The Global Language of Business

Connecting barcodes to related information

Methods for discovering the locations of information related to GS1 identified items by humans and machines.

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Document purpose and audience

This document outlines different techniques for linking a single GS1 barcode to multiple sources of information. 'Barcode' means any 1D or 2D symbol that can be read by scanners and, in some cases, mobile phone cameras.
Connecting GS1 identifiers digitally to multiple sources of data in a B2B environment is handled by the Verified by GS1 Service. GS1 Member Organisations can provide further information on that topic. The scope of the current discussion is primarily B2C or other situations where the aim is to point to the locations of relevant information directly from the barcode.
The early sections address the issue from a business and process point of view; the technical underpinning is provided in the later sections and assume a basic level of understanding of Web technologies.

2D barcode symbols shown in this document

The examples in sections 3-4 show GS1 identifiers in a QR code. This is simply for convenience and broad familiarity. It should be noted, however, that in **healthcare** and in some retail cases, the GS1 DataMatrix is strongly preferred. Either can be used and each has its advantages. See section 5 for a discussion of this point and the different methods for encoding GS1 identifiers, and the syntaxes typically used in those 2D symbols.

1 Introduction

The simple scan of a barcode or RFID tag can be the start of countless journeys from the 'thing' to information about that thing. For example:

- Consider a consumer product. Brand owners will want to present all the relevant information in an exciting and enticing way. They may want to offer promotions, sustainability and traceability information, usage ideas and more. Retailers will want to present different information about the same thing, such as price and availability from stock.
- Consider a medical device or pharmaceutical product. Patients, clinicians, regulators and researchers will want different information about it.
- Consider an asset such as an air conditioning unit. Some people will want the original product specification, others will want details of its installation and its service history.

One way to try and satisfy everyone who may want information about the thing – what GS1 calls the *identified entity* – is to combine it all in one place. In this context, 'combine' is another word for copy. This immediately raises the issue of ensuring that the copy is synchronised with the original and of whether the original or the centralised copy is the better one to use. If there's a mistake, where is the liability and whose job is it to correct it?

Who is responsible for publishing product data?

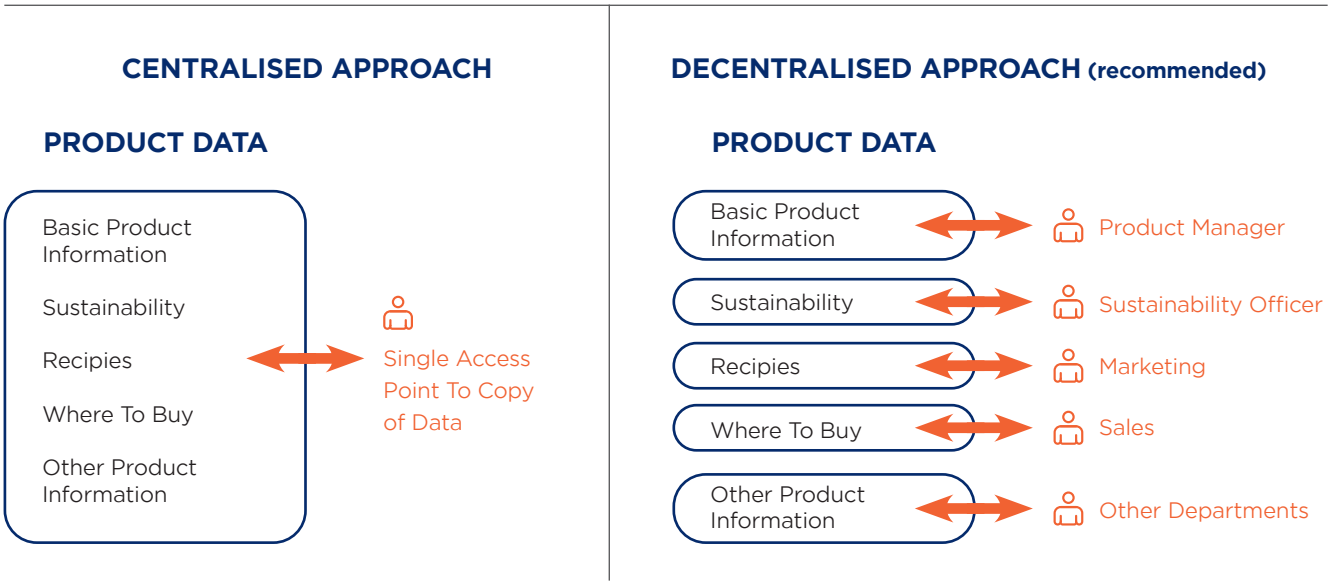


Figure 1. The centralised approach means that one person/department, usually the webmaster or a third party solution provider, publishes copies of all the relevant information. In the decentralised approach, each department remains in control of the data for which they are responsible and may publish it directly through their own channel.

