FULCRUM DIGITAL FD.

QR Code Adoption

Enabling the Digital Future - Challenges & Considerations

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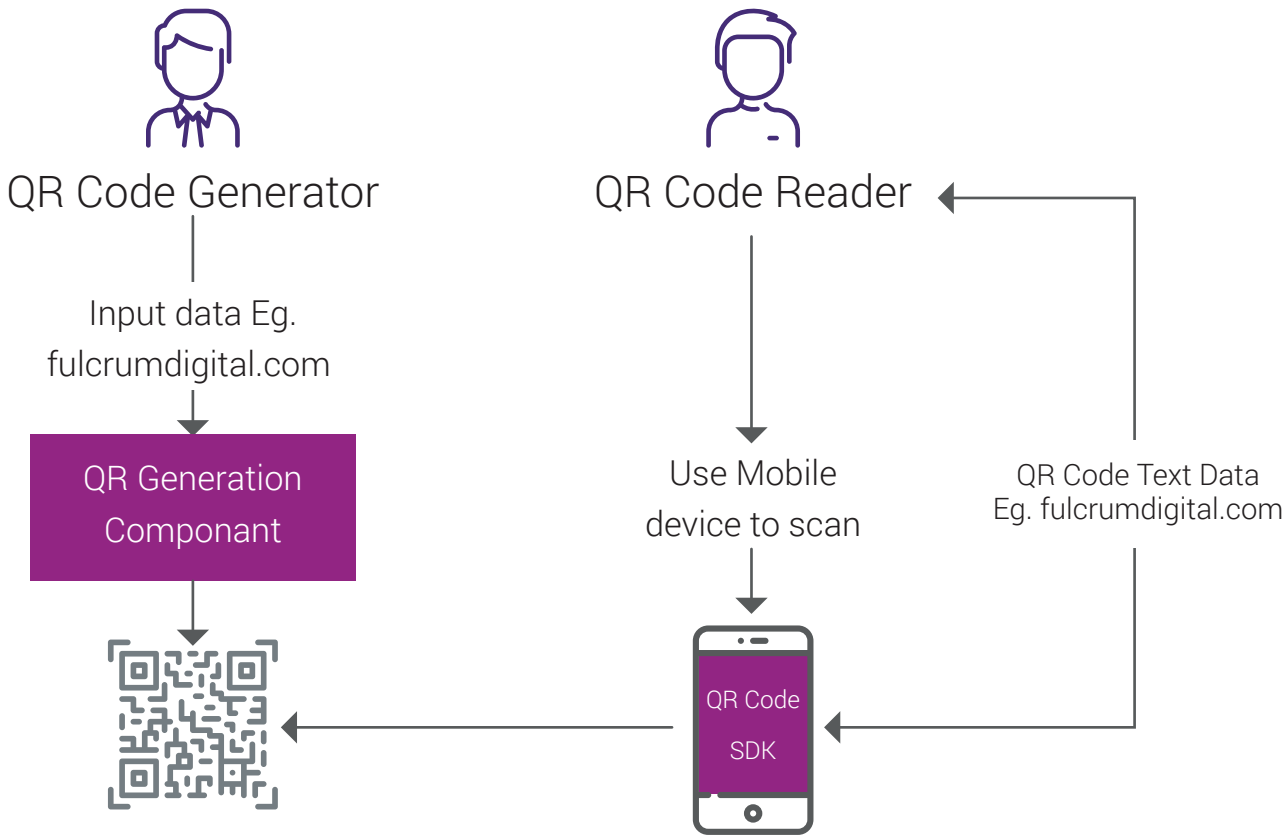
INTRODUCTION

QR Code (Quick Response code) represented in a 2-dimentional way is a type of matrix code to represent information that is machine readable. In practice, QR code is used for a variety of uses, such as location, website URL, payment information, WIFI network details, shopping item details etc.

QR Code became quite popular due to its greater storage capacity, fast readability and error detection capabilities. QR code is also dirt and damage resistant and readable from all directions. A QR code consists of black squares arranged in a square grid on a white background, which can be read by an imaging device such as a camera. A QR Code uses four standardized encoding modes to store data efficiently. These character encoding type modes are numeric, alphanumeric, byte/binary and kanji while alphanumeric is the most commonly used encoding type.

