The Global Language of Business

Implementation Considerations for Unique DPP Product Identifiers

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1 Introduction

The paper has been prepared for regulators to consider implementation factors for various identifier methods being considered for Digital Product Passports e.g., in Europe in a) AIDC[1] data carriers, b) regulatory registries, c) production or distribution scanning systems, and d) retail point-of-sale (POS) scanning systems.

The paper begins with a decision tree that explores a series of 'patterns' that may be found inside an encoded URI string in a QR Code barcode, Data Matrix barcode, or NFC tag. The 'patterns' can be used to determine which type of DPP product identifier is present. Specifications by ISO/IEC, GS1, ANSI MH10, the DOI Foundation and potentially others can then determine how the identifier can be parsed from the URI for registry, production, distribution, and retail point-of-sale scanning systems.

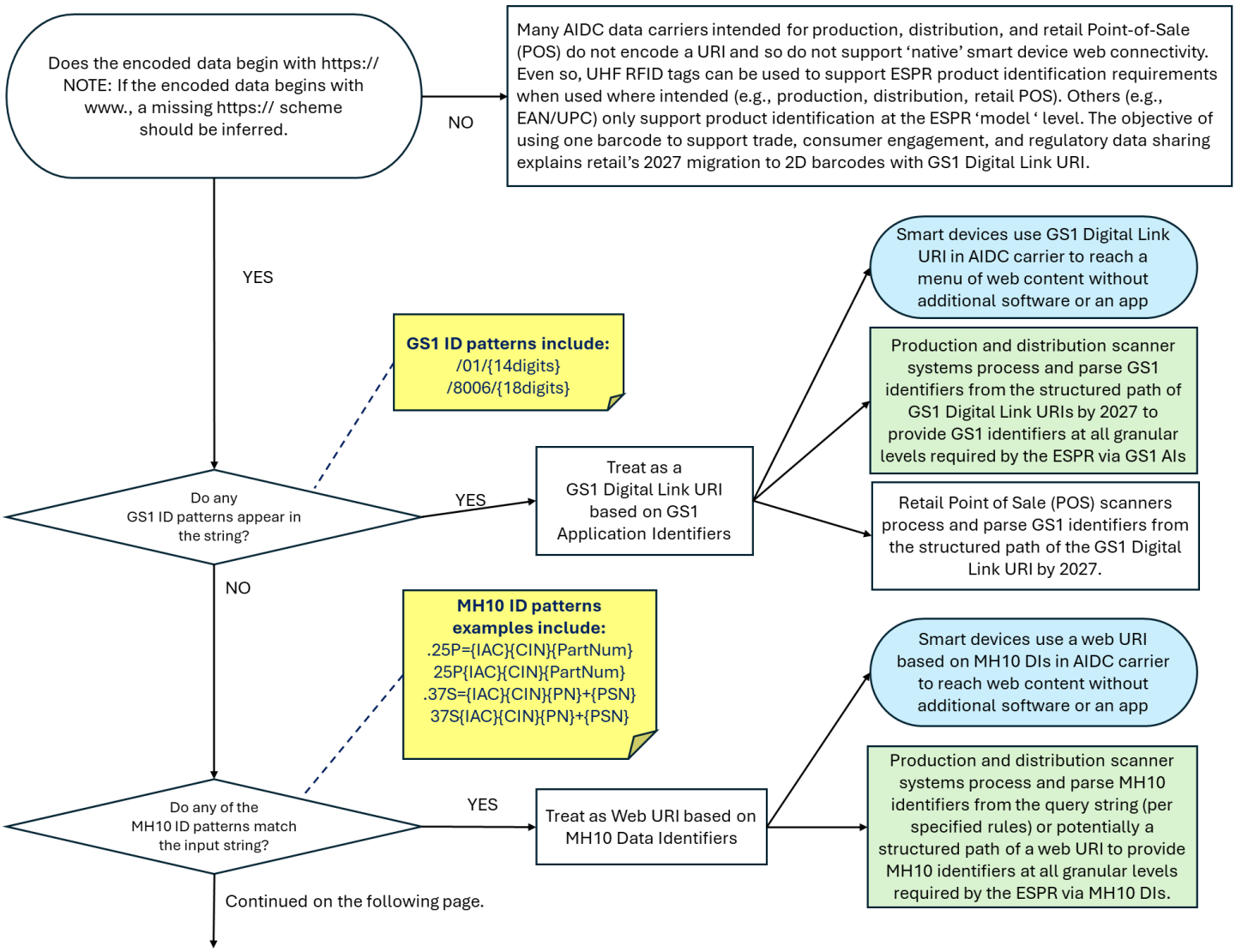
The paper continues after the decision tree by assessing identification and AIDC data carrier combinations. It provides:

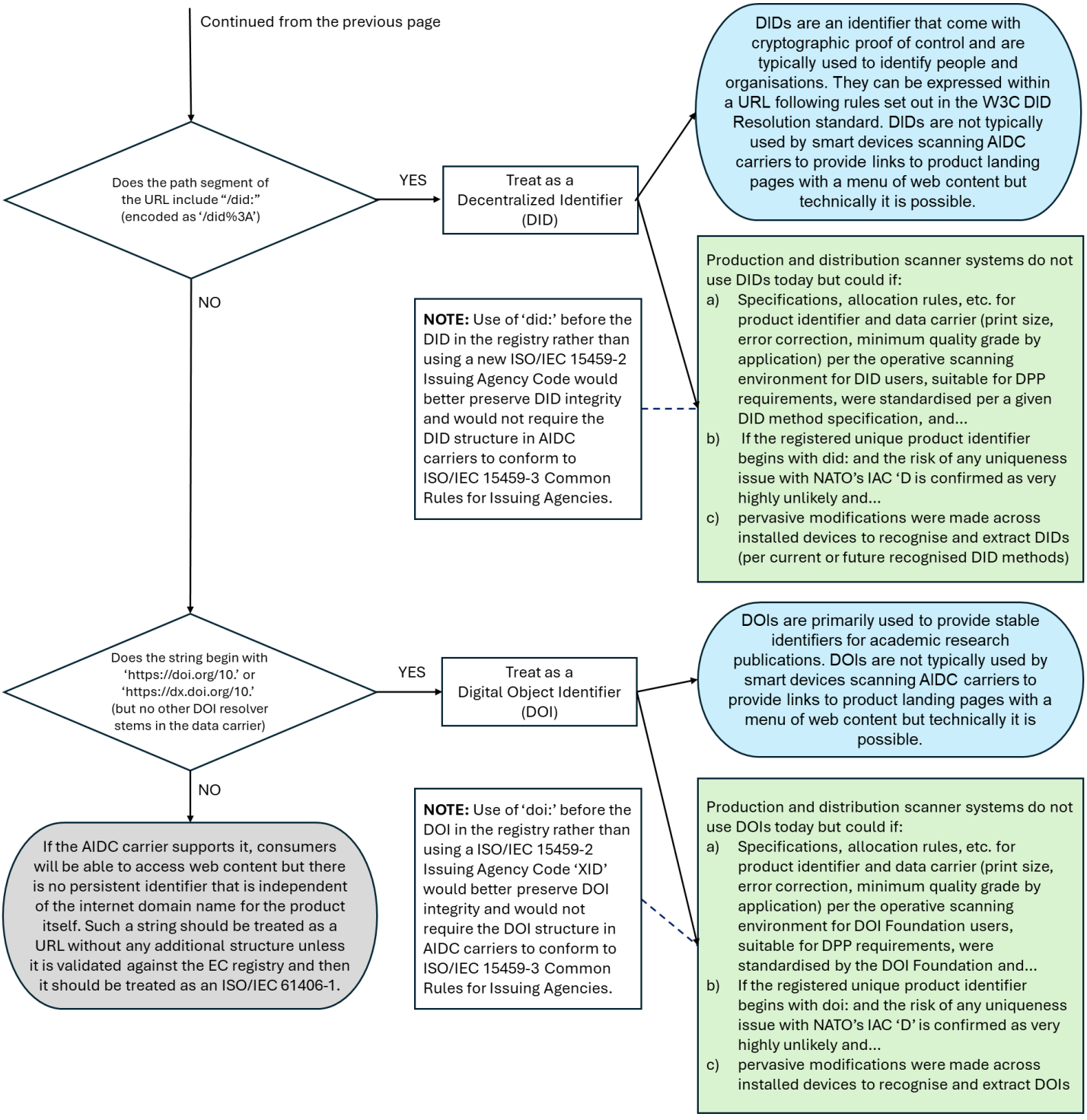
1. Five separate tables for five different identification methods.
2. Within each identification method's table, there are sub-sections for each AIDC data carrier.
    a. The paper focuses on four data carriers, QR Code, Data Matrix, NFC, and UHF RFID as they are likely to serve the needs of industry, consumers, and authorities for ESPR.
    b. QR Code and Data Matrix are assessed together as the result is the same for both.
3. For each identification/carrier combination, a series of rows is provided based on identification and data carrier assessment criteria and has been completed for the major operating environments for scanning/reading. The three application environments are:
    a. Consumers using smart devices to reach web content without additional software or apps
    b. Production and distribution scanning/reading (including online order fulfilment)
    c. Retail point-of-sale (POS) scanning/reading

