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The Global Language of Business

GS1 Digital Link Implementation Guideline (Global Edition)

Not suitable for use in North America

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Table of Contents

1 Executive Summary

GS1 Digital Link (also sometimes referred to hereafter as "**GS1 DL**") is a method by which a range of specific business objectives may be achieved:

- one data carrier can perform multiple functions, reducing the need to add further data carriers to any item;

- simpler data sharing for B2B and B2C tasks.

The technologies and standards that underpin the World Wide Web and the GS1 system are mature and well-proven. Solutions already exist that perform many of the tasks for which GS1 DL is suited. However, *only* GS1 DL is suitable for so many tasks while being based on open standards that promote interoperability across solutions.

There are several different components to the system:

- the syntax, that is, the structure of a GS1 DL Web URI, that allows complete interchangeability between the GS1 AI syntax and a URL;

- link types – the machine-readable labels attached to links that radiate out from an identified item and provide a virtual navigation menu;

- resolvers that redirect Web requests to matching resources related to a physical or digital object identified using the GS1 system.

GS1 DL does not need to be implemented as a big, single project, but can be implemented incrementally. Initial changes can be made at zero cost that lay the foundation for future developments that provide much simpler and cheaper routes to meeting more sophisticated demands in future.

2 The purpose of this document

This GS1 Digital Link Implementation Guide (Global Edition) provides guidance for retailers, brand owners, healthcare providers and solution providers on WHY and HOW to implement solutions that use and leverage GS1 Digital Link. It is not a substitute for the standard itself which is where you'll find full technical details, neither is it designed as a non-normative source of general information about the standard. A basic familiarity with the kind of thing that GS1 DL can do is assumed. Please be also reminded that implementations in the North America region should follow that region's implementation guide.

Figure 2-1 The relationship between this document and others related to GS1 DL

General information

Implementation Guide (Global Edition) (this document)

The GS1 Digital Link Standard
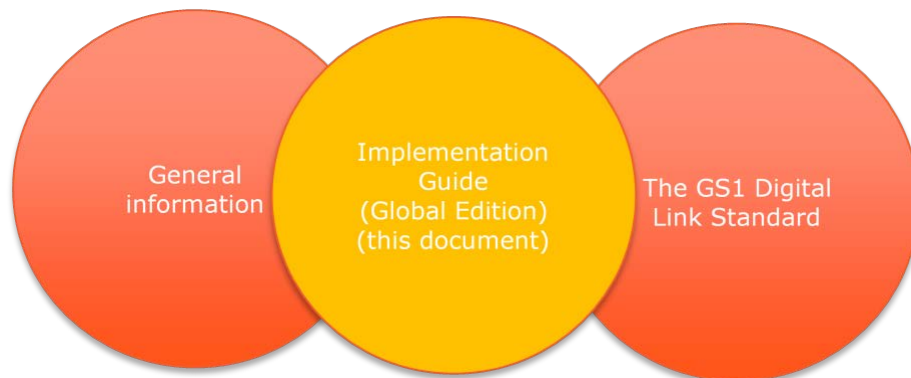
3 Introduction

GS1 Digital Link (GS1 DL) has the opportunity to transform the way in which data concerning products, shipments, companies, locations and assets passes between business partners, consumers, clinicians and more. Current labelling can become an efficient, empowering platform that enables limitless linked information, reduced data latency, and more. As with the AI-based syntax, GS1 DL syntax provides the ability to encode additional detail about a product that can then be used to serve up richer product experiences for brands, retailers, AND consumers. It is completely independent of any data carrier and has the potential to work with all barcodes as well as with RFID, NFC, and other data carriers that do not require a line of sight to be scanned.

GS1 DL has the potential to deliver a single line-of-sight barcode per product/pack that can provide value to consumers, retailers, and brands. There are equally exciting opportunities for GS1 identifiers such as those for locations, assets and shipping units too but this guide focuses particularly on trade items.

3.1.1 Advantages over existing solutions

GS1 DL does not solve individual problems for which no other solution exists. Many of the use cases for DL can be addressed simply by using more granular identification in higher capacity data carriers, and/or by existing apps. However, GS1 DL offers a unified approach to solving multiple problems at once using open standards that promote interoperability across solutions. It means that the GS1 identifier(s) on a given item are a point of entry for a network of related information and services in a way that no other single solution can offer. Moreover, that single point of entry can be used by any number of applications that address B2B and B2C needs using open or access-controlled resources, perhaps with just a smartphone without running a specialised app.

Uniquely, that same data carrier performs exactly the same *offline* functions that GS1 identifiers have done since 1974.

