Useful Facts about Barcoding

When Did Barcodes Begin? (Part 1)

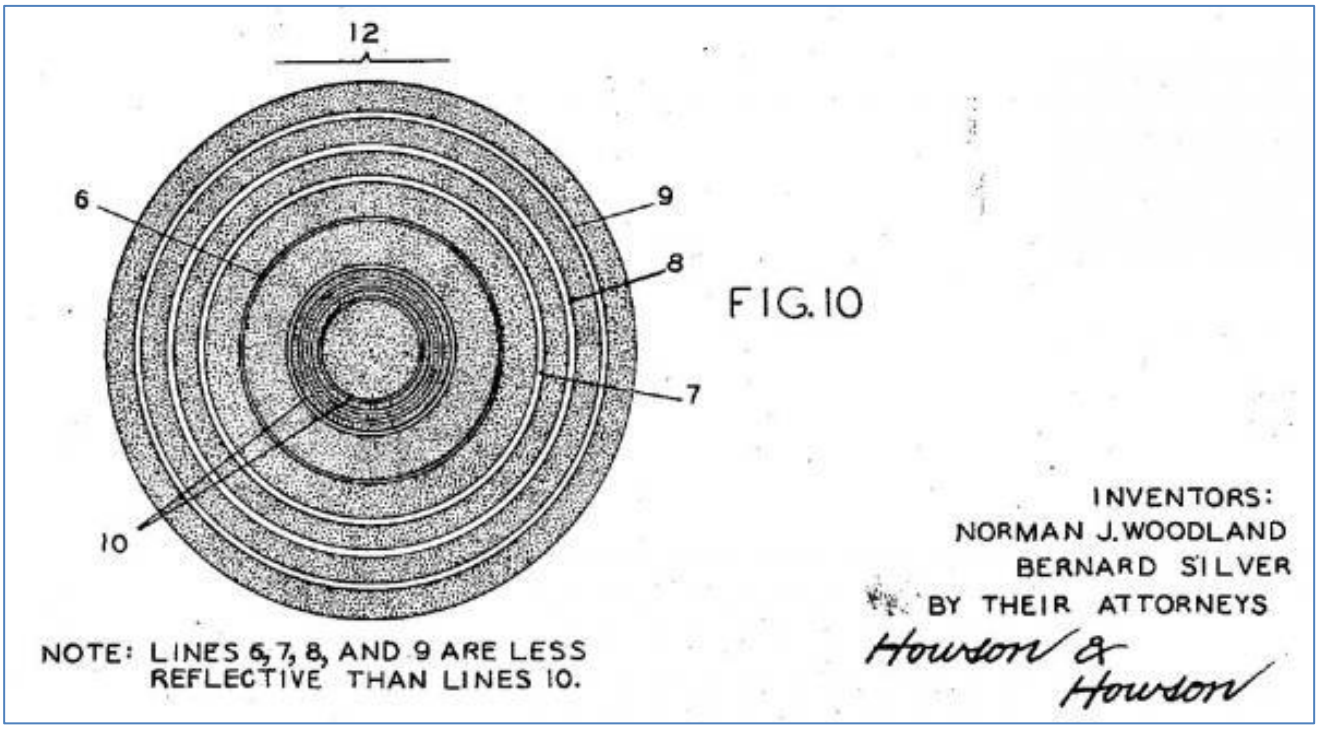
A barcode is an optical machine-readable representation of data relating to the object to which it is attached. Originally barcodes represented data by varying the widths and spacing's of parallel lines and may be referred to as linear or one-dimensional (1D). Later they evolved into rectangles, dots, hexagons and other geometric patterns in two dimensions (2D). Although 2D systems use a variety of symbols, they are generally referred to as barcodes as well. Barcodes originally were scanned by special optical scanners called barcode readers; later, scanners and interpretive software became available on devices including desktop printers and smartphones.

Barcodes are on the leading edge of extraordinary things. They have given humans the ability to enter and extract large amounts of data in relatively small images of code. With some of the latest additions like Quick Response (QR) codes and Radio-frequency identification (RFID), it's exciting to see how these complex image codes are being used for business and even personal use.

The original idea of the barcode was first introduced in 1948 by Bernard Silver and Norman Joseph Woodland after Silver overheard the President of a local food chain talking about their need for a system to automatically read product information during checkout. Silver and Woodland took their inspiration from recognizing this rising need and began development on this product so familiar to the world now.

