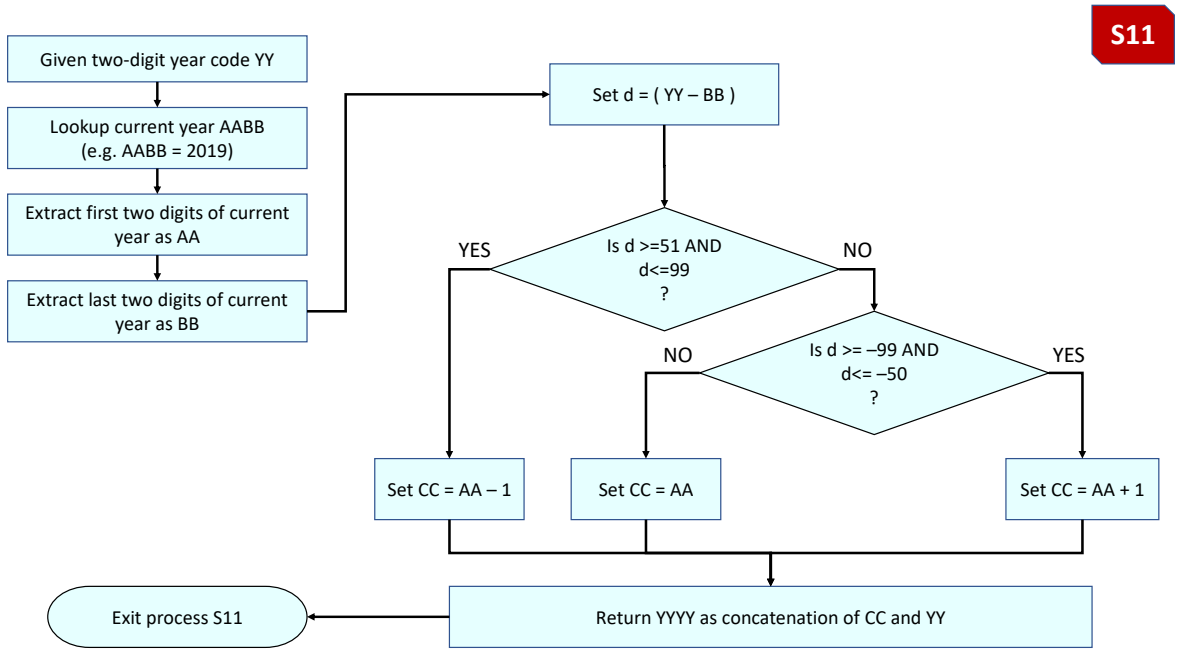
Flowchart S10 explains how to convert a six-digit date value (YYMMDD) into an xsd:date value.

S10

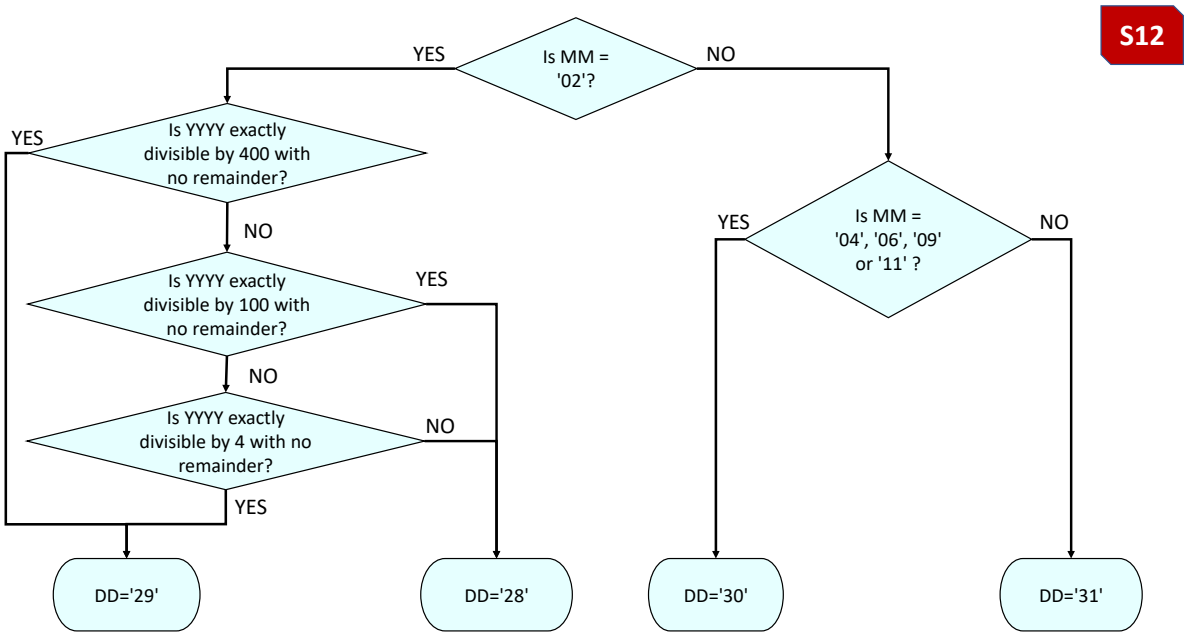


Flowchart S11 explains how to correctly interpret a two-digit year (YY) value as a four-digit year (YYYY) value, according to GS1 rules.

S11



Flowchar S12 explains how to determine the maximum days in a month in situations where the value of the month component within the value of the GS1 Application Identifier is expressed as '00'



3.7.3.3 Properties expecting dateTime values with minute granularity

Table 'dateTimeMinSemantics' and 'dateOptTimeSemantics' list the GS1 Application Identifier that expresses date values to granularity in minutes. Flowcharts S13 and S14 explain how to convert that YYMMDDhhmm value into an xsd:dateTime value suitable for use with Linked Data RDF triples.

Table 'dateTimeMinSemantics' – GS1 Application Identifiers and their corresponding properties that expect a dateTime value with minute granularity

GS1 Application Identifier	Corresponding property	Explanation
7003	gs1:expirationDateTime	Expiration date and time

Flowchart S13 explains how to prepare RDF triples for a date/time value with a granularity of one minute.