3.2 The benefits and value proposition of GS1 DL
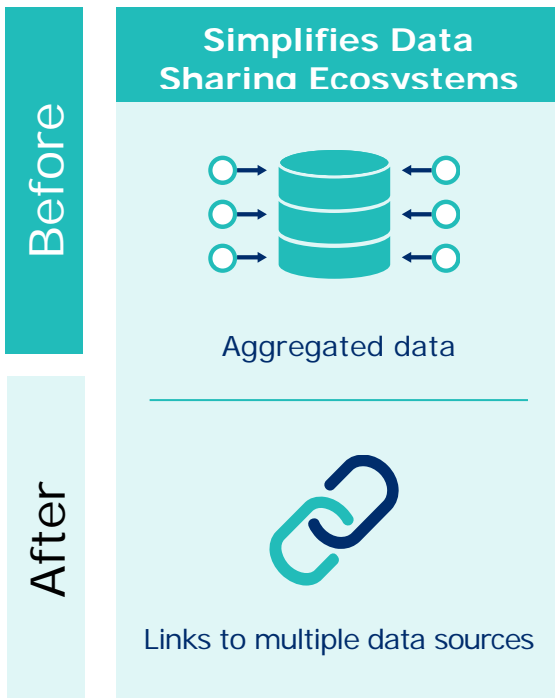
3.2.1 Multi-functional data carriers
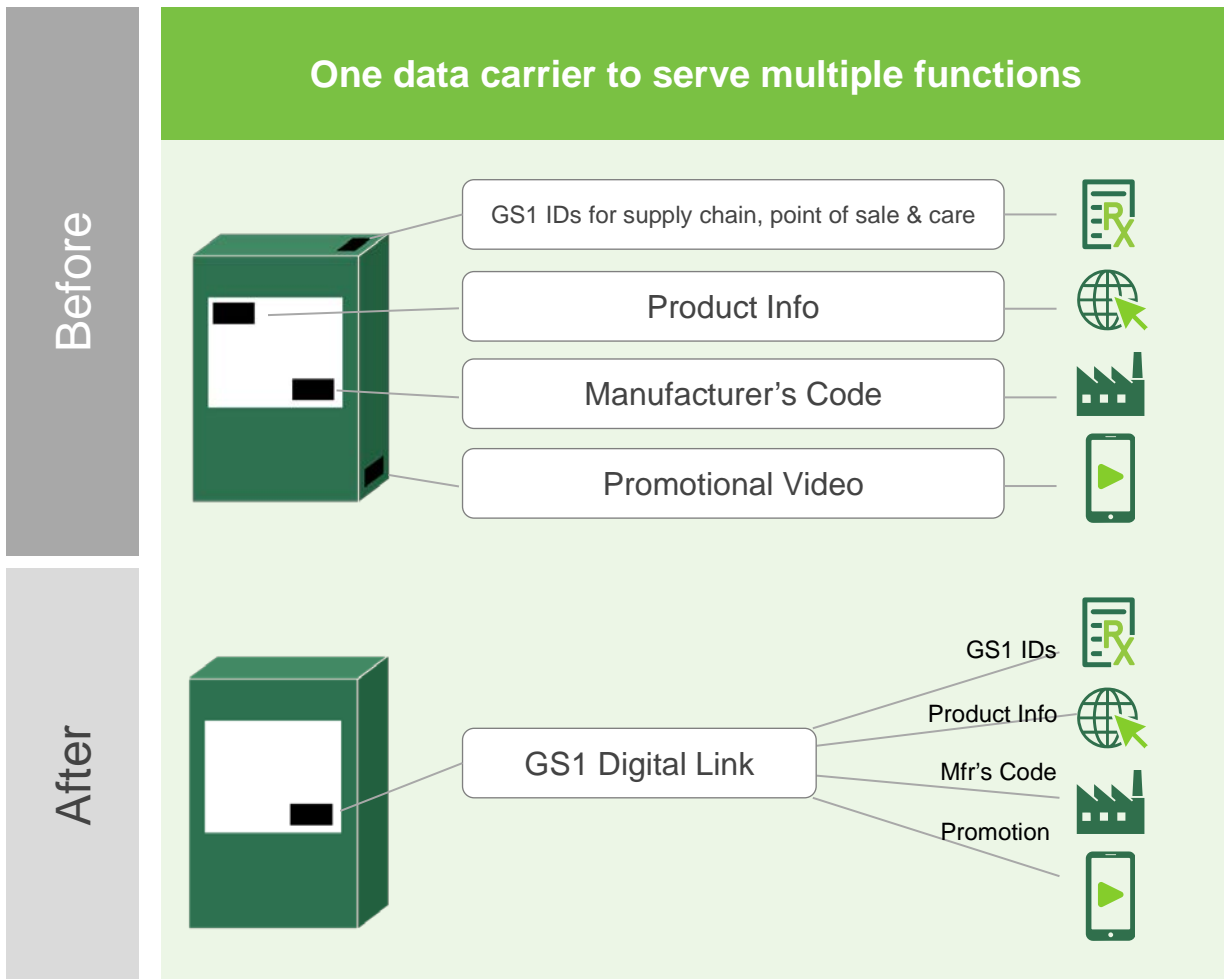
It is increasingly common to see multiple data carriers on a single item. This is because each one is placed there for a single purpose such as supply chain operations, point of sale, extended consumer information and promotional interaction. This takes up a lot of space on the pack and confuses consumers, staff and scanners. In some situations, such as a hospital operating theatre, confusion about which code should be scanned can have serious consequences.

GS1 DL enables a *single* code to perform *multiple* functions, both online and offline, reducing the need for multiple codes on a pack and has the future potential to realise a single data carrier for all functions.

These benefits are explored in more detail in section *4.3*.

3.2.2   Simpler data sharing

Before

Simplifies Data Sharing Ecosystems

Aggregated data

After

Links to multiple data sources

Barcodes and other data carriers have always been a reference to data about the identified object stored in a computer. Traditionally, this was limited to data stored specifically in the computer or computing infrastructure to which the scanner was attached.

For this reason, it's common for manufacturers to have to aggregate data, that is, make a local copy of some combination of: master data (perhaps communicated through GDSN); data managed by other business partners including supplier traceability info; information made available for regulators; information for customers (websites, apps); multimedia assets created and managed by marketing agency or agencies.

That usually means that data has to be harmonised in some way and managed according to a single process. It can be a full-time task – perhaps several people's full time task – to manage aggregated data and to keep it up to date.

GS1 DL connects identified items to limitless sources of data, whether stored locally or remotely, whoever they are curated by, enabling many new possibilities in addition to the data carrier's current role in supply chain and POS tasks.

Furthermore, the GS1 DL syntax effectively provides a *common API* for multiple points on the Web making it easy to query different sources for information about the same item. For example, a retailer will provide information about their offer compared with the brand owner whose focus will be on the product.

Before

Extends Uniqueness

Class-level identical codes
on
1D labelled products

After

More granular codes possible
on all products including
batch/lot and serial no.

3.2.3 Granular identification

The EAN/UPC barcode has served industry well since 1974 but it only offers class-level identification. There is a growing demand for more data to be encoded in the data carrier such as the batch/lot, expiry date, measured weight and, in some cases, individual item level identification through serialization.

GS1 DL is applicable at all levels of identification including batch/lot and serialised level.

Such identification is possible using GS1 DL *without* having to make an online lookup, even if the identifiers are encoded in the data carrier as a Web address.

GS1 DL can be used with *any* data carrier, however, those that typically encode a URL, such as QR, NFC or non-GS1 Data Matrix, are a more natural fit. See FAQ in *6*.

Before

Removes Data Latency

01

1 Day refresh rate

After

Real time refresh

3.2.4   Reduced latency

When data is copied and aggregated, there is almost always a delay between the facts on the ground changing and copies of the data being updated. This inherent latency can mean that important updates to the data on which a business depends are not reflected with due speed.

Because GS1 DL avoids the need for data aggregation and simply points to the original source data, latency is eliminated.

3.3 How it works

3.3.1 Mature technology

Figure 3-1 GS1 DL is the intersection between two well-established domains

GS1 Digital Link

GS1 DL simply brings together the World Wide Web with the GS1 system of identify, capture and share. The identifiers that are seen encoded in barcodes and RFID tags can be expressed as Web addresses so that each identified item can be linked to and from, just like a page on a website.

Likewise, GS1 identifiers can be extracted from a Web address (a URL) that follows the GS1 DL structure *without* an online look up. It is this ability that enables a future where an on-pack URL can also be converted to GS1's AI syntax and used by existing systems such as those at point of sale.

3.3.2 Harnessing the power of the Web

The enormous power and flexibility of the Web is something we experience everyday although we may not think of it in such a way. What we see online is typically personalised to us (everyone might see something slightly different); we may see different information depending whether we're logged in or not, that is, we may only see content we're authorised to see; we may see different information depending on our location, time of day, language and so on. GS1 DL makes that power available within the context of the industries and processes that GS1 serves, both B2B and B2C.