After several attempts to create something usable, Silver and Woodland finally came up with their "Classifying Apparatus and Method" which was patented on October 07, 1952.

Here is an image extracted from the original patent documents of the idea that eventually led to the barcode:



Though it took many years to see a real application of their invention, there is no doubt that it marked the beginning of streamlining an otherwise arduous task. Their patent was purchased by Philco in 1962 and then later bought by RCA.

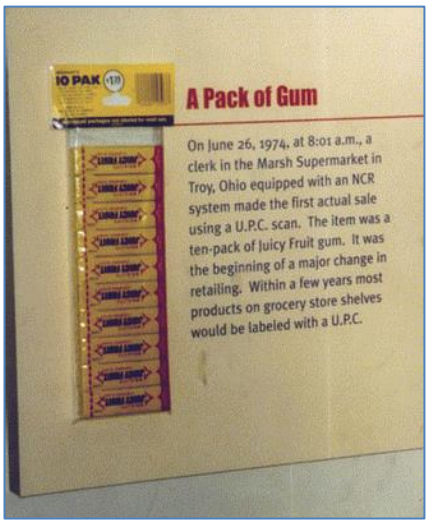
Around the same time, David Collins, a worker at the Pennsylvania Railroad, started noticing a similar need for railroad cars to be automatically identified. In 1959, Collins came up with a precursor to barcodes when he invented a system called KarTrak. He used blue and yellow reflective stripes attached to the side of the cars and encoded a six-digit company identifier and a four-digit car number in them.

The Boston and Maine Railroad tested the KarTrak system on their gravel cars in 1961 and continued testing until 1967, when the Association of American Railroads (AAR) selected it as a standard, Automatic Car Identification, across the entire North American fleet. By 1974, 95% of the fleet was labelled, though the system was easily fooled by dirt in some applications.

In 1966, the National Association of Food Chains met to discuss the idea of automated checkout systems. RCA attended the meeting with their recently purchased rights to the original Woodland patent. The NAFC established the U.S. Supermarket Ad Hoc Committee on a Uniform Grocery Product Code in the mid-1970s. This committee set guidelines for barcode development and created a symbol selection subcommittee to help standardize the approach.

The first commercial appearance of the UPC barcode was on June 26, 1974 at Marsh's Supermarket in Troy, Ohio. At 8:01 AM, Sharon Buchanan scanned a 10-pack of Wrigley's Juicy Fruit gum purchased by Clyde Dawson. The pack of gum and the receipt are now on display in the Smithsonian Institution.

Clyde Dawson's pack of Wrigley gum on display at the Smithsonian



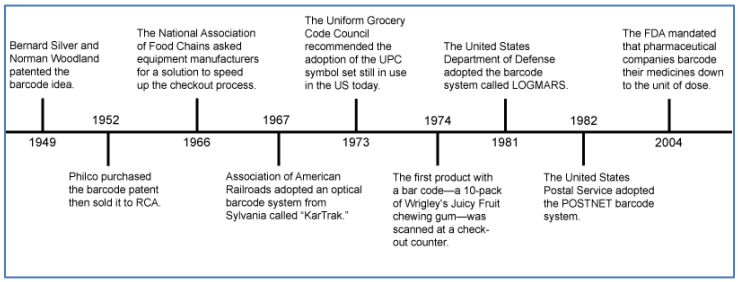
While manufacturers were simultaneously adopting barcode labels, the usefulness of the barcode required the adoption of expensive scanners by a critical mass of retailers. Customer needs were understood better with the implementation of the UPC as well. This was clearly evident when only about 5 weeks after installing barcode scanners, sales in grocery stores typically started climbing and eventually levelled off at a 10-12% increase in sales that never dropped off. It was shown in the field that the return on investment for a barcode scanner was 41.5%. 8,000 stores per year were converting by 1980.

The United States Department of Defence adopted the use of Code 39 for marking all products sold to the United States military in 1981.

When Did Barcodes Begin? (Part 2)

The history of the barcode from the mid-1970s to the mid-1990′s.

Barcodes such as the Universal Product Code (UPC) have become a widely used component of contemporary society, as evidenced by their enthusiastic usage by stores world-wide; almost every unit other than fresh green goods from a grocery store, department store, and mass merchandiser has a UPC barcode on it.



