The Global Language of Business

Principles and Criteria for High-Capacity Data Carriers in the GS1 system

GS1 Architecture Finding

Release 1.0, Final, Nov 2025

Document Summary

Document Item	Current Value
Document Name	Principles and Criteria for High-Capacity Data Carriers in the GS1 system
Document Date	Nov 2025
Document Version	1.0
Document Issue	
Document Status	Final
Document Description	GS1 Architecture Finding

Contributors

Name	Organisation
Peta Ding	GS1 Global Office
Mark Harrison	Milecastle Media Limited
Steven Keddie	GS1 Global Office
Craig Alan Repec	GS1 Global Office
Sylvia Rubio Alegren	ICA Sverige AB
Sue Schmid	GS1 Global Office
Eugen Sehorz	GS1 Austria
Ralph Troeger	GS1 Germany

Log of Changes

Release	Date of Change	Changed By	Summary of Change
1.0	Nov 2025	S. Schmid (GS1 GO)	Release 1.0 approved by the GS1 Architecture Group (meeting date 19/11/25)

Disclaimer

This document is not an official GS1 standard or guideline, and was not developed pursuant to GS1's IP Policy (https://www.gs1.org/standards/ip). Please note the possibility that an implementation of anything described in this document may be the subject of a patent or other intellectual property right.

Accordingly, GS1 recommends that any person or organisation developing an implementation of anything described in this document should determine whether any patents or other intellectual property may encompass such implementation, and whether a licence under a patent or other IP right is needed. The implementer should determine the potential need for licensing in view of the details of the specific implementation being designed in consultation with that party's patent counsel.

THIS DOCUMENT IS PROVIDED "AS IS" WITH NO WARRANTIES WHATSOEVER, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY, NONINFRINGEMENT, FITNESS FOR PARTICULAR PURPOSE, ACCURACY OR COMPLETENESS, OR ANY WARRANTY OTHERWISE ARISING OUT OF THIS DOCUMENT. GS1 disclaims all liability for any damages arising from any use or misuse of this document, whether special, indirect, consequential, or compensatory damages, and including liability for infringement of any intellectual property rights, relating to use of information in or reliance upon this document.

GS1 makes no commitment to update the information contained herein, and retains the right to make changes to this document at any time, without notice. GS1® and the GS1 logo are registered trademarks of GS1 AISBL.

Table of Contents

1 Executive summary

With the advancement and use of high-capacity data carriers, particularly 2D barcodes, there has been an increase in requests for new GS1 Application Identifiers (AIs) as a mechanism to encode more data in these high-capacity data carriers.

Automatic Identification and Data Capture (AIDC) is based on the concept that data can be looked up or exchanged within systems, from a minimal set of encoded data. Within the ISO/IEC standards for data carriers, the presumption is that: "…. associated information is typically held in some kind of database. The information can be accessed using EDI exchange or another appropriate access protocol, e.g., a directory access protocol"[1].

However, the increased use of high-capacity data carriers, emerging use cases and regulatory demands, have led to a growing demand to encode more data in GS1 compliant data carriers. Some of the reasons for this include:

- avoiding manual re-entry of data that is not currently shared/exchanged or cannot be accessed via EDI, EPCIS or other electronic means (e.g., the weight of a variable-measure product)
- lack of access to retrieve information in a timely fashion (i.e., instant localised access, no data exchange and no network connection)
- difficulty accessing data in private or restricted databases
- untimely delivery of data that is not accessible or transferable across systems
- short term opportunity to solve industry problems without implementation of "share" standards
- securing a method to manage transitions of programs to support the "sharing" of data

As a result of these requests for more GS1 AIs, several unintended consequences and challenges are arising with the ongoing management and alignment of the GS1 system.

The primary purpose of this document is to provide a guide for the Global Standards Management Process (GSMP) and the GS1 community, to ensure a consistent approach when assessing requests for new GS1 AIs required for encoding in high-capacity data carriers.

[1] Reference: ISO/IEC 15459

2 Introduction

2.1 Principles for an assessment framework

When assessing requests for data elements, specifically new GS1 Application Identifiers (AIs) for encoding in applicable GS1 data carriers – clear guiding principles have been established below. These principles ensure consistent and transparent response to industry when considering whether to accept, reject or propose alternatives for such requests.

- It is important to note that the existence of a similar or precedent GS1 AI is not, by itself, a valid justification for approving /or defining a new GS1 AI, especially when more optimal solutions are available, see Appendix 2.
- A key requirement is that any information to be encoded as a new GS1 AI in a data carrier must remain consistent and static throughout the entire lifetime of the object. This means that data should not require updates as the objects move through the supply chain and beyond.
- However, encoding static information in a data carrier is not the solution if it is possible to retrieve the requested information in any other way. It is essential to understand the underlying business need the request for the new GS1 AI meets and determine if the information may be more appropriately managed through other processes, such as the exchange of master data (e.g., in purchasing systems). Avoiding duplication of information is critical.
- It is also important to recognise that introducing a new GS1 AI requires that the trading partners at origin/upstream have the information and capability to print or encode it in a data carrier. Downstream trading partners must also be able to adopt their scanners and databases to accommodate the new GS1 AI.
- Encoding data in a data carrier that would "normally" be shared electronically, may lead to discrepancies. Data maintained online has the potential to be updated and may differ from what was encoded at the time of application, potentially causing misalignment and operational issues within the demand chain.