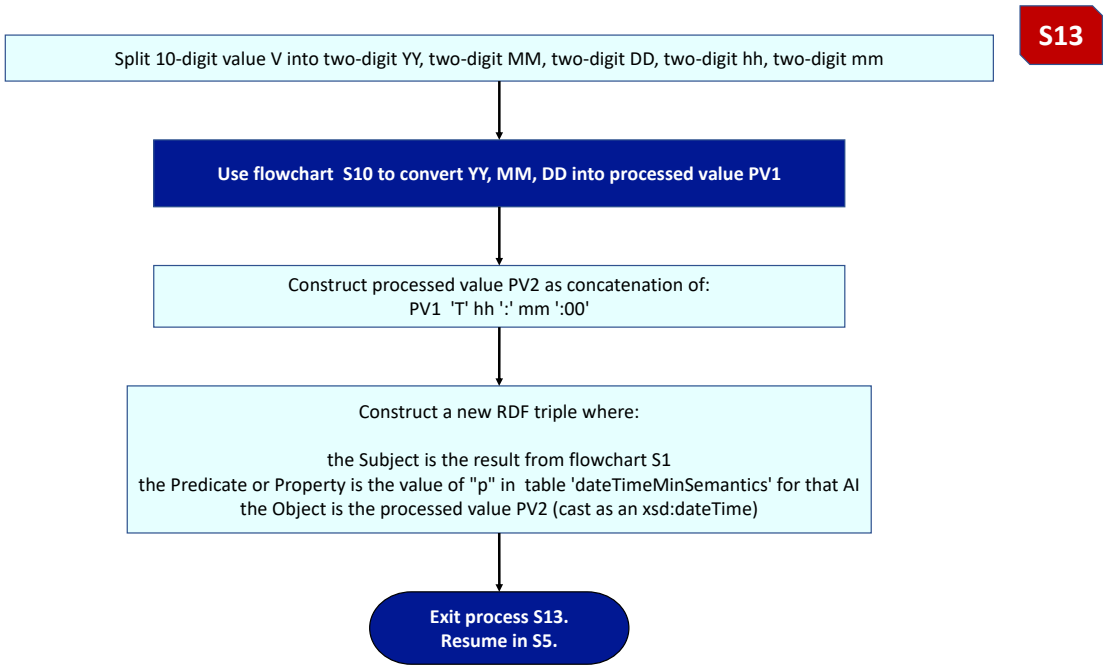
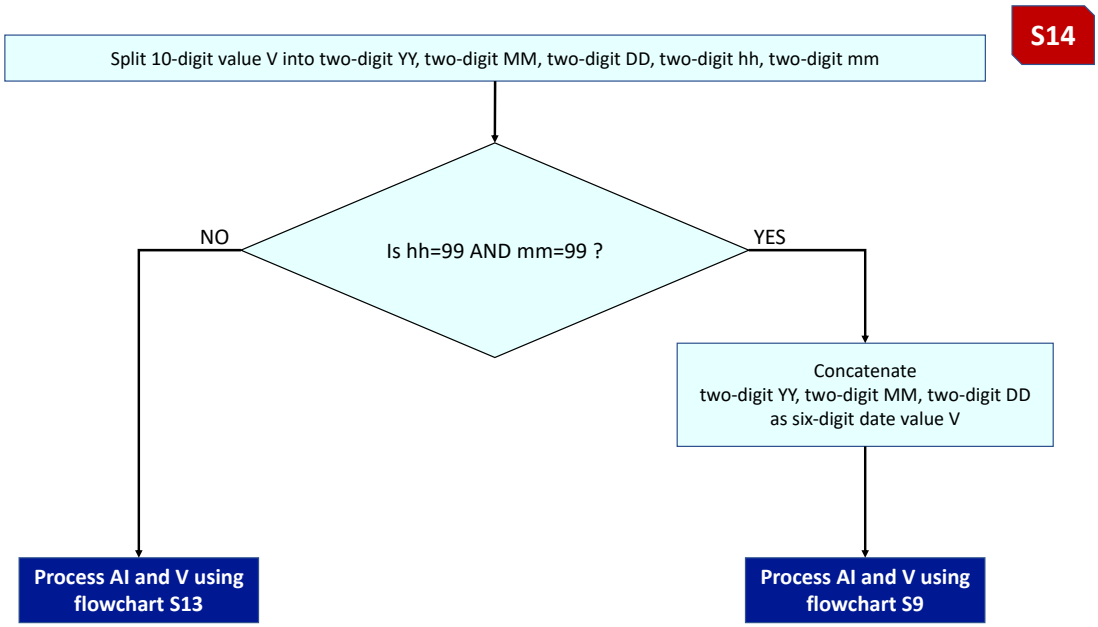


Table 'dateOptTimeSemantics' - GS1 Application Identifiers and their corresponding properties that expect a dateTime value with minute granularity in which the time (hh:mm) may be unspecified as '9999' within the value of the GS1 Application Identifier.

GS1 Application Identifier	Corresponding property	Explanation
4324	gs1:deliverNotBeforeDateTime	Not before delivery date/time
4325	gs1:deliverNotAfterDateTime	Not after delivery date/time

Flowchart S14 explains how to construct RDF triples for GS1 Application Identifiers that express a date/time to a granularity of one minute, where the time component may be omitted.



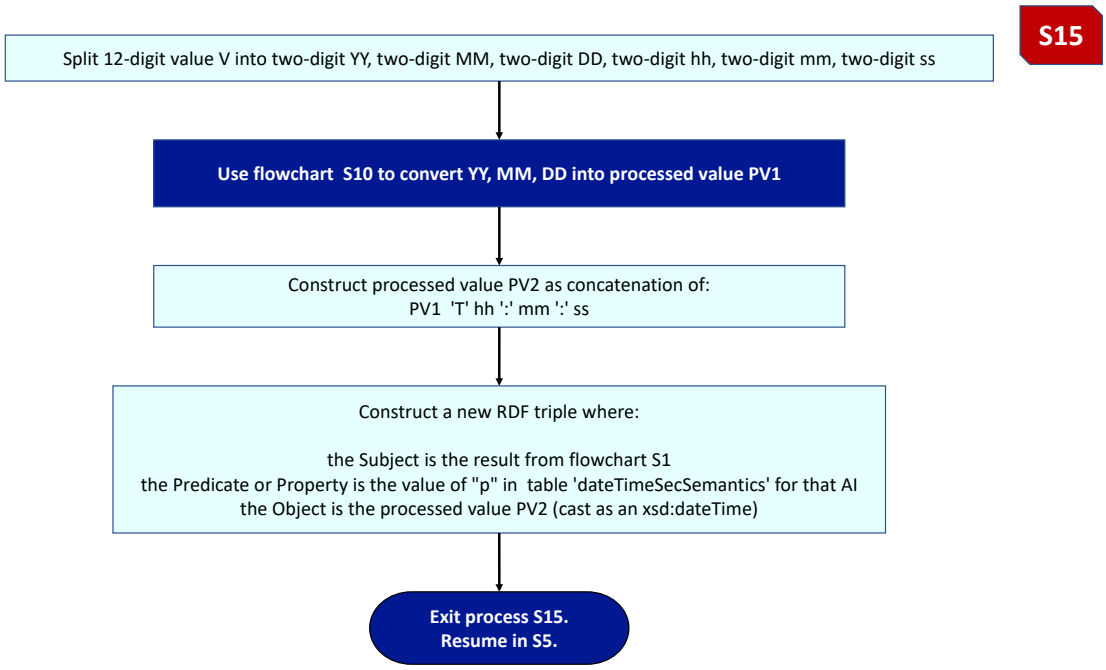
3.7.3.4 Properties expecting dateTime values with second granularity

Table 'dateTimeSecSemantics' lists the GS1 Application Identifier that expresses date values to granularity in seconds. Flowcharts S15 and S10 explain how to convert that YYMMDDhhmmss value into an xsd:dateTime value suitable for use with Linked Data RDF triples.

Table 'dateTimeSecSemantics' – GS1 Application Identifiers and their corresponding properties that expect a dateTime value with one second granularity

GS1 Application Identifier	Corresponding property	Explanation
8008	gs1:productionDateTime	Date and time of production

Flowchart S15 explains how to prepare RDF triples for date/time values with granularity of one second.