Another approach is to keep all the different pieces of information at their current locations under their current management regime. This has the distinct advantage that data remains with the person or team that created it.

They retain direct responsibility for its accuracy and maintenance. It might be tempting to add a separate data carrier pointing to each data source but this can quickly lead to a single item having several barcode symbols, some 1D, some 2D, and/or RFID tags.

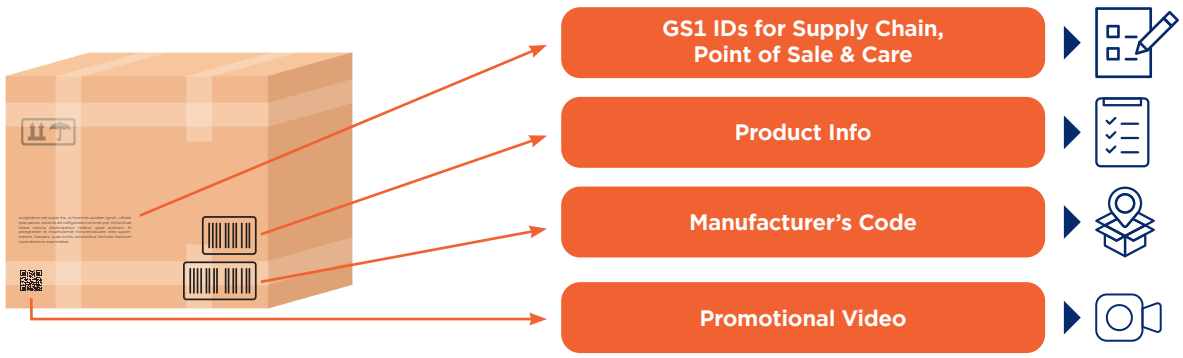


Figure 2. The data is decentralised but each data source is associated with a single-used barcode

This presents immediate problems:

1. In many cases, space will be very limited so there simply is not enough room for multiple carriers.
2. Barcodes are not a primary design aspect of product packaging. They're included on items for automatic identification and play an important role but even if there is space, no brand owner will prioritise the visibility of a barcode over their branding and design.
3. When confronted by multiple scannable symbols, how does anyone know which one to scan? Explanations can be provided but that takes up even more room on the item and may cause confusion. This is the principal reason for the Single Barcode GS1 Healthcare strategic project that aims to reduce and ultimately eliminate multiple barcodes on product packs scanned at point of care [HCS]. See section 4 for more information about healthcare application of the GS1 Digital Link and resolver. For all sectors, if the user has limited vision, the problem of knowing which barcode to scan becomes even more acute.
4. Single use QR codes carrying the URL of a piece of online information identify the linked electronic information, not the physical item itself. The lifecycle of a physical item and data about that item are almost always different. They're managed separately by different people with different priorities and workflows. Therefore, it's very possible that the data will be out of date or disappear from the Web altogether.

For all these reasons it is highly desirable that a single barcode/tag can lead to multiple sources of data and thereby perform multiple functions.

This guide describes several methods to achieve this with increasing levels of resilience, flexibility and functionality. The location of those data sources can be human-discoverable, machine-discoverable, machine-actionable or all three.

