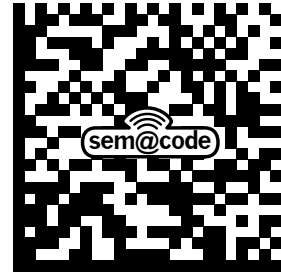


## Technical white paper

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## Choosing the best 2D barcode format for mobile apps

Choosing the best two-dimensional barcode format for mobile applications is a difficult decision. There are many different formats which vary over a wide range of axes—how much data they can store, whether or not they are standards, how large they are for a given amount of data. This paper provides a technical comparison of the different formats' strengths and weaknesses. Through a combination of our own and independent third-party analysis, we demonstrate that Data Matrix, the format chosen by Semacode, is the best choice.



An independent third-party assessment of Data Matrix and QR Code from the **Consumer Electronics Association (CEA)**'s **R9 Automatic Data Capture Committee** was made for the IEC 62090 committee. We include data and information from that document.

## Data Matrix vs. QR Code

Data Matrix and QR Code are both 2D barcode formats available as open standards. Data Matrix was designed in 1989, and standardized by partners including NASA, US DoD, and major industries such as electronics, pharma and postal marking. Although QR was developed later (1994) by Japanese company Denso, it had only one unique feature, to easily encode Japanese kana characters.

Although Data Matrix is now used in Japan, QR Code has never seen any significant use outside of Japan.



**Semacode uses the Data Matrix barcode format.** This is the “physical layer” of the semacode system, which also includes the use of URLs as a standard application addressing system. Semacode’s software is capable of reading and decoding Data Matrix codes containing any type of data, not just URLs, but also addresses, text, and binary data such as small images.

### Which is more spatially efficient?

Space on the printed page, on the screen, or on other media is a precious commodity which must be carefully conserved. However, some barcodes are more efficient at packing data into a small amount of space than others. In practice the question is: for a given amount of data, how much space (in terms of modules) does the format use up? As we know, the fewer modules, the less physical space is needed.



Experts measure the size of a 2D barcode as the number of modules in the grid along each side. Each grid module can be either “on” (black) or “off” (white). The size of each individual module is called the “X Size”. Each optical scanner has an inherent minimum X Size it can read, a limitation that is the same for all 2D codes that it reads, QR or Data Matrix or otherwise. The total size of the symbol will be the X Size x the number of modules.

An independent committee from the Consumer Electronics Association’s R9 Automatic Data Capture group submitted a comparison for the purpose of developing the IEC 62090 specification. They compared Data Matrix to QR Code, and concluded:

**“Data Matrix has proven to be the most space efficient of all the two-dimensional symbologies.”<sup>1</sup>**

The CEA document provides four specific examples<sup>2</sup> which we summarize in this table.

<sup>1</sup> “Comparison of Data Matrix and QR Code” (hereafter “CEA Comparison”) - [http://www.autoid.org/2001\\_documents/ANSI/ANSI\\_WG6/R9\\_Neg\\_IEC62090\\_5thCDV\\_0701.doc](http://www.autoid.org/2001_documents/ANSI/ANSI_WG6/R9_Neg_IEC62090_5thCDV_0701.doc) - downloaded 2006-07-12 - page 1 (2)

<sup>2</sup> CEA Comparison - pages 2-3

	QR Code	Data Matrix (Semacode)	Space Savings
Example 1	42x42	24x24	67%
Example 2	25x25	18x18	48%
Example 3	29x29	20x20	52%
Example 4**	29x29	26x26	20%**

\*\* Example 4 encodes Japanese Kana characters. QR Code was specifically designed to encode these efficiently. Even so, it is less efficient than Data Matrix for this task.

We can also analyze the performance of the two formats side by side using independently developed code generators for Data Matrix and QR Code. This analysis gives similar results.

	QR Code	Data Matrix (Semacode)	Space Savings
<a href="http://semacode.org/about/technical/">http://semacode.org/about/technical/</a>	29x29	22x22	42%
<a href="http://en.wikipedia.org/wiki/Semapedia">http://en.wikipedia.org/wiki/Semapedia</a>	29x29	24x24	32%
<a href="http://google.com">http://google.com</a>	25x25	18x18	61%

The conclusion from both independent and our own analysis is a Data Matrix code uses between 30% and 60% less space than a QR Code containing the identical data.