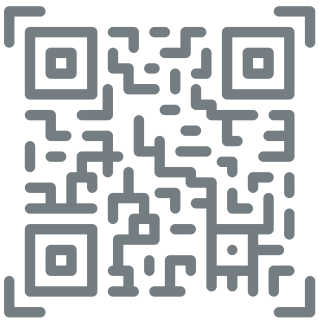
QR Code is processed using suitable software component such as Mobile Software Development Kit (SDK) that supports error correction and then subsequently interpret the character data from the image. The required data is then extracted from patterns that are present in both horizontal and vertical components of the image. High level flow of how QR Code is used is represented in diagram below.



INTRODUCTION

QR Codes are usually generated with opposite contrasting colours so that it is easily machine-readable. The most typical mechanism used is black & white combinations to generate QR Codes. Recent developments in QR Code use different colour combinations, support for logos, personalisation and branding.

For example, the Fulcrum web address is provided below using the typical use of QR Codes (shown on the left), and with the use of colour and branding (shown on the right).



QR CODE INTERNALS

Models & Versions

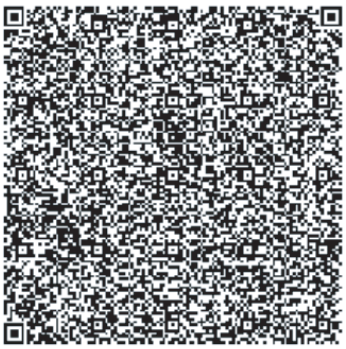
QR codes are classified into Model 1, Model 2 and Micro QR. They have different features and data capacities. Model 1 is the forerunner of Model 2 and Micro QR. For Model 1, 1-14 versions are registered to the AIMI standard. Model 2 has an alignment pattern for better position adjustment and contains greater data than Model 1 and has 1-40 versions. Model 2 is managed under the ISO/IEC 18004:2015 standards.

A module in QR Code refers to the black and white dots that make up a QR Code. Each version has a different module configuration or number of modules. Module configuration commences from Version 1 (21 × 21 modules) up to Version 40 (177 × 177 modules). Each higher version number comprises 4 additional modules per side.

Each QR Code symbol version has the maximum data capacity according to the amount of data, character type and error correction level. In other words, as the amount of data increases, more modules are required to comprise the QR Code, resulting in larger QR Code symbols.