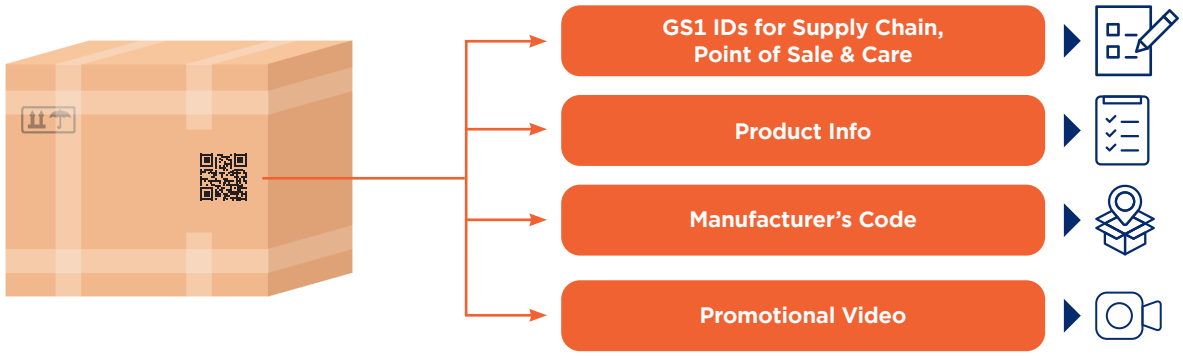


Figure 3. The optimal solution: a single barcode linked to multiple sources of data, each managed by the appropriate person or team

2 Usage scenarios

Choosing the most appropriate method to connect a single identifier to multiple sources of information will depend on context. Sections 3 - 4 indicate the kind of methods that are likely to be suitable for different usage scenarios but there is an almost infinite variety of alternatives. The methods described are underpinned by section 5 that provides important background and minimal technical detail that applies to all contexts and usage scenarios across all sectors. The assumption is made that for every identified entity there is at least one dedicated Web page, or source of information online, at the level of the GTIN, GLN, GIAI etc.

Before choosing the appropriate method to implement, it's worth considering what the desired goal is and what level of IT infrastructure is available.

a. Do you want humans to be able to select which information source(s) they wish to consult?

b. Do you want to make information available to consumers/patients with or without using an app?

c. Do you want to improve the visibility of your brand-authorised data by making it readily discoverable by search engines and other applications that gather such information?

d. Do you want apps to be able to discover and present specific types of information directly from one or more of your sources?

e. Are there regulatory restrictions on what you can present to end users who are not using an app?

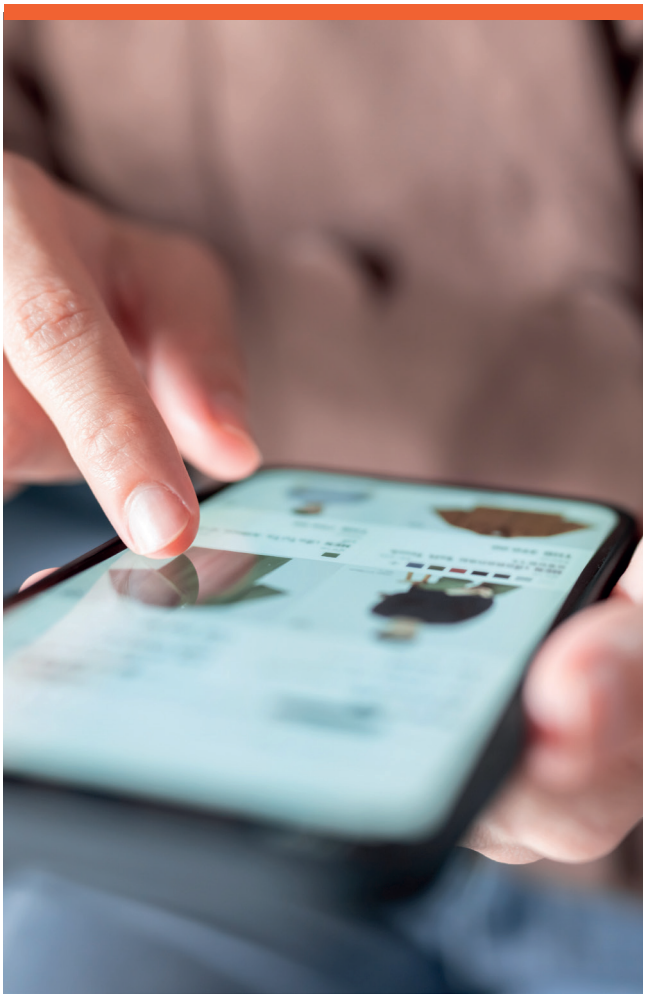
A small or micro-sized business with no IT resources will likely just want to link their GS1 barcode to a single location, usually a specific Web page that describes the product or service. Section 3 describes the simplest of the recommended solutions but this only achieves points a and b in the list above. Furthermore, this approach is not without its challenges.