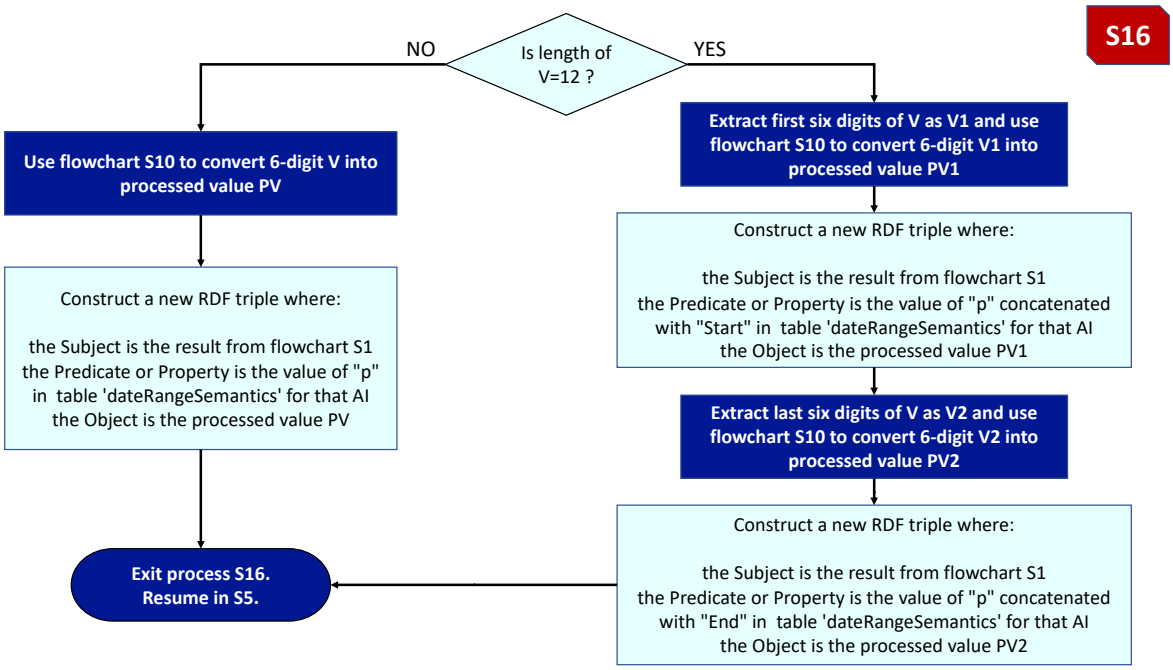
3.7.3.5 Properties related to date ranges

Table 'dateRangeSemantics' lists the GS1 Application Identifier that expresses a date or a date range. Flowcharts S16 and S10 explain how to convert that value from format YYMMDD or YYMMDDYYMMDD into an xsd:dateTime value suitable for use with Linked Data RDF triples. Note that where a date range is expressed via a 12-digit value formatted as YYMMDDYYMMDD, additional properties are defined to express the start and end of the date range.

Table 'dateRangeSemantics' – GS1 Application Identifiers and their corresponding properties that expect a date or date range

GS1 Application Identifier	Correponding property	Required matching format of value
7007	gs1: harvestDate	YYMMDD
	gs1: harvestDateStart	**YYMMDD**YYMMDD
	gs1: harvestDateEnd	YYMMDD**YYMMDD**

Flowchart S16 explains how to construct RDF triples when the GS1 Application Identifier may correspond to a single date value or to a date range expressing a start and end date.



3.7.3.6 Properties expecting quantitative values (value and unit code)

Table 'qvSemantics' below lists GS1 Application Identifiers whose values correspond to quantitative values (gs1:QuantitativeValue, schema:QuantitativeValue) that have a numeric floating-point value and an associated unit code, expressed using the appropriate UN ECE Recommendation 20 unit code. Note that unlike the previous tables, the first column of table 'qvSemantics' expresses a range of GS1 Application Identifiers. For example, considering the first row, 310*n* corresponds to GS1 Application Identifiers 3100, 3101, 3102, 3103, 3104 and 3105 since *n* takes values in the range 0 through 5. The value of the fourth digit (*n*) is meaningful and is used to indicate that the 6-digit value NNNNNN of that GS1 Application Identifier should be divided by 10^n in order to reach the actual value. Note also that several ranges of GS1 Application Identifier correspond to the same semantic property but differ in the unit code associated with each range. For example, 310*n*, 320*n*, 356*n*, 357*n* all correspond to net weight.

Flowchart S17 explains the logic for converting the 6-digit numeric value of the corresponding GS1 Application Identifier into a class (of type gs1:QuantitativeValue or schema:QuantitativeValue) that expresses the numeric value and unit code.

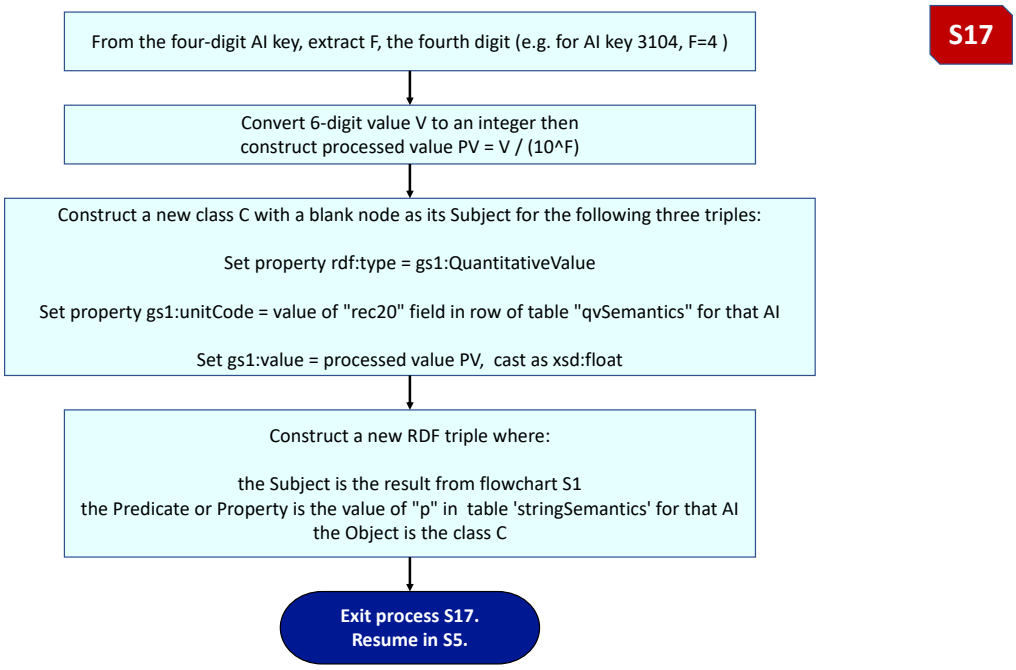
Table 'qvSemantics' – GS1 Application Identifiers and their corresponding properties that expect a quantitive value, comprising a numeric value and an associated unit code.