It's worth noting that the Web is a two-way channel. Every time an application interacts with a server, the server may log the interaction. For example, a consumer scans a product and, immediately, the brand owner is able to capture information about where and when the item was scanned. If they user is logged in, they'll know who scanned it too.

4 Overview

4.1 The Dal Giardino brand

This implementation guide makes extensive use of the 'Dal Giardino' brand. This is an entirely fictitious brand name. It was created originally by SGK/Schawk to support the development of the *GS1 Mobile Ready Hero Images Guideline* but has been re-used here. The website at *dalgiardino.com* exists purely to exemplify different features of GS1 DL.

4.2 The id.gs1.org domain name

This guide includes a number of examples. In order to make sure that they function as described, we have used the id.gs1.org domain name, at which the examples are established. However, this should not be taken to mean that GS1 DL only works on this specific domain. On the contrary, the establishment of a network of such services is foreseen and specifically encouraged. The id.gs1.org service was originally set up as a test bed before being integrated into GS1's Data Services suite but

has no formal role distinct from any other service except that it is the basis for canonical GS1 DL URIs[1].

4.3 What is GS1 Digital Link?

GS1 has created a global language based on unique and unambiguous identification encoded in data carriers including barcodes and RFID tags, and the communication of data essential for business processes that rely on those identifiers. These fundamentals are key for enabling efficiencies in processing of goods and services and are used all around the world to support supply chain partners' business needs.

The World Wide Web is an environment where people as well as companies can access or share

information on anything. This of course, includes interacting with products and services.

GS1 Digital Link (GS1 DL) provides the bridge needed to connect GS1-based identification schemes with the syntax used on the World Wide Web. In simple terms, GS1 DL provides a standard way of expressing GS1 keys and attribute data in a format that can be used on the Web. To take a simple example: the GTIN 9506000134369 can, of course, be encoded in a 1D barcode thus:

Using software, we can turn that GTIN into a Web address thus:

https://id.gs1.org/01/9506000134369

or

https://dalgiardino.com/01/9506000134369

This example is three things in one:

1. An identifier, specifically a Uniform Resource Identifier (URI)

2. A GS1 identifier (a GTIN in this case)

3. An API call to where more information can be found (a Uniform Resource Location, URL)

The GS1 DL standard defines how to structure Web URIs to include further information (e.g., batch/lot, expiration date, serial number etc.) as well as other GS1 keys such as GLN (Global Location Number), SSCC (Serial Shipping Container Code) etc.

✅ **Note**: *Any* valid combination of GS1 element strings, as defined in section 4.14 of the GS1 General Specifications, can be encoded in a GS1 DL URI.

To take a more complex example, this GS1 DataMatrix contains 4 AIs and their values:

GTIN: 09506000134376
Expiry: 211200
Batch/lot: ABC
Serial no: 123456

---

[1] See section 6.1 of the DL standard v1.1 and RFC 6596 The Canonical Link Relation https://tools.ietf.org/html/rfc6596

These four elements can be written in a GS1 DL URI thus:

https://id.gs1.org/01/09506000134376/10/ABC/21/123456?17=211200

or

https://dalgiardino.com/01/09506000134376/10/ABC/21/123456?17=211200

The reverse is also true, so that, for example, given a GS1 DL URI such as either of the ones above we can easily extract and express the same information using GS1 AI syntax:

(01)09506000134376(17)211200(10)ABC(21)123456

Importantly, this means that a DL URI, once converted through a simple routine, and *without* an online lookup, can be used by existing software that understand the GS1 system.

GS1 makes a toolkit available to do these conversions as free, open source software (see section *7*). Optionally, the most commonly used application identifiers, such as 01, 10 and 21 can be replaced by human-readable strings, such as gtin, lot and ser respectively.

4.4 How one data carrier performs multiple functions

There are many factors that will affect a manufacturer's choice of data carrier (1D, GS1 DataMatrix, RFID, QR, NFC etc.) These include things like:

- Printing capabilities such as speed and quality
- Data capacity
- Need for product authentication
- Installed equipment base
- Intended use by business partners/fellow clinicians etc. (GS1 operates in 30 different sectors)
- Intended use by consumers/patients
- Visual appearance, available area on the pack
- More…

This document does not provide direct guidance on this choice, which is available elsewhere within GS1. However, we do emphasise an important key feature of GS1 DL:

- one data carrier can perform multiple functions. It is not necessary to add a new data carrier, every time you have a new use case.

This has a number of key benefits:

1. Less space on the pack is taken up by data carriers and other symbols, leaving more space under the control of the brand designers.
2. Consumers are less confused by the multiplicity of data carriers.
3. The likelihood is reduced of a scan failing due to one data carrier interfering with another.
4. In the context of healthcare, the presence of a single data carrier ensures that important clinical decisions are not taken on the basis of the 'wrong' data carrier being scanned.
5. The primary purpose of the data carrier – to identify the item – is left intact and is not compromised by being associated with data that may or may not be up to date.
6. Data carriers that *only* serve a short-term aim, such as linking to a promotion, are likely to become out of date very rapidly. GS1 Digital Link allows real time updates to information accessed from a persistent data carrier on the pack.
7. Some information can be retrieved using multiple applications with no need for mobile phone users to install a specific app for the purpose.
8. Specific apps may be developed to read the same data carrier but deliver specific types of content to their users

Before you consider adding another data carrier to your product, especially for a single-function, consider whether your existing on pack data carrier can be used without modification.

A barcode or other data carrier can be made multi-functional using simple Web technology. All that's needed is to arrange for links to be established *from* the identified item to things like

- Product information
- Instructions
- Spares and accessories
- Use ideas (recipes, designs)
- User forums/feedback
- Registration
- Product authentication
- Traceability
- Social media (online 'social shopping')

This is what GS1 DL achieves. Bear in mind also that, because GS1 DL is using Web technologies, the information can be tailored to the end user according to factors such as purchase history, language, location and whether the customer is known (logged in) or not.

4.4.1   Link types

Directions by *joohander* *cc-by-nc*

Scanning a barcode or NFC tag with a mobile phone or device and being taken to a product information page is trivially easy and offered in many apps available today. Likewise, scanning a code and being taken to a promotional page is easy. But these are single use codes which leads to the proliferation of codes on packs.

In order for it to be possible to use **one** data carrier for **multiple** purposes, there needs to be some sort of way-finding service. A means to 'ask for directions' to a particular type of content.

That's the job of the *link types*. That is, the labels that are applied to links so that a human or a computer application can see which link to follow to find a particular thing. They perform exactly the same role as menu options on a website.

Think of a typical online retailer. You'll see things like a search box, a login link, categories of items for sale, information about delivery options, an option to checkout, view previous orders, an add to basket button and so on. These are common and therefore widely understood.