Version 1

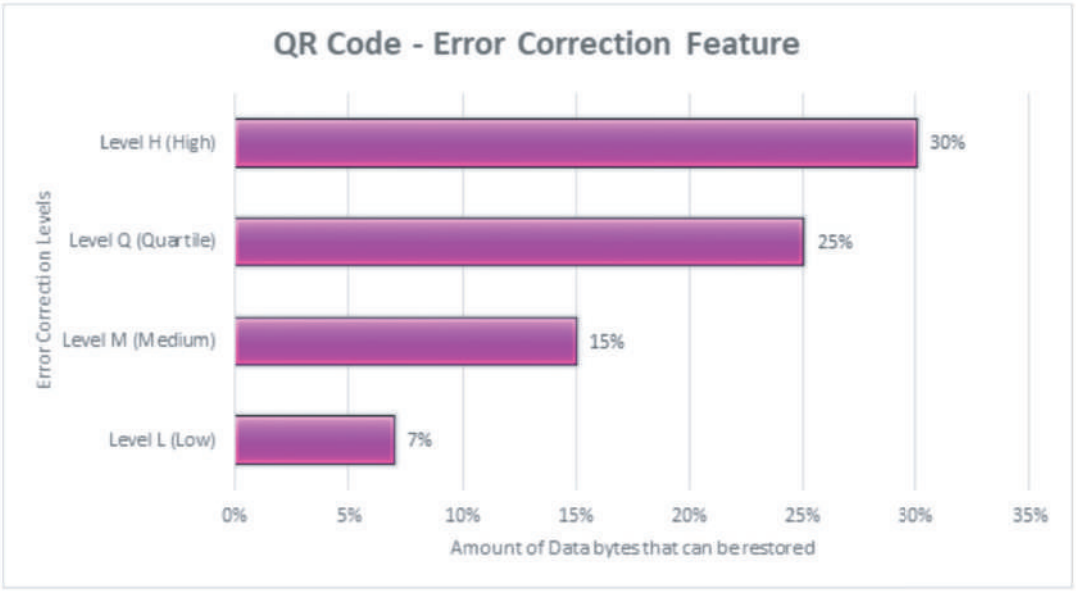
Version 4



Version 25

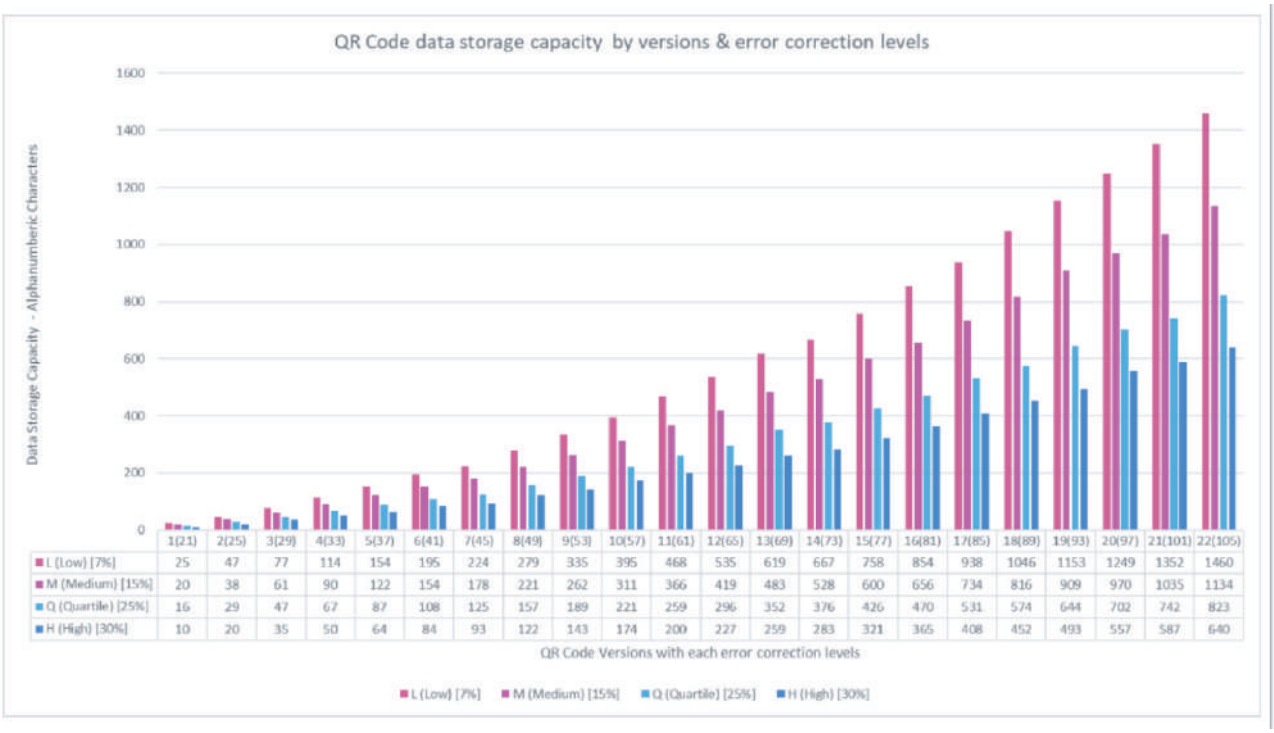
Error Correction

QR Code error correction capability provides the ability to restore data if the QR code is dirty or damaged. QR Codes use the Reed–Solomon error correction mechanism which adds the error correction bytes in addition to the data bytes into the QR Code. Four error correction levels are available for users to choose according to the operating environment and requirements. Raising the correction level improves error correction capability, but also decreases the amount of data that can be stored in the QR Code. The error correction levels supported by the QR Code is provided below:



Determining the Version of QR Code to be used

The size of QR Code is determined by the version and the size of a module. The version selected will be driven by data contents, character type and error correction rate. The module size must also consider the resolution of the printer, and the performance of the scanner. The actual size of the QR code is determined by multiplying the number of modules by the printable size of the module. Margins need to be added to determine the required space for the QR code. Model 1 and 2 require 4 modules and MicroQR requires 2 modules with a margin on each side. For example, as per the table below, to accommodate 200 characters in QR Code with error correction level H (30%), version 11 (module 61) was used for QR Code generation.