GS1 Application Identifier range (where *n* = 0 through 5)	Corresponding property	UN ECE Recommendation 20 unit code
310*n*	gs1:netWeight	KGM
320*n*	gs1:netWeight	LBR
356*n*	gs1:netWeight	APZ
357*n*	gs1:netWeight	ONZ
330*n*	gs1:grossWeight	KGM
340*n*	gs1:grossWeight	LBR
315*n*	gs1:netContent	LTR

GS1 Application Identifier range (where *n* = 0 through 5)	Corresponding property	UN ECE Recommendation 20 unit code
316*n*	gs1:netContent	MTQ
360*n*	gs1:netContent	QT
361*n*	gs1:netContent	GLL
365*n*	gs1:netContent	FTQ
364*n*	gs1:netContent	INQ
366*n*	gs1:netContent	YDQ
335*n*	gs1:grossVolume	LTR
336*n*	gs1:grossVolume	MTQ
368*n*	gs1:grossVolume	FTQ
367*n*	gs1:grossVolume	INQ
369*n*	gs1:grossVolume	YDQ
363*n*	gs1:grossVolume	GLL
362*n*	gs1:grossVolume	QT
328*n*	gs1:outOfPackageDepth	FOT
327*n*	gs1:outOfPackageDepth	INH
313*n*	gs1:outOfPackageDepth	MTR
329*n*	gs1:outOfPackageDepth	YRD
348*n*	gs1:inPackageDepth	FOT
347*n*	gs1:inPackageDepth	INH
333*n*	gs1:inPackageDepth	MTR
349*n*	gs1:inPackageDepth	YRD
322*n*	gs1:outOfPackageLength	FOT
321*n*	gs1:outOfPackageLength	INH
311*n*	gs1:outOfPackageLength	MTR
323*n*	gs1:outOfPackageLength	YRD
342*n*	gs1:inPackageLength	FOT
341*n*	gs1:inPackageLength	INH
331*n*	gs1:inPackageLength	MTR
343*n*	gs1:inPackageLength	YRD
325*n*	gs1:outOfPackageWidth	FOT
324*n*	gs1:outOfPackageWidth	INH
312*n*	gs1:outOfPackageWidth	MTR
326*n*	gs1:outOfPackageWidth	YRD
345*n*	gs1:inPackageWidth	FOT
344*n*	gs1:inPackageWidth	INH
332*n*	gs1:inPackageWidth	MTR

GS1 Application Identifier range (where *n* = 0 through 5)	Corresponding property	UN ECE Recommendation 20 unit code
346*n*	gs1:inPackageWidth	YRD
351*n*	gs1:netArea	FTK
350*n*	gs1:netArea	INK
314*n*	gs1:netArea	MTK
352*n*	gs1:netArea	YDK
354*n*	gs1:grossArea	FTK
353*n*	gs1:grossArea	INK
334*n*	gs1:grossArea	MTK
355*n*	gs1:grossArea	YDK
337*n*	gs1:massPerUnitArea	28

Flowchart S17 explains how to prepare RDF triples when the GS1 Application Identifier corresponds to a gs1:QuantitativeValue that expresses an amount and a unit of measure code.



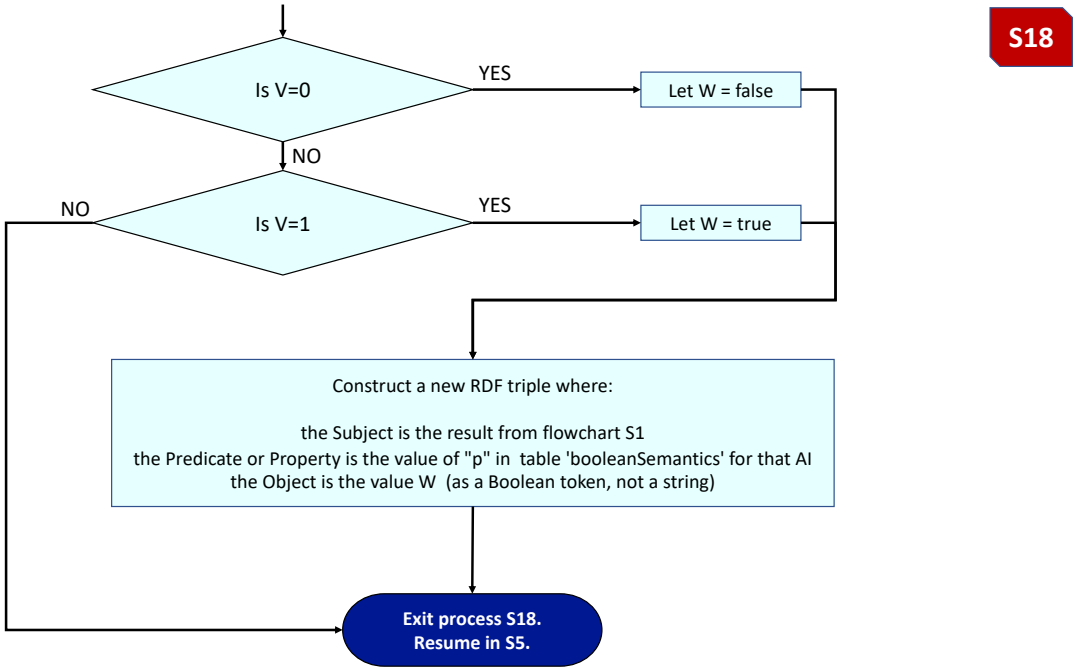
3.7.4 Properties expecting Boolean values

Table 'booleanSemantics' lists the GS1 Application Identifier that expresses a Boolean value. Flowchart S18 explains how to convert the encoded value '0' or '1' to a boolean value.

Table 'booleanSemantics' – GS1 Application Identifiers and their corresponding properties that expect a Boolean value

GS1 Application Identifier	Correponding property	Required matching format of value
4321	gs1:dangerousGoods	0 or 1
4322	gs1:authorityToLeave	0 or 1
4323	gs1:signatureRequired	0 or 1

Flowchart S18 explains how to convert numeric values 0 (false) or 1 (true) into Boolean tokens, false or true for use in RDF triples.