Economic studies were conducted by the mid-1970s for the grocery industry committee that projected over $40 million in savings to the industry from scanning. Those numbers were not met in the time frame they projected and some were said to have expected the demise of barcode scanning. The usefulness of the barcode required the adoption of high-priced scanners by a critical mass of retail merchants while manufacturers were adopting barcode labels at the same time. Neither wanted to move first and outcomes were not promising for the first couple of years, with Business Week exclaiming ”The Supermarket Scanner That Failed.”

Barcodes have opened the door to a revolutionary way of tracking business assets. A barcode provides automatic data capture which reduces human error during data entry, saving time and expense due to errors and manual entry. By 1980, the barcode was introduced by over 8,000 grocery stores per year. 1980 also signified the year that the first thermal transfer printer that was introduced by Sato.

In 1984, the Los Angeles Olympics chose Computer Identics to track and control access and security with barcode.

By 1984, several businesses had already kicked off the barcoding industry into what we now know it to be including:

Bar Code Graphics, Inc.
Express Identification Products
ATM Tech Solutions
Barcode QLD
Progressive Microtechnology, Inc.
Alliance Asset Tags

In 1987, David Collins left Computer Identics to start the Data Capture Institute (DCI), the first company dedicated completely to bar code education and advanced bar code and IT integration. Later DCI purchased Mac-Barcode software and forms subsidiary, The Mac-Barcode Company.

In 1989, the popular 2D code PDF417 was introduced by Symbol Technologies.

Example of PDF417 2-D Barcode

In 1994, the checkerboard symbology known as Data Matrix was invented by International Data Matrix, Inc. (ID Matrix) and eventually covered several ISO/IEC standards.
In 1996, the Federal Aviation Administration (FAA) awarded a prime contract to Data Capture Institute for tracking and control of operational assets in a program known as BCATS (bar code asset tracking system). This program, which continued until the events of 9/11 deflected funding, became the prototype for the DoD’s IUID

mandate. We will have more information on the development and integration of the IUID mandate as well as the future of barcodes in Part 3 to come.

What Barcode Symbologies are the Best?

With the variety of barcode symbologies currently available, how can you be sure that the one you choose will fulfil your requirements? This guide is a basic reference to help you sort through the options. Additional articles will follow soon with more detail about each symbology on its own, and as always, please let us know if you have any questions or input!

Linear Barcode Symbologies (1D):

Linear Barcode symbologies are likely the ones most people are familiar with. These barcode symbologies are created with parallel black and white bars and spaces of varying sizes and are used to automatically and accurately capture data and reduce human error during entry as they are read by a laser scanner. The scanner reads the barcode from left to right in one dimension which is why linear barcodes are referred to as 1-D barcodes.

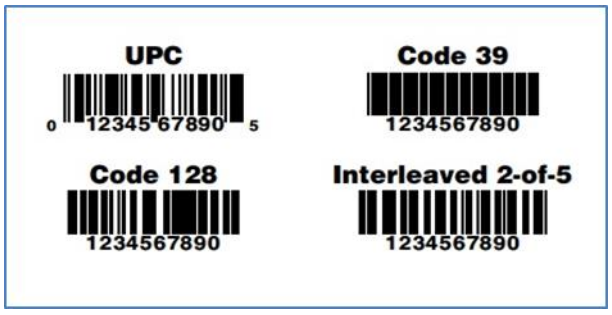
Some of the common Linear Barcode symbologies you might come across are:

UPC: Standard barcode for retail environments. Each UPC number relates to one specific retail item. Codes are regulated by www.GS1.org and are only produced as static (non-changing) numbers.

Code 39 (or Code 3 of 9): Most common barcode symbology. Codes alphanumeric character set, and is very strong in asset tracking applications requiring sequential data (i.e. 0001, 0002, 0003, etc.).

Code 128: Less common than code 39, but still widely used. It is also more compact than code 39, so you can fit more characters in smaller spaces.

Interleaved 2 of 5 (or I 2 of 5): Symbology that requires an even number of encoded digits. Only numeric information can be encoded.



