White Paper

NOT ALL CODES ARE CREATED EQUAL

Why some serial numbers are better than others

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EXECUTIVE SUMMARY

Serial numbers and product codes have existed for decades, even centuries, yet many organizations give little consideration to what types of codes are best suited to their needs. This can stunt progress in managing product inventory, shipping and other key logistical areas. More importantly, the proper code structure can support traceability and brand protection through anti-counterfeiting and diversion-protection solutions.

Many types of serial numbers and applications for serial numbers exist due to various use cases. Organizations can make significant advances in supply chain security, logistical and operational efficiencies and brand protection by investing in the proper serialization strategy. Basic serialization strategies such as sequential numbering offer advantages in their simplicity, while more advanced serialization strategies support use cases for customer engagement, supply chain management, security and anti-counterfeiting. Support for standardized serialization schemes enhances an organization's ability to collaborate with partners and use serial numbers outside their organization. Radio frequency identification (RFID) tags, traditional barcodes, data matrix barcodes, quick reference (QR) codes and human-readable codes are the most common ways that organizations apply serial numbers to items.

This white paper illustrates why organizations should adopt a strategy that supports multiple serialization schemes and standards to address their various needs.

SERIAL NUMBER BASICS

A serial number can be defined as a code assigned to an item or group of items for the purpose of identification. Serial numbers can identify items as a particular model (e.g., all units of model "X" are assigned the serial number "1234"), a product type (e.g., all units and models made with specification "Y" are assigned the serial number "5678") and more. In addition, serial numbers can be uniquely assigned to an individual item so that no two objects have the same number.

This creates a unique identifier for that item, similar to a Social Security number issued to each US citizen.

Sequential numbers are the most basic form of codes and serial numbers. This system has been popular due to the simplicity of creating the codes and the basic tracking of manufacturing numbers. For example, the first item produced within a model is often given serial number 1 (or 01, 001, etc.) with the second item numbered 2 and so on. Although this technique offers easy insights into the order of items manufactured, it lacks the flexibility that modern code structures offer. For example, an item with enough space only to fit two characters (e.g., 12) can support at most 99 individual codes when sequentially numbered. As such, many use cases require alphanumeric codes.

Alphanumeric codes include both numbers and letters, offering two basic advantages over sequential numbering as serial numbers: more unique codes can be created within a given code length, and additional product attributes can be represented by numbers or letters.

In this instance, the number in an item code could represent the order in which items were manufactured, and the letter could represent a specific model. Alphanumeric code structures range from random generation to standardized codes, where a variety of elements can be defined.

SERIAL NUMBER STANDARDS

Standards for serial numbers create a set of defined characters, lengths, code organization or even character spacing. This allows other organizations to understand or interpret elements of other codes within the given standard, often for the purpose of identifying an item, its model or its manufacturer. One prominent example of a standardized serial-number structure would be the Universal Product Code (UPC) as defined by standards organization GS1 and applied to barcodes across the world. If a manufacturer chooses to embed a GS1 UPC and barcode into a barcode on the back of their product, it allows the company's internal staff as well as their partners in warehousing, distributing, shipping and retail, and even the consumer, to scan the barcode and interpret the data to get information about the product itself, such as the product name or manufacturer. GS1 offers several code guidelines and prefixes for organizations to apply across items, products and even shipping containers.

The International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC) and the American National Standards Institute (ANSI) are just three of the groups involved in setting standards for serial numbers, product codes and their applications beyond GS1. Each of these standards organizations have become involved in serial numbers due to the efficiency gains when organizations use common standards. Any organization can create its own set of serial numbers and associate data in a proprietary method that is unique to that organization. Companies then share the meaning behind that serialization method with their partners and can gain advantages in describing an item as listed in the above example of UPC barcodes; however, that becomes a major challenge for trading partners if they attempt to support multiple serialization methodologies. As a result, organizations that require coordination between the manufacturer or supplier and outside groups—from distributors to logistics companies, other supply chain partners and even customers—are heavily incentivized to use standards-based serial numbers. In these cases, the way in which a serial number is applied to an item also becomes an important aspect of usability across organizations.

APPLICATIONS

Serial numbers can be applied to items through several different technologies including a human-readable code (e.g., a printed code on a label), RFID tags, one-dimensional barcodes (traditional barcodes), data matrix codes (two-dimensional barcodes) and QR codes. Beyond these five main applications, a number of proprietary applications exist. Each of the five common applications are briefly described below.

- **Human-readable codes** are typically printed onto labels and then applied or laser-etched onto an item. Some items have human-readable codes stamped, engraved or even built into the original product mold.
- **RFID tags** use radio frequencies to allow scanning and communication of codes at a greater distance than barcodes. RFID tags also transmit associated identification information and use automated technologies rather than human processes.
- **Traditional barcodes** are a set of lines, varying in widths and spaces between lines, which act as machine-readable data describing the item on which the barcode is applied. Traditional barcodes are considered linear as the line widths and spaces are read in a single linear direction. The UPC is a specific barcode symbol widely used in the Western world for tracking items.
- **Data matrix codes** are like traditional barcodes as they are a visual representation of a product code to be read by machines. Data matrix codes have blocks instead of lines, allowing for a variety of widths and spaces in two dimensions instead of one. This allows for a significant increase in the amount of data that can be associated with an item through the serial number representation.
- **QR codes** are a particular type of data matrix barcode. QR codes are popular due to their ability to rapidly identify an item and present associated information. QR codes allow for more data than a traditional barcode but less data than other data matrix codes. ISO/IEC have defined standards around QR codes, further encouraging their propagation and allowing them to be scanned by most smartphones.