2.1. Discovery by machines

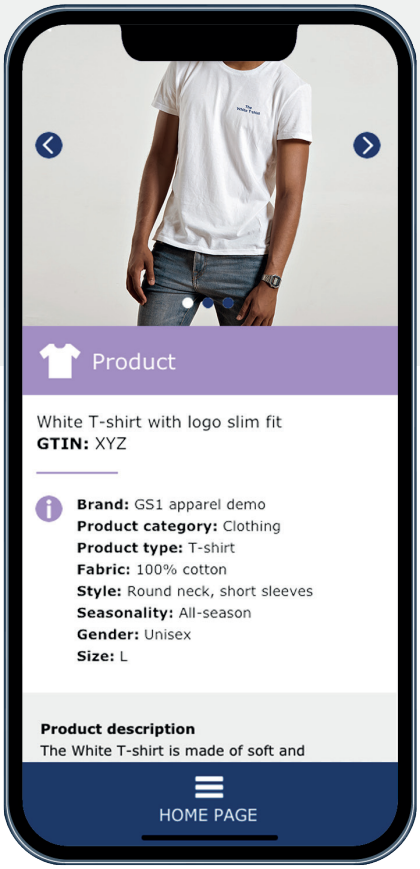
Human-driven interaction is always important. Consumers, in particular, will have a set of in-built expectations based on their previous online experience and 'media literacy'. These interactions can be enhanced if all the information about the entity is also discoverable by machines. This includes search engines, solution providers' services and artificial intelligence agents. Of course, search engines and solution providers can discover all the information they want by crawling and indexing the Web – that's how search engines gather their data – but making the locations of the information machine-discoverable starting from the GS1 barcode provides an easy route to discover authoritative, brand-authorised data, which is clearly distinguishable from any other information about the entity that may exist online. This is covered in section 5.3.

2.2. Enabling apps

Finally, it's possible to enable apps and their users to ask for specific types of information for a given identified entity, in real time. This is covered in section 5.



3 The simplest solution



The simplest recommended method to link a single identifier to one or more other sources of information is to redirect from the QR Code to a landing page on the Web and for that one page to include information about the entity and links to whatever other sources of data are relevant.

For a product, this would mean redirecting from the GTIN to a product information page.

PRODUCT GTIN IN QR CODE GS1 DIGITAL LINK URI

https://id.example.com/01/09506000164908

REDIRECT

PRODUCT INFORMATION PAGE TARGET URL

https://example.com/my-product

Ultimately, it can only be up to the person or team responsible for the website to determine what a consumer's experience will be when they scan a QR Code powered by GS1. There is an enormous amount of flexibility available. However, the advice is to always redirect from the QR Code to information specifically about the item, that is, an individual product page rather than, say, a website homepage or social media feed. If the redirect just goes to a brand's home page, the user will have a poor experience as they will be required to take further action to find the information they were expecting to get when they scanned the code.

Although redirecting to a single page is simple to achieve, it misses a lot of opportunities, doesn't address B2B data sharing, and may be difficult to manage over the long term as a business scales upward. The reason for this caution is that, although redirecting from the QR Code powered by GS1 to a single, consumer-facing landing page achieves the important step of separating the entity's identity from the location of the data about it (see section 5.1), it doesn't separate the roles of the different teams managing different data sources.

Updating or adding a new source of information – a new promotion, a new video, updated details or usage instructions, contact details or service history – any update to any source of data about the item is likely to mean making a change to the single Web page, even if it's just adding or removing a link. If it is kept up to date, that page may become a bottleneck in data management. More likely, it won't be kept up to date, at which point the barcode ceases to be the starting point for discovery of all relevant information about the entity.

Separating the entity's identity from the location of the data about it, as emphasised in section 5.2, helps to alleviate this problem. The redirect from the identifier to the information page can be updated at any time.

Section 5.3 describes how to make all the links from that page machine-discoverable. As with redirection, this is something any webmaster should be able to do easily.

4 GS1-Conformant resolver

Redirecting from the QR Code powered by GS1 to a page about that item requires no special software of any kind either by the user or the brand owner. It can be achieved using the same tools that are used to create and manage any website. A simple scan with a mobile phone's camera is all that's needed.

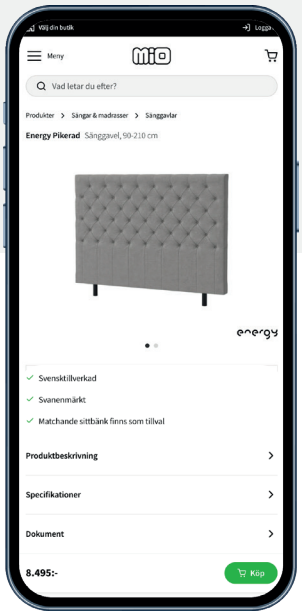
However, more powerful options are available.

