



The Global Language of Business

## Web enabled, structured path identification

GS1 identification and AIDC carrier support for the EU Digital Product Passport via ISO/IEC 15459 identifiers, GS1 Digital Link URI and global 2D barcode migration

Empowering green product choices for consumers

*Release 1.0, July 2024*



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# 1 Introduction

GS1 welcomes the Ecodesign for Sustainable Products Regulation (ESPR), published in June 2024, as a key pillar of the EU Circular Economy agenda and of the Green Deal. Among several ambitious goals and new requirements, the ESPR introduces the Digital Product Passport for products and components being placed on the EU market <sup>1</sup>.

In this new ecodesign framework, built on expanding the older Ecodesign Directive, great attention is also given to providing better information to consumers and enabling their greener choices.

In its capacity as the ISO/IEC 15459 Issuing Agency for retail and other product types, GS1 has established a Mission Specific Work Group (MSWG) on Circularity and the Digital Product Passport, to ensure GS1 standards are ready for the regulatory implementation phase by industry that uses GS1 standards.

This paper discusses how the retail industry, through years of careful planning, is advancing interoperability of legacy supply chain systems to enable consumer smartphone connectivity to information, including regulatory data, on the web. At this stage, at the global level, industry is four years into a seven-year migration program that will mean billions in investment. This transition of their automatic identification and data capture (AIDC) systems to support 2D barcodes and a standardised web-enabled identification syntax will allow consumers to find a product landing page with links to many types of information (e.g., DPP, instructions for use, required maintenance, proper disposal).

These efforts support backward compatibility for supply chain AIDC implementations and represent forward-looking innovation required to share an extensible array of data with regulators and consumers via the web using smartphones. As it relates to regulatory data requirements, the goal is to utilise extensible data sharing techniques to provision information while avoiding national or region-specific approaches to foundational identification and AIDC carrier specifications and so avoid inventory segmentation, stock out conditions and significant increases in the cost of products for consumers.

By utilising structured ISO/IEC 15459 identifiers (e.g., GTIN) in the AIDC technology domain with the web-enabled innovation of ISO/IEC FDIS 18975, one AIDC carrier on each physical product can support business-to-business (B2B), business-to-government (B2G) and business-to-consumer (B2C) requirements at an international level.

Here is the full list of the prioritised product categories present in ESPR Article 18.5: iron and steel; aluminium; textiles, in particular garments and footwear; furniture, including mattresses; tyres; detergents; paints; lubricants; chemicals; some energy related products; information and communication technology products and other electronics.

ESPR will enter into force 20 days after its publication in the EU Official Journal, on 18 July 2024 and the full text is available here: [https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L\\_202401781](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202401781)

In summary, web-enabled, structured path identification facilitates a green future where multiple regulatory efforts around the world interoperate based implemented international standards that couple innovation with the years of work and investment that has already been needed to implement it.

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<sup>1</sup> See ESPR Article 1 paragraph 2 for out-of-scope products: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1781&qid=1719580391746>

## 2 Product identification landscape

There are various identification approaches being considered as unique product identifiers to support ESPR, but this paper will discuss the approach supported by GS1 users. The standardisation process of GS1 on DPP is in full swing and the following statements are based on the state of the play within this process. At this stage, one method aligns with ISO/IEC 15459 and FDIS 18975, use of GTIN, and [industry's 2D/GS1 Digital Link adoption plans for 2027](#). This method is web enabled, structured path identification.

The standards factors described in the points below are shared with a fair degree of confidence as these standards artefacts are used in transactions all around the globe and in every European nation.

1. Use of the Global Trade Item Number (GTIN) or GTIN with a version code (e.g., product variant) to support ESPR granularity for 'model'.
2. Use of GTIN with a lot/batch number to support ESPR granularity for 'batch'.
3. Use of GTIN with a serial number to support ESPR granularity for 'item'.
4. All ISO/IEC 15459 identifiers that begin with a digit (0, 1, 2, 3, 4, 5, 6, 7, 8, or 9) signify the identifier is issued by GS1 and identifiers that begin with an alpha character belong to other ISO/IEC 15459 Issuing Agencies. This means GTIN SHALL begin with a digit and appear first in the full identification string when GTIN and other data elements (e.g., variant, lot/batch number, serial number) are stored as a concatenated string.
5. All the identifiers above, once allocated to a product subject to the ESPR, SHALL not be reused to identify another product to safeguard uniqueness. Additional rules may be required (e.g., requirements for 'non-new' products and configurable products).
6. There SHALL be a single 'value' for any identification data element on any single physical product, its packaging, or documentation accompanying the product.
7. GS1 Digital Link URI syntax will be used in the AIDC carrier to permit consumer smartphone web connectivity (using the full URI) but the identification data elements, which will persist independent of the domain address, will be used to identify the product in the DPP registry.
8. Lot/batch and serial number uniqueness per each GTIN is recommended to reduce barcode size or tag cost while facilitating decentralised allocation.
9. The coarsest level of granularity as specified by regulation will always be mandatory but finer levels of identification granularity will remain optional or mandatory for non-DPP regulatory based business processes as specified by other GS1 AIDC application standards.
10. ISO/IEC 15418 GS1 Application Identifiers SHALL be used exclusively with GS1 identifiers by GS1 user AIDC systems (design, printing, verification, scanning).

