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NORTH AMERICA

Track and Trace for the Cannabis Industry, from Cultivation to Consumer

White Paper

AIM North America Cannabis Work Group

3/15/2022

AIM NA WP / CWG 2203

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Visit www.aim-na.org for more information about automatic identification & capture (AIDC) technologies and innovation.

About AIM North America

Established in 2003, AIM North America (NA) is committed to providing commercial-free, accurate, unbiased information to its members and their customers. AIM NA members are manufacturers, distributors, resellers, educators, system integrators, and technology users of barcode, RFID, the Internet of Things, RAIN, RTLS and NFC services and solutions.

AIM NA delivers accurate and unbiased information on technologies, standards, and applications. Through AIM committees and alliances, AIM NA provides an unbiased technology perspective to legislators, media, and consumers. Members have access to the most up-to-date industry information, education, and business tools available.

Table of Contents

FOREWORD

This document was prepared by the Cannabis Work Group of AIM North America, the trade alliance for stakeholders of RFID, barcoding, smart devices, and other automatic identification and data capture (AIDC) technologies and supporting Blockchain, IoT, and RTLS applications. We represent all industries and organizations that use, implement, resell, or develop technology. We are essential to enabling adoption, growth, and interoperability to those who depend on accurate, available, and identifiable data.

The AIM North America Cannabis Work Group was formed to engage in outreach to the global cannabis industry, educating and promoting adoption of automatic identification strategies and technologies, supporting the industry's growth and need for compliance with traceability and packaging regulations.

For more information, contact AIM at info@aim-na.org or visit www.aim-na.org.

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INTRODUCTION

Goals of document

- Create an understanding of the advantages of AIDC technologies
- Explore and define AIDC, including a forward look at trends and innovations as they relate to the cannabis industry
- Develop a continuing relationship between the AIDC community and the cannabis industry — growers, processers, packagers, and retailers.

What is Automatic Identification and Data Capture (AIDC)

Automatic Identification and Data Capture (AIDC) technologies are all around us. Our modern economy wouldn't and probably couldn't function without it. Retail stores and food establishments everywhere rely on AIDC and it has become so ubiquitous that even the casual user of the technology recognizes its benefits. Nearly everyone at one time or another has used AIDC whether trying to speed their grocery store exit through the self-checkout line; using an e-boarding pass by scanning a barcode displayed on their smartphone or has utilized a keyless entry system in their home, hotel, or place of employment.

AIDC has been around for decades, but the advancements in engineering mean that the technologies are continually evolving. The AIDC community has helped solve the complex problems of identification, traceability, and authentication for regulated industries like aerospace, medical device and pharmaceutical manufacturing and food production, helping to keep supply chains running and human beings safe. You see AIDC every day: in the UPC barcode on your groceries, in the RFID that identifies your car and automatically bills you for road toll payments, even in your pet's microchip.

AIDC is a constellation of technologies and tools used to design, encode, print, identify, verify, and record electronic information. It includes barcode and RFID technologies and their related tools such as design and print software, printers, barcode and RFID labels, RFID infrastructure such as readers including smart phones and antennas, along with software/middleware, and verifiers and vision systems.

AIDC technologies help users with inventory accuracy, track and trace, loss prevention, visibility, and other business needs by connecting the physical to the digital.

Why AIDC?

- Create an understanding of the advantages of AIDC technologies
- Explore and define AIDC, including a forward look at trends and innovations as they relate to the cannabis industry
- Develop a continuing relationship between the AIDC community and the cannabis industry — growers, processers, packagers, and retailers.
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- Deploying AIDC solutions, cannabis companies reduce the likelihood of errors and mislabeling. AIDC systems can reduce error-prone human interaction, decreasing the chance of regulatory non-compliance and accompanying fines.
- AIDC solutions reduce the workload of employees. Labeling, confirming, logging, put away, picking, shipping, and invoicing are employee-based activities, and they all become more efficient with AIDC systems, increasing worker productivity.
- Through implementing AIDC based solutions, cannabis companies can reduce the likelihood of contamination and mislabeling, quality issues that reduce the consumer's confidence in brands and cost a significant amount of money to repair.
- By implementing an AIDC-based track and trace solution, cannabis companies can improve profit margins by lowering overall costs.
- Using AIDC technologies, cannabis companies capture actionable data and gain institutional knowledge, enabling improved practices and approaches over time.