GS1 standards can also be used to enable simple software (apps) to interrogate physical objects and ask for specific types of information. This builds on the idea of a machine-readable set of links and is achieved with a GS1-Conformant resolver. From a consumer, business partner or regulator's point of view, it means an app can be used to ask specific questions and get specific answers that may not be the same as a casual scan of the item without such an app. GS1-Conformant resolvers are defined in a GS1 standard [CR].

In healthcare, use of a GS1-conformant resolver with an app that follows the GS1 standards is the preferred option.

(01)07322976568142

REDIRECT



A network of GS1-Conformant resolvers, each run by the manufacturer, enables apps to access information for patients as distinct from clinicians and regulators. Following the standards allows any app to access links to information in any networked resolver, irrespective of the operator.

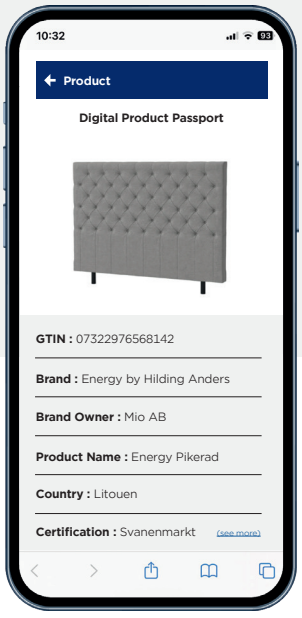
For retail uses, ProPare, the Digital Product Passport app created by GS1 Sweden, provides an example of how a GS1-conformant resolver can be used to offer a default experience, without an app, and a specific type of response with an app.

Scanning the QR Code with just a phone's camera and no app will redirect the user to the general product information page which includes lots of marketing information and a buy button.

However, scanning the same QR Code using the ProPare app (available for both Android and iOS) leads to a different presentation – the product's Digital Product Passport (DPP).

(01)07322976568142

REDIRECT



In both cases, the redirection is handled by a GS1-conformant resolver but only the app is asking specifically for the DPP.

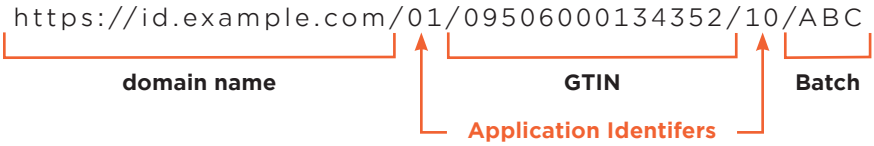
The combination of mobile device applications and a resolver provide a foundation to solution providers to developed secure and specialised solutions and services that help improve a variety of use cases and scanning scenarios.

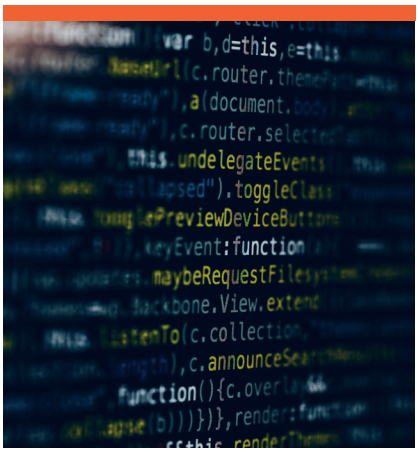
For more information, see the GS1-Conformant resolver standard [CR] and implementation guide [CRIG].

5 Technical background

The role and semantics of the GS1 Digital Link syntax

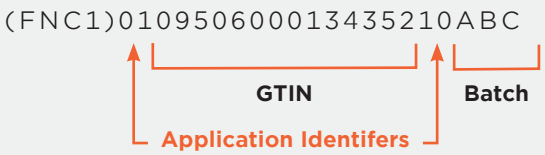
GS1 defines a number of syntaxes that can be used to encode its identifiers. These include GS1 Element String Syntax, EPC URN and GS1 Digital Link. The latter is most relevant to the current discussion, as it encodes a GS1 identifier (including any qualifiers) in a structure that is also a URL [DL-URI]. It is important to recognise the semantics (the precise meaning) of the GS1 Digital Link syntax. An example is shown below:





The example includes a GTIN and a batch/lot. For emphasis, any GS1 identifier and qualifier combination can be encoded in a GS1 Digital Link URI including SSCCs, GLNs with GLN extensions, GRAIs, Ship To addresses, best before dates, packaging identifiers etc.