**NOTE:** The ANSI MH10.8 Data Identifier (DI) standard deprecated the use of DIs (3P, 4P, 8P, 17P, 17S, 2V, and 3V) with GS1 identifiers in 2020 to conform with ISO/IEC 15418, 15459, 15424, and 15434. DI 4N remains and is defined as, "Coding Structure and Formats in Accordance with GS1 Application Identifiers (AI plus data) (GS1)." This may be useful to user companies that need to encode DIs then GS1 identifiers with AIs, but GS1 standards do not support DI 4N because GS1 standards-conformant AIDC systems do not require processing of DIs.

Table 2.1-1 on the following page summarises how web-enabled, structured path identification, as defined in ISO/IEC FDIS 18975 (final standard approval expected in 2024), when coupled with QR Code and possibly other AIDC carriers described in Section 3 (e.g., RAIN RFID, Data Matrix, NFC), is compliant with ESPR, conformant

with ISO/IEC and GS1 standards, and supported by [industry plans to support 2D barcodes with GS1 Digital Link URI syntax by 2027](#).

**NOTE:** It should be mentioned that ISO/IEC FDIS 18975 allows for two approaches, structured path and query string. While GS1 Digital Link URI conforms to the structured path approach, other ISO/IEC Issuing Agencies may specify the query string approach utilising ANSI MH10.8 Data Identifiers.

## 2.1 Unique Product Identifier (UPID) method for GS1 users

Unique product identifier discussions have, are, and will occur inside and outside GS1 in Forums like CEN/CENELEC, Cirpass, and other venues. This Section will provide the state of play in a broad directional sense for the method (#1 below) GS1 standards users support, do not support, and others they do not use and will not assess. Table 2.1-1 below looks at various proposals being discussed (columns) and weighs them against the criteria for assessment by GS1 user companies (rows) based upon the ESPR and the EU Standards Request. Descriptions of the criteria and methods follow Table 2.1-1.

Unique Product Identification (UPID) methods for Digital Product Passport	Method 1: ISO/IEC 15459 via FDIS 18975 and 15418 using ANSI DIs (per IEC 61406-2) or GS1 AIs (per GS1 Digital Link URI)	Method 2: ISO/IEC 15459 and 15418 using ANSI MH10.8 Data Identifiers (DIs) or GS1 Application Identifiers (AIs)	Method 3: ISO/IEC 15459 via UPID + URL domain "stub" and 15418 using ANSI DIs but not GS1-Application-Identifiers	Method 4: IEC 61406-1	Method 5: Decentralized identifiers (DIDs)
Globally unique	Within AIDC domain per ISO/IEC 15459	Within AIDC domain per ISO/IEC 15459	Within AIDC domain per ISO/IEC 15459		
Implementable by 31 Dec 2027	Migration path to pervasive support in industrial scanning devices is planned by GS1 users by 2027; unknown for non-GS1 sectors but DI logic is supported	Requires APP on all smart devices	Requires APP on all smart devices		
Persistent	Per established Issuing Agency rules	Per established Issuing Agency rules	Per established Issuing Agency rules		
Web resolvable syntax w/o APP					
Openness					
ISO/IEC 15459 compliant					
Granular Product ID	AIs & DIs support model, lot, item level ID	AIs and DIs support model, lot, item level ID	AIs and DIs support model, lot, item level ID but AI (8200) only supports model level and is only approved for legacy applications		
Extensible (modifiable)	Encoded data can change and still support persistent ID	Encoded data can change with persistent ID	Encoded data can change with persistent ID		

**Globally unique:** ESPR Article 10 (1) (a) states, "it [digital product passport] shall be connected through a data carrier to a persistent **unique** product identifier." Standards mandate, Recital (9) states, "The unique identifier and the corresponding identification

*system of the product passport are to allow interoperability with existing legacy identification systems, as far as possible."*

As GS1 standards user companies manufacturer products for European Union placement in every country of the Union and over 100 countries outside of it, this means that two products SHALL not have the same identifier and one product SHALL not have two different identifiers. ISO/IEC 15459, parts 2 and 3, ensure that GS1 identifiers are unique in relationship to other ISO/IEC 15459 conformant Issuing Agencies and GS1 application standards (including identifier allocation rules) ensure GS1-standards conformant implementations conform to ISO/IEC 15459-3 (6) Common Rules.