2.2 Decision tree

To support navigation through the decision tree, please reference the relevant content in Appendix 1 to see more detailed considerations and actions for each decision, action or conclusion point.

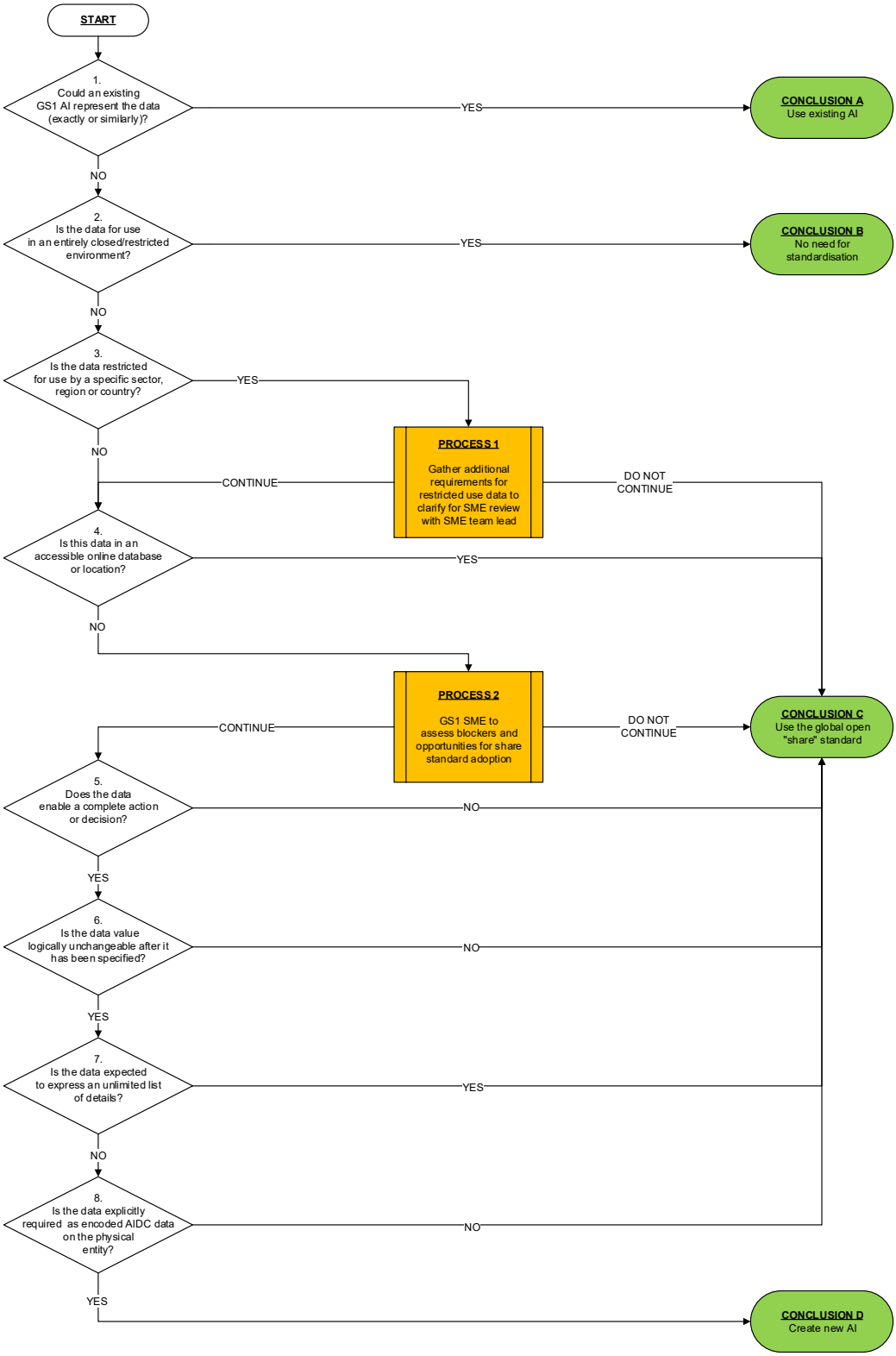


Figure 2-1 Decision tree[2]

[2] The management and updating of this flow chart will be completed by a defined GS1 process

3 Other considerations

3.1 Technical capabilities and limitations

3.1.1 Data carrier capacity

A high-capacity data carrier can be defined as a data carrier that can contain significant amounts of data. In the GS1 community this would be data that is over and above the identification of the entity and include 2D and Radio Frequency Identification (RFID) data carriers. However, there are challenges with adding more and more data to high-capacity data carriers.

If we focus on the use of 2D barcodes as high-capacity data carriers, more data means a larger barcode and potentially slower reading/decoding, which in turn may impact scan rates/efficiencies etc., see Table 3-1 for examples of symbol/data carrier size with increasing data capacity. Larger 2D barcodes may require multiple print heads in order to be printed – and these need to be precisely aligned.

Considering RFID tags as high-capacity data carriers, tags with higher capacities are typically manufactured in smaller volumes than relatively low-capacity tags that are used primarily for encoding a unique instance-level identifier. This lack of economy of scale typically leads to a higher tag cost for high-capacity tags.