From a GS1 point of view, the entity in the example is identified by that GTIN and batch/lot number in exactly the same way as would be the case if GS1 Element String Syntax were used. That is, it is possible to provide exactly the same identifiers as the GS1 Digital Link example using GS1 Element String Syntax thus:



In healthcare and some retail situations, GS1 Element String Syntax encoded in a GS1 DataMatrix is the strongly preferred option. In other situations, GS1 Digital Link syntax is preferred. This can be encoded in a data matrix but is more usually encoded in a QR code. The difference between the two of course is that the full GS1 Digital Link URI also provides a point on the Web where pointers to information about the entity can be discovered, but the domain name is not part of the identity expressed by the GS1 identifiers. The connection to the Web is not included in a GS1 DataMatrix but can be provided by scanning software, in particular, mobile phone apps. In healthcare, the domain name supplied by the app will typically be a GS1-conformant resolver.

To make working with GS1 syntaxes as easy as possible, GS1 provides production-grade software libraries for generating, interpreting and converting between the various syntaxes. GS1's Barcode Syntax Resource [BSR] is available as open source, freely-licensed software.

The GS1 Digital Link URI identifies the entity and should not be thought of as the location (URL) of a Web page. Rather, it is the online identity of the entity itself from which it is possible to discover one or more pieces of information about that entity. This distinction – between the identity of the entity itself and the location of any information about the entity – should become clearer in the next section.

GS1 Digital Link syntax is assumed in sections 3-4, whether encoded directly in a QR code or generated by an app from a GS1 DataMatrix encoded with GS1 Element String syntax.

5.1. Separation of entity identification and data location

There is a distinction between the identity of the entity itself (the thing identified by the GTIN, GLN, GSRN, SSCC etc) and the location of information about the entity. This document talks repeatedly about the need for some form of redirection from the entity's identifier to the location of information about it.

There are two reasons for this, both equally important.

Firstly, they're simply not the same. A block of cheese is made of, well, tasty bites of cheese. Digital information about the cheese is made of bytes of data. Using the same identifier for both the physical object and information about the object is likely to cause confusion and error.

Secondly, it's because the identity of the entity itself is allocated and managed in accordance with standards-based rules and process such as GS1's GTIN and GLN allocation rules. Many GS1 identifiers have rules that prevent their re-use.

In contrast, most data sources (including Web pages, images, videos, EPCIS repositories etc.) are managed under entirely different rules. In the case of marketing-driven webpages the guiding force will be attracting attention and converting that attention into sales. Digital content may be updated, moved or deleted. New content can be added. It's a very different mindset than allocating an identifier to a physical thing.

There can be any number of sources of data about an item, each managed in its own way, some public, some access controlled. The aim of all the methods set out in the document is to link from a single entity's identifier to all those separate pieces of information.

It is this second reason that underpins the advice in *Best* practices for creating your QR code powered by GS1 [QRBP] to use a dedicated subdomain for entity identity management and the recommendation to ensure that this subdomain is logically and organisationally separate from a brand's website.

GS1 ***strongly recommends*** that the GS1 Digital Link URI is not used directly as the URL of any Web content.

The separation of entity identity and location of data is even more clear when we consider GS1 barcodes that use syntaxes other than GS1 Digital Link. Consider a GS1 DataMatrix as seen on billions of healthcare products. Apps can be used to convert the GS1 Element String into a GS1 Digital Link URI (the app provides the domain name) which can then point to one or more sources of information. For more information on this in the specific context of healthcare, see *Accessing online product information with the GS1 Digital Link Standard* [AOPI].

5.2. Redirection

Redirection is a very common feature of the World Wide Web. It is most prominently encountered in social media. If a user posts a link to an external site on social media, the social media platform will immediately convert it to a URL in its own system that, when clicked, will redirect to the original URL that was posted. Domain names like ow.ly, t.co and lnkd.in are likely to be familiar to the reader. This is done because those platform-generated links allow them to monitor exactly who shared which links and who clicked them. That's core to the business model of social media.

Redirection is also used to allow content to be moved from one part of a website to another without the original link being broken, and to provide persistent URLs for content like academic research papers. Digital Object Identifiers are the best-known example of this.

There are several ways in which redirection can be established. Web servers can be configured to simply redirect requests for URL 1 to URL 2. Such redirects can be set up one by one or can be pattern-based so that all URLs matching a specified pattern will redirect to another URL that follows a different pattern.