ELEMENTS OF AIDC

Data carriers and technologies

Barcodes

A barcode is a series of parallel, adjacent bars and spaces in the case of linear or 1D barcodes; dots and squares (modules) in the case of two-dimensional or 2D barcodes, such as a QR code; or a combination of these in the case of composite barcodes. These geometric structures encode data in a machine-readable form.

The technology enables real-time data to be collected accurately and rapidly.

Barcodes are read by 1. Scanning a point of light such as a laser across the symbol to measure the bars or dots and spaces; or 2. By capturing an image of the symbol, as with a smartphone camera and then analyzing the pattern of its bars and spaces or colored modules. All modern smartphones are capable of scanning 1D and 2D barcodes with an appropriate application. QR codes can be scanned by most resident camera applications. Additionally, most symbols must be surrounded by empty space, called the "quiet zone," in order to be differentiated from background and be scanned correctly.

An example of a 2D barcode

Barcodes can contain many different kinds of information, for example, lot numbers, sell-by dates, location information — typically any numeric or alpha-numeric data string, including data as complex as Asian languages. Most 1D barcodes include a check digit or another method to ensure data integrity. Most two-dimensional barcodes utilize an error correction scheme that allows data recovery of barcodes with minor damage. Because 2D barcodes add a second axis of data, they can hold much more data than a 1D code and are particularly useful when space is limited.

Some 2D barcodes are complex enough to contain thousands of characters' worth of information and can encode URLs, advertising, Short Message Service (SMS) messages,

location information, and so on. QR code is widely used for these applications with smartphones and is popular for consumer applications. When choosing a type of barcode, you should consider:

- Whether regulations or industry norms specify a particular type of barcode encoding schema
- The space available on the item/package for the barcode
- How much data, and of what type, needs to be encoded
- The reading environment — is the item still or moving? How much light is there? What is the source of light?
- The distance at which it is to be read
- The likelihood of the barcode being damaged by handling or in transit or storage\
- The scanner technology your trading partners have available

RFID

RFID is a key AIDC technology, with many uses and applications in the cannabis industry. RFID can identify and locate items, people, and other things by the transmission of radio signals. There are many types and variations of RFID, based on different frequencies, standards, and technologies, each with varying use cases and applications.

The two main types of RFID commonly used in the cannabis industry are:

- **RAIN RFID**
  The brand name for passive UHF RFID standardized by GS1 EPC Gen2 and ISO/IEC 18000-63
- **Near Field Communications (NFC)**
  The brand name for a particular type of HF RFID standardized by ISO/IEC 14443, ISO/IEC 15693, ECMA 352 and ECMA 356 among others

In RFID communication, a radio signal is broadcast from a reading device (RFID reader); then, a tag with an attached or embedded transponder receives the incoming signal; and finally, the transponder sends back a return signal to identify the tagged item.

RFID tags do not need a power supply — they can derive their power from the signal sent by the reader. Tags are all programmable, which means that they can be written with information relevant to the application. The information stored on the tags is dependent on the application, but always includes a serial number (trackable to the application) and may include other information such as sell by date, expiration date, lot number and other production data.

Some RFID tags can hold encrypted information. These could be useful in the cannabis industry — non-authorized readers cannot access to the information in the tag, and any transactions that take place can also be secured. Recently, protocols have been developed that allow password protection of all or parts of the data stored on a tag.

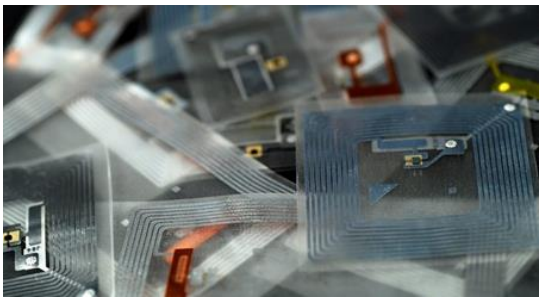
Generally, the data capacity of the modern RFID tag is sufficient for most applications, unless very large amounts of data are to be stored. This will require specialized tags.

RFID tags are more expensive than barcodes, but they can be used repeatedly, making them cost-efficient for most applications.

Unlike barcodes, line of sight is not required to read an RFID tag — RFID readers "listen" for data, rather than "look" for it. (And since tags can be read at a distance, sometimes they can be read unintentionally.)

