Returnable Asset Tracking 101

Operating Principles

Before moving forward with an investigation into tracking returnable assets, it is important to understand the available technologies, their capabilities, and how they relate to tracking functions in a production facility.

WHITE PAPER

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Content:

Industry
Ideal for automotive, secondary automotive, food and beverage, aerospace, metal working, welding

Processes
Learn how to design a robust automatic returnable asset tracking system for perimeter control

Key Data:
Basic portal design and tracking concepts are explained

Time to read
20 Minutes

Tracking Technologies

There are different tracking technologies typically used in a production facility. Depending on the amount of data transmitted and the complexity of implementation each have corresponding price points.

Manual, semi-, or automatic code scanning

LOW COST - LOW COMPLEXITY

The manual manipulation of hand scanners requires time for processing and allows for error in recording.

The cost of implementation is low, but systems require consistent investment of time devoted to ensuring accuracy.

The cost to serialize assets for tracking is low, but the data can be damaged and capacity/flexibility for data storage is limited.

Automatic tracking with RFID technologies

LOW COST - MEDIUM COMPLEXITY

A completely automated RFID tracking system is reliable and allows for tracking of units in motion (eliminating small stops).

The cost of implementation is medium, but this system allows for expansion and flexibility for additional capabilities.

The cost to serialize an asset is low, there are no batteries to maintain, there is large storage capacity with data manipulation.

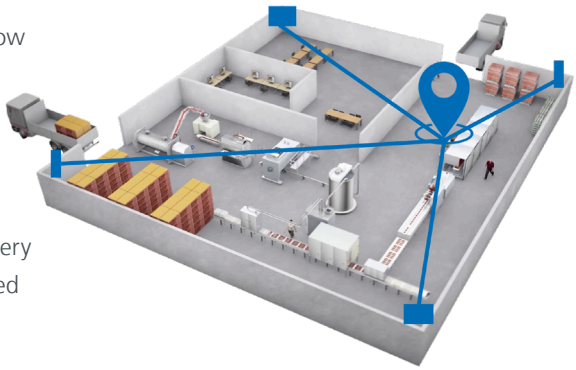
Real time tracking with RTLS systems

HIGH COST - HIGH COMPLEXITY

Completely automated RTLS systems are reliable, and allow for real time localization of an asset. They are the best fit for intralogistics.

High cost of implementation, and very complex. Useable location(s) requires plant-wide transponder grid.

The cost to serialize an asset is high, requiring active battery powered tags to relay location data through a grid of fixed gateways and wireless trilateralization.



Why is UHF the chosen technology for Asset Tracking?

Over the past 10 years, the purchase cost of UHF reading equipment and identifying transponders has been significantly reduced due to the adoption of the technology in both the manufacturing and the retail industries. In times past, one could expect to pay tens of thousands of dollars for UHF RFID reading equipment, and ~10+ dollars for a transponder. The recent demand due to retail adoption has driven these costs down to a point of a few thousands dollar for a fully functioning portal and just cents per identification transponder.

What does this mean?

It means that a long range, highly reliable, wireless and fully automated tracking system is no longer a large investment for a company wishing to institute a fully capable tracking system for returnable assets.

As an example, this capability has not been ignored in the automotive sector. In fact, many primary assemblers are leveraging this technology to institute a forced tracking program for all of their suppliers.

In operation, the system is significantly more reliable that optical image-based code reading. Tracking systems now:

- provide an operating range of over 10 meters
- do not need a direct line of sight to the target
- are position independent
- read many assets at once
- are a completely automated process

These systems operate on the RF principle for wireless communication, and in most cases utilize an inexpensive passive transponder. The passive transponder is a perfect choice for a returnable asset in that it does not contain a power source that will drain over time.

Enable tracking with intelligence

A UHF tag contains four main memory banks for manipulation and storage of information (under the UHF Gen2 standard):

1 Electronic Product Code (EPC)

The EPC memory is the tag identifier, meaning that this memory is broadcast first when the tag is powered up from the RF field. This memory area is used in almost all asset tracking standards and is normally either 96 or 128 bits. Memory capacities over this are pulled from the user memory bank (see User Memory below).

2 Tag ID

The tag ID is a serial number encoded on the tag Integrated Circuit (IC) and is entirely unique between transponders. This memory area is “read only” and is normally 96 bits.