**Implementable by 31 Dec 2027:** The date when the regulation is expected to be in force for the first product types using GS1 standards. By this date, the technology to encode (print barcodes, encode tags), verify barcode print quality, and decode (scan barcodes, read tags) must be in place. Given the implementation timeline is now less than three and a half years away, anything not already pervasively implemented or well on its way to being implemented will be problematic for consumers and industry who are using GS1 standards, particularly small to medium size companies. Even using standards that are implemented will present challenges for industry (e.g., small product marking, permanent product marking, products composed of multiple products each covered by DPP, variable data from granular identifiers encoded in AIDC data carriers as high production line speeds (100s or 1000s per minute).

**Persistent:** ESPR Article 10 (1) (a) states, "*it [digital product passport] shall be connected through a data carrier to a **persistent** unique product identifier.*" Here there are several factors to consider.

- **Consistency:** Once the unique identification is assigned, it SHALL remain unchanged. Conformity to GTIN allocation rules ensures that a GTIN, once assigned to a product, is not used on another product.
- **Preservation:** The identifier SHALL be preserved throughout the expected lifetime, or as long access to the data in the digital product passport is required (lifecycle, lifetime, end-of-life). The use of GS1 Digital Link URI provides the Web resolvable feature (see next item) but the identification data elements (e.g., GTIN, GTIN variant, lot/batch number, serial number) will be used independently of the domain address to register the product with the Registry. This means the structured identifiers, assigned per GTIN allocation rules, will persist in the registry independent of a domain address which may not persist. If a product changes in a way that requires a new identifier per a Delegated Act, a new identifier needs to be created to reach the new DPP data.
- **Registry accessible:** The identifier SHALL remain available including after an insolvency, a liquidation, or a cessation of the economic operator that created the product passport. By using permanently assigned identifiers in the Registry, this is enabled while also allowing the URL to change when additional data elements may be needed for non-regulatory requirements such as needing to add an expiration date, weight or measure in the AIDC carrier.
- **Physically accessible:** The identifier in the AIDC carrier SHALL remain available on the product, product packaging, or documentation accompanying the product.

**Web resolvable without an APP:** Standards mandate, Recital (9) states, "*The unique identifier and the corresponding identification system of the product passport are to allow interoperability with existing legacy identification systems, as far as possible. The product passport system is to allow a suitable assignment of data carriers to the product which should be accessible **without the need for the download of additional software.** Moreover, all identifiers are to be portable and transferable through an open interoperable data exchange network without vendor lock-in, including their portability across resolver services or systems.*" Given the identifier should be used to access the digital product

passport without the need of additional software, a consumer will need to scan/read the AIDC carrier using their smartphone and reach a Web resource with DPP information without needing to download additional software.

**Openness:** The Standards Mandate Recital (9) states, *"The unique identifier and the corresponding identification system of the product passport are to allow interoperability with existing legacy identification systems, as far as possible. The product passport system is to allow a suitable assignment of data carriers to the product which should be accessible without the need for the download of additional software. Moreover, all identifiers are to be portable and transferable through an open interoperable data exchange network without vendor lock-in, including their portability across resolver services or systems."* And in Recital (15), *"European standards should be technology neutral and performance-based. They contribute to ensuring equal conditions of competition among relevant economic operators, in particular small and medium-sized enterprises. Indirectly those standards also contribute to lower production costs benefitting consumers, to increase the sustainability, to limit the energy consumption of the product passport system and to ensure technical interoperability."*

The statements above are clearly aligned with the goals for a web-enabled, structured path identification method. This method is based on internationally recognised standards implemented by industry including small and medium enterprises, are developed without unknown IP claims, avoid vendor lock-in and provide the transparency to ensure technical interoperability or to determine if it is not possible.