Link types (short for link relation types) are both human and machine-readable – and that's what enables different apps to access different information. GS1 defines its *set of link types* as part of the *Web Vocabulary* (for which the usual prefix is gs1:) This list is under continuous review with change control under the *Global Master Data SMG* under GSMP but at the time of writing, examples include:

gs1:pip (product information page)	gs1:hasRetailers
gs1:ePIL (electronic patient information leaflet)	gs1:instructions
gs1:traceability	gs1:safetyInfo
gs1:recallStatus	gs1:review

It's possible to think of link types as forming a standard API for all items identified using GS1 identifiers.

The table below shows some examples for a (fictitious) Dal Giardino product with GTIN 9506000134352

Link type	URL
gs1:pip (product information page)	*https://dalgiardino.com/risotto-rice-with-mushrooms/*
gs1:recipeInfo	*https://dalgiardino.com/mushroom-squash-risotto/*
gs1:hasRetailers	*https://dalgiardino.com/where-to-buy/*
gs1:productSustainabilityInfo	*https://dalgiardino.com/about/*

Try this yourself – all of these links work:

https://id.gs1.org/01/9506000134352?linkType=gs1:pip

https://id.gs1.org/01/9506000134352?linkType=gs1:recipeInfo

https://id.gs1.org/01/9506000134352?linkType=gs1:hasRetailers

https://id.gs1.org/01/9506000134352?linkType=gs1:productSustainabilityInfo

In defining a set of link types, GS1 strikes a balance between the need for precision on the one hand – which suggests that we should define link types for every possible scenario in every possible detail - and the need to maximise interoperability on the other – which tends towards as few link types as possible.

When selecting a link type be sure to:

1. Look carefully at all the definitions in the list – don't just take the first one as there may be one better suited to your needs further down.

2. Note that the link type is defined for machine processing. The text that humans see can be set by the GS1 Company Prefix (GCP) owner, in any language, so there *is* a way to communicate in more detail what the link is to, beyond the link type itself.

For example, the link type 'instructions' can link to a video, a page of text, a set of diagrams etc. They're all 'instructions' to which you can apply human readable titles like "instruction video" or "instruction leaflet." For clarity for any link, as well as the URL there is also associated metadata:

1. The link type

2. A human readable title

3. The human language of the target (following IETF BCP47 *Tags for Identifying Languages*)

4. The media type - HTML, JSON, XML etc. (using IANA-*registered media types*)

The first two are mandatory for GS1 Digital Link.

If you're sure there isn't a defined link type for your particular situation then additional terms can be defined through GS1's standards process (the Web vocabulary is formally managed by the Global Master Data SMG[2]). You can also define your own terms as set out in the GS1 DL standard but be aware that it is unlikely that these will be interoperable outside your ecosystem.

So how do all these links work? Where are they stored? Does every website understand this? If not, what kind of service does understand this? That's the job of the *resolver*.

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[2] https://www.gs1.org/standards/development-work-groups#GMD

4.5   Resolver

A resolver is the system that stores the URLs of the resources you would like to make available to the market, for example product videos in different languages, leaflets and much more. The contents themselves are not typically stored on the resolver which simply redirects requests to wherever the content is:

- Anyone can operate a resolver. GS1 Member Organisations, brands, retailers, solution providers.

- There is no requirement that every resolver will offer the same links.

- Resolvers can be chained: one resolver can forward requests to another.

- The GS1 DL standard provides precise detail on the required and optional functionalities of a conformant resolver.

As we saw in the previous section, links are labelled with a 'link type' – that is, a label telling humans and computers what kind of information the link points to. We also saw that you can ask for a specific link type.

What happens if you don't ask for a specific link type? What happens if the requested link type isn't available?

In both cases, the answer is that the resolver will redirect to the *default link*.

Try this, for example: *https://id.gs1.org/01/9506000134352*

Here we have not specified a link type in the GS1 DL URI - it just contains the GTIN. Following that link will take you to the product information page, that is, the same destination as if we had resolved (looked up) *https://id.gs1.org/01/9506000134352?linkType=pip*. That's because the `pip` link has been set as the default.

A requirement of all conformant resolvers is that for every link there is a default. This means that brands can include the basic GS1 DL URI on their packs and then, separately, configure the resolver's default which is what you'll see if you use a general-purpose application. This can be updated at any time and as often as required so the online information can be refreshed without any need to alter the packaging.

Examples

1. A product has been recalled. The information available by scanning the product can be updated by simply switching the target of the default in the resolver to point to information about the recall – no need to relabel the items. Remember that GS1 DL can encode fine-grained identity so that such recall information could be applied at the batch/lot level rather than at the GTIN level.

2. A promotion runs for 3 weeks, during which time the default link is set to information about the promotion. When the promotion is over, the default is reset back to the usual product information page.

In both cases, there is no need to update the symbols on the product and no need to add another barcode.

More specific applications might ask for specific types of information. In that case the resolver will do its best to respond accordingly.
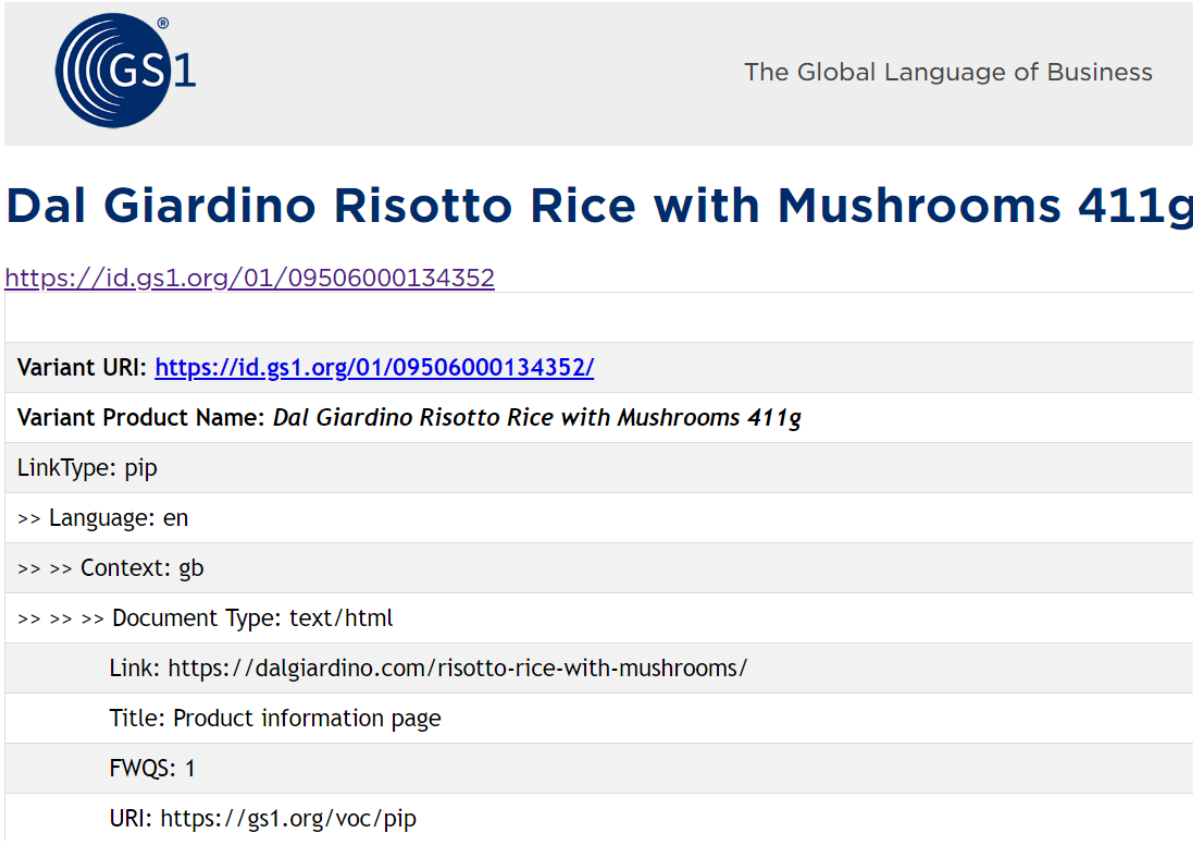
It's also possible to ask the resolver for "all the links it has for a given identifier or set of identifiers." This is achieved by setting the value of linkType to 'all'. Following this link:

https://id.gs1.org/01/9506000134352?linkType=all

will bring you to a page on the GS1 Global Office resolver that shows you the links it has for that GTIN. This information is available for both humans and machines to read and process.

- Link types should not normally be included in data carriers. It is applications that add the request for a specific link type before resolving the identifiers.

Figure 4-1 The GS1 Global Office resolver human-readable response for a request for all links for GTIN 9506000134352

Dal Giardino Risotto Rice with Mushrooms 411g

https://id.gs1.org/01/09506000134352

Variant URI: https://id.gs1.org/01/09506000134352/
Variant Product Name: *Dal Giardino Risotto Rice with Mushrooms 411g*
LinkType: pip
>> Language: en
>> >> Context: gb
>> >> >> Document Type: text/html
Link: https://dalgiardino.com/risotto-rice-with-mushrooms/
Title: Product information page
FWQS: 1
URI: https://gs1.org/voc/pip

Figure 4-2 Machine-readable (JSON) response to a request for linkType=all for GTIN 09506000134352

```
{"_id":"/01/09506000134352","unixtime":1578332149,"/":{"item_name":"Dal
Giardino Risotto Rice with Mushrooms
411g","responses":{"default_linktype":"gs1:pip","linktype":{"gs1:pip":{"l
ang":{"en":{"context":{"gb":{"default_mime_type":"text/html","mime_type":
{"text/html":{"link":"https://dalgiardino.com/risotto-rice-with-
mushrooms/","fwqs":1,"linktype_uri":"https://gs1.org/voc/pip","title":"Pr
oduct information page"}}}},"default_context":"gb"}… etc.
```
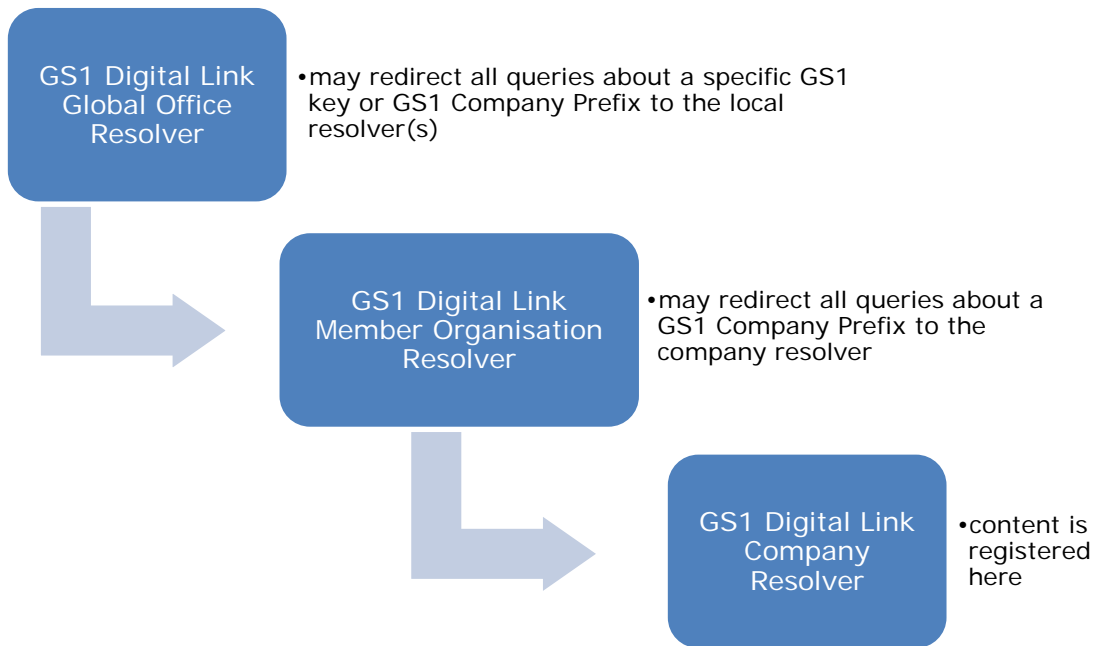
GS1 recommends that you take the GS1 Global Office resolver into consideration when implementing the standard, no matter whether you plan to make primary use of a resolver operated by your company, your local GS1 Member Organisation or a service provider. The thinking behind this is as follows.

If a data carrier does not contain the full GS1 DL URI – such as an EAN/UPC barcode – an app will need to construct the URI that includes the GS1 identification keys and send it 'somewhere.' That is, it must have the address of a resolver built into the software. This 'somewhere' should be set to the resolver that, in the app developer's judgement, is most likely to lead to useful information. This does not have to be id.gs1.org – use of the GS1 Global Office resolver is *not* mandatory. However, it is the nature of the GS1 system that Global Office manages the number space and delegates authority to the MOs who then delegate it further. Making use of the GS1 Global Office resolver reflects this existing system as it can be programmed to redirect requests to the relevant MO, brand resolver or solution provider as needed. It may therefore be the 'best bet' to get a response.

Continuing this thought process, a resolver that is handling a request for an identifier about which it has no information is likely to redirect the request to id.gs1.org.

We recommend getting in touch with your local GS1 Member Organisation that allocated your GS1 Company Prefix to discover which options are available for you.

Figure 4-3 A possible (likely) chain for resolvers operated by, or on behalf of, different stakeholders including MOs, brands and retailers.