3.1.2 Capacity of GS1 Application Identifiers (AI)

There are only a finite number of GS1 AIs available, which, at the time of writing, is 5,830 four-digit GS1 AIs remaining. To mitigate potential risks of depleting GS1 AIs and ensure the stability and future of the GS1 system, it is essential that the assignment of new GS1 AIs is based on a consistent and thorough assessment of business requirements to determine that a new GS1 AI is necessary.

3.1.3 Data alignment

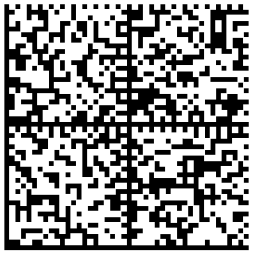
When some data is encoded in the data carrier that is also available online via “share” standards, there is the potential risk for conflicting data values and different actions being taken as a result. The data available online has the potential to be more up to date - or to have been updated after the data carrier was encoded - but it is unclear whether a downstream party will rely on potentially stale or outdated data read from the data carrier - or potentially more up-to-date data retrieved online via “share” standards, potentially resulting in different outcomes, depending which has been used.

Table 3-1 Symbol/data carrier size with increasing data capacity

Scenario	QR Code with GS1 Digital Link URI	GS1 DataMatrix with GS1 Element String
GTIN + serial number, as used for trade items (compound GS1 identifier only)[3]	 (01)09520123450090 (21)987654	 (01)09520123450090 (21)987654
	29 x 29 modules	18 x 18 modules
GTIN + batch/lot number + best before date, as used for trade items (compound GS1 identifier + minimal attribute data)[4]	 (01)09520123452377 (10)Lot1 (15)260504	 (01)09520123452377 (10)Lot1 (15)260504
	33 x 33 modules	22 x 22 modules

[3] Encoded GS1 Digital Link URI (corresponding GS1 Element String notation omitted for reasons of brevity): https://id.example.com/01/09520123450090/21/987654
This could also be encoded per the current version of the Tag Data Standards on an EPC/RFID tag, using the **SGTIN+** EPC scheme and a Filter value of 3, with an EPC Hex value of F730952012345009006F1206.

[4] Encoded GS1 Digital Link URI (corresponding GS1 Element String notation omitted for reasons of brevity): https://id.example.com/01/09520123452377/10/Lot?15=260504
This **cannot be encoded per TDS 2.2 on an EPC/RFID tag**, due to the absence of GS1 AI (21). An EPC encoding identifies a unique instance and requires a serial component.

Scenario	QR Code with GS1 Digital Link URI	GS1 DataMatrix with GS1 Element String
SSCC + Scan 4 Transport (S4T) data, as used for logistics units (simple GS1 identifier + many attribute data)[5]	 (00)095201234567891235 (3301)000025 (4301)Wascally+Wabbit (4302)Avenue+Louise+326 (4303)Blue+Tower (4304)Ixelles (4305)Bruxelles (4306)Brussels-Capital+Region (4307)BE (420)1050 (4308)+32-2-788-78-00 (4309)14220219500001282028	 (00)095201234567891235 (3301)000025 (4301)Wascally+Wabbit (4302)Avenue+Louise+326 (4303)Blue+Tower (4304)Ixelles (4305)Bruxelles (4306)Brussels-Capital+Region (4307)BE (420)1050 (4308)+32-2-788-78-00 (4309)14220219500001282028
	61 x 61 modules[6]	44 x 44 modules

[5] Encoded GS1 Digital Link URI (corresponding GS1 Element String notation omitted for reasons of brevity):
https://id.example.com/00/09520123456789123?3301=000025&4301=Wascally%2BWabbit&4302=Avenue%2BLouise%2B326&4303=Blue%2BTower&4304=Ixelles&4305=Bruxelles&4306=Brussels-Capital%2BRegion&4307=BE&420=1050&4308=%2B32-2-788-78-00&4309=14220219500001282028

This cannot be encoded on an EPC/RFID tag using TDS 2.x, because the Gen2 air interface limits the encoding size of EPC scheme and supplementary "+AIDC data" in the EPC memory bank to 496 bits (or 464 bits, if a tag supports Extended Protocol Control bits, XPC); the https://id.gs1.org/00/09520123456789123?3301=000025&4301=Wascally%2BWabbit&4302=Avenue%2BLouise%2B326 portion alone would already require 400 bits. If the ENTIRE payload depicted above were possible, **the encoding size would be 1104 bits (!). That is more than double the 464-bit limit.**

[6] At the time of writing this document, the use of QR Code with GS1 Digital Link URI is not yet permitted by the GS1 application standard for encoding transport process information. This example is provided for demonstration purposes only.

3.2 "Share" standards adoption

Today's AIDC data carriers can encode large amounts of data, but large amounts of encoded data can be impractical or impossible to produce. For this reason, encoded data elements should be limited to GS1 identifiers and data that will remain constant for the marked entity and that cannot be obtained via look-up of shared data.

The adoption of GS1 share standards seems to have reached a plateau. With the advent of newer technologies for structured data sharing, such as modern, lightweight APIs and user-friendly data formats like JSON/JSON-LD, companies using either current, traditional or legacy "share" standards, are often challenged by the adoption to the latest versions. Additionally, they struggle to keep pace with evolving changes within this suite and its broader adoption across more supply chain partners. The variety within "share" standards could be perceived as a hindrance to their adoption.