THE RIGHT CODE FOR THE RIGHT USE

The use case is the most important factor that should dictate the basic structure of a serial number, the adherence to standards and the application of a serial number. Use cases range from inventory control to operational insights on manufacturing or warehouse logistics to supply chain security and more. Machine-readable codes applied to items through barcodes, RFID tags, data matrix codes or QR codes support one set of use cases, while human-readable codes support a different set of use cases. The use cases around supply-chain and product security demand their own serial number characteristics due to the nature of security operations, whether those codes are human readable, machine readable or both.

Human-readable codes are best used where automated technologies for capturing serial numbers cannot be assumed and the code is intended to be used by a wide variety of end users, especially the average consumer. In these cases, an individual will be checking the code against information provided to them or entering the code to a system for verification. Because human intervention is required, certain code structures are considered best practices. These include eliminating vowels from the character set to avoid accidental generation of codes that spell inappropriate words, separating long code sets with spaces or dashes for enhanced readability, representing a zero with a strike through the center to avoid a user confusing a zero with the letter "O," and keeping codes as short as possible. Serial numbers should be kept short because there is a greater chance of errors in generating codes, applying codes, reading codes, re-entering codes and so on when more characters are included in a single serial number.

Human-readable codes can also be used as backup for machine-readable codes that may fail to be read by an automated system.

Organizations with many distributors, resellers, logistics partners, retail partners and other supply chain partners often include human-readable serial numbers since they can be used by the greatest number of individuals with the fewest technology requirements.

Organizations that require the consumer to read the serial number when entering a promotional code or redeeming a product key also employ human-readable codes due to the broad base of usability.

Machine-readable codes support high-volume use cases, automated data capture and the widest variety of code structures. While human-readable codes should be short, easy to read and easy to re-enter, machine-readable codes can be much longer, especially when supported by data-rich applications like RFID tags and data matrix codes. Plus, machine-readable codes support automated processes, allowing for rapid scanning of large numbers of codes. Barcode scanners and data matrix scanners are widely available compared to other applications like RFID tag readers, making them an attractive option for high-volume processes across multiple trading partners. In many cases, manufacturing and production lines, shipping facilities and warehouses are already equipped with barcode or data matrix scanners to support automated processes. Support for long serial numbers and automated data capture also makes machine-readable codes attractive for security functions.

When creating security through serial numbers, an organization's needs are best complemented by unpredictable codes applied uniquely to items or groups of items. This means that a single code would not expose any information about other codes, whether that is the total number of codes in circulation, another specific code that would be applied to a different item, or even the set of characters used within other codes. The longer a secure serial number is, the greater the set of possible combinations for other "valid" codes, and thus the greater the security provided by that serial number; however, long serial numbers have certain disadvantages, even when applied to items through machine-readable substrates. Organizations should consider the required level of security provided by a serial number in contrast to the challenges associated with using various lengths of codes within their given security use cases. This trade-off between the ease of using a serial number and the challenge of guessing another "valid" number is critical when determining how to match a serialization strategy with a security use case.

Serial numbers create supply-chain and product security when a unique and unpredictable code is applied to a specific item. This allows an individual to compare that serial number with a list of "valid" codes. That number confirmation can be used as a type of authentication, which can be provided by call centers, websites, mobile applications, text messaging services and more. In each of these cases, matching the serial number on an item with the serial number on a list of "valid" codes allows the user to confirm the identity of the item. This can establish the item as authentic in cases where large numbers of counterfeit items are a risk. Most counterfeiters seek to maximize profits by making a large number of counterfeit items. In the case of sequential serial numbers, counterfeit operations can easily guess other valid numbers, or if the manufacturer uses a single serial number for many items, the counterfeiters can use serial numbers known to be valid on many items. Uniquely applied and unpredictable serial numbers prevent counterfeiters from knowing any more "valid" codes, drastically reducing the profitability of counterfeiting that item. Beyond preventing counterfeiting, secure serialization can protect organizations against theft, illegal diversion, product tampering and other supply chain security challenges.

SECURITY USE CASE

Serialization within security use cases is especially complex and typically requires some expertise in secure serialization to ensure the desired outcomes are achieved.

Item traceability is the ability to verify the location, transaction history and application of an item by assigning a single, unique serial number to an individual item. Traceability helps protect against several supply chain security threats by establishing a chain of custody for individual items. For example, if a truckload of products is stolen and sold on an online retail website, organizations can use secure serialization practices to distinguish which items are legitimate. Furthermore, traceability enables organizations to track instances of diversion or theft over time, providing greater insight into the security gaps within a supply chain or trading partner. In many cases, this allows an organization to track security breaches back to a partner, facility or even a specific individual within a partner organization.

QR codes have several disadvantages within security use cases. These disadvantages are inherent to technologies where the information needed to create and use a code is publicly available. While QR code standards allow any smartphone user to capture the code, they also allow almost any counterfeiting operation to mimic the information associated with an authentic product by presenting falsified information within a website or application that appears to be authentic. For instance, a fake product may have a QR code that directs users to a website that looks legitimate but is actually controlled by a counterfeiting operation. A user may only become suspicious by recognizing discrepancies between the URL they have accessed and the URL for the genuine authentication website.

CONCLUSION

When organizations plan how serial numbers are created and applied, they can enhance supply chain security, supply chain management, brand protection and customer engagement.

Serialization strategies that support security initiatives can be especially complex and often require the involvement of subject-matter experts. Organizations should consider reviewing their approach to serialization with a focus on strategic initiatives impacted by serialization strategies. Many will find opportunities for improving security, operational efficiencies and customer satisfaction.

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