Examples of Linear Barcode Symbologies

2D Barcode Symbologies

This second category has been gaining popularity in recent times due to their advances in encoding and flexibility of use. 2D Barcode Symbologies have been included in many applications including: print advertisement, social networking, military identification, and much more. These 2 dimensional barcode symbologies are read in 2 dimensions (surprise surprise… they are read horizontally and vertically). Since these are read in both directions, a standard laser scanner will not be able to read these. Instead an optic scanner or smartphone will be required. Typically fashioned as a square shape, 2 Dimensional barcode symbologies are able to hold hundreds of characters on much smaller areas than their 1 Dimensional counterparts.

The two most common 2 Dimensional barcode symbologies you will come across are:

QR Codes: These are most common for applications in advertising as the proliferation of mobile scanning apps for smartphones has allowed companies to create 'hardlinks' that the customer can scan with a smartphone and learn more information right on the spot. However, more companies are starting to utilize the technology in standard asset tracking processes, as the use of smartphones is widespread.

Data Matrix: These barcodes are used regularly in many military applications due to their robust encoding and error correction ability. A Data Matrix has the ability to be scanned even though it may be damaged. They are also used in asset tracking applications with more regularity due to their ability to hold a lot of information in a very small space.

Above Examples of 2D Barcode Symbologies

Barcode Uses

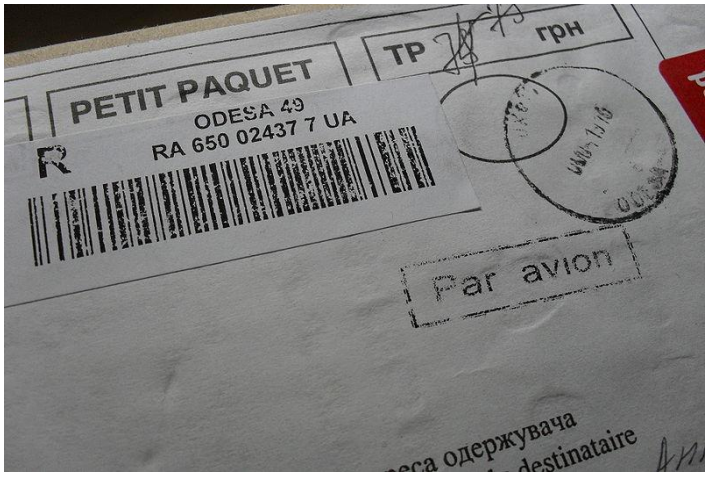
Barcodes such as the UPC have become a ubiquitous element of modern civilization, as evidenced by their enthusiastic adoption by stores around the world; almost every item other than fresh produce from a grocery store, department store, and mass merchandiser has a UPC barcode on it.[citation needed] This helps track items and also reduces instances of shoplifting involving price tag swapping, although shoplifters can now print their own barcodes. In addition, retail chain membership cards (issued mostly by grocery stores and specialty "big box" retail stores such as sporting equipment, office supply, or pet stores) use bar codes to uniquely identify consumers, allowing for customized marketing and greater understanding of individual consumer shopping patterns. At the point of sale, shoppers can get product discounts or special marketing offers through the address or e-mail address provided at registration.

Example of barcode on a patient identification wristband

Barcodes can allow for the organization of large amounts of data. They are widely used in the healthcare and hospital settings, ranging from patient identification (to access patient data, including medical history, drug allergies, etc.) to medication management. They are also used to facilitate the separation and indexing of documents that have been imaged in batch scanning applications, track the organization of species in biology,[13] and integrate with in-motion check weighs to identify the item being weighed in a conveyor line for data collection.

They can also be used to keep track of objects and people; they are used to keep track of rental cars, airline luggage, nuclear waste, registered mail, express mail and parcels. Barcoded tickets allow the holder to enter sports arenas, cinemas, theatres, fairgrounds, and transportation, and are used to record the arrival and departure of vehicles from rental facilities etc. This can allow proprietors to identify duplicate or fraudulent tickets more easily.

Barcodes are widely used in shop floor control applications software where employees can scan work orders and track the time spent on a job.



Barcoded parcel

Barcodes are also used in some kinds of non-contact 1D and 2D position sensors. A series of barcodes are used in some kinds of absolute 1D linear encoder. The barcodes are packed close enough together that the reader always has one or two barcodes in its field of view. The relative position of the barcode in the field of view of the reader gives incremental precise positioning, in some cases with sub-pixel resolution. The data decoded from the barcode gives the absolute coarse position. An "address carpet", such as Howell's binary pattern and the Anoto dot pattern, is a 2D barcode designed so that a reader, even though only a tiny portion of the complete carpet is in the field of view of the reader, can find its absolute X,Y position and rotation in the carpet.