RAIN RFID

RAIN RFID is based on standards administered by GS1 and ISO/IEC, and uses radio waves in the Ultra-High Frequency (UHF) range of the electromagnetic spectrum, from 860-930 MHz. The GS1 standards are commonly referred to as Electronic Product Code (EPC). RAIN also encompasses many ISO/IEC, non-EPC standards that are used by many other applications, such as luggage handling, toll roads and vehicle parts identification.



RAIN RFID offers benefits specific to the cannabis industry:

- The ability to read hundreds of tags almost simultaneously, enabling the inventory of thousands of plants in seconds.
- Easy identification of single items, such as individual plants.
- Item location without line-of-sight.
- Dirty or obscured tags can still be read.
- Large read ranges: RAIN systems are often designed with read ranges of 10 meters or even greater.
- Security features — tags can be locked, password-protected, obscured from unauthorized readers and even encrypted.
- Insight to the status of an item, for example, temperature and humidity, when paired with sensors.
- And finally, RAIN tags can be written to multiple times, and may be updated with new data as an item progresses through its lifecycle.

The standards around encoding tags were originally published in the early 2000's and not universally followed, causing an issue called "tag clutter," interference caused by RFID encodings not following defined standards.

There are several cannabis business systems such as METRC, BioTrack, MJFreeway and KindAgrosoft that utilize preprogrammed RFID tags, ready to use when they arrive, no encoding necessary. This can simplify RFID implementation by eliminating the encoding step, thus minimizing the potential for tag clutter.

Tag encoding for RFID tags falls under two published standards sets: GS1 and ISO. (Some tags remain non-compliant with standards.) If you are creating UPC Barcodes for retail or the retail supply chain, or for products purchased by consumers, consider using a GS1 Company Prefix (GCP) and the SGTIN-96 encoding from the GS1 Specifications.

It is imperative to encode tags according to a data standard. Reading systems need to be able to quickly and efficiently filter for tags of interest while disregarding tags from other applications. Likewise, your tags should be "good citizens" and not interfere with reading systems from other applications. If you already work with GS1, you will want to use your existing "Company Prefix" (a GS1-issued number that uniquely identifies your company) and a GS1 "Encoding Scheme" for your data-formatting. Information on GS1's RFID data-formatting can be found in their Tag Data Standard. Alternatively, you may wish to encode your tags with your own numbering system. For a complete list of Issuing Agencies, visit here.

NFC

Near Field Communication (NFC) is a form of AIDC and RFID that originated in 2002 and became an approved ISO/IEC standard in 2003. The NFC Forum, the world's leading standards organization for NFC technologies, was established in 2004.

NFC has become commonplace, used by smartphones to communicate with other nearby electronic devices.

NFC's acceptance and use has been driven by the evolution of smartphone technologies. Applications include:

- Google's Android platform leverages NFC for smart cards and electronic payment transactions, and Apple uses it for Apple Pay.
- Electronic identity documents, such as passports.
- Enabling consumer experiences in retail products, giving consumers visibility to the entire life cycle a product.
- Providing brand protection through anti-counterfeiting capabilities.
- Food supply chain traceability, enabling complete Farm to Fork traceability.

NFC operates at 13.56 MHz and is similar to RAIN — a device such as a smartphone transmits a radio signal to an NFC tag to initiate a response. NFC, however, communicates within a very short read range of four centimeters or less via a simple "tap" of the device to the tag.

There are three primary scenarios for NFC use:

- **NFC card emulation**
  NFC-enabled devices can act as a smart card for payment-like transactions
- **NFC writer/reader**
  NFC devices write specific information to the tag which is then read by the NFC reader. This data may be personal information such as debit/credit card info and can even provide a secure URL.
- **Peer to Peer**
  Two NFC-enabled devices transmit/share information between each other.

Digital watermarks

A digital watermark is an advanced two-dimensional (2D) data carrier designed to be scanned reliably and efficiently when applied to packaging and labeling materials. The process creates a typically imperceptible pattern that is designed to be redundantly spread across graphic elements of a package or label design, enabling reliable and easy optical

capture without interfering with design aesthetics. Effectively, watermarks can be "hidden" within the image content of any consumer packaging, label design or other print media, or they can be applied in an overt manner similar to 2D barcodes.

Digital watermarks can be applied through printing (offset, flexographic, digital, gravure, thermal transfer, inkjet, etc.) as well as other forms of marking and reproduction, such as laser marking, 3D printing, etching, embossing, heat transfer, and digital screens. Any media that is digitally processed, or made from something digitally processed, can be watermarked.