An alternative method is to set up a dedicated redirection service. Redirection servers can be as sophisticated as necessary, perhaps redirecting to different information depending on the user's language, location or the time of day, perhaps adding extra parameters needed by the target web page. Such services are very likely to include the kind of traffic monitoring and analytics used by social media and online marketing campaigns. Many brands will already use such services, either in-house or operated by third parties, from which valuable market intelligence is captured.

5.3. The linkset

The fundamental tool for achieving machine-readable links from one identifier to multiple sources of information is the linkset. The set of links to webpages, data sources, documents, certificates and images that are related to the identified entity.

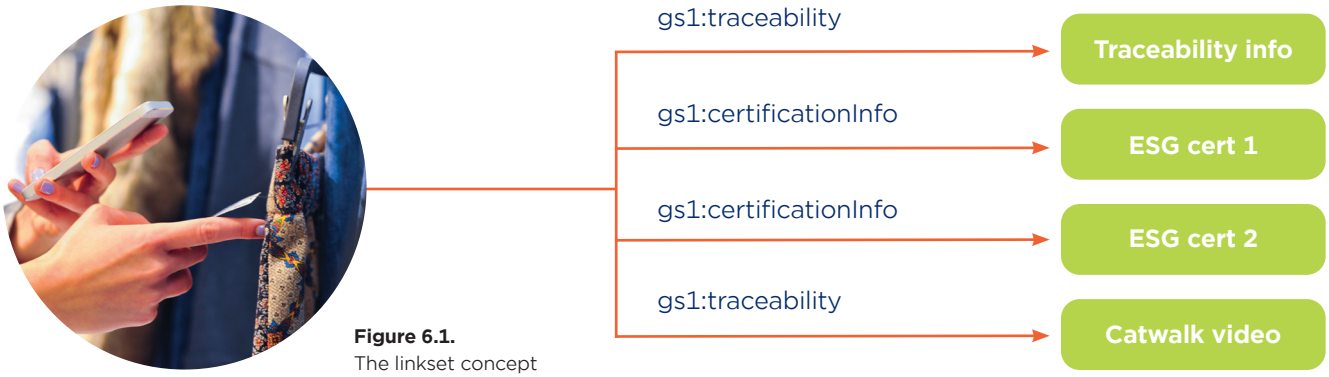


Figure 6.1.
The linkset concept

A linkset is more than just a list of URLs. It tells you what kind of thing is available where in what language and format. Defined in a standard developed at the internet standards body, IETF, [RFC 9264], a linkset is a small block of data that has a structure and semantics that make it possible for applications to recognise and follow links to particular kinds of information. For example, a product, or its manufacturer, might have one or more certificates of conformance. In data engineering terms there are three elements, known as a triple, as illustrated in the diagram below:

On the left of the diagram is the entity that carries the GS1 identifier, expressed as a GS1 Digital Link URI. On the right is a certificate about that item. The label for the connector has different names depending on the technology being used ('relationship', 'object property' and 'predicate' to name just three). The term used in GS1 is link type which is a shortened version of the more accurate name link relation type. In the example, the **link type** is 'gs1:certificationInfo'. That is, if you follow this link you will find certification information related to the identified entity.

The term for the URL itself – the URL of the certificate in the example here – is **target URL**. There can be any number of 'triples' for each identified entity. When there is more than one triple, it can be easily thought of as a table.

Entity	Link type	Target URL
https://id.example.com/01/09506000134352	gs1:certificationInfo	https://cert.example/023
	gs1:pip	https://example.com/my-product
	gs1:instructions	https://example.com/my-product/instructions

Why the ‘gs1:’ prefix in the link type column of the above table?

The Internet Assigned Number Authority maintains a list of recognised link types that exist as unqualified plain text words [IANA-LT]. These include things like ‘canonical’, ‘next’ and ‘describedby’. Of particular note here is that the IANA list includes a link relation type of ‘linkset’. That is, “follow this link to the find the set of links to information about whatever it is you’re looking at”. Those recognised link relation types do not cover the kind of things the GS1 community needs and so it was necessary to create a new set. Link types that are not recognised by IANA must be defined as a URL to ensure that they’re unique but it’s possible to use a shorthand, known as a Compact URI or Curie [CURIE]. The ‘gs1:’ prefix can be substituted with the URL https://gs1.org/voc/ (the base URL of the GS1 Web Vocabulary). So gs1:certificationInfo is a convenient shorthand for https://gs1.org/voc/certificationInfo. It is important to include the gs1: prefix as, without it, the same term “certificationInfo” could, at least in theory, mean something quite different.