GS1 should consider developing strategies to assist users transitioning between different GS1 share standards and/or structured data sharing formats. This would support broader usage and enhance the value of these standards across various stakeholder groups. Such strategies could help drive increased uptake and address emerging use cases where the lack of connectivity necessitates the request for additional data in high-capacity data carriers.

GS1 share standards include:

- Electronic Product Code Information Services/Core Business Vocabulary (EPCIS/CBV)
- GS1 Electronic Data Interchange (EDI)
  - GS1 EANCOM® – for "classic" Electronic Data Interchange (EDI)
  - GS1 EDI Business Terms (Semantics / Dictionary)
  - GS1 XML
  - GS1 UN/CEFACT XML
- Global Data Synchronisation Network (GDSN)
- GS1 Web Vocabulary

GS1 share standards supports structured data sharing formats such as:

- JavaScript Object Notation (JSON)
- JavaScript Object Notation for Linked Data (JSON-LD)
- Extensible Markup Language (XML)

Taking the example of a 2D barcode whose data content would become similarly extensive as the third example in Table 3-1 shown above, Figure 3-1 illustrates how a corresponding data structure – which could be accessible through a simple web request – would look like. This data structure uses the GS1 Web Vocabulary, and all properties that are included in the data structure can be immediately understood globally as the definitions of all contained field names are accessible online (e.g., see https://ref.gs1.org/voc/grossWeight).

With such a forward-looking approach, companies only needed to encode a GS1 Digital Link URI embedding the GS1 identification key (i.e., 'https://example.com/00/09520123456789235'), for example on a logistic label, which points to a block of JSON-LD data as depicted on the left-hand side. This approach would entail several advantages: better readability of the barcode, the option to apply EPC/RFID tags, and the opportunity to update the data e.g., when the receiving party desires to change the shipment's destination.

Note: At the time of writing this document, there is no GS1 application standard yet permitting the outlined approach in open supply networks. Therefore, it is meant as stimulus for future standardisation efforts.

https://example.com/**00**/095201234567891235?**3301**=000025&**4301**=Wascally+Wabbit&**4302**=Avenue+Louise+326&**4303**=Blue+Tower&**4304**=Ixelles&**4305**=Bruxelles&**4306**=Brussels-Capital+Region&**4307**=BE&**420**=1050&**4308**=%2B32+2+788+78+00&**4309**=14220219500001282028

{	
"@context": {	
"gs1": "https://ref.gs1.org/voc/",	
"gs1:value": {	
"@type": "xsd:float"	
}	
},	
"@graph": {	
"**@id**":"https://example.com/00/095201234567891235",	https://example.com/00/095201234567891235
"**@type**": "*gs1:LogisticUnit*",	
"**gs1:grossWeight**": {	
"**gs1:value**": "2.5",	?**3301**=000025
"**gs1:unitCode**": "KGM"	
},	
"***gs1:shipTo***": {	
"@type": "gs1:Place",	
"**gs1:address**": {	
"@type": "gs1:PostalAddress",	
"**gs1:postalName**": "Wascally Wabbit",	&**4301**=Wascally+Wabbit
"**gs1:streetAddress**": "Avenue Louise 326",	&**4302**=Avenue+Louise+326
"**gs1:streetAddressLine2**": "Blue Tower",	&**4303**=Blue+Tower
"**gs1:addressSuburb**": "Ixelles",	&**4304**=Ixelles
"**gs1:addressLocality**": "Bruxelles",	&**4305**=Bruxelles
"**gs1:addressRegion**": "Brussels-Capital Region",	&**4306**=Brussels-Capital+Region
"**gs1:addressCountry**": {	
"**gs1:countryCode**": "BE"	&**4307**=BE
},	
"**gs1:postalCode**": "1050"	&**420**=1050
},	
"**gs1:contactPoint**": {	
"**gs1:telephone**": "+32 2 788 78 00"	&**4308**=%2B32+2+788+78+00
},	
"**gs1:geo**": {	
"**gs1:latitude**": "52.2021950",	&**4309**=14220219500001282028
"**gs1:longitude**": "0.1282028"	
}	
}	
}	
}	

Figure 3-1 A GS1 Digital Link URI (simple Scan4Transport example) and its corresponding Linked Data / JSON-LD representation using the GS1 Web Vocabulary

Note: The class *gs1:LogisticUnit* and the property *gs1:shipTo* are not yet defined within the GS1 Web Vocabulary but are likely to be added as a result of the ongoing work on Semantics of GS1 Application Identifiers.

3.3 Access to online data

Storing data online is generally not a problem. However, offline or locally-based systems – such as retail Point of Sales (POS) ecosystems – often cannot access real-time online data, making it challenging to fully leverage the benefits of online storage. Another significant hurdle to adopting "share" standards for online data access may arise when there is a need to restrict who can request, retrieve, or read the data.

This challenge is amplified when there is no direct relationship between the data provider and the data requester, complicating efforts to demonstrate any legitimate basis for granting access. One of the essential characteristics of data encoded in an AIDC data carrier is that it's readable by anyone who has custody of the labelled/tagged entity. Even when the data is encrypted, it remains physically accessible, though not necessarily understandable, by all parties in the chain of custody. This trust in data integrity through secure, tamper-evident digital signatures is the focus of the recently developed GS1 Digital Signatures Technical Implementation Guideline.

