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Empowering Organizations in the Food Sector to Provide Potentially Unknown Parties Easy Access to Trusted Data. Discussion of a Web-based, Globally Applicable Solution Based on Well-established Standards and Technologies

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ABSTRACT

A number of the most relevant trends for the food sector require increased data sharing amongst different stakeholders. However, apart from established communication methods in the business-to-business (B2B) domain (e.g. bilateral exchange of EDI transactions or product master data synchronization), the level of standardization is low. There is no consistent, reliable and standardized entry point through which interested parties can easily discover and access data on products, shipments, parties, assets, or further business objects.

Against this background, this paper aims at contributing to address this issue. To this end, it employs a number of prototypes and use cases to investigate the applicability of a new standard, GS1 Digital Link, in different areas of application. Thereby, it touches upon brand-authorized data (e.g. product information pages, list of retailers selling a given product), data for users of reusable transport items (e.g. temperature profiles provided by IoT-empowered trays), consumer-oriented data (e.g. nutrition information, related videos), master data pertaining to arbitrary business objects, service endpoints of EPCIS servers, and laboratory test data.

The analysis reveals that the technical ecosystem GS1 Digital Link provides (especially normative specifications for resolvers, standardized link types, and consistent URI patterns) indeed represents an open, flexible, scalable, and future-oriented solution approach, which is superior to existing, proprietary solutions in various ways. In the course of the discussion, the paper also points to various open source projects intended to ease the adoption of this standard.

Keywords

GS1 Digital Link; Web; Standard; Data sharing; Resolver; GitHub; Open Source; QR; Links; URI; EPCIS; Food

1 Introduction

A number of the most compelling 50 trends influencing Europe's food sector by 2035 as identified by *Moller et al.* (2019, 3 ff.) require accessibility to a lot of data. However, as of to date, plenty of food-related master data (e.g. ingredient and allergen information), visibility event data (e.g. information on where, when, how and by whom a given item was made), transparency data (e.g. information as to certification or provenance) and

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marketing data (such as high quality images) are not effectively shared yet, thus cannot unfold their true potential.

There is no consistent entry point from which stakeholders (i.e. consumers, suppliers, retailers, authorities, service providers) can discover and access this data: in most cases, companies already run product information pages with authorized content, provide traceability information, publish product-specific videos, offer APIs, operate a service desk, maintain a social media channel, provide value-added services, and much more. However, many people and/or companies are just not aware that all these data and services are actually available.

How would it be if every party could see, with a simple web request, what kind of data and or services is accessible for a given item – no matter if it is a product, an asset, a logistics unit, a location, a reusable transport item, a document, or any other business object? Based on various implementation prototypes and case studies, this paper will pursue this question, thereby addressing several business use cases from the food sector.

2 State of the art

Business-relevant data can broadly be grouped into three categories: master data (e.g. ingredient information, product images), transactional data (e.g. orders, invoices), and visibility data (supply chain events such as production, packing, and shipping). Some of that data (especially master data and visibility data) also becomes increasingly relevant for consumers. During the past few decades, businesses have developed well-established communication methods to share that data: bilateral push notifications (as with EDIFACT-based business messages), publish/subscribe mechanisms (as with product master data synchronization), broadcast (as with embedding semantic web statements into websites) and query interfaces (as with EPCIS event data). (*GS1* 2019a, 43)

So far, all of them are focusing on B2B-related data exchange, while Business-to-Consumer (B2C) and Business-to-Government (B2G) communication is little standardized. Further, with the exception of broadcast, "...where a party publishes business data in a publicly-accessible place such as a World Wide Web page, where it may be retrieved by any interested party" (*GS1* 2019a, 42), all communication methods require organizations to know the companies with which they share data, and accessibility to that data is restricted to those the data owner authorized. In addition, apart from master data synchronization (which typically enables a supplier to provide master data to a networked infrastructure from where any number of parties can access it), data exchange often follows a bilateral pattern.

The following morphological box (see Table 1) illustrates this situation: for all characteristics marked in light gray, there already are established communication methods, whereas for those in dark gray, the level of standardization is low.