3 User Memory (User)

This memory can be considered as an expansion of the EPC memory. In fact many tags offer an expanded EPC memory which automatically pulls the additional information from the User bank to expand the EPC beyond 128 bits. Typically, this memory bank is ~512 bits, but can be 8 Kbits or more.

4 Reserved for Future Use (RFU)

A memory bank for future use is usually 64 bits (if available) and stores the security access password for the memory banks on the tag, as well as the kill command to disable the tag.

When introduced to the RF created by the reader/controller – the tag will charge its internal capacitor wirelessly and communicate directly with the reader using the RF backscatter principle. Unlike inductive field modulation in HF frequencies (13.56 MHz ISO 15693 – Industrial) – the tag rebroadcasts its communication in the ~900-920 MHz frequency band (FCC) which allows for significant increases in read/write distances over HF (High Frequency 13.56 MHz inductive coupling principle).

What is an asset tracking portal?

Perhaps the most common application in UHF technology for asset tracking (and logistics) is the creation of tracking portals that scan and create manifest of a set of finished products, or assets in this case, tied to a physical location.

Utilizing circular polarization and a set of antennas (read/write heads) an automatic scanning portal is constructed at egress points to wirelessly and automatically:

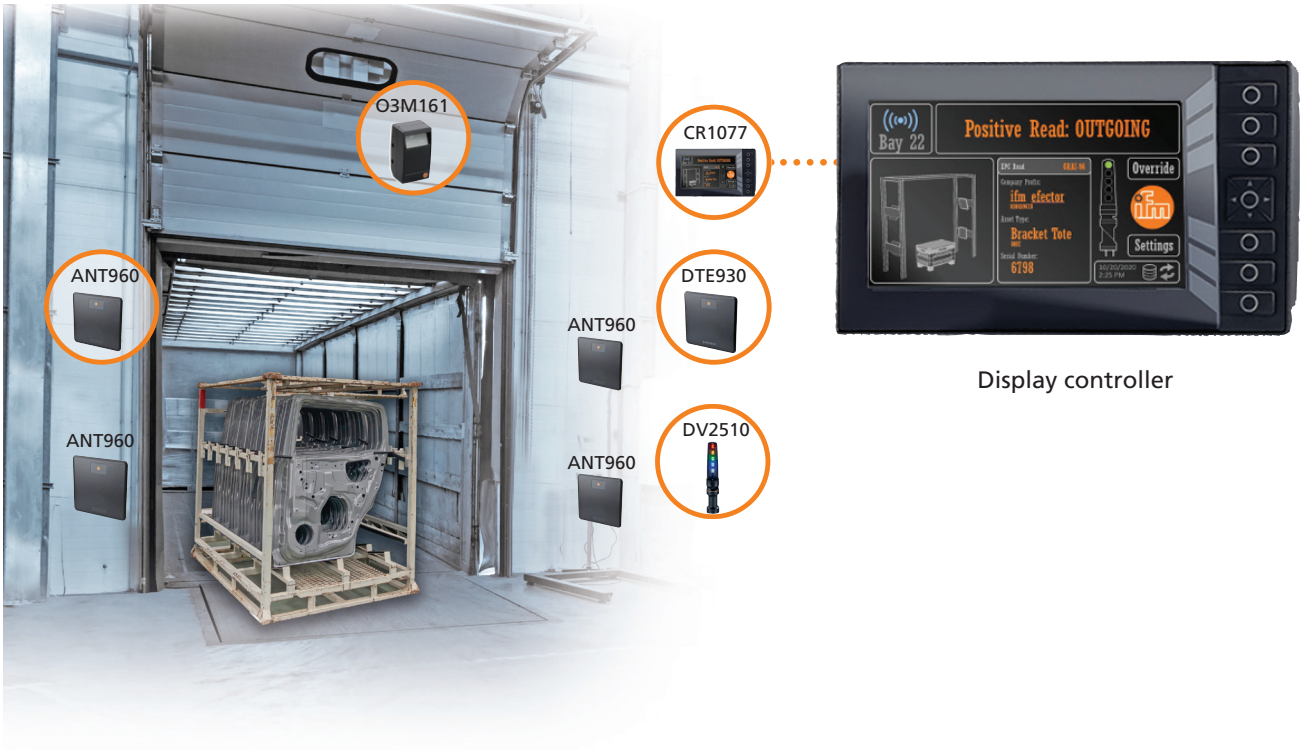
- Scan and record the asset GRAI information
- Track time of shipment, destination, and truckload information (manifest)
- Destination records and product sequencing

By erecting scanning portals at all entrances and exits to the facility, (shipping/receiving) perimeter control ensures that all asset movements are tracked. Additional portals can be added to storage bays or production lines to track movement within the facility.