Supporting this effort, the GS1 Architecture Finding on GS1 Identification and Data – Integrity and Security and the GS1 White Paper on Verifiable Credentials and End-to-End Traceability both provide critical insights into authentication, authorisation, and governance within a chain of custody. These resources collectively discuss the challenge of restricted access to online data while promoting interoperability and minimising unnecessary data to AIDC data carriers.

Together, these resources provide a forward-looking approach to a comprehensive framework in which digital signatures ensure the authenticity and integrity of underlying data, and Verifiable Credentials allow for controlled, minimal disclosure of sensitive commercial information, such as trading relationships. This approach not only safeguards sensitive commercial information but also enables GS1 to explore future standardisation opportunities to develop and prototype "proof of connectedness" approaches, that further strengthen trust and security in global supply chain interactions.

4 Recommendations

The growing adoption of high-capacity data carriers, such as 2D barcodes and RFID tags, presents new opportunities and challenges for the GS1 system. Increasing demand for greater data encoding capacity, driven by emerging use cases and regulatory requirements, necessitates a strategic approach that maintains the integrity and efficiency of the GS1 system.

The following recommendations aim to provide a comprehensive framework to evaluate and implement high-capacity data carriers, to ensure consistent data alignment, to promote the adoption of "share" standards, and to support the GS1 community in navigating this evolving landscape.

4.1 Decision flow for new GS1 Application Identifiers (AIs)

- Implement a decision flow within the Global Standards Management Process (GSMP) to evaluate requests for new GS1 AIs based on defined principles and criteria.
- Ensure that the assessment framework evaluates the necessity, business requirements, and potential alternatives for new GS1 AIs.
- Ensure the rationale for approving new GS1 AIs are clearly documented, at minimum within internal GO operational process, but ideally as part of the public standard.

4.2 Promotion of GS1 share standards

- Develop and promote free/open-source tools to simplify implementing of "share" standards, making them accessible to small and medium-sized enterprises.
- Establish clear guidelines differentiating between data for sharing and data requiring encoding in high-capacity data carriers.

4.3 Communication and education

- Highlight the benefits and value of transitioning to new "share" standards to drive broader adoption.
- Provide companies with support and training to facilitate the transition to new standards, addressing any technical or operational challenges.

4.4 Support for emerging use cases

- Develop strategies to support emerging use cases where connectivity limitations require encoding additional data into high-capacity data carriers.
- Facilitate program transitions to support data sharing, addressing industry challenges in both the short and long term.
- Explore opportunities to develop and prototype of solutions for standardizing online data access control, accounting for emergent paths (non-predefined) in supply chain networks.

By implementing these recommendations, GS1 can improve both adoption and effective utilisation of high-capacity data carriers while ensuring system robustness, scalability, and alignment with industry needs.

A Appendix 1: Considerations and actions to support decision tree

START: New business requirement for additional data

A new GS1 Application Identifier (AI) may be proposed as an action or suggested change to a business problem or opportunity via a Work Request.

Important: for a new AI to be assessed, there is a presumption that the data is available at the time of encoding the AIDC data carrier.

A.1 Check for an existing solution

1. Could an existing GS1 AI represent the data (exactly or similarly)?

Considerations

- GS1 Architecture Principle of Non-Duplication, states that "The goal of the GS1 system is to establish one and only one way to perform a given function in a GS1 system conformant way."
- This means that an existing GS1 AI should be used, if its purpose may be the same as, or similar to the requested GS1 AI.
  - An existing GS1 AI's purpose can be expanded to be more broadly applicable e.g., cross-sector, multi-regional etc., if the change does not disrupt or impact existing implementations.
  - Note that great care must be taken when considering any adjustments to the expected format or maximum length of values permitted for an existing GS1 AI. Reducing the length or changing from alphanumeric to all-numeric is generally not a problem but increasing the length or changing from previously all-numeric to alphanumeric may not be possible because of the way in which GS1 Application Identifiers are encoded in binary using the GS1 Tag Data Standard. In such cases, if there is a strong justification to increase the length or change from all-numeric to alphanumeric, it may still be necessary to introduce a new GS1 AI to support the additional capacity requirements, even if it expresses the same data attribute or purpose. GS1 SMEs responsible for TDS / TDT can advise further on this.
- For GS1 AIs that express a unit of measure, GS1 should align with the Système International (SI) units of measure wherever possible / practical for what is encoded in the AIDC data carrier, even if non-SI units are displayed on a device or printed as non-HRI text on a label.
  - Software can easily perform unit conversions to display the same measurement converted into multiple or familiar units of measure, as required, such as for non-HRI text on label or software Graphical User Interface (GUI).
- GS1 AIs defined in the past do not set a precedent for approving new GS1 AIs of a similar nature.

Actions

- If YES: Go to CONCLUSION A: Use existing GS1 AI
- If NO: continue to the next decision point 2

A.2 Understanding intended environment and data accessibility

2. Is the data for use in an entirely closed/restricted environment?

Considerations

- GS1 standards are developed for voluntary adoption by an unlimited number of stakeholders in global open-value chains.

- Standardisation enables interoperability among an unlimited number of stakeholders in open/unrestricted environments, even those without direct trading relationships.
- If a use case is for an entirely closed or restricted environment, there is no need for standardisation.