**NOTE:** Ensuring interoperability with legacy systems has been core to the years of careful planning around innovation of retail product identification. These efforts aim to balance backward compatibility for supply chain processes with forward-looking innovation that supports the sharing of rich and relevant data with regulators and consumers.

The goal is to avoid inconsistent national or regional approaches to identification and AIDC carriers as this would cause segmentation of inventory, stock out conditions and would greatly increase the cost of products for consumers. By utilising structured ISO/IEC 15459 identifiers in the AIDC technology domain with the web-enabled innovation of ISO/IEC FDIS 18975, one AIDC carrier can support business-to-business (B2B), business-to-government (B2G) and business-to-consumer (B2C).

**Interoperable per ISO/IEC 15459 compliance:** ESPR Annex III (c) states, *"The Global Trade Identification Number as provided for in International Organization for Standardisation/International Electrotechnical Commission standard ISO/IEC 15459-6 or equivalent of products or their parts"*; and ESPR Annex III (l) states, *"...the unique product identifier referred to in point (b), ... shall, where relevant for the products concerned, comply with standards ISO/IEC 15459-1:2014, ISO/IEC 15459-2:2015, ISO/IEC 15459-3:2014, ISO/IEC 15459- 4:2014, ISO/IEC 15459-5:2014 and ISO/IEC 15459-6:2014."*

GS1 identification and automatic identification and data capture (AIDC) standards comply with ISO/IEC JTC1 SC31 standards for unique identifiers encoded in AIDC carriers used in the supply chain. These international standards domain for unique identification via AIDC technology is utilised in the supply chain from upstream suppliers to manufacturers, from manufacturers to consumers, and downstream actors. ISO/IEC 15459 ensures that each Issuing Agency identifier will not conflict with any other and establishes rules to facilitate interoperability. ISO/IEC JTC1 SC31 provides the baseline for international AIDC supply chain management and consumer communication in a broad array of industry sectors supported by 10,000s of solution providers and systems integrators. By utilising these standards and embracing the innovation promised by FDIS 18975, one barcode can support trade, consumers, and regulatory requirements and aligns with the retail 2027 2D migration program.

Demand for ISO/IEC 15459 compliance in the context of DPP comes also from the fact it reflects all aspects of a well deployed standard: it is international, has been in place for

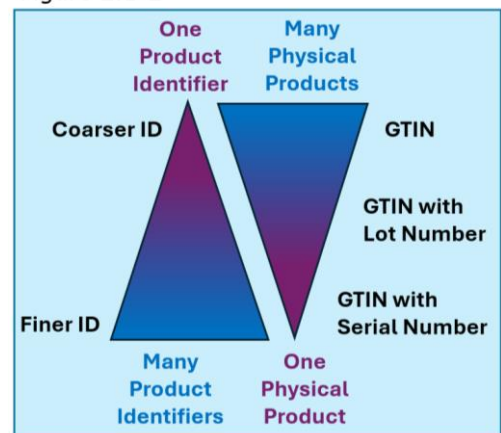
decades, is widely implemented, continues to expand for additional Issuing Agencies, requires all Issuing Agencies to follow Common Rules (described later in the document), and thus is trustworthy and cost efficient.

**Granular product identification:** The ESPR Article 10 (1) (f) states, “The data included in the digital product passport shall refer to the **product model, batch or item** as specified in the delegated act adopted pursuant to Article 4;” and the Standards Mandate Section 1.4 states, “The unique product identifier shall always allow the possibility to include the three different granularity levels, i.e. model, batch, or item. This is needed because product passports of products sold online will only be available at model level, while product passports may need to be available at batch level with the item level. The move from batch to item level will also be necessary for product groups for which updates of product passports will be expected, for example due to repair activities. In addition, in some cases, for instance batteries covered by Regulation (EU) 2023/1542, the granularity level for the product passport is at item level.”

For GS1 users, the corresponding GS1 identifiers are shown in the Figure 2.1-2. GS1 users also support the statement in the Standards Mandate Section 1.4. The granularity of the identifier required may differ for various supply and value chain processes such as:

- B2B order fulfilment
- B2C order fulfilment (including online distance selling)
- Product traceability or recall
- Warranty/repair, etc.

Figure 2.1-2



The web enabled, structured path approach of ISO/IEC FDIS 18975 accommodates this need for addressability of various granular identification data elements by allowing one AIDC system to pass the identifier elements called for by the application (e.g., GTIN or GTIN plus variant for order fulfilment, GTIN plus lot/batch number for a traceability event record, GTIN plus serial number of a warranty return). This is illustrated in Figure 2.2-1.