3.7.4.1 Application Identifiers corresponding to hierarchical sequences of properties

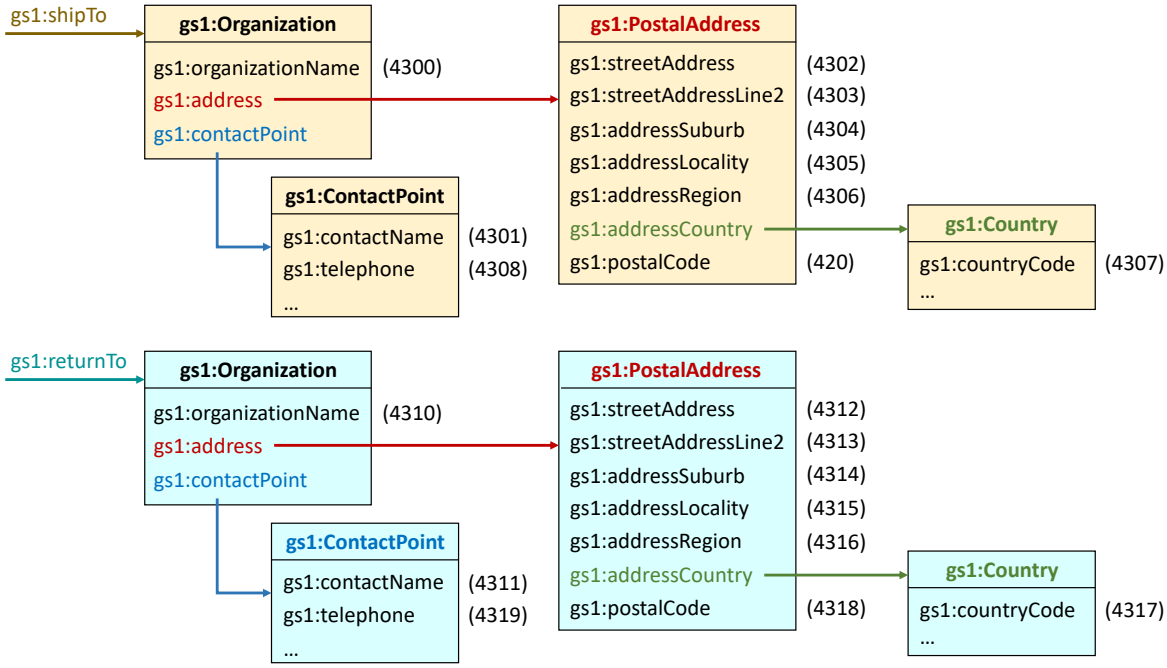
GS1 Application Identifiers 420 and 4300-4308 express 'ship-to / deliver-to' address details for a logistic unit identified by an SSCC. GS1 Application Identifiers 4310-4319 express 'return-to' details for a logistic unit identified by an SSCC.

The GS1 Web vocabulary and schema.org support various attributes for postal addresses and contact point information (e.g. telephone numbers) within the gs1:PostalAddress and gs1:ContactPont class or within schema:PostalAddress and schema:ContactPoint, as shown below in Figure 3-2.

In Linked Data (e.g. using the GS1 Web vocabulary or schema.org) there is no need to define two distinct attributes or properties, one for 'ship-to Organization Name' and the other for 'return-to Organization Name'. Instead, the preference is to define a 'ship-to / deliver-to' property and a 'return-to' property so that these can point to a PostalAddress or ContactPoint class and the attributes or properties defined within it, such as gs1:organizationName, gs1:streetAddress .

Unfortunately, GS1 Application Identifiers within element strings cannot easily express this kind of hierarchical data structure, so it was necessary to define pairs of Application Identifiers for each of the address/contact fields, one AI within each pair expressing the 'ship-to / deliver-to' value, the other AI expressing the corresponding 'return-to' value.

Figure 3-2 - How some GS1 Application Identifiers correspond to hierarchical property relationships



Flowcharts S19 and S20 explain how to construct a hierarchical set of RDF triples when GS1 Application Identifiers correspond to such sequence paths of properties as shown in Figure 3-2.

In Table 'sequencePaths', the second column shows the property sequence path, aligning with the notation used in SPARQL to express a hierarchical sequence of properties, using the forward slash character ('/') as the separator character.
For example, gs1:shipTo/gs1:organizationName means 'navigate through gs1:shipTo (to find the ship-to/deliver-to organization), then use the gs1:organizationName property to find the organization name for the ship-to organization'.

As a more complex example, gs1:returnTo/gs1:address/gs1:postalCode means 'navigate through gs1:returnTo (to find the return-to organization), then use the gs1:address property to find its postal address, then use the gs1:postalCode property to find the value of its postal code'.

Note that the forward slash does not indicate alternation or a logical OR operator. In this sequence path notation, forward slash is strictly a path separator in a hierarchical sequence of properties; gs1:shipTo/gs1:organizationName means gs1:shipTo THEN gs1:organizationName.

The GS1 Web vocabulary defines rdfs:range values for the properties gs1:shipTo , gs1:returnTo , gs1:address, gs1:contactPoint and gs1:addressCountry. These indicate the type of class expected for the value, as shown in the table 'propertyRanges' below:

Table 'propertyRanges' – showing rdfs:range value for some specific properties in the GS1 Web vocabulary.

Property	rdfs:range (the value is expected to be of this class)
gs1:shipTo	gs1:Organization
gs1:returnTo	gs1:Organization
gs1:address	gs1:PostalAddress (connects a gs1:Organization to a gs1:PostalAddress)
gs1:contactPoint	gs1:ContactPoint (connects a gs1:Organization to a gs1:ContactPoint)
gs1:addressCountry	gs1:Country (connects a gs1:PostalAddress to a gs1:Country)

For this reason, it is not necessary to indicate the classes within the sequence paths of properties but software that performs semantic interpretation of GS1 Digital Link URIs that involve GS1 Application Identifiers (420) or (4300)-(4319) should use the table above to specify the class type correctly, as explained in Flowchart S21.

GS1 Application Identifiers 4300-4306 and 4310-4316 also support encoding of non-Latin characters and the space character through the use of percent-encoding as defined in RFC 3986, including the use of '+' as a shorthand for %20, encoding the literal space character. Extraction of semantics for these AIs therefore needs to support percent-decoding of values to correctly reinstate any non-Latin characters or space characters. This is also mentioned in Flowchart S21.

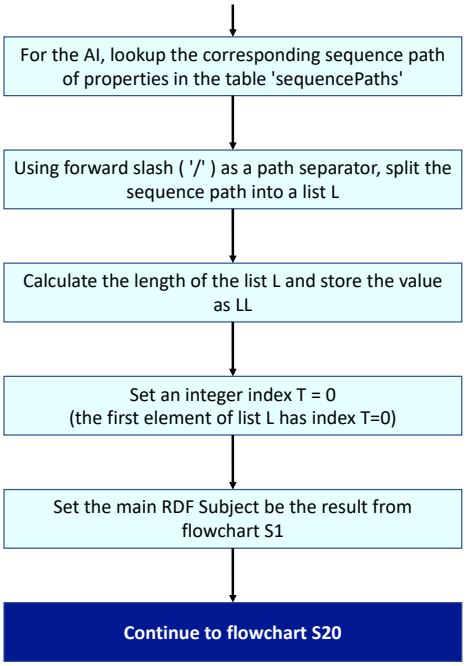
For each of these GS1 Application Identifiers that support encoding of non-Latin characters and the space character, the final property in the property sequence path expects an rdf:langString (a language-tagged string). Unfortunately, at the time of writing, no GS1 Application Identifier has been defined to indicate the human-language used for the ship-to/deliver-to address or the return-to address, so it is not possible to automatically infer which language tag/code to use when expressing the value.