Actions

- If YES: proceed to CONCLUSION B: No need for standardisation
- If NO: continue to the next decision point 3

3. Is the data restricted for use by a specific sector, region or country?

Considerations

- Data restricted for use by sector, country or region represent a special case, as there may still be requirements to exchange globally standardised and interoperable data within the open-value chain.
- GS1 Architecture Principle of Global multi-sector standards, states that "Standards should be developed to be applicable to the broadest possible range of contexts, (e.g., ideally global, multi-sector). Meeting requirements that arise from a global perspective must be balanced against the need to meet local, regional or sector-specific requirements."
- This means that the requirements for restricted use must be carefully examined as a whole and evaluated alongside impact on global multi-sector use.

Actions

- If YES: pause assessment and proceed to PROCESS 1: gather additional requirements
- If NO: continue to the next decision point 4

PROCESS 1: Gather additional requirements for restricted use data

Considerations

The requirements for data that is restricted for use by sector, country or region must be clarified for the GS1 SME to review with the GS1 SME Team Lead, to decide if the assessment should continue or not. Gather requirements to clarify:

- The expected sector, country or region the data is restricted to and whether there is potential for broader application (i.e., multi-sector).
  - Data initially defined for one sector, country or region may be suitable for other sectors or global adoption e.g., date and time of expiration approved for healthcare but adopted by fresh foods.
- If the data is expected to be exchanged with unknown stakeholders.
  - Usually in closed or restricted environments, the stakeholders for data exchange are known, which generally negates the requirement for global standardisation and interoperability.
  - If there is a need to exchange data in the open value chain, despite the restriction, there may be unknown stakeholders involved, resulting in the requirement for global standardisation and interoperability.
- How pervasive the current process is and whether the data supports growth in the adoption of GS1 identifiers.
  - Restricted data may be required to meet regulatory requirements and/or as part of an established existing process.
  - In some cases, the restricted data may need near term support while a sector, country or region is migrating to a global open standard approach e.g., National Healthcare Reimbursement Number (NHRN) was approved to support a limited number of countries to mitigate legacy numbers and transition to adoption of GTIN.

- As soon as a global open standard approach becomes available, all other countries are expected to align with the global open standard approach and any GS1 Application Identifiers exceptionally allocated to support such regional or national-specific use cases should not be construed as setting a precedent for further allocation of such GS1 Application Identifiers for other countries – they should instead make use of the global open standard as a forward-looking approach.

- The expected or estimated quantity of data elements required.
  - At the time of writing, the remaining capacity would support around 5800 four-digit GS1 AI keys, approximately 580 three-digit GS1 AI keys or 58 two-digit GS1 AI keys, so it is very important to conserve the remaining key capacity for future use.
  - Data restricted for country-specific uses are particularly challenging because although initial requests might only be to support a small number of countries, there is a serious risk that other countries will in future have similar requirements. The number of countries is around 200, so there is the risk that such use of GS1 Application Identifiers could waste the remaining capacity of GS1 Application Identifier keys far too quickly.
  - The expected/estimated quantity of required GS1 AIs must be carefully considered with potential ranges reviewed with GS1 SME Team Lead.

Actions

GS1 SME and GS1 SME Team Lead will determine if the requirements for encoding restricted use data are sufficient to continue the assessment. Noting that this decision does not confirm the approval of any new GS1 AIs.

- CONTINUE ASSESSMENT: continue to next decision point 4.
- DO NOT CONTINUE ASSESSMENT: proceed to CONCLUSION C: Use the established, global open "share" standard (GS1 or other)

4. Is this data in an accessible online database or location?

Considerations

- When data is accessible online, for example via a database or structured sharing format, it can be retrieved using a global open “share” standard or mechanism (see “Share” standards adoption section) and need not be encoded in an AIDC data carrier.
- In some circumstances, data stored in an online database may be technically accessible via a “share” standard, yet inaccessible in practice for some reason(s).

Actions

- If YES: proceed to CONCLUSION C: Use the established, global open "share" standard (GS1 or other)
- If NO: pause assessment and proceed to PROCESS 2: GS1 SME to assess blocker(s) and opportunities for “share” standard adoption

PROCESS 2: GS1 SME to assess blockers and opportunities for “share” standard adoption

Considerations

When “share” standards can technically support the data BUT industry has adoption challenges, the GS1 SME, submitter and where required, the relevant GO team e.g., industry engagement, public policy etc. should identify these challenges, to understand any opportunities to mitigate such challenges e.g., additional training, support resources, change to industry process/practice etc. and decide if the assessment should continue or not.

- Assess options to enable accessible online data and data sharing, with consideration of any access control or security requirements.
- In some cases, the challenge with adoption of “share” standards can't be feasibly or practically mitigated within the current industry process, for example, lack of network connectivity, speed of data access, security and access controls etc.

- A change to industry process/practice may enable the challenge to be mitigated e.g., exchange/retrieval of data at a different stage, alternate security and access controls etc.

- Although "share" standards may be perceived as complex to use, less investment and time may be required to share data, in comparison to enabling capability in hardware and software for a new GS1 AI.
  - For example, it can be quicker to change a "share" standard to enable sharing of online data, with additional training, tools, and engagement etc. to support change to industry process/practice, instead of waiting for the rollout of new firmware or procurement of new hardware to use a new GS1 AI.
- An industry investment analysis can provide a systematic evaluation of financial implications, resource impacts/requirements, and overall value of industry changes as well as clarity on industry support for the required investment to adopt "share" standards versus implementation of a new GS1 AI.