Some 2D barcodes embed a hyperlink to a web page. A capable cellphone might be used to read the pattern and browse the linked website, which can help a shopper find the best price for an item in the vicinity. Since 2005, airlines use an IATA-standard 2D barcode on boarding passes (BCBP), and since 2008 2D barcodes sent to mobile phones enable electronic boarding passes.

Some applications for barcodes have fallen out of use; In the 1970s and 1980s, software source code was occasionally encoded in a barcode and printed on paper(Cauzin Softstrip and Paperbyte are barcode symbologies specifically designed for this application.), and the 1991 Barcode Battler computer game system used any standard barcode to generate combat statistics.

In the 21st century, many artists have started using barcodes in art, such as Scott Blake's Barcode Jesus, as part of the post-modernism movement.

Scanners (barcode readers)

The earliest, and still the cheapest, barcode scanners are built from a fixed light and a single photo sensor that is manually "scrubbed" across the barcode.

Barcode scanners can be classified into three categories based on their connection to the computer. The older type is the RS-232 barcode scanner. This type requires special programming for transferring the input data to the application program.

"Keyboard interface scanners" connect to a computer using a PS/2 or AT keyboard–compatible adaptor cable (a "keyboard wedge"). The barcode's data is sent to the computer as if it had been typed on the keyboard.

Like the keyboard interface scanner, USB scanners are easy to install and do not need custom code for transferring input data to the application program. On PCs running windows the HID interface emulates the data merging action of a hardware "keyboard wedge", and the scanner automatically behaves like an additional keyboard.

Barcode scanners can be used in Google's mobile Android operating system via both their own Google Goggles application or 3rd party barcode scanners like Scan. Nokia's Symbian operating system features a barcode scanner,

while mbarcode is a QR code reader for the Maemo operating system. In the Apple iOS, a barcode reader is not natively included but more than fifty paid and free apps are available with both scanning capabilities and hard-linking to URI. With BlackBerry devices, the App World application can natively scan barcodes and load any recognized Web URLs on the device's Web browser. Windows Phone 7.5 is able to scan barcodes through the Bing search app.

Quality Control & Verification

Barcode verification examines scanability and the quality of the barcode in comparison to industry standards and specifications. Barcode verifiers are primarily used by businesses that print and use barcodes. Any trading partner in the supply chain can test barcode quality. It is important to verify a barcode to ensure that any reader in the supply chain can successfully interpret a bar code with a low error rate. Retailers levy large penalties for non-compliant barcodes. These chargebacks can reduce a manufacturer's revenue by 2% to 10%.

A barcode verifier works the way a reader does, but instead of simply decoding a barcode, a verifier performs a series of tests. For linear barcodes these tests are:

- Edge Determination
- Minimum Reflectance
- Symbol Contrast
- Minimum Edge Contrast
- Modulation
- Defects
- Decode
- Decodability
- 2D matrix symbols look at the parameters:
- Symbol Contrast
- Modulation
- Decode
- Unused Error Correction
- Fixed (finder) Pattern Damage
- Grid Non-uniformity
- Axial Non-uniformity

Depending on the parameter, each ANSI test is graded from 0.0 to 4.0 (F to A), or given a pass or fail mark. Each grade is determined by analyzing the scan reflectance profile (SRP), an analog graph of a single scan line across the entire symbol. The lowest of the 8 grades is the scan grade and the overall ISO symbol grade is the average of the individual scan grades. For most applications a 2.5 (C) is the minimum acceptable symbol grade.

Compared with a reader, a verifier measures a barcode's optical characteristics to international and industry standards. The measurement must be repeatable and consistent. Doing so requires constant conditions such as distance, illumination angle, sensor angle and verifier aperture. Based on the verification results, the production process can be adjusted to print higher quality barcodes that will scan down the supply chain.

Barcode verifier standards

Barcode verifiers should comply with the ISO/IEC 15426-1 (linear) or ISO/IEC 15426-2 (2D).
This standard defines the measuring accuracy of a bar code verifier.