Links within a linkset are annotated with their link type and optional additional attributes. These are the language(s) and the media type (format) of each linked resource. The linkset standard is flexible enough to allow further attributes to be included if needed.

The linkset itself can be formatted in a variety of ways but is most usefully formatted as a block of JSON-LD [JSON-LD]. This can be treated on its own or embedded into the webpage described in section 3 in a way that is invisible to humans, but very much discoverable by machines.

This format explicitly renders the linkset as Linked Data, a simple form of knowledge graph that is consistent with several other GS1 standards including as EPCIS 2.0, TDS/TDT, GS1 Digital Link and the GS1 Web Vocabulary.

By following the links in the set, information systems such as search engines and other aggregators of publicly available data can discover and more easily interpret the brand-authorised information. This makes it more likely that those third-party services, including artificial intelligence agents, will be based on accurate data.

Link types are defined at GS1 within the Web Vocabulary. A complete list of ratified link types can be seen at https://www.gs1.org/voc/?show=linktypes. Notice that they are all high level. For example, there is a link type of gs1:certificationInfo but not gs1:organicCertification, gs1:dolphinFriendlyCertification etc. There are two principal reasons for this:

1. Link types are used to label links such that they are machine-discoverable and understandable. They are not provided for humans. That is the job of the text that is read and clicked by humans. Hyperlinks on a Web page might be labelled as “organic certification” and “dolphin friendly certification” and each would point to a different certificate but they would both be of type gs1:certificationInfo. Of course, this is true whatever the human language shown to end users. Links on a Web page labelled as certificación orgánica, βιολογική πιστοποίηση , 有机认证 or органик гэрчилгээ would all be of type gs1:certificationInfo.
2. If a new link type were defined for every possible situation, the number would quickly become unmanageable and effectively meaningless.

When necessary, new link types can be defined through the GSMP process.

6 Apps

The GS1-conformant resolver standard [CR], its accompanying implementation guide [CRIG] and GS1's open-source software are all designed to support a standards-based ecosystem in which apps can help consumers, patients, business partners and regulators discover the information they want. This vision is described in section 4 and is explicitly promoted for the healthcare sector that favours GS1 DataMatrix symbols over QR codes with GS1 Digital Link.

Separately, there are any number of apps available that can scan GS1 barcodes and RFID tags. The user experience is entirely in the control of the app which often acts as an interface to a specific single data source. The type of GS1 data carrier and the syntax used is immaterial: plain syntax in a 1D EAN/UPC barcode, GS1 Element String syntax in a GS1-128 or GS1 DataMatrix, EPC binary string syntax in a GS1 Gen2 RFID tag. Apps can extract and use the identifiers in those data carriers and use them in any way they want. In addition, GS1 offers services where further information can be requested even without a physical data carrier, by simply by entering the GS1 key. Please contact your local GS1 Member Organisation for details of how apps can make use of the Verified by GS1 service.

As emphasised in section 5, GS1 Digital Link is just another way to encode GS1 identifiers and so apps may behave in the same way. They may or may not make use of the GS1 Digital Link URI in which they're encoded.

Consider an app that is designed to provide information leaflets to patients. It scans a GS1 bar code (in healthcare, likely to be a GS1 DataMatrix) and looks up the item in its database and shows the available information drawn from its database. Whether the app converts the GS1 Element String into a GS1 Digital Link URI or not doesn't make any difference to the user experience or information flow.

The same is true for a general consumer app. A user might scan a 1D barcode on a product and be shown a single page of information drawn from the app's own system. Again, whether the app converts the GS1 Element String into a GS1 Digital Link URI or not doesn't make any difference to the user experience or information flow.

This is also true for data carriers with GS1 Digital Link. An app can extract the identifiers and use them as it chooses.

In all these scenarios, the app is tied to a single source of information. That single source of information may be augmented by making use of the machine-readable linkset described in section 5.3, but the app is just using the GS1 identifiers to look up the correct information. These apps are out of scope for this document which is concerned with connecting a single GS1 identifier to multiple sources of information that may be distributed across many different locations.

7 References

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GS1 Healthcare strategy 2023-2027, November 2022. See page 23 https://www.gs1.org/docs/healthcare/Strategy/GS1-Healthcare-Strategy-Final.pdf

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