New AIDC technologies include digital watermarks, which act like "invisible barcodes."

Some benefits of digital watermarks include:

- **Identification data**
  Digital watermarks support most GS1 application identifiers, including many serialized GTIN, as well as other identification information

- **Imperceptibility**
  Digital watermarks are imperceptible in normal use, allowing for many repetitions of identifying data across surface of objects

- **Data redundancy**
  Data carried by a digital watermark is repeated across the entire surface of an item, increasing scan performance and reliability

- **Performance**
  Better reliability and efficiency for many existing use cases, and the only alternative for new use cases like plastics recycling

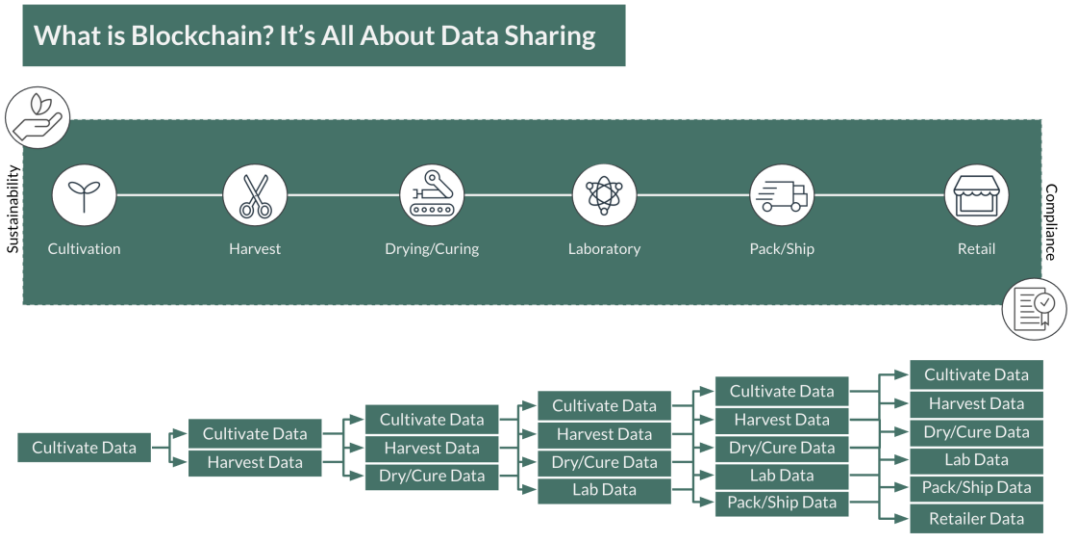
- **Flexibility in printing**
  Digital watermarks do not require dedicated location on packaging or labels, they do not require keep-away-areas for reliable scanning, as necessary with visible barcode symbols

Digital watermarks can be scanned using commercially available barcode scanners throughout the supply chain, from field or harvest to point-of-sale, and for post-sales consumer applications via mobile devices. Additionally, digital watermarks are complementary to other data carriers and do not interfere with their performance. Used in conjunction with other data carriers, digital watermarks enable:

- Layering of covert and overt information (including private and public information) thereby extending the functionality of packaging and labels
- Supporting diverse use cases ranging from improved scan performance and accuracy, to improved security and authentication capability.

Blockchain

Seed-to-sale data — information about cultivation, processing, transportation, testing, distribution and sale — is often siloed, with each participant or trading partner having access to only their own data. Chain of custody from production to retail must be tracked. And lab organizations must stay independent to be able to provide third-party attestation on a product's cannabinoid and terpene profiles.



Above image conveys how cannabis supply chain data can be shared on a blockchain platform.

While AIDC technologies are key to digitally identifying physical products, the underlying data available across these systems is vastly informative and can both help prove compliance with relevant regulations, and back up product-level claims for the consumer. Secure data sharing and validation is critical to establishing trust and transparency in this rapidly growing industry.

Distributed ledger technologies like blockchain can create a digital ecosystem that mimics a distributed supply chain. Stakeholders can participate independently as nodes in the system

contributing data to provide value to the network, or consuming data to extract value from the network. This forms an immutable and distributed sense of truth behind a particular object, whether that be a raw material or final product. Coupled with AIDC technologies, this creates a digital twin, accessible along the product's journey, logging data immutably along the way.