The assessment explores another important aspect, implementation status for each identification/data carrier combination in the three major application environments for products covered by the ESPR.

The decision tree on the following page covers identification methods that can lead to a product landing page with a menu of data or resources for consumers. It assumes the consumer will not be required to install any software or apps on their smart device. The decision tree begins by acknowledging there are existing identification / data carrier combinations, used in production, distribution, and retail Point-of-Sale (POS), that may not meet the ESPR smart device requirement but aid ESPR data sharing in the supply chain.

[1] Automatic Identification and Data Capture





Please note:

The assessment is only filled in for method 1 used by GS1 standards users (GS1 Digital Link URI). Assessments of the other methods should be provided by the standards development organisations that utilise them.

The methods are limited to those covered by the decision tree above. Additional methods that work today in the supply chain but not with smart devices could be used in production and distribution environments per the first 'no' point in the decision tree.

2 Method 1: ISO/IEC 15459 conformant identifiers / 18975 web-enabled, structured path identifiers qualified by ISO/IEC 15418 GS1 Application Identifiers (referred to in GS1 as GS1 Digital Link URI)

ID Standard Requirement ID and Data Carrier Standard Requirement DC Standard Requirement

Method 1 – GS1 Digital Link (method 2 covers the same method using MH10 DIs)	Smart Device (no app)	Production and distribution scanners, readers and applications (including online fulfilment, customs, etc.)	Retail Point-of-Sale (POS) scanners, readers and applications
QR Code and Data Matrix			
Globally unique within domain	Yes, as URI	Yes, per ISO/IEC 15459	Yes, per ISO/IEC 15459
Persistent	Manufacturer domains within URI may lapse	Yes, as the identifier is registered independent of the domain in URI	Yes, as the identifier is registered independent of the domain in URI
Syntax	Encodable in URI	Structure for parsing is recognised across systems, platforms	Structure for parsing is recognised across systems, platforms
Semantic	URI link to web resources enabled without additional software or app	Regulatory as well as other requirements for granularity are supported	Regulatory as well as other requirements for granularity are supported
Interoperable	Compatible and portable with all 15459 / 18975 conformant systems and plausibility tested by regular expression	Compatible and portable with all 15459-3 conformant systems after parsing identifiers from URI	Compatible and portable with all 15459-3 conformant systems after parsing identifiers from URI
Openness	IANA URI schemes are used without registration, software/app, or passwords by consumers	Transparent process per ISO/IEC JTC1 SC31 and the GS1 Global Standards Management Process	Transparent process per ISO/IEC JTC1 SC31 and the GS1 Global Standards Management Process
Proven technology/ adoption by market	QR Code pervasive use Data Matrix 90%+ use per GS1 2027 2D Program goal	GS1 Identifiers are pervasively supported by today's production and distribution	GS1 Identifiers are pervasively supported by today's production and distribution