Actions

GS1 SME should clearly identify the reasons for not using "share" standards for the use case and determine viable options for industry to adopt "share" standards. If industry supports the option(s) to mitigate challenges with adopting "share" standards, the assessment does not need to continue. If industry does NOT support the option(s) to mitigate challenges with adopting "share" standards, the assessment should continue to determine if encoding data in an AIDC data carrier is truly sufficient for the use case or not.

- DO NOT CONTINUE ASSESSMENT: proceed to CONCLUSION C: Use the established, global open "share" standard (GS1 or other)
- CONTINUE ASSESSMENT: continue to the next decision point 5

A.3 Clarifying requirements to encode GS1 AI data

5. Does the data enable a complete action or decision?

Considerations

- GS1 AI data that is encoded in an AIDC data carrier with a GS1 identifier, is intended enable the completion of an action or decision related to the identified entity
  - For example, weight of a variable measure product is used to calculate price, expiry date can trigger inventory actions such as stock removal or price mark-downs etc.
- If the GS1 AI data requires additional data to complete an action or decision, or requires additional validation or verification, it will need to be looked up/retrieved as part of the use case process.
  - For example, lifecycle events for usage/service/repair/refurbishment cycles may require a previously recorded date and/or some unit of time e.g., hours, days, months, years etc. to determine the next date for the required action.
- Note that encoding additional identifiers within an AIDC data carrier might not be sufficient to complete an action or decision, if additional data still requires retrieval based on those identifiers.

Action

- If NO: proceed to CONCLUSION C: Use the established, global open "share" standard (GS1 or other)
- If YES: continue to the next decision point 6

6. Is the data value logically unchangeable after it has been specified?

Considerations

- When data is encoded in an AIDC data carrier that is affixed to a physical entity, that data cannot be changed without re-producing the optical barcode, or overwriting the RFID tag.
  - Once the physical entity moves downstream in supply chain processes, changing the AIDC data carrier is almost impossible, and if possible, is highly disruptive.
- If encoded data has ANY possibility of changing during the lifespan of the entity it is affixed to, there is a risk that the data will become stale.
  - When data is available both online and in an AIDC data carrier, misalignment risks may arise from asynchronous updates. This may also result in inconsistent actions taken by downstream stakeholders due to the conflicting data.
  - For example, "ship-to" data could be updated via a share standard but not on the physical data carrier, resulting in the corresponding data encoded in the AIDC data carrier being outdated.

Action

- If NO: proceed to CONCLUSION C: Use the established, global open "share" standard (GS1 or other)
- If YES: continue to the next decision point 7

7. Is the data expected to encode an unlimited list of details?

Considerations

- GS1 Application Identifiers are not suitable for expressing repeated data structures, hierarchical data structures, or lists with no natural upper limit e.g., packing lists, items on an invoice or order, bill of materials (BOM) etc.
  - No GS1 Application Identifier can appear more than once within either GS1 element string or GS1 Digital Link URI.
- Although high-capacity data carriers can encode a large amount of data, that capacity is finite.
- Additionally, the physical size of the data carrier and/or its encoding/decoding efficiency is directly impacted by the amount of data contained.
- For interoperability, GS1 AI data has a defined maximum length and is intended to encode a finite set of values.

Actions

- If YES: proceed to CONCLUSION C: Use the established, global open "share" standard (GS1 or other)
- If NO: continue to the next decision point 8

8. Is the data explicitly required by regulation or for operations, as encoded AIDC data on the physical entity?

Considerations

- The submitter might assert that the required data needs to be encoded in an AIDC data carrier on the physical entity, but the SMEs should nevertheless carefully scrutinise the wording of the referenced regulation to check whether this really is the case
  - If the regulation does not specifically require encoding as AIDC data, it may simply require the data to be visible on the physical entity, or some mechanism (e.g., using share standards) to exchange the data.
  - If the data is only needed for documentation or certification purposes, it may not even need to be physically attached to the entity nor encoded in/on an AIDC data carrier.

- Similar scrutiny is required to check if encoding the data is absolutely business-critical for the operational process.
  - It calls for a distinction to be made between data that can be looked up within the local host system and data that is looked up from an exterior service accessed over the internet.
  - If data cannot be looked up locally, and access to online data is unavailable for any reason such as due to lack of network connectivity or power failure, the data must be accessible offline to fulfil the use case's operational process.

Actions

- If NO: proceed to CONCLUSION C: Use the established, global open "share" standard (GS1 or other)
- If YES: proceed to CONCLUSION D: Create the new GS1 Application Identifier

A.4 Conclusions

A.4.1 CONCLUSION A: Use existing GS1 AI

- GS1 SME should advise submitter of the relevant GS1 AI(s).
- Develop any necessary changes for approval via GSMP.
- If in relation to units of measure, advise on the capability for software to provide unit conversions for display on a device or as non-HRI text on a label.

A.4.2 CONCLUSION B: No need for standardisation

- Existing specifications defined by GS1 may be used in a closed/restricted environment, with no need for global standardisation. For example:
  - GS1 AI (90) for "information mutually agreed between trading partners", and GS1 AIs (91)-(99) for "company internal information".
  - GS1 Digital Link URI supports non-GS1 key=value pairs as extension parameters in the URI query string.
  - Pilots/trials may be conducted in closed/restricted environments to gather industry support for use in open/unrestricted environment (ideally targeting multi-sector applications).
- If requirements change and data is needed for use in an open/unrestricted environment, the use case can be re-assessed.