GS1 Digital Link Global Office Resolver

- may redirect all queries about a specific GS1 key or GS1 Company Prefix to the local resolver(s)

GS1 Digital Link Member Organisation Resolver

- may redirect all queries about a GS1 Company Prefix to the company resolver

GS1 Digital Link Company Resolver

- content is registered here

5 Implementation Journeys

5.1 Providing healthcare information

In many jurisdictions, medicines and medical devices must be accompanied by information for patients (often known as PI or IFU - Instructions for Use). In Europe alone, every year 6 billion patient information leaflets are printed, folded and included in medical packages. Humans are not good at big numbers. Imagine a printer turning out a patient information leaflet at a rate of 2 per second. To print 1 million would take just over 6 days. To produce 6 billion would take nearly 100 years.

Switching to electronic leaflets offers substantial savings in costs associated with printing, folding and packing are substantial. Furthermore, should any updates to the information be necessary, this can be achieved at any time, even after the item has left the factory.

The provision of such information requires significant management to ensure that the correct leaflet in the correct language for the correct territory is included in each pack. This task is often outsourced to a third party organisation that serves the whole healthcare industry rather than one specific manufacturer.

Figure 5-1 GS1 DL has the potential to dramatically reduce printing costs in the healthcare sector

Since GS1 standards are already relied upon throughout much of the world to provide identifiers in healthcare, GS1 Digital Link (DL) is an obvious technology to use to link every medicine and medical device to the correct electronic leaflet.

Apps can use the identifiers in a GS1 DataMatrix now commonly found on medicines and medical devices and construct the GS1 DL URI and, via a resolver, access either the clinical information or the information for patients.

5.1.1   How GS1 DL can help today

The good news is that for most healthcare manufacturers, most of the work is already done as part of existing operations.

You will need:

- A data carrier on each pack of medicine/medical device. This can be any data carrier including, most notably, an EAN/UPC barcode carrying just the GTIN and/or a GS1 DataMatrix carrying the GTIN, batch/lot, serial number and expiry date and/or an RFID tag.
- A dataset that associates each GTIN with the URL of the relevant leaflet(s).
- A GS1 conformant resolver (section *5.6*).

Here is a small sample of a dataset that has the necessary information.

GTIN	Lang	ePIL	SmPC
9506000134376	en	https://en.example.com?type=epil&id=ASGcn283d	https://en.example.com?type=smpc&id=ASGcn283d
	es	https://es.example.com?type=epil&id=ASGcn283d	https://es.example.com?type=smpc&id=ASGcn283d
	zh	https://zh.example.com?type=smpc&id=ASGcn283d	https://zh.example.com?type=smpc&id=ASGcn283d

It is simply a mapping between a GTIN and two different kinds of information that, in this case, is available in 3 different languages (English, Spanish and Chinese).

5.1.2   Apps

In order to access the leaflets, patients will need to use a smartphone app that:

- scans either a GS1 DataMatrix or a EAN/UPC barcode;
- constructs the Digital Link from the GS1 element strings returned by the scan;
- calls the resolver which then redirects to the information.

A lot of the software necessary to do this is available for free, in particular, software libraries that take care of the scan and the library made available by GS1 that translates between element strings and the Digital Link URI syntax (see section *7*). Furthermore, GS1 DL doesn't invent any new technology, rather, it uses standard Web technologies throughout. Therefore, an app developer is likely to be able to create an app, or, better still, add new functionality to an existing app, that will enable a simple scan to leaflet function. GS1 makes developer-friendly information available (again, see section *7*).

5.1.3   Working with an eLeaflet repository

It is often easier for a healthcare manufacturer to procure an external service to manage patient information than to manage the process in-house. In such a situation, the repository may or may not use the GTIN as an identifier for the item. If the leaflet repository does not include the GTIN in their database, talk to them and explore the feasibility of adding this in. Ultimately, Digital Link relies on the data including a mapping from the GTIN to the patient information.

5.1.4   Future opportunities

The healthcare industry is one aspect of the larger field of life sciences. From that perspective, GS1 DL provides resolvable identifiers for drugs and devices that can be referenced and discussed in all manner of fora from social media through to scientific journals. The underlying technology – Linked data – is commonly used in pharmacological and genetic research and the approach is entirely

consistent with other identifiers such as InChI[3] and DOI[4]. The prospect exists therefore that GS1 DL can make a contribution towards lowering the cost of biomedical research through the simple act of making more drug identifiers resolvable and linkable to other data systems.

5.1.5 Information at the point of care

Providing information at the point of care GS1 Digital Link can support healthcare providers preparing a procedure or performing it at the point of care. They can use GS1 DL for immediate access to supplemental data about an item so that they can more easily and reliably decide whether and how to use an item in a specific case. This offers the potential for greatly enhanced patient safety, for example by identifying allergens and thus avoiding allergic reactions. Also, process efficiency will be enhanced if a detail from the instructions for use of a medical device can be accessed by a scan of the device's data carrier (plus perhaps some mouse clicks). Already there are first prototype functions accessing pertinent information from out of a patient record software. So when the use of a device or drug is documented, the software looks up available information via the GS1 Digital Link and offers appropriate information to the user.

5.1.6 Asset management

Hospitals are highly complex environments with large numbers of assets, the condition of which may be critical to patient care. Assets such as medicines, gas tanks, theatre equipment and more are often subject to regular inspection. Tracking and cataloguing the location of assets, each inspection, and each use, isn't one huge task but a set of many smaller tasks, all of which require interaction between the identified item, the person or people concerned, and the data management system. GS1 DL has the potential to enable different people to interact with the same identified item in different ways, recording locations and times automatically, with obvious possibilities for greatly enhanced efficiency and management oversight.

5.2 Maximising existing B2C digital assets

(Fictional) Italian food manufacturer Dal Giardino has invested in developing a website to promote their products. The website includes:

- a separate page for each product including ingredients and allergen information;
- recipe ideas for their product range;
- information about the company, in particular the pride it takes in its corporate responsibility;
- links to their social media feeds;
- a number of videos that are hosted on a separate online platform.

In order to make this digital content available directly to consumers who may be in a store and considering purchasing a Dal Giardino product, they add a QR code to each product that links to that product's information page.

5.2.1 Potential problems

This increasingly common scenario presents a number of potential problems:

- Adding an additional barcode to the pack takes up real estate on the product;
- The presence of multiple barcodes on a pack can cause interference at the scanner;
- Changes to the website may lead to the URL in the QR code to become obsolete leading to '404 Page not found'
- Pointing the QR code directly to a short-term promotion is almost guaranteed to present consumers with out of date content in future.