Table 'sequencePaths' – GS1 Application Identifiers that correspond to hierarchical sequences of properties

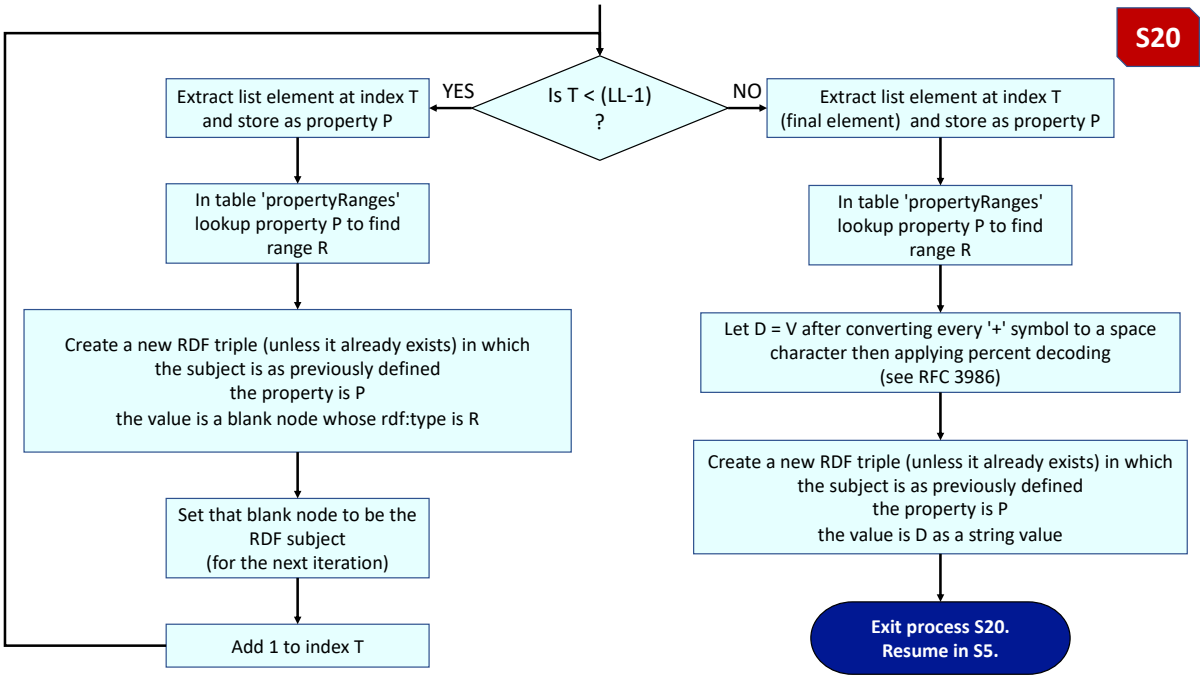
GS1 Application Identifier	Corresponding property sequence path	Supports non-Latin characters and space	Explanation
4300	gs1:shipTo/gs1:organizationName	Y	Company name of the Ship-to/Deliver-to receipient
4301	gs1:shipTo/gs1:contactPoint/gs1:contactName	Y	Ship-to/Deliver-to contact name
4302	gs1:shipTo/gs1:address/gs1:streetAddress	Y	Ship-to/Deliver-to street address line 1
4303	gs1:shipTo/gs1:address/gs1:streetAddressLine2	Y	Ship-to/Deliver-to street address line 2
4304	gs1:shipTo/gs1:address/gs1:addressSuburb	Y	Ship-to/Deliver-to suburb
4305	gs1:shipTo/gs1:address/gs1:addressLocality	Y	Ship-to/Deliver-to locality
4306	gs1:shipTo/gs1:address/gs1:addressRegion	Y	Ship-to/Deliver-to region
4307	gs1:shipTo/gs1:address/gs1:addressCountry/gs1:countryCode	N	Ship-to/Deliver-to country code
420	gs1:shipTo/gs1:address/gs1:postalCode	N	Ship-to/Deliver-to postal code
4308	gs1:shipTo/gs1:contactPoint/gs1:telephone	N	Ship-to/Deliver-to phone number
4310	gs1:returnTo/gs1:organizationName	Y	Return-to company name
4311	gs1:returnTo/gs1:contactPoint/gs1:contactName	Y	Return-to contact name

GS1 Application Identifier	Corresponding property sequence path	Supports non-Latin characters and space	Explanation
4312	gs1:returnTo/gs1:address/gs1:streetAddress	Y	Return-to street address line 1
4313	gs1:returnTo/gs1:address/gs1:streetAddressLine2	Y	Return-to street address line 2
4314	gs1:returnTo/gs1:address/gs1:addressSuburb	Y	Return-to suburb
4315	gs1:returnTo/gs1:address/gs1:addressLocality	Y	Return-to locality
4316	gs1:returnTo/gs1:address/gs1:addressRegion	Y	Return-to region (state/county)
4317	gs1:returnTo/gs1:address/gs1:addressCountry/gs1:countryCode	N	Return-to country code
4318	gs1:returnTo/gs1:address/gs1:postalCode	N	Return-to postal code
4319	gs1:returnTo/gs1:contactPoint/gs1:telephone	N	Return-to phone number

Flowcharts S19 explains the logic for handling situations where a GS1 Application Identifier corresponds to a hierarchical sequence path of properties and how to split this into a list of properties



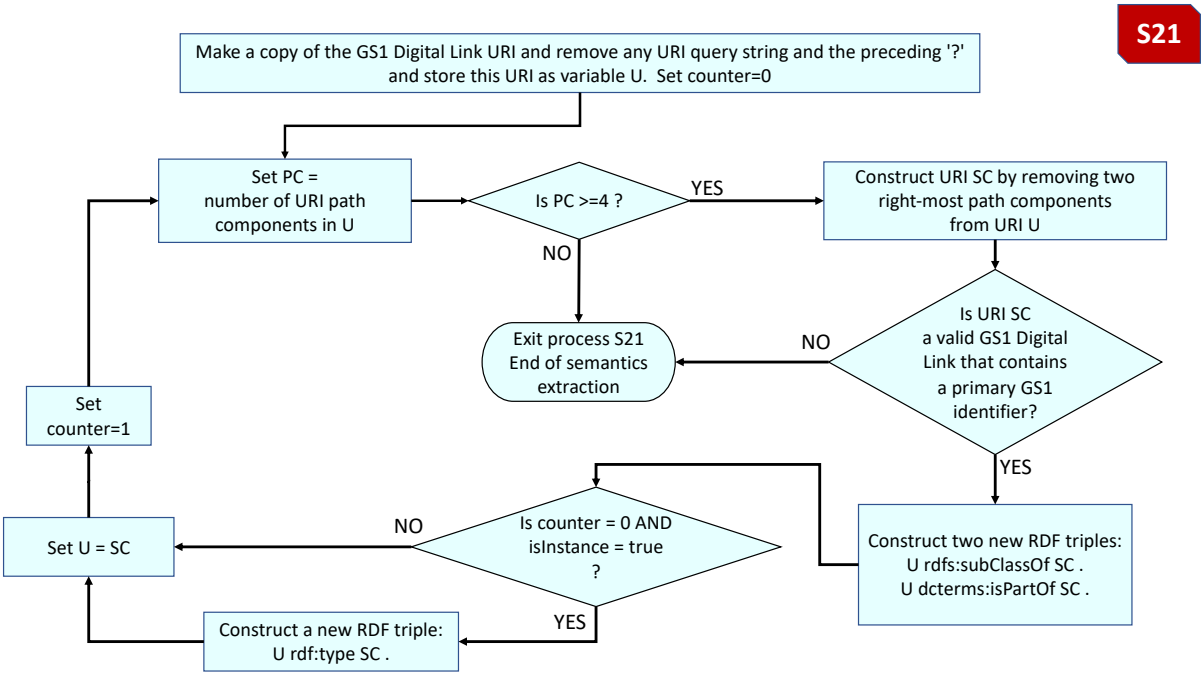
Flowchart S20 explains how to construct RDF triples for a hierarchical sequence of properties



3.7.5 Extract subclass relationships

The URI path information of a GS1 Digital Link URI contains hierarchical information such that successive path components result in increasingly finer levels of granularity of identification. Semantically each successive pair of path components beyond the pair that corresponds to the primary GS1 identification key expresses a subclass or a subclass of a subclass, etc.

