



Enabling GS1 2D barcodes in Retail with Legacy Scanner Infrastructure¹

Middleware for GS1 2D barcodes at POS

Purpose

Retail point-of-sale (POS) scanners must be capable of correctly recognising and processing GS1 retail barcodes to ensure consistent checkout experiences. As retailers transition from traditional linear barcodes to GS1 2D barcodes, scanners need to identify GS1 conformant retail barcodes, distinguish them from non-conformant barcodes (for example, other barcodes that may be used to identify things like packaging artwork), correctly process products that carry multiple GS1 conformant linear and 2D barcodes (e.g., co-located barcodes) and ensure that only a single product identifier (GTIN) is transmitted to the POS system with a single user acknowledgement ("beep").

GS1 has published "scanning modes" that define the standardised scanner behaviour required to do this. They provide a consistent method for scanners to recognise, evaluate and process GS1 conformant retail barcodes, enabling retailers to support both traditional linear barcodes and new GS1 2D barcodes, while maintaining a predictable checkout experience.

The preferred approach to achieving this capability and maintaining optimal throughput (measured as "items per minute") is to upgrade or replace scanners so that they support the GS1 2D Retail scanning modes natively. Retailers should first assess whether their existing scanner infrastructure can be upgraded through a software or firmware update, or whether scanner replacement is appropriate or required.

Some existing scanners cannot support the required software updates. Separately, retailers may choose to adhere to existing asset refresh cycles. In such situations, retailers and POS solution providers may choose to implement a middleware solution (sometimes referred to as a shim library) that provides equivalent scanning behaviour while maintaining existing scanner investments. Middleware can enable GS1 conformant barcode processing without requiring immediate replacement of deployed scanner infrastructure, and should generally be viewed as a transitional implementation strategy that supports the adoption of GS1 2D barcodes.

Further information on the GS1 2D Retail scanning modes is available in the [2D Barcodes at Retail Point-of-Sale Implementation Guideline](#) and the [GS1 2D Barcode Playbook for Retail Scanners](#). Information on scanner readiness is available on the [2D barcode readiness page](#).

¹ Please see the Disclaimer Notice provided at the end of this document.

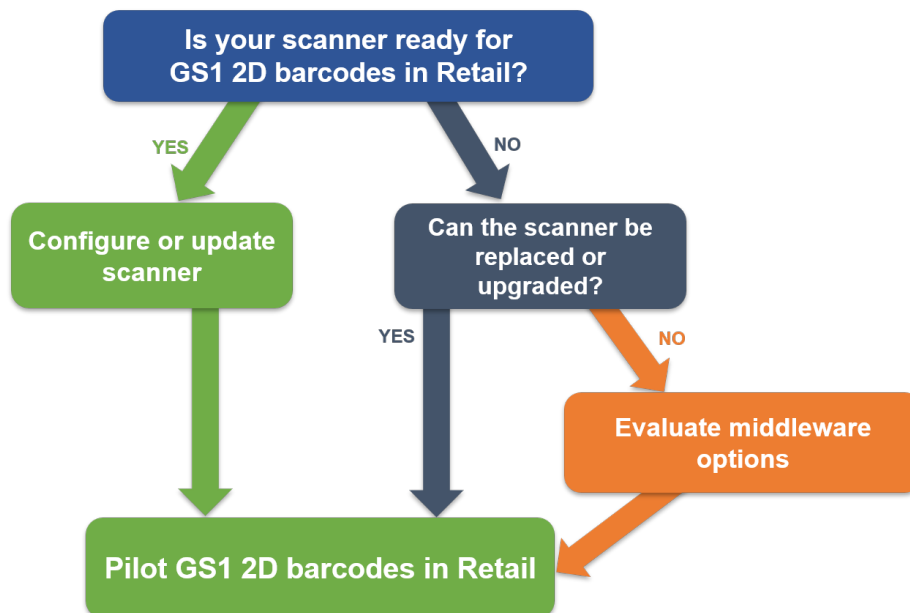


Figure 1: GS1 2D barcodes in retail capability decision tree

Why Middleware exists

Many retailers have invested significantly in scanner infrastructure that remains operationally sound but cannot practically support the software enhancements required for the Retail migration to GS1 2D barcodes. Middleware is an established technology approach that has been used for decades to bridge existing systems and technologies with new capabilities. In this context, middleware provides an alternative migration path that protects this investment, until pre-defined upgrades occur, while enabling GS1 2D barcode processing.