	See Annex A for 2027 2D Programme details/status	scanners and these same identifiers will be parsed from GS1 Digital Link URI by 2027 to support innovation as well as backward compatibility. QR Code and Data Matrix targeted for 90%+ implementation per GS1 2027 2D Program goal	scanners and these same identifiers will be parsed from GS1 Digital Link URI by 2027 to support innovation as well as backward compatibility. QR Code and Data Matrix targeted for 90%+ implementation per GS1 2027 2D Program goal
Capacity for URI	Yes, QR Code and Data Matrix	Parsing GS1 identifiers from URI per GS1 2027 2D Adoption Program goal (backward compatible)	Parsing GS1 identifiers from URI per GS1 2027 2D Adoption Program goal (backward compatible)
Ability to ID granularity/store in existing systems	Not applicable as the URI is not stored by the Smart Device, it is used to reach a web-based menu of options for data (e.g., regulatory, instructions for use)	Structured identity per ISO/IEC 15418 GS1 Application Identifiers (AIs) and parsing of GS1 identifiers elements (e.g., AI 01 for GTIN, AI 10 for LOT, AI 21 for Serial) to provide backward compatibility for storage and use by existing applications.	Structured identity per ISO/IEC 15418 GS1 Application Identifiers (AIs) and parsing of GS1 identifiers elements (e.g., AI 01 for GTIN, AI 10 for LOT, AI 21 for Serial) to provide backward compatibility for storage and use by existing applications.
International carrier specification	QR Code per ISO/IEC 18004 Data Matrix per ISO/IEC 16022	QR Code per ISO/IEC 18004 Data Matrix per ISO/IEC 16022	QR Code per ISO/IEC 18004 Data Matrix per ISO/IEC 16022
Ability to authenticate data carrier	No as any optical data carrier can be copied	No as any optical data carrier can be copied	No as any optical data carrier can be copied
Cost per item	Cost is associated with the printing/marking method but typically a very small fraction of one cent per item.		
UHF RFID			
Globally unique within domain	Not currently used in smart devices but research and development are underway to enable this in the future.	Yes, per ISO/IEC 15459	Yes, per ISO/IEC 15459
Persistent		Yes, as the identifier is registered independent of the domain in URI	Yes, as the identifier is registered independent of the domain in URI
Syntax		Structure for parsing is recognised across systems, platforms	Structure for parsing is recognised across systems, platforms

Semantic		Regulatory as well as other requirements for granularity are supported	Regulatory as well as other requirements for granularity are supported
Interoperable		Compatible and portable with all 15459-3 conformant systems	Compatible and portable with all 15459-3 conformant systems
Openness		Transparent process per ISO/IEC JTC1 SC31 and the GS1 Global Standards Management Process	Transparent process per ISO/IEC JTC1 SC31 and the GS1 Global Standards Management Process
Proven technology/ adoption by market		GS1 Identifiers are pervasively supported by today's distribution scanners, UHF RFID adoption varies but the technology is proven and offers capability not offered by barcodes to distribution channels that require this capability.	GS1 Identifiers are pervasively supported by today's distribution scanners, UHF RFID adoption varies but the technology is proven and offers capability not offered by barcodes to retailers that require this capability (e.g., apparel, tyres).
Capacity for URI		The method for URI support within smart devices is in development, but URIs will be enabled as well as parsing GS1 identifiers from them at a point in time to be determined by the RAIN Alliance efforts with smart device manufacturers.	The method for URI support within smart devices is in development, but URIs will be enabled as well as parsing GS1 identifiers from them at a point in time to be determined by the RAIN Alliance efforts with smart device manufacturers.
Ability to ID granularity/store in existing systems		Structured identity per ISO/IEC 15418 GS1 Application Identifiers and parsing of GS1 identifiers for backward compatibility for storage and use by existing applications.	Structured identity per ISO/IEC 15418 GS1 Application Identifiers and parsing of GS1 identifiers for backward compatibility for storage and use by existing applications.
International carrier specification		UHF RFID per ISO/IEC 18000-63	UHF RFID per ISO/IEC 18000-63

Ability to authenticate data carrier		TBD but would require a significant memory/cost increase per tag.	TBD but would require a significant memory/cost increase per tag.
Cost per item	The cost per tag varies based on its design (e.g., memory) but for passive tags suitable for ESPR requirements in high volumes, costs would be comparable to NFC tags.		
NFC			
Globally unique within domain	Yes, as URI	Not used, nor planned for use in distribution readers.	Not used, nor planned for product identification at retail point-of-sale.
Persistent	Manufacturer domains within URI may lapse		
Syntax	Encodable in URI		
Semantic	URI link to web resources enabled without additional software or app		
Interoperable	Compatible and portable with all 15459 / 18975 conformant systems		
Openness	Use by consumers without registration, software/app, or passwords. Transparent process per NFC Forum and GS1 Global Standards Management Process		
Proven technology/ adoption by market	NFC pervasive use in smart devices		
Capacity for URI	Yes		
Ability to ID granularity/store in existing systems	Not applicable as the URI is not stored by the Smart Device, it is used to reach a web-based resource with links to data which is stored		
International carrier specification	ISO/IEC 14443, ISO/IEC 15693, ISO/IEC 18092, NFC Forum Specifications		

Ability to authenticate data carrier	Designed with security in mind as it is used for payments	
Cost	An NTAG 215 NFC tag with 480 bytes is available for around 10c even in small volumes. This memory provides ample capacity to encode any Web URI including of course a GS1 Digital Link URI with ESPR product identifiers at various granularity levels.	