As a network grows, independent validators can assess data attestations using the blockchain in order to endorse or flag transactions. These validators might be regulators, or consortia that control product-level claims such as "pesticide-free," or "100% organic." Brands that control their genetic strains as a source of intellectual property may also be validators. Genetics can be licensed and distributed through the network, creating a permissioned structure for use and syndication of a particular cannabis varietal.

Blockchain also allows for the use of smart contracts to establish more automation and transparency along the digital ecosystem. These smart contracts can be leveraged to create a tokenization strategy or streamline compliance by having the data and regulatory requirements baked into the same system. Agreeing parties would cryptographically sign smart contract for specified transactions and rules of engagement that will be specified during onboarding, or a future update to the chain.

PRINTERS

Printers are often used in connection with AIDC solutions to print barcode and/or encode RFID labels, usually with variable, or dynamic data, meaning each label in a print run has unique, different data printed/encoded onto it from the data on the other labels.

A "smart label" that includes an RFID inlay and a barcode can provide interoperability across available technologies.

Variable data is a key concept for AIDC in the cannabis industry, as each item, for example, a specific plant, a shipping carton, or a finished product, often must be uniquely identified. Variable data capabilities — and by extension, uniquely identified items — allow users to adhere to strict cannabis regulations and optimize business operations.

Printers' offerings include:

- Reliable barcode and RFID printing
- Rugged printers with long warranties and duty cycles
- Printers for budget constrained end-users

Three different types of printing technologies are commonly used: inkjet, laser and thermal printing.

Inkjet Printers

Inkjet printing propels droplets onto receptive materials to recreate digital images and is commonly referred to as digital printing. Typically, inkjet printers use only four colors of ink to produce a complete spectrum of colors. Benefits include on-demand color printing, short turnaround time, and variable data management. The ever-increasing capability of on-

demand inkjet printing is reaching the point where it can often match preprinted label quality, while enabling variable data printing.

To work properly, printers should be matched with inkjet-receptive materials to achieve the best image quality and durability. Inkjet-receptive materials have a coating applied to make them dry instantly, preventing smearing and improving durability.

Inkjet, on-demand color label printing fits users who want to print color labels that include required variable data. By printing the entire label content including the variable data simultaneously, users can reduce inventory of preprinted labels for every SKU and enable the agility to change label art when required.

Home-office inkjet printers usually use water-based inks which can run if they get wet, however, inkjet printers with more stable inks are available.

Laser Printers

Laser printers produce text and graphics by repeatedly passing a light beam back and forth over a negatively charged cylinder called a drum to define a differentially charged image. The drum then selectively collects electrically charged powdered toner and transfers the image to paper which is then heated to permanently fuse the text or imagery to the label material.

Laser label printers can utilize a wide range of pressure-sensitive label materials that include foils, clear film, and colored paper. In addition, on-demand color laser printers now exist that can print white, enabling creative art possibilities.

Thermal Printers

Thermal printers use heat to print labels. Millions are in use around the world. They are commonly used in locations such as plant nurseries, warehouses, healthcare facilities, factories, and retail point-of-sale.

There are two types of thermal printers: direct thermal and thermal transfer. In simplest terms, thermal transfer printing utilizes a thermal ribbon and direct thermal printing does not.

Thermal transfer involves thermal printhead elements, or dots, heating the backside of a thermal transfer ribbon to melt and transfer the compounds on the front side of the ribbon to the label material, thus creating the printed image.

Direct thermal printing requires a heat-sensitive label material. The printhead elements come into direct contact with the heat sensitive material where the heat from the elements causes a color change in the material to create the printed image. This technology is commonly used to print POS receipts.

Label life is the key differentiator between direct and thermal transfer labels — direct thermal labels simply do not offer the same life span as thermal transfer printed labels. If the product being labeled could be in the supply chain for an extended period, or in extreme conditions such as direct sunlight, then the thermal transfer technology should be used.

Conversely, if the product has a short life in the supply chain and is not exposed to harsh environmental conditions, then direct thermal may be a good choice. Examples of this type of product could include fresh meat, dairy products and shipped parcels.

RFID-enabled plant tags provide traceability for growers.

Overall, thermal printers are designed to print high-quality, readable barcodes.

Thermal printers can not only print barcodes and text, but some models can also encode RFID chips embedded into the labels. These printers are often called RFID printers or RFID-enabled printers. This capability allows users to print traditional barcode labels, but also to simultaneously encode unique data to each label, creating a "smart label."