What is Middleware?

Middleware is a software or hardware layer inserted between the barcode scanner and the POS host application. Its purpose is to examine all barcode data received from the scanner and apply the business logic necessary to support GS1 2D barcode processing. Rather than relying on the scanner firmware to perform all processing, the middleware can implement the required 2D barcodes in Retail behaviour.

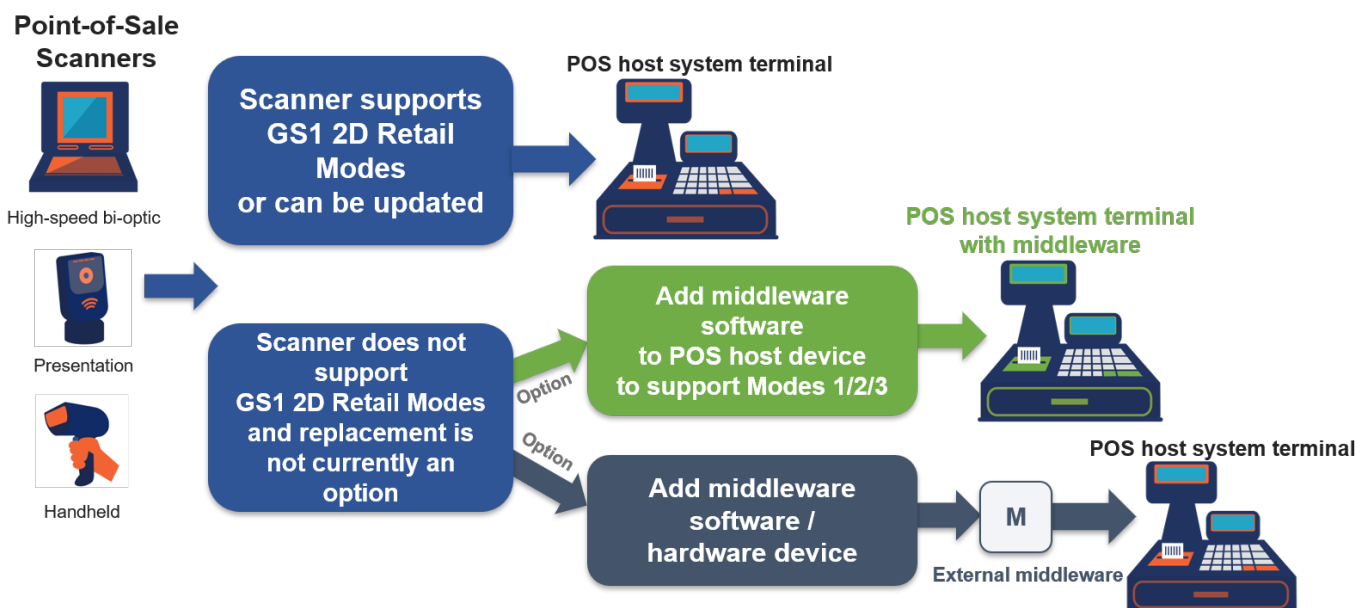


Figure 2: Example of possible GS1 2D in Retail implementations

Typical middleware implementations for this purpose could include:

- **Green Option in figure 1**

- Middleware software library integrated into the POS host system application
- Stand-alone Windows or Linux middleware service residing in the POS host operating system

- **Grey option in figure 1**

- Embedded device (for example an industrial PC or Raspberry Pi class controller) sitting between the scanner and POS host system

Note: The retailer should carefully evaluate the operational and strategic implications of updating scanners versus updating middleware, particularly across environments with multiple stores and POS systems. This assessment is critical to minimising deployment complexity, controlling costs, ensuring system consistency and enabling scalable long-term maintenance.

GS1 support tools

The free, open-source [GS1 Barcode Syntax Resource \(BSR\)](#) provides a versatile suite of tools that enables easy and consistent implementation of GS1 standards in middleware solutions. Several deployment options are available, ranging from lightweight standalone code embedded in a device to a webservice version hosted on a POS host PC. For more information on the GS1 Barcode Syntax Resource, see the Overview and User Guide.

The core BSR must be extended with retailer transaction rules, including one acknowledgement per product ("beep once"), and should account for coupons, loyalty cards and other barcodes that scanners are expected to decode.

Note: If the middleware is correctly implemented, then the consumer and retailer experience the solution as though the scanner supports the required functionality.