Table 1. Characteristics of data sharing

Criteria	Characteristics		
Familiarity of parties accessing data	Known	Unknown	
Data sharing focus	B2B	B2C	B2G
Data sharing relationship	One-to-one	One-to-many	
Restricted data access	Yes	No	Possibly

One intuitive example is the fact that more and more brand owners apply 2D (usually QR) codes on their product packages for the purpose of B2C engagement and information. Thereby, they do not know in advance

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who and how many people will invoke their services. There also may be services (e.g. those comprising to share personal information) with restricted data accessibility. Apart from the usage of QR codes, which ensures a high range of coverage as most smartphones come with a built-in feature to scan them, the encoded content (usually a Uniform Resource Locator or URL) usually follows no reliable pattern. Therefore, they are typically single-purpose, proprietary solutions and, as they cannot be used by trading partners, impede collaborative use cases.

Figure 1. GS1 Digital Link URIs

The latter is one of the reasons why industry triggered a work request that resulted in the development of the GS1 Digital Link standard, its first release being ratified in 2018. In simple words, this standard enables companies to embed GS1 keys and attributes into a Web URI (Uniform Resource Identifier) syntax (see Figure 1) and defines the framework for resolving them.

For instance, a GTIN (Global Trade Item Number), which on its own is just a string of numbers (e.g. '09506000134352') and encoded in an EAN/UPC symbol on most consumer packages, would look sth. like this (see also Figure 1): https://dalgiardino.com/gtin/09506000134352. This is an example of a GS1 Digital Link URI (Uniform Resource Identifier), which enables a number of innovative and inter-company use cases – including direct web requests to access information and services about that product.

The standard comprises the following core components: first, it specifies a common, globally applicable solution to embed GS1 keys and data attributes into a Web URI syntax. Second, it includes normative specifications on how GS1-compliant resolver servers (a software that is part of a web server, see https://github.com/gs1/GS1_DigitalLink_Resolver_CE for an open source project) must behave. Third, it introduces globally applicable 'link types' with which organizations can qualify what a given link is about (e.g. a product information page, traceability data, or a video). In addition to that, it e.g. also addresses its applicability in the Semantic Web and defines an open source algorithm to compress GS1 DL URIs to allow for smaller symbols on the product packaging.

3 Research question and methodology

The study conducted by *Moller et al.* (2019), which deals with the most relevant trends influencing the food sector by the year 2035, reveals that there are a number of challenges that only can be mastered if organizations share data in the B2B, B2C and B2G domain in a better way than up to date.

In this context, the remainder of this paper addresses the following research question: How can organizations provide and retrieve data and services pertaining to business objects in the food sector in a standardized, globally aligned manner? The applied methods of research comprise case studies and prototypes (see Table 2).

Table 2. Characteristics of data sharing

Section	Addressed trends according to *Moller et al.* (2019)	Research method
4.1	digitalization of trade, diversification of business models and marketing, label accuracy and transparency, remote interaction with people and machines	prototype

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4.2	food safety, increased requirement for transparency of supply chain, food losses and waste	case study
4.3	peer to peer based consumption decisions, digitalization of trade, food safety, diversification of business models and marketing, remote interaction with people and machines	prototype
4.4	increased requirement for transparency of supply chain, artificial intelligence and machine learning	prototype
4.5	increased requirement for transparency of supply chain, food safety, remote interaction with people and machines	prototype
4.6	food safety	case study

4 Analysis and discussion

The following sections analyze and discuss how a communication infrastructure leveraging GS1 Digital Link can help in being better prepared to face nine (see Table 2, no. 10, 13, 14, 18, 32, 39, 43, 49, and 50 in *Moller et al.* 2019, 4 ff.) out of fifty trends most relevant for the food sector by the year 2035.

4.1 Utilization of brand-authorized data by third parties

Presume a retailer or an app provider wishes to insert product-related data into their app or web presence, e.g. to enrich their own content/offering with high-resolution images, allergen information, master data, or the latest TV advertising video. So far, integrating such data is not an easy matter: some data may only be accessible for money, some may not be available at all (as it is only stored in a company-specific data silo), and some may just be provided in a proprietary format. Applying web-scraping technology helps in some cases, but cannot ensure that the data really is accurate.

Now, with GS1 Digital Link, it is possible to check which data and/or services are available for a given product. Interested parties only need to ask either the brand owner's or GS1's resolver service by sending an HTTP GET request accommodating a GS1 Digital Link URI. For instance, if you click on https://id.gs1.org/01/09506000134352?linkType=all (note: all links in this section are actually working examples), they can see that for this product (in this case, a ready-made risotto), the brand owner provides a reference on where consumers can buy it, a product information page, sustainability information, and a recipe website.