**Note:** While GS1 users do not use ANSI MH10.8 Data Identifiers (DIs), it is our understanding this standard, used by other ISO/IEC 15459 Issuing Agencies, provides DI qualifiers for non-GS1 identities at the model, lot/batch, and item level.

**Extensible (modifiable):** In the supply chain of GS1 user companies, the ability to add additional information in an AIDC carrier is a commonplace requirement. For example, a product might appear in the supply chain today with a product identifier like GTIN with a lot/batch or serial number in the AIDC carrier, but later, based on a new regulatory, trading partner, or consumer requirement, the manufacturer might be required to add other data elements like a date, a weight, or a measurement in the AIDC carrier. This flexibility must be accommodated without impacting the registered DPP product identifier of GS1 user companies.

## 2.2 Product identification methods summary

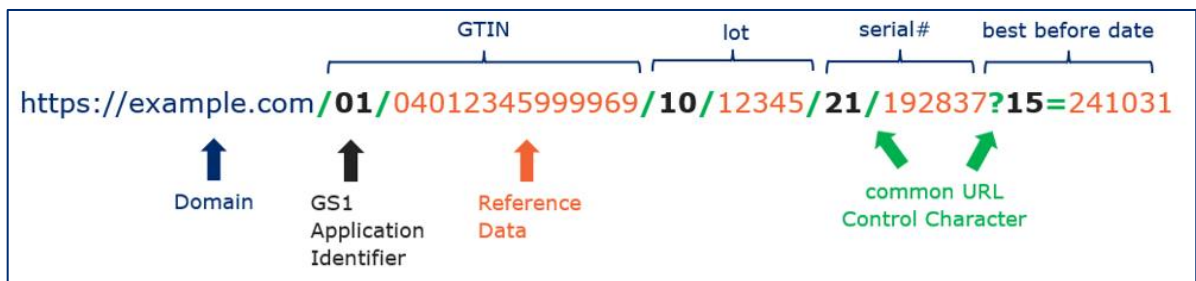
**Method 1:** This method does not rely on the consumer to install any additional software or an app on their smartphone to make the Web link to DPP information. They simply use the smartphone to scan an AIDC carrier, land on a Web page, and then click on different sources of information per their interest (e.g., DPP data, instructions or use). By using these identification elements independent of the domain address and never reallocating them once assigned, the persistence of product identification is assured. All of this occurs by encoding the domain address of the manufacturer before the GS1 identifiers in a structured, web-enabled syntax.



GS1 user companies support the use of a URL with structured ISO/IEC 15459 conformant identifiers (e.g., GTIN, GTIN with lot and/or serial numbers) encoded in the FDIS 18975 conformant GS1 Digital Link URI syntax because:

1. Allows EU registration of structured, persistent product identifiers that ensure uniqueness and interoperability between ISO/IEC 15459 Issuing Agency identifiers.
2. Enables consumers to open a web site using their smartphone's native camera to scan a 2D barcode and then access regulatory or other information (e.g., instructions for use) from links on the landing page.
3. Does not utilise a domain address for product identification as a domain address is not always persistent and would duplicate identifiers used in today's supply chain.
4. Allows GS1 users to add additional structured data elements to the AIDC carrier, as needed, such as an expiration date, weight or measure without compromising the unique identifier that is comprised of other structured identification data elements.

**Figure 2.2-1: Method 1: Web-enabled, structured path, GS1 identifiers**



As it relates to ISO/IEC 15459-3 Common Rules, a unique identifier complies with ISO/IEC 15459 when "An organization can claim that it is compliant with ISO/IEC 15459 (all parts or a specific part) if it can allocate and process identities according to the rules defined in ISO/IEC 15459-3, Common rules, ISO/IEC 15459-2, Registration procedures and all or any other part."

Method 1 is compliant because:

1. The identifier SHALL be assigned to an individual entity whether product, product/production lot/batch, product/production item.
2. GS1 Application Identifiers SHALL be used as the qualifier method.
3. The structured path product identifier SHALL begin with GS1's Issuing Agency Code (0, 1, 2, 3, 4, 5, 6, 7, 8, or 9) followed by a Company Identifying Number (GS1 Company Prefix).
4. Each structured product identifier element (e.g., GTIN, lot/batch#, serial #) SHALL conform to the GS1 General Specifications specified format per each GS1 Application Identifier.
5. The structured product identifier elements, once allocated to a product, SHALL never be allocated to another product.
6. Each identifier qualifier (GS1 Application Identifier) SHALL enable the elements to be stored in a database field, carried by a message, or used in a search. It SHALL determine the maximum length of the identifier element and the characters that can be used.
7. After the domain, the minimum number of identifier elements (e.g., GTIN with variant, lot/batch, and/or serial number) SHALL be used to keep the encoding length as short as possible.
8. The identity SHALL use characters from the invariant set of ISO/IEC 646.