Typical Middleware Functions

Middleware may perform one or more of the following functions:

- Identify conformant GS1 2D barcodes
- Detect GS1 Digital Link URI syntax
- Translate GS1 Digital Link URI into GS1 Element String syntax
- Validate barcode content to GS1 standards
- Apply retailer business rules
 - Transmit Coupon and Loyalty barcode data
- Suppress duplicate GTIN reads from products with more than one barcode
 - Transmit only one GTIN to the POS application
 - Ensure only one product acknowledgement ("beep")
- Optionally provide additional Application Identifier data
- Select preferred barcode when multiple conformant barcodes exist
- Generate logging and diagnostic information

Performance Considerations

Because middleware introduces an additional processing stage, transaction latency is generally higher than when the scanner performs all processing internally.

Although the additional delay is typically small (often measured in only a few milliseconds on modern hardware), retailers operating very high-volume checkout lanes should evaluate performance carefully during pilot testing. Scanner implementations generally provide the lowest latency, simplest architecture, and lowest long-term maintenance burden.

For this reason, middleware should generally be viewed as:

- a migration strategy
- a compatibility solution



- or a temporary bridge until scanners can be upgraded.

Retail Decision Checklist

Consider Middleware if...

- Existing systems cannot support the required 2D Retail Modes.
- Scanner replacement is not planned for several years.
- POS software can be modified with middleware more easily than scanner firmware.
- Multiple scanner brands are deployed across stores, making the update or replacement process more complex.
- A phased migration strategy is preferred.

Consider Updating the Scanner if...

- Scanner manufacturer provides supported firmware.
- Scanner hardware fully supports GS1 2D in Retail Modes.
- Highest-possible checkout throughput is critical (i.e., at least 40 items per minute).
 - Lowest possible latency is required.
- Retailer wishes to minimise software complexity.
- New scanners are already planned as part of normal refresh cycles are soon.

Best Practice Recommendation

Where scanner firmware can be upgraded to support GS1 2D Retail Modes, or GS1 2D barcode capable scanners can be purchased, this is the preferred implementation.

Middleware should be considered where scanner upgrades are unavailable, impractical, or uneconomical. When deployed, middleware should behave transparently, ensuring that retailers continue to achieve the Ambition 2027 objective of identifying, decoding, acknowledging ("beeping") once, and transmitting a single GTIN from any GS1 conformant retail linear or 2D barcode while preserving compatibility with existing POS applications.

Middleware versus Native Scanner Support

Capability	Upgrade Scanner	Scanner + Middleware
Barcode processing	Scanner reads barcode and preprocesses data	Scanner reads barcode and middleware processes encoded data
GS1 Digital Link recognition	✓	✓
GS1 Digital Link translation	✓	✓
Single beep logic	✓	✓
Duplicate scan suppression	✓	✓
Business rules	Limited	Extensive
Performance	Fastest	Additional processing latency
Maintenance	Scanner firmware	Middleware software
Scalability	Excellent	Depends on implementation

GS1 glossary of terms and definitions

Term	Definition
Barcode processing	Reading and processing barcode data in accordance with GS1 standards and retail requirements.
Business rules	Applying retailer-defined rules to determine how barcode data is handled and transmitted to the POS system.
Duplicate scan suppression	Preventing duplicate reads of the same product identifier from being transmitted to the POS system.
GS1 2D barcodes in Retail	The GS1 conformant 2D barcodes used in retail: • QR Code with GS1 Digital Link URI syntax • GS1 DataMatrix • Data Matrix with GS1 Digital Link URI syntax
GS1 Digital Link recognition	Identifying when a scanned barcode contains a GS1 Digital Link URI.
GS1 Digital Link translation	Converting GS1 Digital Link URI data into a format suitable for processing by the POS system, such as GS1 Element String syntax.
Maintenance	The effort required to maintain, update and support the solution over its operational lifetime.
Middleware	A software or hardware layer that acts as a bridge between an operating system and applications, or between different parts of a system such as the scanner and host POS systems in retail.
Performance	The speed and processing efficiency of the solution, including its impact on checkout transaction time.
Scalability	The ability of the solution to support increasing numbers of POS systems, scanners, stores or deployments.
Single beep logic	Ensuring that a product with multiple barcodes results in only one acknowledgement ("beep") to the user.

Disclaimer Notice

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 does not endorse any specific company, brand, product or service, and nothing in this document is intended to serve as such an endorsement.

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.