The benefit of perimeter control for asset tracking is the comparatively low cost of implementation to achieve a fully automatic and reliable tracking program. Portals are now low cost, tags costs have never been lower for assets, and the program can be scaled over time.

As an example, many secondary automotive manufacturers are being required to implement this type of UHF program, and have initially elected to automate only a few doors as a starting point. They will ship/receive through this default perimeter. Others have elected to outfit the entire facility to ensure that all items are accurately scanned and recorded.

Example of modular asset tracking portal by ifm



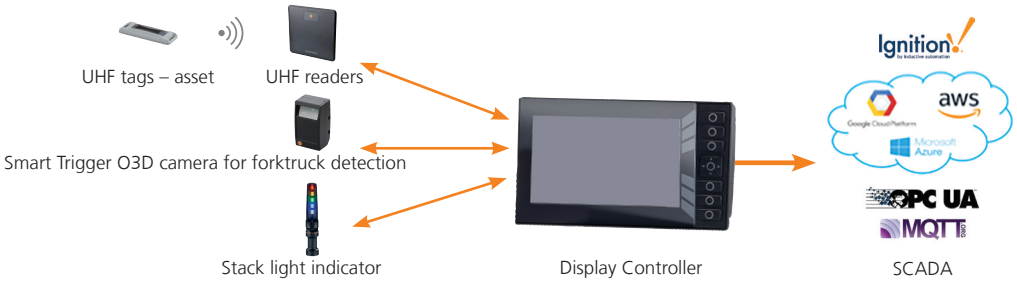
Display controller

This UHF RFID identification system can be used for tracking returnable containers (racks, and bins in the warehouse) or the tracking of finished goods for storage and sequencing for shipment. This system offers an easier and less expensive way to implement RFID by allowing dedicated local control, data filtering, and direct communication to any higher-level system. Local control and data storage allow for data redundancy and pre-filtering, increased reliability, and the ability to continue tracking your assets and product when the connection to your main system is unavailable.

- Reliable tracking of returnable containers, racks, and bins, using IP65 industrial hardened components and M12 connections
- Remote mountable and does not require a control panel/cabinet
- High visibility light stack and audible buzzer effectively conveys positive reads, or lost/damaged tags to operators
- Ethernet and IO-Link supplemental devices communicate directly to the controller, offering device health and high reliability
- ifm display Controller provides local preprocessing and data package management to ensure that data is clean and accessible
- Support of all GRAI tracking standards, as well as custom tracking identifiers with tag data, direction, and time stamp communicated directly to a database

ifm controls architecture

ifm's CR display controller has an integrated plc to display information and process component functions. The 7" display connects to components, such as UHF readers, the O3M fork truck detection camera and light stack data and is programmable via CODESYS. On-board protocols such as Ethernet and USB provide communication and networking programming to universal platforms used in industrial automation manufacturing plants.