This human-readable HTML document is not the biggest advantage though (and it is not necessarily required by the standard anyway). However, it is a mandatory requirement for every GS1-conformant resolver to return a JSON array conveying all link objects. Thus, a company's business application can conduct this work automatically. Thereby, the latter is not just able to index which data is available for which GTIN, but can also check in which media type (e.g. '`application/json`', see *IANA* (2020) for a complete list) and language. Based on this data, the application (again automatically) can decide on how to best integrate the content.

To make that more tangible, presume that a retailer wants to leverage the product information provided by the brand owner for their own website, e.g. in the form of an iframe. The only thing they need to do is to check whether there is a product information page ('`gs1:pip`') available (which in this case is true), and to integrate the latter accordingly via https://id.gs1.org/01/09506000134352?linkType=gs1:pip. Similarly, that works for other link types (e.g. '`gs1:recipeinfo`', '`gs1:hasretailers`'), too. The selection of the most appropriate language and media type in which the respective data/services are provided works through normal HTTP content negotiation, i.e. as part of an HTTP request and response header.

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To gain knowledge about the capabilities (e.g. supported link types, supported GS1 keys, operator contact details, extensions, etc.) of a given resolver, a client application needs to access the Resolver Description File all GS1-conformant resolvers have to provide. The latter is a machine-readable file, made consistently available through the usage of well-known URIs ('`/.well-known/gs1resolver`'). For instance, the Resolver Description File of the GS1 Resolver Service is available at https://id.gs1.org/.well-known/gs1resolver. For more information on well-known URIs, see *Nottingham* (2019).

Apart from having access to reliable, brand-authorized data that retailers/app providers can embed into their websites/apps for free, the advantage for accessing clients consists in the reduced effort to gather that data themselves as well as having the opportunity enriching their own content, which in turn typically entails an increase in sales. For instance, the latter is because "...the mobile is not used only during the shopping preparation to collect information (...), but (...) [also] during the shopping expedition in store as a guide for the purchases." (*Bellini/Aiolfi* 2017, 64)

If, in addition, data objects are provided in a standardized manner, it further makes any bilateral mapping effort unnecessary. An example of an appropriate format, expressed in JSON-LD and adhering to the GS1 Smart Search Standard (whose underlying Web Vocabulary is an official extension of schema.org), is provided in Annex A1 of this paper. The latter utilizes well-established master data attributes, expressed in a machine-readable format while leveraging linked open vocabularies.

4.2 Providing value-added services on reusable transport items

Reusable transport items (RTIs) are increasingly used in the food sector e.g. for efficiency and sustainability purposes. E.g., *Euro Pool Systems* and *IFCO*, two of the largest pool operators in the European food sector, have more than one billion tray rotations per year (*EPS* 2020, *IFCO* 2020). Combined with Internet of Things (IoT) technology, these trays can improve food quality, food safety, efficiency and increased shelf life (which in turn is likely to entail a positive impact on profits of the trading partners involved).

At the time of this writing, more than 1.000 *Euro Pool System* trays are equipped with low-power wide-area network (LPWAN) devices. This trial is part of 'Internet of Food and Farm 2020', an EU-funded research project that aims at generating a maximum impact on IoT adoption in the agri-food sector through numerous individual trials ranging from precision crop management to chain-integrated greenhouse production (see *IOF* 2020). "LPWAN enables devices to communicate with base stations over long distances at a low bandwidth.

While it is only suited to transmit infrequent small data packages, devices can last a long time (up to several years) on battery power. In this particular instance, it transmits the geographic position [as well as temperature readings] of individual trays." (*Troeger* 2018) During the remaining time of the research project, the pool operator strives to put GS1 DL to the test for offering tray-specific services (see Figure 2 for illustration).

Figure 2. Illustration of trial on intelligent food trays

While the system design is not finalized yet, its operating principle is as follows: first, trading partners (e.g. growers or retailers) scan a Global Returnable Asset Identifier (GRAI) identifying an individual tray. The latter is accomplished by either scanning a QR code that directly encodes a URI such as https://id.europoolsystem.com/8003/{GRAI} or by

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scanning the GS1-128, for which they require a dedicated app that translates the GS1 element string as encoded in the GS1-128 into its corresponding GS1 DL URI. (In this context, a GitHub repository provides an open source toolkit to translate GS1 element strings into GS1 DL URIs and vice versa, see https://github.com/gs1/GS1DigitalLinkToolkit.js).