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[3] https://iupac.org/who-we-are/divisions/division-details/inchi/
[4] https://www.doi.org/

5.2.2   How GS1 DL can help today

Instead of using the URL of the Web page directly in the QR code, Dal Giardino uses the GS1 DL standard to create a *persistent URL* that contains the product's GTIN and that redirects automatically to the product's information page. This will work with QR code readers, including the default camera on modern smartphones that remove the need to install any new app, hence significantly reducing friction for consumers.

Why do this today?

■ the redirection from the persistent GS1 DL URL can be updated at any time so that things like website updates and short-term promotions can all be handled easily with no change to the pack;

■ this is a future-looking action;

■ the persistent URL can be on the brand owner's own website or a third-party service.

You will need:

■ A brand owner's website with a specific page per product.

■ A webmaster able to configure the redirection (a standard feature of all web servers) or the use of a GS1 conformant resolver (section *5.6*)

■ A simple barcode/QR code generator.

5.2.3   Adding granular identification

Dal Giardino sets up its production lines so that the GS1 DL QR code includes not only the product's GTIN but also the batch/lot number and expiry date. A feature in the GS1 DL standard is that if no information is available for the specific batch/lot, information at the GTIN level is returned. Therefore in this scenario, there is no effect on the consumer experience of scanning the QR code but Dal Giardino is well set up for future use cases.

You will need:

■ Barcode software able to generate QR codes containing a GS1 DL URI within the production line.

■ Digital printers downstream in the production environment (and associated QC tools to verify the data accuracy and quality of the QR code)

5.2.4   Slightly more advanced

The redirection to the product's information page is augmented so that the batch/lot and expiry date information, present in the QR code, can be processed dynamically by that product information page to present more specific information to the consumer.

This does not entail any software not already listed.

5.2.5   More advanced

Links to the recipe page, company information, social media feeds and videos can also be associated with the GS1 DL URI so that they become readily discoverable by specialised apps. For example, a coeliac consumer will be able to use a specialised app to go directly to information about whether the product does or does not contain gluten.

You will need a GS1 conformant resolver to achieve this (section *5.6*).

5.2.6   Future opportunities

It is anticipated that in future:

■ point of sale scanners will recognise GS1 identifiers encoded as GS1 DL URLs in QR codes so that the existing barcode can be removed, freeing up package real estate;

■ retail staff scanners will be able to make use of the more granular identification for things like product recall, first-in-first-out checks and more.

5.3 Back of retail store operations

Many back of store operations depend on products being identified not just by the GTIN but also with details like the batch/lot number, or the expiry date in the data carrier as well. Either might be used to decide which batch to put on the shelf (first in first out), to identify a recalled batch, to prevent the sale of an expired item or perhaps to give a discount at POS for a near-expired item. These kinds of actions are perfectly possible without Digital Link since the key information can be in the data carrier such as a GS1 DataMatrix or a GS1-128. But they are all possible *with* Digital Link as well as:

■ linking to hazardous materials (hazmat) information;

■ triggering reordering processes;

■ matching to a shelf label;

■ etc.

Rather than any one use case, it's this "one barcode, many functions" that makes GS1 DL so powerful. And it's fully extensible and future-looking in that you can add more functionality at any time.

5.3.1 How GS1 DL can help today

Rather than centralising data in one place, GS1 DL works by redirecting requests to wherever the needed data is. This might be on the company intranet or elsewhere. That allows companies to set up and use discrete APIs and to link to them from a full variety of devices.

Different companies will have different priorities and so this can only be an example.

Dal Giardino receives product recall information from a variety of sources including its own internal quality assurance processes, government information, and consumers and retailers who report problems with specific batches of their products. It exposes this data through a simple API that returns true if the batch is recalled or false if not.

At a retailer's back of store, a staff member is about to restock the shop floor shelf with a Dal Giardino product. Before opening the case, they scan the barcode that contains the GTIN and batch/lot number of the product. The scanning app uses this information to construct a GS1 DL URI and appends the 'recallStatus' link type before sending the request to the Web. The request is forwarded to Dal Giardino's recall API which returns false and so the retailer can unpack the case and add the contents to the shelf.

Later, a problem is reported to Dal Giardino and from that point on, the API will indicate that the batch has been recalled. A store's database can poll that API as frequently as it likes to keep its PoS database up to date, minimising the possibility that a customer will pass through the checkout with a recalled item before it's been removed from the shelf.

You will need:

■ high capacity barcodes such as GS1 DataMatrix, or a QR code carrying a GS1 DL URI;

■ a scanning app/device for staff members that can work with GS1 DL;

■ a GS1 conformant resolver (section *5.6*).

Why do this now?

As we noted at the beginning of this use case, many problems can be solved by using more granular identification without using Digital Link. However if we take the Dal Giardino recall status API as the first use case, it's easy then to add in, say, the FIFO use case, the hazmat use case and more. Putting that first use case into operation makes the subsequent uses progressively easier.

5.3.2   Data carriers for warehouse operations

Unlike consumer-facing use cases, where the ability to scan with a smartphone is important, ideally without the need to install a specific-purpose app, in back-of-store operations, staff will be using a dedicated device that will be linked to the store's own data infrastructure. That means that the choice of data carrier is likely to be much wider.

Why?

Data carriers like RFID tags, GS1 DataMatrix and GS1-128 all carry more data than a simple EAN/UPC barcode that only carries the GTIN, but they do not carry a Web address. That's not an issue where an app is being used as the app constructs the Web address according to the GS1 DL standard.

5.3.3   Future opportunities

Once the basic infrastructure is established, GS1 DL becomes the natural, easy and cheap way to add new APIs and data services into the retailer's system. Any number of new services can be added and made accessible by simply adding more links to the identifier you already have using an infrastructure you already operate.

5.4   Solution provider options

It is not possible, nor is it desirable, to give definitive advice to solution providers about how to implement GS1 DL. However, we can highlight some of the functions and requirements that a brand owner, retailer, transport company or hospital manager may be glad to outsource.

One of the assumptions that underlies GS1 DL is that every product has a dedicated Web page. Not all manufacturers/brand owners have this but if a consumer scans a GTIN then they'll be expecting information about that specific item, not a page with multiple items of which that happens to be one.

The highest value product description pages will be both human and machine-readable, the latter achieved using a combination of terms from schema.org and the GS1 Web Vocabulary. That immediately creates a mini knowledge graph with the product identifier that's printed on the pack as the way in.

From a technical point of view, resolvers are relatively straightforward pieces of software. They comprise a Web server and a database of links. GS1 makes the code for its own resolver available as free, open source software and there's a test suite against which you can assess your own system. The difficulty is in curating the links to related resources. Once done, though, the system is designed to make it easy for app developers to offer end users those links as a menu of options.

5.5   Product catalogues

Many organisations, including GS1 MOs, operate product catalogues, traceability solutions etc. By using the GS1 DL syntax in the URLs for these services, or at least establishing URLs that redirect to them, service operators are putting in place a standardised interface that can be extended in future in whatever direction the operator so chooses. This can usually be done with minimal effort, providing an easy way to do something straight away that will give a degree of future-proofing for existing services.