Method 2: ISO/IEC 15459 conformant identifiers / 18975 web-enabled, structured path identifiers qualified by ISO/IEC 15418 MH10 Data Identifiers per IEC 61406-2

ID Standard Requirement ID and Data Carrier Standard Requirement DC Standard Requirement

Method 2: Web-enabled, structured path identification using MH10 identifiers	Smart Device (no app)	Production and distribution scanners, readers and applications (including online fulfilment)	Point-of-sale scanners, readers and applications
QR Code and Data Matrix			
Globally unique within domain			NA?
Persistent			
Syntax			
Semantic			
Interoperable			
Openness			
Proven technology/ adoption by market			NA?
Capacity for URI			
Ability to ID granularity/store in existing systems			NA?
International carrier specification			

Ability to authenticate data carrier			
Cost per item			
UHF RFID			
Globally unique within domain	Not currently used in smart devices but research and development are underway to enable this in the future.		NA?
Persistent			
Syntax			
Semantic			
Interoperable			
Openness			
Proven technology/ adoption by market			NA?
Capacity for URI			
Ability to ID granularity/store in existing systems			NA?
International carrier specification			
Ability to authenticate data carrier			
Cost per item			
NFC			
Globally unique within domain		Not used, nor planned for use in distribution readers.	Not used, nor planned for product identification at retail point-of-sale.
Persistent			
Syntax			
Semantic			
Interoperable			
Openness			
Proven technology/ adoption by market			
Capacity for URI			
Ability to ID granularity/store in existing systems			

International carrier specification		[redacted]
Ability to authenticate data carrier		
Cost		

Method 3: ISO/IEC 15459 conformant identifiers / 18975 web-enabled, query string identifiers qualified by ISO/IEC 15418 MH10 Data Identifiers per IEC 61406-2

ID Standard Requirement ID and Data Carrier Standard Requirement DC Standard Requirement

Method 3: Web-enabled, query string identification using MH10 identifiers	Smart Device (no app)	Distribution scanners, readers and applications (includes online fulfilment)	Point-of-sale scanners, readers and applications
QR Code and Data Matrix			
Globally unique within domain			NA?
Persistent			
Syntax			
Semantic			
Interoperable			
Openness			
Proven technology/ adoption by market			NA?
Capacity for URI			
Ability to ID granularity/store in existing systems			NA?

International carrier specification			
Ability to authenticate data carrier			
Cost per item			
UHF RFID			
Globally unique within domain	Not currently used in smart devices but research and development are underway to enable this in the future.		NA?
Persistent			
Syntax			
Semantic			
Interoperable			
Openness			
Proven technology/ adoption by market			NA?
Capacity for URI			
Ability to ID granularity/store in existing systems			NA?
International carrier specification			
Ability to authenticate data carrier			
Cost per item			
NFC			
Globally unique within domain		Not used, nor planned for use in distribution readers.	Not used, nor planned for product identification at retail point-of-sale.
Persistent			
Syntax			
Semantic			
Interoperable			
Openness			
Proven technology/ adoption by market			
Capacity for URI			

Ability to ID granularity/store in existing systems		[redacted]
International carrier specification		
Ability to authenticate data carrier		
Cost		

Method 4: Digital Object Identifiers

ID Standard Requirement ID and Data Carrier Standard Requirement DC Standard Requirement

Method 4: Digital Object Identifiers	Smart Device (no app)	Distribution scanners, readers and applications (includes online fulfilment)	Point-of-sale scanners, readers and applications
QR Code and Data Matrix			
Globally unique within domain			NA?
Persistent			
Syntax			
Semantic			
Interoperable			
Openness			
Proven technology/ adoption by market			NA?
Capacity for URI			
Ability to ID granularity/store in existing systems			NA?
International carrier specification			
Ability to authenticate data carrier			