	1(21)	2(25)	3(29)	4(33)	5(37)	6(41)	7(45)	8(49)	9(53)	10(57)	11(61)	12(65)	13(69)	14(73)	15(77)	16(81)	17(85)	18(89)	19(93)	20(97)	21(101)	22(105)
L (Low) [7%]	25	47	77	114	154	195	224	279	335	395	468	535	619	667	758	854	938	1046	1153	1249	1352	1460
M (Medium) [15%]	20	38	61	90	122	154	178	221	262	311	366	419	483	528	600	656	734	816	909	970	1035	1134
Q (Quartile) [25%]	16	29	47	67	87	108	125	157	189	221	259	296	352	376	426	470	531	574	644	702	742	823
H (High) [30%]	10	20	35	50	64	84	93	122	143	174	200	227	259	283	321	365	408	452	493	557	587	640

EMV QR CODE SPECIFICATION

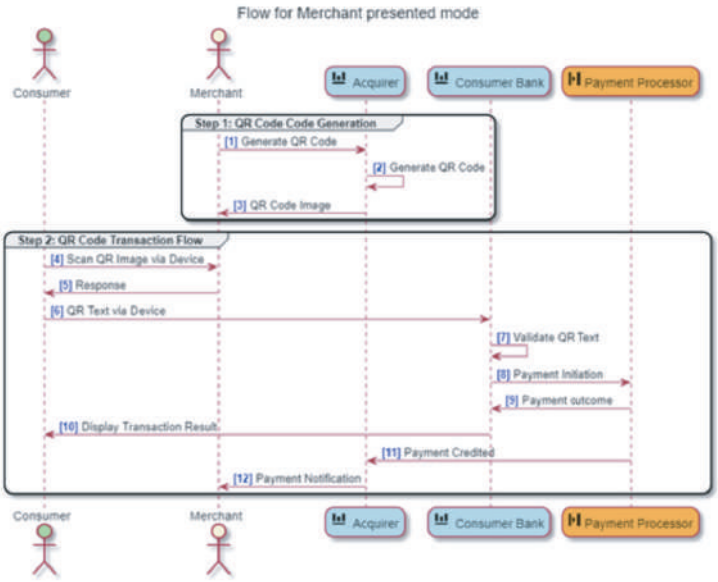
Overview

EMVCo is the global technical body that facilitates the worldwide interoperability and acceptance of secure payment transactions by managing and evolving the EMV specifications and related testing processes. Adoption of EMV specifications and associated approval and certification processes promotes a unified international payments framework, supporting payment methods, technologies and acceptance environments. The EMV QR Code specification enables collaboration with industry participants and reflects the requirements of actors across the payments ecosystem.

A QR Code is an ISO 18004-compliant encoding and visualization of data. EMVCo's specification covers both consumer-presented QR Codes and merchant-presented QR Codes.

Merchant Presented QR Code

The key sequence of events for the merchant presented QR code is depicted below:

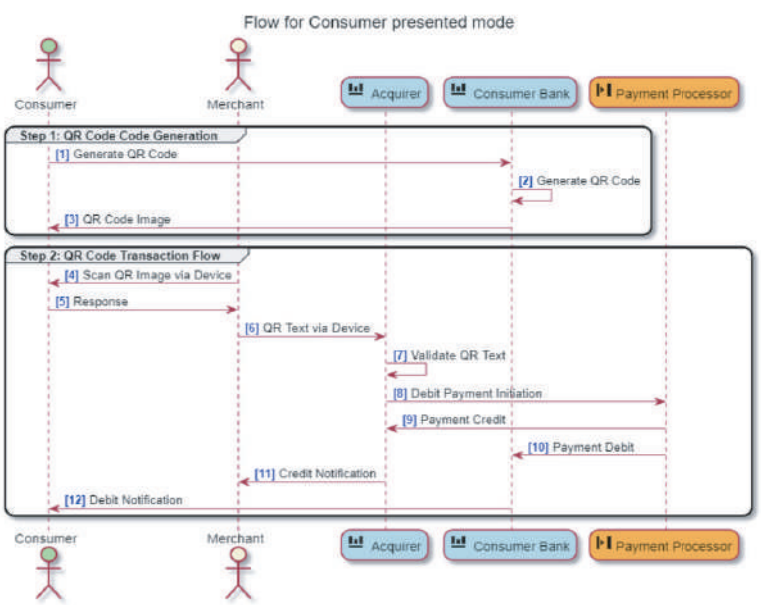


EMV QR Code has the payload data objects that need to conform to EMV specifications. A high-level view of the data objects is provided below:

- Payload format indicator – defines QR Code template and has value “01”
- Point of initiation method – for static QR Code value “11” and dynamic value “12”
- Cyclic Redundancy Check (CRC) – checksum of all data objects
- Merchant account information
  - Merchant category code
  - Country code
  - Merchant name
  - Merchant city
  - Postal code
  - Merchant information – other merchant related info
- Transaction value
  - Transaction amount
  - Transaction currency
  - Tip or convenience indicator
  - Value of convenience fee fixed
  - Value of convenience fee percentage
- Additional data objects include the bill number, mobile number, store label, loyalty number, etc.

Consumer Presented QR Code

The key sequence of events for the consumer presented QR code is depicted below:



The consumer presented QR code contains the payload format indicator and application template and/or common data template. The details of the application and common data template follow the EMV specification

QR CODE SOLUTIONS IN MARKET

There are number of tools in the market, both open source and commercial, that provide the capability to generate and read the QR Codes. They also come with an SDK capability for the common mobile platforms, including Android and iOS. They provide a configurable ability for QR Code Image generation, including Image type, logo options, colours, dimensions, error correction levels etc. They help suit different needs to generate customized QR Codes based on the requirements.

The most prominent Open Source QR Code solutions market are Google ZXing (a.k.a. Zebra Crossing) and ZBar. ZXing is built using Java language and has over 26 stars in Github with continually growing activity. On the other hand, ZBar is built using C language and comparatively has a lower star in Github (2K) and a flat activity.

QR CODE IMPLEMENTATION DESIGN CONSIDERATIONS

Unlike common software solutions that involve structured data, a QR Code based implementation uses a binary data image generated and processed. Design considerations that need to be considered for the implementation to be successful include:

Security Considerations

QR Code can represent any piece of text which means there is a risk it can also carry executable data e.g. JavaScript code that could run on a browser or app which can be used to exploit vulnerabilities in applications on the host system such as the reader, the web browser or the image viewer. Hence, it is quite important that QR Images are scanned using the certified SDKs or libraries that is issued by trusted organisations / institutions.

QR Generation Process Considerations

- QR code generation process needs to be configured with optimal error correction levels to allow enough redundancy to be built into part of the image to mitigate against tampering, tilting or very low contrast / dim images, yet protect image recognition.

- It is important to choose correct Version and Module for QR Code generation as it will impact how successfully a QR Code is read - factors to be considered include length of data characters, error correction level, module size and QR Image size.

- Ensure that QR Code image is not too dense, which will help successful scanning from a reasonable distance (at least 0.5 m).

- While the QR Code image has redundancy built in, when a logo image is overlaid to generate the final QR image, consideration needs to be given to the size of the logo and how much space the logo will occupy in relation to the overall QR image. This can have an impact on reading capability of the QR image.

QR Code Reader Considerations

- Generated QR Code image needs to consider various resolutions of the mobile devices, to enable the QR Code scanner SDK to identify issues at the point of transaction / request.
- Ensure contrasting colours are used when choosing coloured QR Codes to ensure better reading capability of QR Code.
- Ensure the Mobile SDK libraries for QR Code are tested will all the supported combinations of mobile platform and versions to ensure compatibility and compliance are met.

Performance Considerations

- Generated image data size needs to factored into consideration to ensure sufficient network bandwidth and storage is available to support user volumes.
- Consideration needs to factored into the solution so that the service is highly scalable, available, resilient and secure to support the business needs.

SUMMARY

With the ever-evolving digital economy, QR Code plays an important part enabling various key services benefiting both customers and businesses. QR Code based solutions have already been successful in large economies based in Asia and the US. With the increased adoption of QR Code based solutions globally, careful consideration needs to be made to ensure all the risks and challenges are understood and addressed for a successful and sustainable implementation.

REFERENCES

- https://www.qrcode.com/en/about/index.html
- https://www.emvco.com/emv-technologies/qrcodes/
- https://www.iso.org/standard/62021.html

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