A.4.3 CONCLUSION C: Use the established, global open "share" standard (GS1 or other)

- Although industry may not have supported the options(s) to mitigate challenges with adopting "share" standards (as determined in PROCESS 2), the completion of this assessment has concluded that encoding data in an AIDC data carrier is not an appropriate solution for the use case.
  - GS1 SME should advise submitter how to use "share" standard for data exchange/retrieval and if required, work with submitter to extend or update the relevant GS1 share standard(s).
  - Work with community engagement, training and industry to develop the required resources to support and enable industry adoption.
  - Please see "Share" standards adoption for a list of GS1 share standards and structured data sharing formats supported by GS1 share standards, as well as additional information on the advantages of sharing data for a use case that traditionally encodes data.
  - Please refer to the Recommendations provided by this Finding, to support and promote the adoption of "share" standards.

- GS1 Architecture Principle of Extensibility, states that "… Extensibility is a necessity for all GS1 system components in order to cater for new and/or more efficient business processes and for the expanding user community." This means that every GS1 share standard should have some mechanisms to support extensibility of an established structured data format. For example:
  - EPCIS/CBV 2.0 supports extension fields in custom namespaces at various parts of the event data model.
  - GS1 Web Vocabulary can also be easily extended and is perhaps currently the most agile of GS1's master data share standards for supporting extensions, since it has a very flexible publication cycle.
  - GS1 XML can leverage extensions to support additional requirements. GS1 EDI is also currently undergoing modernisation via JSON/JSON-LD / Linked Data and will benefit from the same flexibility as the GS1 Web Vocabulary.
- In some cases, the complete solution to fulfil the use case requirement(s), is simply an update or extension to the relevant GS1 share standard to enable its use.
  - However, in other cases, the use, update or extension of a "share" standard may only be a partial solution to fulfil the use case requirement(s) and new requirements for alternate GS1 AI data may arise during the assessment process.
  - If new GS1 AI data requirements are identified to support the use of a "share" standard for the original GS1 AI data requirement, during assessment at any point of the decision tree, those new GS1 AI data requirements should be assessed from the starting point of this decision tree.

A.4.4 CONCLUSION D: Create the new GS1 Application Identifier

- Assign GS1 AI based on GS1 standard operating procedure and business rules.
  - Use a 4-digit GS1 AI key where possible to conserve capacity.
  - Re-use an existing value format where possible (e.g., YYMMDD or X..20) to minimise the disruptions to the GS1 EPC Tag Data Standard (and GS1 EPC Tag Data Translation) to efficiently encode the GS1 AI value in binary. This ensures existing encoding/decoding methods already defined can be used, instead of needing to invent new methods just for the specific value format for the new GS1 AI.
- Clearly document the requirements to encode the data for regulatory and/or operational purposes.
  - The motivations and expectations for the requirement (e.g., 10 country-specific codes, to meet regulatory requirement during migration to GTIN) must be documented clearly, ideally publicly as part of the standard, but at minimum, internally as part of GO operational process.
  - Where future assignments of GS1 AIs are required for the use case, GS1 SME Team Lead should reserve GS1 AI ranges as reviewed during PROCESS 1, with a trigger for further assessment if the reservation is close to exceeding the documented expected number of GS1 AIs.

B Appendix 2: From Hindsight to Foresight: Lessons for the Future

With the benefit of hindsight, it can be observed that there is some duplication within the current set of defined GS1 Application Identifiers. This is understandable, given the historical context in which these identifiers were developed. As the system has evolved and new capabilities and requirements have emerged, decisions made through the consensus-based GS1 Global Standards Management Process (GSMP) have occasionally resulted in redundant GS1 Application Identifiers.

It is important to recognise that the GSMP provides a defined and transparent framework for the development of standards, guided by established GS1 Architecture Principles. These principles are intended to ensure consistency, scalability, and interoperability across GS1 standards. At the same time, the application of these principles is balanced with the practical realities of industry adoption, which can at times necessitate pragmatic solutions to meet immediate needs.

If the decision tree outlined in the flowchart of this document had been available and applied from the outset, it is possible that some of these GS1 Application Identifiers may not have been introduced. For example, in the case of temperature-related identifiers, a more consistent application of the process may have resulted in defining only two GS1 Application Identifiers, using Kelvin as the SI unit of absolute temperature. Since Kelvin does not permit negative values, there would have been no need to encode a minus sign. Nevertheless, this approach would still allow for the familiar representation of temperatures in degrees Celsius or Fahrenheit on shipping labels or user interfaces, as conversion from Kelvin is straightforward and easily managed by software. However, it is important to note that these decisions were made based on industry consensus at the time.

A similar perspective applies to other GS1 Application Identifiers, such as 7258 (Baby birth sequence). Had the process been in place, the inclusion of a literal forward slash separator may not have been necessary. This is consistent with the approach taken for the ITIP value, where a notional separator exists between the two-digit ‘piece’ and ‘total’ components, but a literal forward slash was deemed unnecessary when ITIP was introduced.

Ultimately, the current state of GS1 Application Identifiers reflects a combination of historical decisions, evolving system capabilities, and the ongoing need to balance architectural rigour with practical industry requirements. Recognising this context provides valuable insight for future improvements and greater consistency in the development of new GS1 Application Identifiers.