Cost per item			
UHF RFID			
Globally unique within domain	Not currently used in smart devices but research and development are underway to enable this in the future.		NA?
Persistent			
Syntax			
Semantic			
Interoperable			
Openness			
Proven technology/ adoption by market			NA?
Capacity for URI			
Ability to ID granularity/store in existing systems			NA?
International carrier specification			
Ability to authenticate data carrier			
Cost per item			
NFC			
Globally unique within domain		Not used, nor planned for use in distribution readers.	Not used, nor planned for product identification at retail point-of-sale.
Persistent			
Syntax			
Semantic			
Interoperable			
Openness			
Proven technology/ adoption by market			
Capacity for URI			
Ability to ID granularity/store in existing systems			
International carrier specification			

Ability to authenticate data carrier		
Cost per item		

Method 5: Web Links per IEC 61406-1

ID Standard Requirement ID and Data Carrier Standard Requirement DC Standard Requirement

Method 5: Web Links per IEC 61406-1	Smart Device (no app)	Distribution scanners, readers and applications (includes online fulfilment)	Point-of-sale scanners, readers and applications
QR Code and Data Matrix			
Globally unique within domain			NA?
Persistent			
Syntax			
Semantic			
Interoperable			
Openness			
Proven technology/ adoption by market			NA?
Capacity for URI			
Ability to ID granularity/store in existing systems			NA?
International carrier specification			
Ability to authenticate data carrier			
Cost per item			
UHF RFID			
Globally unique within domain	Not currently used in smart devices but research and development are		NA?
Persistent			
Syntax			

Semantic	underway to enable this in the future.		
Interoperable			
Openness			
Proven technology/ adoption by market			NA?
Capacity for URI			
Ability to ID granularity/store in existing systems			NA?
International carrier specification			
Ability to authenticate data carrier			
Cost per item			
NFC			
Globally unique within domain		Not used, nor planned for use in distribution readers.	Not used, nor planned for product identification at retail point-of-sale.
Persistent			
Syntax			
Semantic			
Interoperable			
Openness			
Proven technology/ adoption by market			
Capacity for URI			
Ability to ID granularity/store in existing systems			
International carrier specification			
Ability to authenticate data carrier			
Cost per item			

Method 6: Decentralised Identifiers

ID Standard Requirement ID and Data Carrier Standard Requirement DC Standard Requirement

Method 6: Decentralised Identifiers	Smart Device (no app)	Distribution scanners, readers and applications (includes online fulfilment)	Point-of-sale scanners, readers and applications
QR Code and Data Matrix			
Globally unique within domain			NA?
Persistent			
Syntax			
Semantic			
Interoperable			
Openness			
Proven technology/ adoption by market			NA?
Capacity for URI			
Ability to ID granularity/store in existing systems			NA?
International carrier specification			
Ability to authenticate data carrier			
Cost per item			
UHF RFID			
Globally unique within domain	Not currently used in smart devices but research and development are underway to enable this in the future.		NA?
Persistent			
Syntax			
Semantic			
Interoperable			
Openness			
Proven technology/ adoption by market			NA?

Capacity for URI			
Ability to ID granularity/store in existing systems			NA?
International carrier specification			
Ability to authenticate data carrier			
Cost per item			
NFC			
Globally unique within domain		Not used, nor planned for use in distribution readers.	Not used, nor planned for product identification at retail point-of-sale.
Persistent			
Syntax			
Semantic			
Interoperable			
Openness			
Proven technology/ adoption by market			
Capacity for URI			
Ability to ID granularity/store in existing systems			
International carrier specification			
Ability to authenticate data carrier			
Cost per item			

Annex A: Details on the retail aspiration to migrate to 2D and GS1 Digital Link URI by 2027

A standard is just the start of the migration journey from 1D barcodes to 2D barcodes with GS1 Digital Link URI in retail.

All points in the supply chain need to be ready. All industry stakeholders need to commit to enabling the implementation. It starts when the product's brand owner generating a compliant 2D barcode so it can be used by trading partners in the supply chain, consumers in the value chain, and regulators wherever the need for product data is required. Once the industry reaches an agreement on the "why, what, where, and when" the next important commitment for change must come from the solution providers to provide the "how". This requires updates to all systems (e.g., barcode design, printing, quality verification, scanning, processing, and applications) to deploy the updates needed to ensure 2D barcodes with GS1 Digital Link URI will be deployed pervasively (90%+) by the target date.