Flowchart S21 explains the logic for extraction of subclass relationships from a GS1 Digital Link URI.



3.8 Data Types

In order to complete the semantic interpretation of the GS1 system of identifiers, it is necessary to define two data types. The underlying semantics for both data types are defined in the GS1 General Specifications [GENSPECS].

Data of type `gs1:AI` is a GS1 Application Identifier such as "01" for GTIN, "10" for batch/lot etc. Although they are all numeric, they are strings, not integers. Each AI has an associated value space that typically restricts the characters that can be used, the length and, in some cases a checkbit. The full list of AIs is maintained at *https://www.gs1.org/standards/barcodes/application-identifiers*.

Data of type `gs1:ElementString` is a sequence of one or more GS1 Application Identifiers and their values in human-readable format. AIs are shown in parentheses followed by their value, for example (01)09506000134376(17)211200(10)ABC(21)123456. Note that in this format, GTINs are *always* padded to 14 digits.

3.9 Worked examples

This subsection is informative

To explain the semantics in more detail we'll work through some examples.

3.9.1 GTIN + CPV

This Digital Link URI includes a GTIN and a consumer product variant

```
https://example.com/gtin/9520123456788/cpv/2A
```

and should be interpreted as follows:

```
<https://example.com/gtin/9520123456788/cpv/2A> a schema:Product, gs1:Product;
  rdfs:subClassOf <https://example.com/gtin/9520123456788>;
  gs1:gtin "9520123456788";
  schema:gtin "9520123456788";
  gs1:consumerProductVariant "2A";
  skos:notation "(01)09520123456788(22)2A"^^gs1:ElementString.
```

Because the primary identifier is a GTIN, this is a `schema:Product` and a `gs1:Product`

We know that this is a consumer product variant of the given GTIN and this is expressed as a sub class relationship.

The GTIN and CPV are both given directly in the Digital Link URI but there is no query string containing attributes about a product instance, therefore we can make assertions at the class level using identifiers in the URI.

3.9.2 GTIN + batch/lot + Serial number + expiry date

This Digital Link URI includes a GTIN and a serial number

```
https://example.com/gtin/9520123456788/lot/ABC/ser/00001?exp=190400
```

Importantly, this is an instance level identifier and so we can assign the attributes in the query string to the identified product instance to give the interpretation as follows:

```
<https://example.com/gtin/9520123456788/lot/ABC/ser/00001> a schema:Product,
gs1:Product;
  rdfs:subClassOf <https://example.com/gtin/9520123456788/lot/ABC>;
  dcterms:isPartOf <https://example.com/gtin/9520123456788/lot/ABC>;
  gs1:hasSerialNumber "00001";
  gs1:expirationDate "2019-04-30"^^xsd:date;
  skos:notation "(01)09520123456788(10)ABC(21)00001"^^gs1:ElementString.
```

We can further assert:

```
<https://example.com/gtin/9520123456788/lot/ABC>
  rdfs:subClassOf <https://example.com/gtin/9520123456788>;
  gs1:gtin "9520123456788";
  schema:gtin "9520123456788";
  gs1:batchLot "ABC";
  skos:notation "(01)09520123456788(10)ABC"^^gs1:ElementString.
```

3.9.3 GTIN + Measured Weight

This GS1 Digital Link URI includes a GTIN and a measured weight

```
https://example.com/gtin/952012345678?3103=000500
```

In this case, we have a query string that provides attributes of the item, its measured weight, and so we have to use a blank node to represent the product instance rather than make the obviously false assertion that all instances of this product hve the same measured weight. The semantic interpretation is therefore as follows:

```
[] a <https://example.com/gtin/9520123456788>, schema:Product, gs1:Product;
  gs1:gtin "9520123456788";
  schema:gtin "9520123456788";
  gs1:netWeight [a gs1:QuantitativeValue; gs1:unitCode "KGM"; gs1:value "0.5"];
  skos:notation "(01)09520123456788(3103)000500"^^gs1:ElementString.
```

3.9.4 SSCC and delivery address details

The following GS1 Digital Link URI includes a SSCC and delivery address details using the new GS1 Application Identifiers introduced by GS1 Scan4Transport in GS1 General Specifications v21.

```
https://example.com/00/195212342345678908?4300=Caf%C3%A9+Ni%C3%A7oise+at+GS1+AISBL&
4302=s&4305=Bruxelles&4307=BE&420=1050&4321=1&4322=0&4323=1&4324=2001180000
```

In this example, the SSCC appears within the URI path information, while the URI query string provides attributes that represent details for the delivery.

The SSCC is an instance identifier for a logistic unit. Using the logic explained in section 3.7.4.1 and flowcharts S19 and S20, the semantic interpretation is as follows in RDF Turtle:

```
@prefix gs1: <https://gs1.org/voc/> .
@prefix skos: <http://www.w3.org/2004/02/skos/core#> .
<https://example.com/00/195212342345678908> a gs1:LogisticUnit;
  gs1:sscc "195212342345678908";
  gs1:shipTo _:1;
  gs1:deliverNotBefore "2020-01-18T00:00:00";
  gs1:dangerousGoods true;
  gs1:signatureRequired true;
  gs1:authorityToLeave false;
  skos:notation "(00)195212342345678908"^^gs1:ElementString.

_:1 a gs1:Organization;
  gs1:organizationName "Café Niçoise at GS1 AISBL";
  gs1:addresss _:2.
```

```
_:2 a gs1:PostalAddress;
  gs1:streetAddress "Avenue Louise 326";
  gs1:addressLocality "Bruxelles";
  gs1:postalCode "1050";
  gs1:addressCountry _:3.

_:3 a gs1:Country;
  gs1:countryCode "BE".
```

or equivalently in JSON-LD:

```
{
  "@context": {
    "gs1":"https://gs1.org/voc/",
    "skos":"http://www.w3.org/2004/02/skos/core#"
  },
  "@id": "https://example.com/00/195212342345678908",
  "skos:notation": {
     "@value": "(00)195212342345678908",
     "@type":"gs1:ElementString"
  },
  "@type": "gs1:LogisticUnit",
  "gs1:authorityToLeave": false,
  "gs1:dangerousGoods": true,
  "gs1:deliverNotBefore": "2020-01-18T00:00:00",
  "gs1:shipTo": {
    "@type": "gs1:Organization",
    "gs1:addresss": {
      "@type": "gs1:PostalAddress",
      "gs1:addressCountry": {
        "@type": "gs1:Country",
        "gs1:countryCode": "BE"
      },
      "gs1:addressLocality": "Bruxelles",
      "gs1:postalCode": "1050",
      "gs1:streetAddress": "Avenue Louise 326"
    },
    "gs1:organizationName": "Café Niçoise at GS1 AISBL"
  },
  "gs1:signatureRequired": true,
  "gs1:sscc": "195212342345678908"
}
```

3.10 Link type semantics

GS1 defines its link types in the Web Vocabulary [WebVoc]. In terms of semantics, we define a super property of `gs1:linkType` that has a domain of `owl:Thing` and a range of `xsd:anyURI`, i.e. it is very generic. Each GS1 link type is a sub property of this and typically has further restrictions.