Second, once users have scanned the GRAI, they are directed to a page offering a number of tray-related data and services. At this moment of time, the pool operator considers offering a service that indicates the point of time of the last washing and – taking into account privacy concerns – provides the temperature profile of a specific tray. Based on the latter, e.g. a grower is able to examine whether any temperature data point exceeds a certain threshold until the retailer receives the tray.

Apart from what *Euro Pool System* intends in the course of the trial described above, further value-added features may include services for resolving thefts or checking a tray's authenticity.

4.3 Providing food information to end consumers

There already is a great number of brand owners applying QR codes on their product packages encoding an arbitrary URL, which enables consumers to access product information. However, a solution leveraging GS1 DL (see https://digital-link.tools/ for e.g. creating a QR code encoding a standard-compliant GS1 DL URI) has a decisive advantage: it allows third parties to easily insert data into their own consumer-facing apps while further disseminating product-related data authorized by the brand owner. That works in an efficient manner, i.e. without the need for extensive bilateral agreements or individual adjustments.

For illustration purposes, presume there is a provider of a purpose-built app whose sole purpose is to provide nutritional facts and an online retailer wishing to enhance its product presentation through embedding a product-related video. To obtain nutrition facts or the video of a given GTIN, the only thing these two parties have to do is to check whether the brand owner of a given GTIN offers a link type for these contents (here, '`gs1:nutritionalInfo`' and '`gs1:relatedVideo`') as described in section 4.1. Taking the example of the first one (which would be retrievable e.g. through a web request for https://id.gs1.org/01/05011157888163/?linkType=gs1:nutritionalInfo), they could embed the brand owner's product description into their own website either directly via e.g. an iframe or through inserting a corresponding structured data set into their content management system.

It is important to note that this not only provides benefits for the app provider or the retailer, but for the brand owner as well: First, it enhances the spreading of both trusted and authorized data (note that there are many platforms that apply technologies such as web scraping to gather product-related data, which however can result in the provisioning of incorrect data). Second, content (such as videos) is used by far more people since it is not just accessible through the brand owner's own communication channels, but propagated through the trading partner's communication channels as well.

In addition to that, a GS1 Digital Link URIs is perfectly suited for embedding them in Semantic Web data structures, thus applicable to generate machine-readable ontologies and bringing "…information closer to human thinking and decision making" (*Karthik et al.* 2014, 241). Amongst other things, the latter also enable search engines or voice assistance systems to effectively answer questions such as where a given item was produced, which allergens it contains, or if it has been recalled.

GS1 (2020, 111 ff.) includes an explanation as well as an illustration on how to describe a product through semantic data structures while leveraging GS1 DL URIs (the example in Annex A.1 gives an impression, too). That offers the potential to achieve better search results through an improved matching of what consumers

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actually want with products featuring the required characteristics (see *Edward* 2018). Further, it also provides the means to reach illiterate or blind people (see *Karthik et al.* 2014, 341 ff.).

4.4 Enriching visibility event data

There is a great number of publications on the benefit of visibility event data for the food sector in general and the applicability of the ISO/IEC/GS1 standard EPCIS (*GS1* 2016) in particular. For instance, *Troeger et al.* (2013, 601 ff.) discuss on how EPCIS helps to meet five important requirements in the food sector: end-to-end tracking and tracing, accurate food quality information, online monitoring on transport conditions, separation of unsafe food as well as proactive exception reporting.

To identify physical or digital objects such as products, assets, logistics units, documents, or locations, EPCIS applications should use EPC 'Pure Identity' URIs as defined in *GS1* (2019c, 25 ff.). It is the preferred way within information systems to denote arbitrary business objects and takes the form of a Uniform Resource Name (URN) and looks sth. like this: '`urn:epc:id:sgtin:4012345.011111.987`'.

URNs are not resolvable though, i.e. do not enable direct web requests to retrieve data. However, there is an easy way to enable the powerful combination of both supply chain visibility (as enabled through EPCIS) with Web accessibility (as enabled through GS1 Digital Link). Companies just need to implement a simple translation method to convert an EPC URN into a GS1 DL URI. To ease that, the author provided an open source library, which is available via GitHub (https://github.com/RalphTro/gs1-epc-digitallink-translator) as well as the Python Packaging Index (https://pypi.org/project/epcdltranslator/).