The Global Migration to 2D program is on track to have all retail POS systems capable of reading and processing a defined set of 2D barcodes with GS1 standards, in addition to existing linear barcodes. This global ambition requires a multiyear roadmap with several phases for industries connected to retail. The following provides a summary and snapshot of current progress.

Phase 1 community building: (the 2027 2D in retail ambition → **completed**)

- Solution provider engagement
  - Create contacts within global SP (Label creation, Printing, Scanning, Verification, Host systems & Digital (online providers))
  - Build community space for conversations like GS1's Solution Provider 2D focus group, Industry consortia (e.g., PMMI, AIM Global, industry trade associations, …) & industry events
  - Use SP community to solve migration to 2D issues (e.g., scan modes, 2D colour guide, printing considerations)
  - Supply open-source tools to accelerate complaint adoption such as the GS1 barcode syntax resource

Phase 2 readiness: "solutions ready to deploy" (the 2027 2D in retail ambition → **nearing completion**)

- 2D barcode creation
  - In the creation of 2D barcodes you have four primary categories:
  - Open-Source players like ZXing & BWIPP (>90% readiness)
  - Commercial players like Seagull Scientific & Loftware (>80% readiness)
  - Software Development Kit or SDK players like Scandit & Cognex (>70% readiness)
  - Printer manufacture software like Markem-Imaje & Domino (>90% readiness)
- 2D hardware solution

  In the in 2D barcode hardware solutions you have three primary that include printing and scanning categories:
  - Printer players like Domino, Videojet (>90% readiness)
  - Imaging Scanners
    - Retail POS scanner system providers like Datalogic and Newland AIDC (>90% readiness)
    - Distribution, including warehouse, and customs players like Cognex and Zebra (>50% readiness)
    - Production line players, like Cognex and Keyence (>70% readiness)
  - Barcode verification players like Axicon and REA (>80% readiness)
- 2D software and digital solution

In the in 2D barcode software and digital solution you have two that include processing of the data included in the 2D barcodes and connect the data to online content categories:
  - Host systems players like SAP and Toshiba (>70% readiness)
  - Digital content players like Digital Link Connexum and Buyerdock (>80% readiness)

Phase 3 Implementation: "solutions ready to deploy" (the 2027 2D in retail ambition → **midway to completion**)

- Test and guidance
  - Lab testing to aid in scanner solutioning and printer 2D compliance (>90% readiness)
  - Create 2D readiness criteria and website to promote acknowledge solution provider readiness and indicate hardware compliance for 2D barcodes; 2D Barcodes POS Solutions | 2D Barcodes at Point of Sale | GS1 (>90% readiness)
  - Create 2D barcode colour and quality guide to assist industry on what's possible for colours, logos and other aspects influencing decodability. (>90% readiness)
  - Test suite to validate scanner updates and readiness; https://ref.gs1.org/test-suites/2d-barcodes-in-retail/ (>90% readiness)
- Pilot, Implement and learn
  - Create 2D in Retail Implementation guideline (>90% readiness)
  - Used closed retail environments to gain insight (>70% readiness)
  - Learn and update solutions from pilots and implementation (>70% readiness)
  - Share learnings and improve solutions (>70% readiness)

Phase 4 Accelerate adoption: → **underway**

- GS1, Brands, Retailers and SP commitments with following objectives.
  1. Amplify commitment from hardware manufacturers through clear and consistent messaging about 2D scanning at retail checkout to meet the industry's 2027 goal:
     - public statements, videos, collaborative marketing and letters of intent
  2. Ensure intentional communication and education from top down, including:
     - customer-facing teams, technical stakeholders, architects, product teams and partner channels.
     - Industry Global Joint Statement, which reinforced the messages and understandings about Ambition 2027
     - providing users with implementation resources to facilitate industry adoption, including engaging videos and an updated website,
     - bringing together learnings from existing implementations to accelerate future adoption
  3. GS1, brand, retailer and solution provider partnerships to validate end to end solutions:
     - customer-facing teams, technical stakeholders, architects, product teams and retail stakeholders.