For recognising a GS1 Digital Link URI, regular expressions can be used as plausibility check. The regular expression test determines whether the string of characters conforms to GS1 Digital Link URI per "A scanner working within the GS1 system that recognises GS1 Digital Link SHALL only pass on the scanned string if it has determined that it is plausibly a conformant GS1 Digital Link URI."<sup>2</sup>

**Method 2:** This method, pervasively implemented within industrial supply chain scanner systems, is utilised by product types across the many ISO/IEC 15459 Issuing Agencies such as automotive, blood and tissue, electronics, chemical, retail consumer products, pharmaceuticals, medical devices, publishing, rail, and construction. This method is not resolvable to a Web address by scanning a barcode using the consumer smartphone's native camera, but method 1, supported AIDC carriers as described in Section 3, permit this for ANSI Data Identifiers and GS1 Application Identifiers per ISO/IEC FDIS 18975.

**Method 3:** This method is like method 2 but includes the mandatory use of an additional data element, a 'URL stub' (<https://example.com>), qualified by DI (34L) or AI (8200). This method requires a consumer to install an app (additional software) within their smartphone to extract the identification data element(s) then append them in a sequence to generate a URL to find online info. GS1 AI (8200) requires additional software on consumer smartphones and can only support GTIN (does not support GTIN with variants, lot/batch numbers, or serial numbers in a structured way) so all new applications for GS1 use GS1 Digital Link URI (see Method 1). ANSI MH10.8 Data Identifiers, including (34L), are not used by users who utilise GS1 standards based AIDC systems and so any assessment of DI (34L) must be performed by other Issuing Agencies.

**Method 4 (IEC 61406-1) and Method 5 (Decentralised Identifiers):** These methods are not used nor supported by users of GS1 standards-conformant, automatic identification and data capture (AIDC) systems. For this reason, GS1 has not assessed their fitness to meet ESPR requirements, conformity to international ISO/IEC JTC1 SC31 (AIDC technology) standards, or their current or planned implementation levels in AIDC technology systems. If they are appropriate for product types that are not using GS1 standards and are interoperable with the international AIDC standards in Annex A, GS1 users cannot speak for others who have implemented these methods in their AIDC systems and consumer devices.

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<sup>2</sup> <https://ref.gs1.org/standards/digital-link/uri-syntax/>, chapter 6.1, p. 39.

### 3 AIDC carrier landscape

AIDC carriers used by GS1 users are carefully selected, some for pervasive adoption, others for niche adoption. Over the 51 years since IBM’s EAN/UPC barcode was selected by an industry committee, GS1 has added three linear (1D) barcodes (ITF, Code 128, GS1 DataBar), two 2D barcodes (Data Matrix, QR Code), and RFID for use in open application environments.

Approval of additional AIDC carriers over this long history comes when an industry requirement within an application area is unmet by existing technologies or is better met by a new technology, however the goal is to allow any company to put a barcode on their products, returnable assets, logistic units, etc. that can enter the open supply chain and be scanned or read by the AIDC systems installed by millions of companies. For this reason, GS1 has a [Policy](#) for their adoption, approved by the GS1 General Assembly, that sets the criteria that must be considered such as 90% pervasive support for the technology, its license position being known and acceptable, etc.

Once an AIDC data carrier becomes an option in one application standard, it is typically used in addition to the previous technology to balance innovation with backward compatibility. Once support for the new AIDC carrier reaches an implementation tipping point (again the 90% threshold), the entity can be identified with the new AIDC carrier instead of the previous one. To achieve this, GS1 users, Member Organisations, and AIDC solution providers (design software, printing systems, print quality verification systems, scanners, processing software) work together to communicate the reason for change, measure the progress of change, then use the reported progress to make decisions on when the tipping point is reached.

Fortunately, the retail industry began the effort for 2D AIDC carriers and GS1 Digital Link URIs four years ago and industry’s aspirational goal of 2027 aligns with the ESPR implementation timeline and requirement to encode a “unique identifier” defined by the ESPR as a “*unique string of characters for the identification of a product that also enables a web link to the digital product passport.*” Even so, as the GS1 Mission Specific Work Group working on Circularity/DPP progresses, there are still data carrier assessments and decisions that must be weighed. This section discusses the current state of play for AIDC carriers used by GS1 users as it relates to the ESPR.