5.6   Establishing your own resolver

Whether you're a brand owner, healthcare manufacturer, retailer or solution provider, advanced uses of GS1 DL are likely to entail operating your own resolver.

Recall that, unlike other identifier resolver systems, such as DOI or ORCiD, GS1 DL resolvers do not have to all point to the same target destination. To take a simple example, a manufacturer is likely to set the default link to be their product information page. A retailer would set the default in their resolver to the page on their website from which the product can be ordered.

Different resolvers therefore will serve different needs but they all link to information relevant to the specific identified item.

Resolvers can redirect to other resolvers (see **Error! Reference source not found.**).

5.7 How can I build a resolver?

You are, of course, free to build your own resolver according to the GS1 DL standard. A test suite is available for assessing the conformance of any resolver service. Alternatively, GS1 provides the full source code of its Global Office resolver as free software that can be installed on a wide range of computing environments. Details of all the tools available are provided in section *7*.

6 FAQs

6.1 Do I have to use QR codes to use GS1 DL?

No. The GS1 DL standard is completely agnostic about data carriers. 1D barcodes, DataMatrix, NFC, RFID, digital watermarking and more are all equally usable with GS1 DL.

However, not all data carriers are equally convenient. Those such as QR codes, NFC tags and non-GS1 Data Matrix symbols that encode full URLs are more easily accessed using a smartphone as they either need no app at all or a generic app that has no specific knowledge of GS1 Digital Link.

GS1 data carriers, such as GS1 DataMatrix, EAN-13/UPC-A, GS1 128 and RFID tags, at least for now, will need an app that understands GS1 DL.

6.2 How can a 1D barcode or GS1 DataMatrix be used with Digital Link?

The GS1 standard specifies precisely how any valid set of GS1 element strings can be converted into a Digital Link and vice versa, that is, how the element strings can be extracted from a GS1 DL. A set of GS1 element strings and a GS1 DL are completely interchangeable.

(01)09506000134352 (17)141100(10)PX8L(21)1BAAAA2BB3

The traditional AI syntax and GS1 Digital Link syntax are completely interchangeable

https://id.gs1.org/01/09506000134352/10/PX8L/21/1BAAAA2BB3?17=141100

When converting from a Digital Link to a set of GS1 element strings, there is no need to make an online lookup, all the information is provided in the Digital Link.

6.3 Does everyone have to use id.gs1.org?

No. The GS1 DL standard allows anyone to operate a resolver anywhere. The domain name doesn't matter, it's the structure of the rest of the GS1 DL URL that carries the GS1 identifiers. It is assumed that brand owners and retailers will use their own domain names. It is a good idea to use short domain names as this will lead to shorter URLs.

6.4 Do resolvers need to be synchronised?

No. Resolvers exist in their own right. It is anticipated that when a resolver has no information about a given item, rather than simply return a '404 Not Found' message, it will redirect to another resolver. For example, imagine resolving a French GTIN against a resolver operated by GS1 Sweden. It's likely in that scenario that GS1 Sweden would redirect the request to either GS1 France or id.gs1.org. Likewise a manufacturer's resolver might redirect resolution requests for identifiers other than its own to id.gs1.org.

6.5 How will end users know what link to follow?

Resolvers may provide links to multiple resources. Some will be human readable, others machine-readable. Some links will lead to public resources, for others the user will need to be authorised. This sounds complicated!

The good news is that an end consumer is very unlikely ever to see all the available links.

For each GS1 key, there will be a default destination. This might be a product description page or a current promotional page. This is what the resolver will redirect the user to unless there is a reason not to, that is, unless there is information that some other behaviour is required.

For example, an application might be one that offers recipe ideas, in which case when it looks up an item on a resolver (perhaps after scanning a barcode), it will include information in the request that declares that it is only interested in recipes. In this case, the resolver will redirect immediately to the recipe page (if it knows of one). Otherwise it will redirect to the default.

In order to see a complete list of links associated with the identifier, the application will have to specifically ask for the list. Again, it's unlikely that a consumer-facing application would ever present such a list to an end user. Rather, it will filter the list and only present links likely to be of interest to their user.

6.6 Do I need to run a resolver in order to use GS1 DL?

No. Section *5* provides examples of how you can start to use GS1 DL today without setting up a resolver of your own or using anyone else's.

7 Available Tools

GS1 makes a number of tools available through GitHub (the most widely used repository for open source software). These include:

- *https://github.com/gs1/digital-link.js*
  - A JavaScript toolkit contributed by EVRYTHNG. GS1 DL SDK for working with Digital Links as objects, including validation.
- *https://github.com/gs1/GS1DigitalLinkToolkit.js*
  - A JavaScript toolkit developed by Mark Harrison for GS1. Supports translation between GS1 element strings and GS1 DL URI format.
- *https://github.com/gs1/GS1DigitalLinkCompressionPrototype*
  - An extended version of the previous toolkit that supports translation between GS1 element strings and GS1 DL URI format as well as the reversible lossless compression/decompression algorithm developed for GS1 DL v1.1 and extraction of semantics from GS1 DL URIs. This toolkit can therefore work with compressed GS1 DL URIs.
- *https://github.com/gs1/GS1_DigitalLink_Resolver_CE*
  - The complete code base for a resolver, made available within a Docker container that can be installed easily on a server infrastructure to establish a fully scalable Web Application.
- *https://github.com/gs1/GS1DL-resolver-testsuite*
  - A test suite for assessing whether a resolver does or does not confirm to the GS1 DL standard.

For a complete list of free, open source tools and developer documentation available from GS1, see *https://github.com/gs1*. All GS1 tools are made available under the Apache 2.0 licence.

8 Legal considerations and disclaimers

Attention is drawn to the disclaimers and legal section of the standard, as well as the notice clarifying the territorial scope of application of this GS1 Digital Link Implementation Guide (Global Edition). It is important to be aware of the legal context before embarking on any implementation of GS1 Digital Link.

9 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	Definitions
AI	Application Identifier – the property such as GTIN, GLN, expiry date etc. All GS1 AIs are numeric (e.g. 01 for GTIN)
Data carrier	A barcode, RFID tag, digital watermark etc. Any artefact that can be read either optically or via radio frequency interaction to extract an identifier.
DL	An abbreviation for Digital Link
GS1 Digital Link	The name of the GS1 standard
GS1 Digital Link URI	A URI/URL that conforms to the structure (syntax) defined in the GS1 Digital Link standard.
Link type	A machine-readable label for a link. For example, a product information page would have the link type 'pip' (there's significant extra information about this in the GS1 DL standard).
Resolver	A Web server that processes Digital Link URIs in accordance with the standard and normal HTTP operations.