The current international barcode quality specification is ISO/IEC 15416 (linear) and ISO/IEC 15415 (2D). The European Standard EN 1635 has been withdrawn and replaced by ISO/IEC 15416. The original U.S. barcode quality specification was ANSI X3.182. (UPCs used in the US – ANSI/UCC5).

This standard defines the quality requirements for barcodes and Matrix Codes (also called Optical Codes).

As of 2011 the ISO workgroup JTC1 SC31 was developing a Direct Part Marking (DPM) quality standard: ISO/IEC TR 29158.[24]

International standards are available from the International Organization for Standardization (ISO).

These standards are also available from local/national standardization organizations, such as ANSI, BSI, DIN, NEN and others.

A Table of Symbologies & Uses

Symbology	Continuous or Discrete	Bar Widths	Uses
UPC	Continuous	Many	Worldwide retail, GS1-approved – International Standard ISO/IEC 15420
CODEBAR	Discrete	Two	Old format used in libraries and blood banks and on airbills (out of date)
CODE 25 (NON-INTERLEAVED 2 OF 5)	Continuous	Two	Industrial
CODE 25 (INTERLEAVED 2 OF 5)	Continuous	Two	Wholesale, libraries International standard ISO/IEC 16390
CODE 39	Discrete	Two	Various – international standard ISO/IEC 16388
CODE 93	Continuous	Many	Various
CODE 128	Continuous	Many	Various – International Standard ISO/IEC 15417
CODE 128A	Continuous	Many	Various – only a CODE 128 character set, not an own Symbology
CODE 128B	Continuous	Many	Various – only a CODE 128 character set, not an own Symbology
CODE 128C	Continuous	Many	Various – only a CODE 128 character set, not an own Symbology
CODE 11	Discrete	Two	Telephones (out of date)
CPC BINARY	Discrete	Two	
DUN 14	Continuous	Many	Various
EAN2	Continuous	Many	Addon code (magazines), GS1-approved – not an own Symbology – to be used only with an EAN/UPC according to ISO/IEC 15420
EAN5	Continuous	Many	Addon code (books), GS1-approved – not an own Symbology – to be used only with an EAN/UPC according to ISO/IEC 15420
EAN-8, EAN-13	Continuous	Many	Worldwide retail, GS1-approved – International Standard ISO/IEC 15420
FACING IDENTIFICATION MARK	Continuous	One	USPS business reply mail
GS1-128 (Formerly UCC/EAN-128), wrongly referenced as EAN 128 & UCC 128	Continuous	Many	Various, GS1-approved -is just an application of the Code 128 (ISO/IEC 15417) using the ANS MH10.8.2 AI Data structures. It's not an own Symbology.
GS1 DataBar, formerly Reduced Space Symbology (RSS)	Continuous	Many	Various, GS1-approved
HIBC (HIBCC Health Industry Bar Code)	Discrete	Two	Healthcare[27] – is a data structure to be used with Code 128, Code 39 or Data Matrix
ITF-14	Continuous	Many	Non-retail packaging levels, GS1-approved – is just an Interleaved 2/5 Code (ISO/IEC 16390) with a few additional specifications, according to the GS1 General Specifications
LATENT IMAGE BARCODE	Neither	Tall/Short	Colour print film
PHARMACODE	Neither	Two	Pharmaceutical packaging (no international standard available)
PLESSEY	Continuous	Two	Catalogues, store shelves, inventory (no international standard available)
PLANET	Continuous	Tall/Short	United States Postal Service (no international standard available)
POSTNET	Continuous	Tall/Short	United States Postal Service (no international standard available)
INTELLIGENT MAIL BARCODE	Continuous	Tall/Short	United States Postal Service, replaces both POSTNET and PLANET symbols (formerly named OneCode)
MSI	Continuous	Two	Used for warehouse shelves and inventory
PostBar	Discrete	Many	Canadian Post office
RM4SCC / KIX	Continuous	Tall/Short	Royal Mail / Royal TPG Post
JAN	Continuous	Many	Used in Japan, similar and compatible with EAN-13 (ISO/IEC 15420)
Telepen	Continuous	Two	Libraries (UK)

If you have any further questions on what barcode symbologies are the best for your application, please do not hesitate to give us a call on **+44 (0)1482 506560 or 505101**, or shoot us an email to sales@datamarkuk.com !

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