Once installed via 'pip', companies just need to pass the module an EPC URI:

```
import epcdltranslator as edt
edt.epcDLTranslator('urn:epc:id:sgtin:4012345.011111.987')
```

In this particular instance, it should return:

```
https://id.gs1.org/01/04012345111118/21/987
```

Thus, organizations are then able to get information on any arbitrary product, location or party identifier by accessing a machine-readable file for a specific GS1 identifier in following a link with an appropriate link type such as '`gs1:masterData`'). Note that the above-mentioned library translates an EPC URI into the 'canonical' form of a GS1 DL (i.e. using the GS1 domain name). However, the software can easily be modified to work with any other domain name, too.

4.5 Empowering trading partners to access EPCIS repositories

GS1 Digital Link also comes in handy if organizations are interested in obtaining visibility data about a given item. For instance, if a retailer expects an important delivery from a distributor and wants to know the shipment's status, they can send a request to the distributor's or GS1's resolver service to find out whether the distributor provides an EPCIS query endpoint. For this purpose, the retailer needs to embed the distributor's Global Location Number (GLN) into the GS1 DL URI syntax, append the appropriate link type ('`gs1:epcis`') and invoke a request with e.g. '`https://id.gs1.org/gln/{GLN}?linkType=gs1:epcis`'). The accessing client is then returned with the link to the distributor's EPCIS repository (for the purpose of illustration e.g. '`http://www.freepcis.com/server/RALPHS-EPCIS/query`').

On this basis, the retailer is than able to issue a 'Simple Event Query' to obtain visibility data for the Serial Shipping Container Code (SSCC) of concern. Please refer to Annex A.2 for an illustrative example of an appropriate SOAP request. Note that the above query endpoint is operational (without requiring any authentication) for at least the upcoming 12 months, thus ready for anyone interested in trying it out.

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When issuing the referred query operation, an accessing client (given the necessary access rights are granted) is returned two events (see Figure 3), which may be redacted by the distributor for privacy reasons. The first one tells the retailer that the shipment already left the distributor's warehouse, the second one that its last reported position is near the German town Garmisch-Partenkirchen.

		Event 1	Event 2
Type	Event Type	**Object Event** OBSERVE	**Object Event** OBSERVE
When	Event Time	2020-02-20 12:50:00.000 GMT+01:00	2020-02-20 16:50:00.000 GMT+01:00
	Record Time		
What	"What" Dimension	*SSCC* 140123451122233341	*SSCC* 140123451122233341
Where	Read Point	*GLN* 4012345000221	geo:47.506694,11.104301
	Biz Location		
Why	Biz Step	**Departing** (CBV)	**Transporting** (CBV 1.1)
	Disposition		
	Biz Transactions	**DesAdv** (CBV) *GLN* 4012345000009 *Local ID* ASN1099	
	Sources EPCIS 1.1	**Possessing Party** (CBV) *GLN* 4012345000009	
	Destinations EPCIS 1.1	**Possessing Party** (CBV) *GLN* 4023333000000	

Figure 3. EPCIS events on a specific shipment

The same principle also constitutes a partial remedy for addressing the so-called discovery problem which "...is concerned with how to directly share data between parties that are connected in a chain but do not have a direct relationship." (*GS1* 2017, 36) If trading partners of a given value network agree on an event choreography that mandates the capturing of EPCIS shipping and receiving events, it is possible to achieve end-to-end-traceability through iterative queries.

If companies are linked through unambiguous source-destination relationships as illustrated in Figure 4 (enabled by EPCIS shipping and receiving events accommodating the respective preceding or succeeding party or location), it is possible for any accessing application – given that necessary access rights are granted – to traverse through specific chains of events. For that purpose, organizations just need to convert a location or party GLN populating the source or destination list as part of a goods issuing/receipt event and look for a corresponding link capable of returning the service endpoint of an EPCIS server. On this basis, it is technically conceivable to obtain a complete event graph in an iterative manner.