Standard office printers

One question often asked by new users is, "why not use our existing office printer?" There are two key considerations when deciding to move to a label printer versus a standard office printer: cost and productivity.

Standard office printers are designed primarily to print sheets of text, which on average is only 15% coverage. To print text and barcodes only, thermal label printers are significantly less expensive, both in terms of ink and label. To print art with colors, images and barcodes requires significantly more ink, making office printers more expensive to operate.

Label printers will also increase productivity. Generally, a label printer operates more quickly than an office printer, and operators will spend less time fixing sheet-fed jams or selecting which labels on a sheet to print, saving valuable time. If only a few labels are needed, the exact number can be printed, rather than a full sheet of 4 - 16 labels at time. And, rolls of labels enable you to use a label applicator or dispenser to increase process automation.

Overall, lower costs and more productivity make label printers, rather than office printers, the correct tool for labeling.

SCANNERS

Barcode Scanners

1D, or linear, barcodes can be scanned with traditional laser scanners or using camera-based imaging scanners. 2D barcodes can only be read using imagers:

- **Area imagers**
  Includes a range of scanning technology, from omnidirectional scanning to 1D and 2D scanning. These trusted presentation scanners increase productivity, lower operational costs, and ensure reliable scan performance every time.

- **In-counter scanners**
  Typically seen in the retail environment, in-counter barcode scanner and scale solutions enable cashiers to quickly scan barcodes in high volume retail and grocery environments, resulting in increased throughput, profitability, and customer satisfaction. 360° bioptic, in-counter scanners are available in multiple lengths for easy integration into almost any counter, including small checkout environments.

- **Wired scanners**
  A low-cost solution, cabled to a POS or other device; can be 1D or 2D. Limited range and field, they can also be mounted for easy presentation scanning capabilities.

Wireless scanners

Wireless barcode scanners allow mobile employees to efficiently scan barcodes in challenging environments. They utilize Bluetooth technology for the best in wireless connectivity and barcode scanning. These advanced scanners will reach barcodes from extended distances.

Mobile Scanners

Mobile computers have become mainstream for many horticulture and Cannabis applications. Adoption has been driven by things such as:

- The U.S. federal and some state governments advocating for the use of RFID technologies.

- Refinements and improvements to mobile computers with RFID attachments.

- Improved price points of mobile computers, including smart phones.

The flexibility of mobile computers, which can be configured for a variety of software applications, barcodes, and RFID readability.

SOFTWARE

Many of the applications in the cannabis industry that require software are the same as in other industries, for example, accounting, warehouse management, raw material tracking, inventory and retail programs including both POS and back office. But there are factors that impact the choice of application and software platforms specific to the cannabis industry:

- Regulatory compliance
- State-mandated software systems
- Retail loss prevention
- Seed-to-sale tracking

While some states are requiring certain software products and technologies, such as RFID, most applications can be either provided as a stand-alone application or interfaced into one of the many ERP systems in the marketplace. Some of these ERP applications have applications built into the financial software platforms but lack the capabilities to complete a true end-to-end product experience. many will require middleware to enhance functionality with the chosen ERP system.

AIDC AND THE CANNABIS INDUSTRY

Implementing the right solution requires expertise and careful planning. By working with a qualified solution provider who is also familiar with the unique requirements of the cannabis industry, you can reduce expense and risk, and increase efficiency. The solution provider will provide clear information on which data standards they recommend and why. Data needs to be properly encoded according to established standards to ensure interoperability across systems and stakeholders.

The implementation process should start with a feasibility study, and then attributes of the solution, applicable standards and necessary equipment need to be carefully defined. Eventually, proof-of-concept (POC) testing should be conducted, and only when such testing is successfully completed can the implementation move on to a larger pilot study. Full go-live should only occur after the pilot is tested, QA'd and running satisfactorily.

As subject matter experts of the design and application of asset tracking technologies, AIM North America can respond to any technical support requests and the value of standards.

INDUSTRY RELATED ASSOCIATIONS

AIM North America Cannabis Work Group

Brightfield Group

Cannabis Alliance

Cannabis Regulator Association

CannaCon

Coalition for Cannabis

CPX (Cannabis Products Exchange)

ExpoCANN

Green Flower

Hemp Industries Association

Minority Cannabis Business Association

MJBizCon

National Association of Cannabis Businesses

National Association of Convenience Stores

National Cannabis Industry Association

NECANN

Retail Solutions Providers Association Cannabis Group

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