### Example codes



These two barcodes both encode the text “<http://google.com>”. The X-size is equal for both (1.41 mm) but the Data Matrix code is 61% smaller.<sup>3</sup>

<sup>3</sup> Data Matrix generated with 3rd party online tool “Free Online DataMatrix Barcode Image Generator ECC200” <http://www.idautomation.com/java/dmservlet.html> - accessed 2006-07-14.  
QR Code generated with 3rd party online tool “QR-Code Generator” <http://qrcode.kaywa.com/> - accessed 2006-07-14.

**Which has a smaller minimum size?**

For carrying small amounts of data, a small minimum size is essential to save additional space. The minimum size for QR Code is 21x21 modules, while Data Matrix has a much more space-efficient minimum size at 10x10 modules—77% smaller.

**Which has more third-party products and tools available?**

The availability of third-party tools and products can make or break the success of a total-product toolchain that uses barcodes to print and display on a wide range of media such as paper, plastic, metal, and specialized materials as well as electronic display through any one of a number of digital publishing systems.

The independent CEA committee states that Data Matrix is the most widely implemented matrix symbology.<sup>4</sup>

**Well over 20 label and marking companies – representing such technologies as thermal, thermal-transfer, and laser printing, ink-jet, dot-peen, chemical etch, and industrial lasers – presently support Data Matrix encoding in their products. Imaging scanners manufactured in Japan, Europe, and the United States now incorporate Data Matrix reading capability. The same is not true for QR Code.**

**This fact assures continued development and enhancements of Data Matrix decode capabilities and the availability of products from multiple suppliers at competitive prices.<sup>5</sup>**

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<sup>4</sup> CEA Comparison, page 1 (2)

<sup>5</sup> CEA Comparison, page 1, (4)-(5)

## Data Matrix vs. proprietary codes

Many companies now offering products in the mobile phone barcode space have developed their own, proprietary barcode formats. These formats may have unique features which differentiate them from the standardized formats. However, they are severely compromised by not having gone through a rigorous, open and impartial technical development process.



Standardized barcode formats benefit from years of experience and lengthy design process by recognized industry experts in an open forum (ISO, IEC, AIAG, and other standards organizations). Through standardization they collect a large number of third-party companies that support and improve the standards collectively. Proprietary codes enjoy none of these advantages and have many drawbacks.

### Are the designers known experts?

The designers of proprietary formats are unknown. Their qualifications, history, technical background are unproven, and their identities may be kept secret by the companies. They have not been through a formal or even informal process of vetting by the barcode standards community.

### Are the technical specifications available?

The technical specification of proprietary codes are not documented. This restricts the ability of independent provider to create alternative code generators and readers.

In addition without a public specification (such as found with standards-based formats) it is impossible to precisely characterize the spatial efficiency and the security characteristics of the format.

### Is there wide-ranging industry support?

Since the format is proprietary, third party companies cannot create an industrial ecosystem to support the format. This includes integrating the barcode format into standard barcode creating products that interface with word processors, imaging tools, page layout software, and other elements of the production toolchain.

### Does the format force a reliance on a single vendor (lock-in)?

Since the proprietary vendor is the only company with a license to know the specification and produce compatible codes, customers must “put all their eggs in one basket” and rely on the single vendor to continue to support the product. If the original company changes its business model or closes down, there may be no way to recover the proprietary scheme.

In addition, the proprietary vendor may make decisions or restriction on the use of the format that are not in the interests of the customer or of the industry growing around the format.

### **Is there substantial data capacity?**

The proprietary codes may have a very limited ability to store data, such as just a few numerical digits, or a handful of characters. The designers might not have had the ability to design a larger capacity, there might be inherent limitations in the geometry used, or they might not have foreseen the need for larger capacities when they designed the format.

It is also possible that the format was designed with a limited data capacity to facilitate the vendor's desire to act as a required middleware service provider.

## Conclusion

Standards-based barcode formats have clear superiorities over proprietary formats:

- the designers are known experts;
- the technical specifications are available;
- there is wide-ranging industry support;
- there are multiple vendors; and
- there is guaranteed data capacity.

Thus both Data Matrix and QR Code, as standards, are superior to the proprietary formats.

Comparing Data Matrix and QR Code, Data Matrix has additional advantages:

- Data Matrix is 30% to 60% more spatially efficient for encoding the same data, meaning that the barcodes fit more easily onto the page or screen;
- Data Matrix has more third-party industry support for both creation and decoding; and
- the minimum size of Data Matrix is 77% smaller.

Therefore we conclude that compared to QR and proprietary formats, Data Matrix is the best choice for mobile barcode applications.