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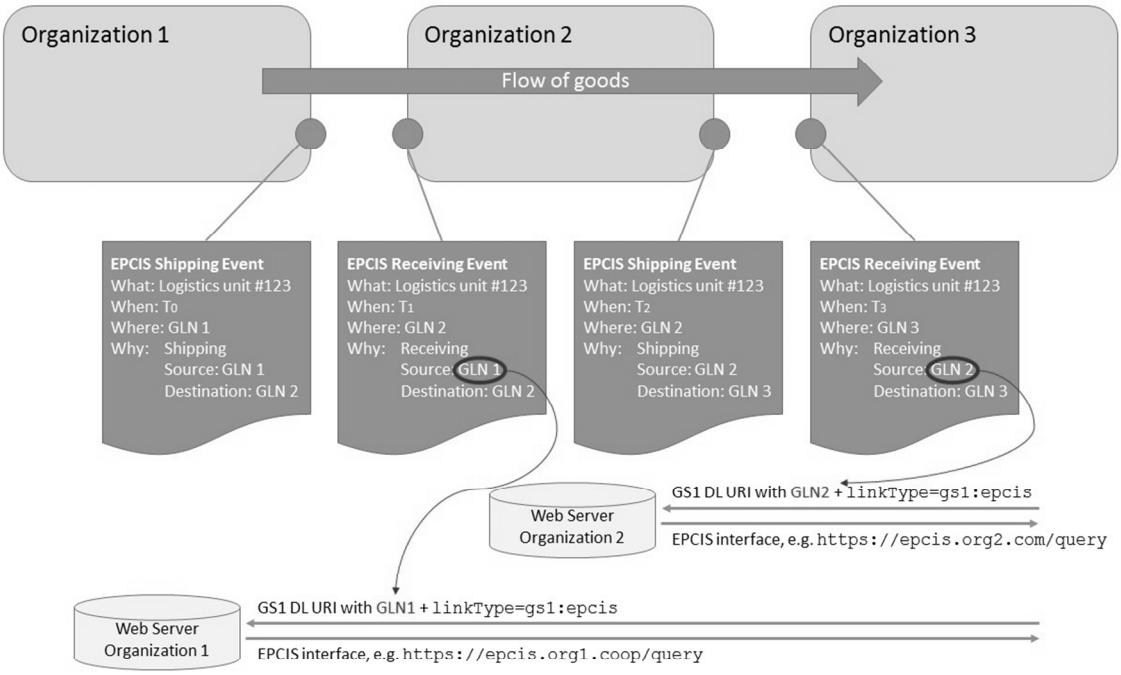

Figure 4. Minimum EPCIS event set enabling the iterative discovery of visibility data

Though that approach is feasible, it comes with a couple of issues (e.g. robustness, efficiency, response time). However, as long as a Discovery Service (as a key enabler for a distributed query choreography) is not available yet, it is a viable solution candidate in case trading partners are uncomfortable with establishing a centralized solution.

4.6 Sharing laboratory test data

Manufacturers, retailers, and public authorities continually conduct chemical analysis of both food and food ingredients for the purpose of foodstuff and quality control. Amongst other things, these analyses enable organizations to disclose contaminants, food fraud and quality issues. However, there is little consistency in identifying entities such as laboratory samples and test reports. What is more, there is a fragmented data exchange infrastructure in this domain (e.g. proprietary platforms, spreadsheets, e-mail, and still even fax).

Noscendo, a company providing pathogen identification via next-generation sequencing (see *Noscendo* 2020), offers a solution that could help to overcome this friction. They identify all critical test set components with globally unique and logically related identifiers: an SGTIN to identify each box containing all material and documentation, a Global Individual Asset Identifier (GIAI) identifying the test tubes and a Global Document Type Identifier (GDTI), which identifies the lab report form. In addition to that, they apply a QR code on the latter that encodes a GS1 Digital Link URI and enables authorized physicians and medical staff to access the respective lab test results once they are available.

It is important to note that unlike the areas of application described in the previous chapters data is restricted to legitimate users only, i.e. employs an authentication and authorization layer, thus being a suitable example demonstrating that GS1 DL is also a viable choice when pointing to services that involve personal data. Though the service provider is not from the food, but the healthcare sector, the underlying solution approach is applicable to the food sector, too (e.g. to enable easy data access to quality tests, food authenticity analysis results, certificates, etc.).

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5 Conclusion and outlook

Based on various prototypes and case studies in six areas of application, this paper demonstrated on how the utilization of a new standard, GS1 Digital Link, can simplify the exchange of data in the food sector. In so doing, it contributed to the scientific discussion in bringing forward a technical solution approach that is a promising means to address the increased need for data sharing in the food sector, required in light of nine trends in the food sector as identified in a recently published study.