Where possible, the Web vocabulary includes matches to schema.org properties using the relevant SKOS vocabulary term [SKOS]. Resolvers MAY use this information to include schema.org as additional link types when exposing available links. For example, this formal relationship is asserted:

```
gs1:pip skos:broader schema:url
```

This means that when exposing the link to the product information page, the `@rel` value on that link MAY be `"gs1:pip schema:url"` since both relations apply.

4 Glossary

The glossary lists the terms and definitions that are applied in this document. Please refer to the *www.gs1.org/glossary* for the online version.

Term	Definition
Attribute	An element string that provides additional information about an entity identified with a GS1 identification key, such as batch number associated with a Global Trade Item Number (GTIN).
Brand Owner	The organisation that owns the specifications of a trade item, regardless of where and by whom it is manufactured. The brand owner is normally responsible for the management of the Global Trade Item Number (GTIN).
Consumer	Often considered as the "recipient" of the supply chain in the past, today's consumer is an active part of the supply chain and expects more data, with higher accuracy, and greater ease.
Consumer Product Variant (CPV)	An alphanumeric attribute of a GTIN assigned to a retail consumer trade item variant for its lifetime.
Data Field	A field that contains a GS1 identification key, an RCN, or attribute information
Data titles	Data titles are the abbreviated descriptions of element strings which are used to support manual interpretation of barcodes.
Dereferencing a URI	The use of an appropriate access mechanism (e.g. Web request) to perform an action on the URI's resource (e.g. to retrieve an information representation via HTTP GET or to send data to a resource via an HTTP POST operation). Dereferencing a URI is often considered synonymous with making a Web request or 'looking up' a URI on the Web.
Domain name	A domain name is an identification string that defines a realm of administrative autonomy, authority or control within the Internet. Domain names are formed by the rules and procedures of the Domain Name System (DNS). Any name registered in the DNS is a domain name. Domain names are used in various networking contexts and application-specific naming and addressing purposes. Domain names provide a abstraction layer that separates a registered name for an organisation or activity from the actual internet addresses (IP addresses) that provide its associated information services such as its Website, its e-mail server etc. The system that connects the domain names with the corresponding IP addresses is the Domain Name System (DNS).
Element string	The combination of a GS1 Application Identifier and GS1 Application Identifier data field.
GS1 Application identifier	The field of two or more digits at the beginning of an element string that uniquely defines its format and meaning.
GS1 Application identifier data field	The data used in a business application defined by one GS1 Application Identifier.
GS1 Identification key	A unique identifier for a class of objects (e.g. a trade item) or an instance of an object (e.g. a logistic unit).
GS1 key qualifier	A key qualifier is an additional attribute that is designated for use as part of a compound key (e.g., GTIN + serial number is a compound key, with the serial number being a key qualifier for the GTIN)
GS1 Resolver	A Web server that is able to understand the GS1 Digital Link URI syntax
GS1 Digital Link URI	A Web URI conforming to the GS1 Digital Link URI syntax.
Identification number	A numeric or alphanumeric field intended to enable the recognition of one entity versus another.
QR Code®	A two-dimensional matrix symbology consisting of square modules arranged in a square pattern. The symbology is characterised by a unique finder pattern located at three corners of the symbol. QR Code® symbols are read by two-dimensional imaging scanners or vision systems

Term	Definition
Resolver	A resolver connects a GS1-identified item to one or more online resources that are directly related to it. The item may be identified at any level of granularity, and the resources may be either human or machine readable. Examples include product information pages, instruction manuals, patient leaflets and clinical data, product data, service APIs, marketing experiences and more.
Retailer	An organisation engaged in the sale and distribution of products to consumers. Also includes online retailers / e-tailers
URI	Uniform Resource Identifier. A string of characters used to identify a resource. The resource may be an information resource such as a Web page or a thing in the real world, such as a physical object, person or location. URIs refer to the superset of Uniform Resource Names (URNs), Uniform Resource Locators (URLs) and Web URIs (which can function both as globally unambiguous names, while also behaving like URLs by enabling intuitive retrieval of related information via the Web).
URI path information	A path consists of a sequence of path segments separated by a slash ("/") character. A path is always defined for a URI, though the defined path may be empty (zero length). The path component contains data, usually organized in hierarchical form, that, along with data in the non-hierarchical query component, serves to identify a resource within the scope of the URI's scheme and naming authority (if any). The path is terminated by the first question mark ("?") or number sign ("#") character, or by the end of the URI.
URI query string	The query component contains non-hierarchical data that, along with data in the path component, serves to identify a resource within the scope of the URI's scheme and naming authority (if any). The query component is indicated by the first question mark ("?") character and terminated by a number sign ("#") character or by the end of the URI.
URL	Uniform Resource Locator (URL), a specific type of URI colloquially known as Web address. A URL is a URI starting with http or https .

5 Future work

GS1 Digital Link is impacted by, and has impact upon, several other GS1 standards. The bulk of the changes in this version of Digital Link: Semantics have been driven by the introduction of new application identifiers in other standards (especially S4T). Since it is GS1 Digital Link that exposes the semantics of the GS1 system to external information systems, this document needs to reflect those additions. We therefore expect relatively frequent updates. Furthermore, many long-standing AIs have not yet been incorporated into this work. Again, this points to the need for more updates to this document and related updates to the GS1 Web Vocabulary in the relatively near future. The authors welcome input that can help to prioritise the future work. Offers of help are even more welcome.

6 References

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A.1 Intellectual Property

A.1.1 Introduction and Disclaimer

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A.1.2 Notices

A.1.2.1 Patents and Patent Applications of Mobilead SAS

MobiLead SAS of 1 Cour du Havre, 75008 Paris (France), the owner of the granted patent and five patent applications listed in this sub-section (for the purpose of this specific paragraph A.1.2.2, the "**Patent and patent applications**") who participated to the Work Group designing the GS1 Digital Link:Semantics Release 1.2, gave notice that they believe the Patent and patent applications contain Essential Claims for the implementation of the GS1 Digital Link: Semantics Release 1.2 as follows.

For the patent applications US 20180025195, EP 3276503 & CN 107657291, relevance is claimed for the following sections:

- 3.3 Information encoded within the URI

For the patent and if the patent applications materialise, Mobilead SAS grants a royalty free license according to the GS1 IP Policy but only as far as methods are described explicitly in the GS1 Digital Link: Semantics Standard Release 1.2. Implementations that extend in implementation what is described in GS1 Digital Link: Semantics Standard Release 1.2 can contact Mobilead SAS for licensing.

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7 Change log

Changes since GS1 Digital Link version 1.1

1. Previous versions of the GS1 DL standard were published as a single document. To enable greater flexibility and manageability of future versions, and readability of the current work, the standard was split into 4 interlinked documents.
2. Terms related to the Scan for Transport (S4T) standard added.
3. Classes and properties related to primary keys added (3.7.2).
4. Relationship with the GS1 Web Vocauary explained (2.2)
5. Data types added (3.8)