Upcoming EU delegated acts may specify which data carriers may be suggested or accepted and we underline that the due diligence to foster their approval and most importantly smooth implementation takes many years to achieve and that with GS1/ISO compliant data carriers, this will be already completed or well underway.

A summary of DPP useful AIDC carriers is found in Table 3.1-1 with details following it.

**Table 3.1-1 Assessment of AIDC carrier candidates**

1. There are hundreds	1. All Automatic Identification and Data Capture (AIDC) Carriers includes:	Anything that automates identification and data capture (e.g., 1D barcode, 2D barcode, RFID, NFC, biometrics, watermark)
2. Dozens including A (QR Code), B (Data Matrix), C (RAIN RFID), and D (NFC)	2. ISO/IEC, AIM or NFC Standard AIDC Carriers includes:	ISO/IEC JTC1 SC31 or AIM standards (e.g., QR Code (QR), Data Matrix (DM), UHF RFID, NFC, GS1 DataBar, Code 39, Code 128, EAN/UPC, ITF)
3. A and D now B and C TBD	3. Pervasive smartphone support – ISO/IEC 18975 AIDC carrier by 2027 without additional software includes:	Yes: QR code, NFC Maybe: Data Matrix (requires software upgrade across all smartphones), RAIN RFID (requires additional hardware, software, and ETSI certification)
4. See table →	4. Multi-purpose (B2B, B2C, B2G) AIDC carriers include:	B2B: Barcodes and RAIN RFID (supply chain) and NFC (financial transactions) B2G for ESPR: Barcodes and RAIN RFID (NFC TBD) B2C: QR Code and NFC (RFID & DM TBD)
5. A, B, D C - TBD	5. Isolation of one AIDC carrier/ item by smartphones includes:	Yes: Barcodes and NFC To be determined: RAIN RFID
6. See table →	6. Producibile & persistent include:	TBD per space or memory, encoding/markings

Starting from the “funnel top” above, the following explanations are provided:

1. There are hundreds of AIDC carrier technologies in the world.
2. Of those, a few dozen have advanced to attain international standards designation.
3. Of those, four have been discussed by GS1 users as candidate technologies for product identification for DPP based on their existing use in the supply or value chain. The four are QR Code, Data Matrix (another 2D barcode symbology), RAIN RFID, and NFC. Of those, the level of native consumer smartphone capability (that does not require the consumer to download software) range from: practically ubiquitous (QR Code), heavily implemented (NFC), unevenly implemented (Data Matrix), to not currently supported (RAIN RFID).
4. The industry strategically requires a single barcode on a product that supports supply chain communication, consumer interaction, and regulatory processes. Currently, the use of GS1 Digital Link URI with structured GS1 identifiers in AIDC carriers is essential to achieving this goal.
5. Barcodes require the consumer to aim the camera at it and NFC requires the consumer to place the product next to the smartphone to ensure the consumer receives the DPP data that pertains to the intended product. One of RAIN RFID’s advantages in certain use cases is readers can read all the tags within a large read range. This advantage in those applications can be very helpful in creating greater visibility for many supply chain applications. Some of these will enable B2B data sharing of DPP data or even the unique capability to build DPP data about products and components upstream. As it pertains to B2C use, GS1 has learned that the RAIN Alliance will research if it is possible to isolate the intended tag using consumer smartphones and looks forward to collaborating with them in the standards process.
6. The DPP covers a broad range of product types, many of which are produced by GS1 user companies, many in very high volumes at very high production line speeds. For this reason, it is critical that the AIDC carrier be producible. There are too many factors to list here, but for example: How will an AIDC carrier fit on a small, curved surface of a cosmetic pencil, be printed in line for shampoo bottles at hundreds per minute, be etched on a metal part used in a rail car? What is the impact of the data required on the tag memory?

### 3.1 Quick Response (QR Code)

QR Code encoding product identifiers in the GS1 Digital Link URI syntax meets the requirements of the regulation (QR Code is specifically cited by the ESPR), is supported ubiquitously by consumer smartphone native cameras, can be conformant with ISO/IEC 15459 and FDIS 18975, and is central to [industry’s 2D/GS1 Digital Link adoption plans for 2027](#). For these reasons, QR Code with GS1 Digital Link URI syntax is very likely to be supported in the GS1 AIDC Application Standard for DPP.