Thereby, it provided illustrative examples as well as pointers to open source software (e.g. for a resolver service, for creating GS1 DL URIs, and for translating other GS1 syntax forms into GS1 DL URIs) that may be beneficial for organizations wishing to test or implement the discussed solution. In this context, the examples discussed in the course or this paper demonstrate that there is no first mover disadvantage – thus, companies can start implementing the solution at once without the need for any agreement with any of their trading partners.

In terms of future research areas, the following subjects seem to make sense:

a) the development of additional open source software easing the implementation of data sharing empowered by GS1 DL,
b) the investigation of further implementations, which also could result in valuable input for the international standardization work (e.g. by bringing forward additional link types),
c) in-depth case studies on the implementation of GS1 DL, thereby identifying e.g. technical and organizational challenges and exploring options on how to address them.

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Annex

A.1 Product description file, based on the GS1 Web Vocabulary

Machine-readable product description based on the GS1 Web Vocabulary Standard, formatted in JSON-LD (built with the Web Markup Tool provided by GS1, see https://www.gs1.org/1/smart-search-demo/)


```
{
    "@context": {
        "gs1": "http://gs1.org/voc/",
        "xsd": "http://www.w3.org/2001/XMLSchema#",
        "@vocab": "http://gs1.org/voc/"
    },
    "@type": "gs1:FruitsVegetables",
    "@id": "https://id.gs1.org/01/04012345123456",
    "productName": [
        {
            "@value": "Our best Gala apples",
            "@language": "en"
        },
        {
            "@value": "Unsere besten Gala Äpfel",
            "@language": "de"
        },
        {
            "@value": "Nuestras mejores manzanas de Gala",
            "@language": "es"
        }
    ],
    "gtin": "04012345123456",
    "brand": {
        "brandName": [
            {
                "@value": "Example Fruit",
                "@language": "en"
            },
            {
                "@value": "Example Fruit",
                "@language": "de"
            },
            {
                "@value": "Example Fruit",
                "@language": "es"
            }
        ],
        "@type": "gs1:Brand"
    },
    "brandOwner": {
        "@id": "Example Fruit Corporation"
    },
    "image": {
        "referencedFileURL": {
            "@id": "https://pixabay.com/photos/apple-variety-gala-fruit-red-3433826/"
        },
        "@type": "gs1:ReferencedFileDetails"
    },
    "gpcCategoryDescription": [
        {
            "@value": "Apples",
            "@language": "en"
        }
    ],
    "gpcCategoryCode": "10005900",
    "isProductRecalled": {
        "@value": "false",
```


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```
        "@type": "xsd:boolean"
    },
    "targetMarket": [
        {
            "targetMarketCountries": [
                {
                    "@type": "gs1:Country",
                    "countryCode": "DE"
                },
                {
                    "@type": "gs1:Country",
                    "countryCode": "ES"
                },
                {
                    "@type": "gs1:Country",
                    "countryCode": "GB"
                },
                {
                    "@type": "gs1:Country",
                    "countryCode": "US"
                }
            ],
            "@type": "gs1:TargetMarketDetails"
        },
        {
            "targetMarketCountries": [
                {
                    "@type": "gs1:Country",
                    "countryCode": "US"
                }
            ],
            "@type": "gs1:TargetMarketDetails"
        },
        {
            "targetMarketCountries": [
                {
                    "@type": "gs1:Country",
                    "countryCode": "DE"
                }
            ],
            "@type": "gs1:TargetMarketDetails"
        }
    ]
}
```


A.2 EPCIS query for a specific shipment


```
<?xml version="1.0"?>
<epcisq:EPCISQueryDocument xmlns:xs="http://www.w3.org/2001/XMLSchema"
xmlns:epcisq="urn:epcglobal:epcis-query:xsd:1" xmlns:xsi="http://www.w3.org/2001/XMLSchema-
instance" schemaVersion="1" creationDate="2019-12-19T14:27:21.342Z">
  <EPCISBody>
    <epcisq:Poll>
      <queryName>SimpleEventQuery</queryName>
      <params>
        <param>
          <name>MATCH_epc</name>
          <value xsi:type="epcisq:ArrayOfString">
            <string>urn:epc:id:sscc:4012345.1112223334</string>
          </value>
        </param>
      </params>
    </epcisq:Poll>
  </EPCISBody>
</epcisq:EPCISQueryDocument>
```


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Note: the upcoming version of the EPCIS standard (2.0), expected to be released by the end of 2020, will introduce a REST binding to capture and share EPCIS events, making it easier to access visibility event data.

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