### 3.2 RAIN RFID (also referred to as UHF RFID)

RAIN RFID is used in addition to barcodes on some products manufactured by GS1 user companies. This technology has the capacity to carry GS1 Digital Link URI in a binary string and, therefore, is to be considered for supply chain use cases. However, the binary string is not natively supported by smartphones to produce a web result and it is unclear how a consumer’s smartphone would read and isolate the “intended” tag versus all tags “available within its read range”. GS1 has learned the RAIN Alliance is working on how these questions could be addressed and looks forward to collaborating with them in the standards process. For these reasons, RAIN RFID with GS1 Digital Link URI syntax is very likely to be supported in the GS1 AIDC Application Standard for DPP.

### 3.3 NFC

NFC is used in addition to barcodes on some products manufactured by GS1 user companies, but it is not currently an approved GS1 data carrier. This means to be prepared, GS1 should begin the assessment of NFC per [GS1's Policy on Data Carrier adoption](#) in the event NFC is specified as an AIDC carrier option within a Delegated Act. Even so, this technology has the capacity to carry GS1 Digital Link URI and is natively decoded by smartphones to produce a web result. NFC also enables the consumer to isolate the "intended" tag as the tag "available within its read range" is typically limited to the one held next to the smartphone. The assessment will occur only if the GS1 standards group establishing which AIDC carriers will be used by GS1 user companies requests NFC or unless there is a clear regulatory requirement for it.

### 3.4 Data Matrix

Data Matrix 2D barcodes encoding product identifiers in the GS1 Digital Link URI syntax (conformant with ISO/IEC FDIS 18975), meets the requirements of the regulation, and is supported by [industry's 2D/GS1 Digital Link adoption plans for 2027](#). With that said, Data Matrix is not ubiquitously supported by the cameras resident in consumer smartphones. This means that adoption would require smartphone support of this technology across Europe by 2027. This then raises the question, why would Data Matrix be considered if QR Code is already natively supported by smartphone camera connection to the Web? The primary factors both relate to Data Matrix's capability versus QR Code on some small, cylindrical products where equivalent error correction (~30%) is required of either barcode type.

1. Data Matrix has a size advantage over QR Code at the same level of error correction check (ECC) as the data expected for DPP AIDC carrier encoding should be around 40-70 characters maximum.
2. Rectangular Data Matrix, helpful on small or cylindrically shaped products, is supported by supply chain scanning devices where rectangular QR support is quite low.

If the GS1 standards group establishes these benefits warrant it, an initiative regarding consumer smartphone readiness could be warranted.

## Annex A: GS1 user companies require the following international AIDC Standards to be included in the European Standards Mandate list

### ISO/IEC JTC1 SC31 Standards

- 15418: *Information technology; AIDC techniques; GS1 Application Identifiers and ASC MH10 Data Identifiers and maintenance*
- 15459-2: *Information technology; AIDC techniques; Unique identification, Registration procedures*
- 15459-3: *Information technology; AIDC techniques; Unique identification, common rules*
- 15459-4: *Information technology; AIDC techniques; Unique identification, Individual products and product packages*
- 15459-6: *Information technology; AIDC techniques; Unique identification, Groupings*
- 15434: *Information technology; AIDC techniques; Syntax for high-capacity AIDC media*
- FDIS 18975: *Information technology; AIDC techniques; encoding and resolving identifiers over HTTP*
- ISO/IEC 15424: *Information technology; AIDC techniques; data carrier/symbology identifiers.*
- ISO/IEC 16022: *Information technology; AIDC techniques; Data Matrix bar code symbology specification, as it pertains to GS1 DataMatrix.*
- ISO/IEC 18004: *Information technology; AIDC techniques; QR Code bar code symbology specification*
- ISO/IEC 15415: *Information technology; AIDC techniques; bar code print quality test specification; two-dimensional symbols.*
- ISO/IEC 15426-2: *Information technology; AIDC techniques; bar code verifier conformance specification - Part 2: Two-dimensional symbols.*
- ISO/IEC TR 29158: *Information technology; AIDC techniques; direct part marking (DPM) Quality Guideline.*
- ISO/IEC 18000-63: *Information technology — Radio frequency identification for item management, Parameters for air interface communications at 860 MHz to 960 MHz Type C*

### GS1 Standards

- GS1 General Specifications (as normatively referenced by ISO/IEC 15459 parts 1-6, ISO/IEC 15418, ISO/IEC 15424, ISO/IEC 15434)
- GS1 Digital Link URI Standard (as informatively referenced by ISO/IEC FDIS 18975)