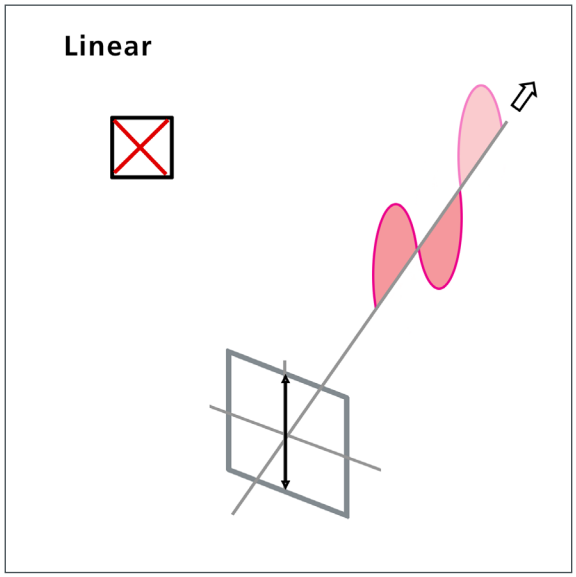
Components list

	Type	Part No.	Description
	UHF Reader	DTE930	Ethernet/IP, TCP/IP 4-port UHF smart reader module
	UHF Antenna	ANT960	Wide angle UHF circular antenna
	Smart Trigger	O3M161	Automatic target size and direction muting trigger
	UHF Tag	E80393	Metal mount, long range, 512 bit UHF ID tag
	Indicator	DV2510	Read indication light stack and buzzer
	Display Controller	CR1077	7 inch multi-touch display, 800 x 480, quadcore processor, plc function, Ethernet (2), USB 2.0, IP 67

Understanding antenna types

Linear polarization is achieved by broadcasting electromagnetic waves on a single plane. By focusing communication on a single plane, more power can be effectively used to achieve distance and still adhere by the FCC standards for the UHF spectrum (increase in about 3dB on a single plane). While this does not seem like much, it can allow for significantly longer read distances, with some major drawbacks:

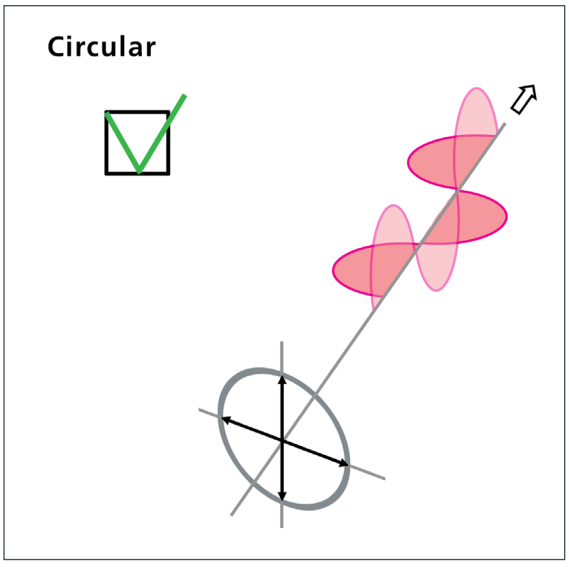
- There must be uninterrupted RF visibility to the target tag
- The tag must be on the same plane as the emitter
- The tag must be perpendicular to the antenna



While there are some specific applications where this antenna polarization is beneficial, when investigating an asset tracking program, circular polarization should be used.

Circular polarization utilizes RF transmission in two planes, which results in a rotating electromagnetic wave, completing a whole revolution throughout a single wavelength emitted. Simply, this results in a corkscrew-like emission of the RF signal. By broadcasting on two planes, the effective emission loss is about 3dB, resulting in a shortened read range than its linear counterpart.

However, when discussing asset tracking with UHF, the benefits of the circular polarization far outweigh the loss in read range. Because of the corkscrew-like nature of the field – the tags orientation can be effectively omni-directional, and the tags no longer need to be on the same plane as the reader.



This is significant in discussing the tracking of assets when location, orientation/plane, and distance are never guaranteed. Circular antenna polarization is what allows for tracking portals and UHF mobile automation tracking for intralogistics applications.

Making your program universal

In order to maintain global compatibility of asset tracking around the world, standards have been developed to ensure that the tracking identifying information can be decoded and interpreted regardless of the country of origin or destination. By following a standard, an asset-tracking program

can offer global visibility for recovery and return of reusable containers and racks.

Within secondary automotive (among other industries) the common standard to be followed is the Global Returnable Asset Identifier (GRAI) which is maintained and executed by the GS1 organization.

This standard contains a structure for encoding and decoding information to ensure that all assets can be returned to their origin, while being optimized for both 1D barcode/2D Datamatrix and UHF RFID encoding. Optimized for the two standard Electronic Product Code (EPC) memory capacities in UHF tags, the two most common standards are GRAI-96 and GRAI-128 (96 bits and 128 bits respectively). As GRAI-96 is perhaps the most common, we will look deeper into how this information is encoded, stored, and accessed with any manufacturer's available UHF hardware in returnable asset tracking.

Encoding and Decoding GRAI

It is important to understand that while the methods of encoding information in the GRAI-96 (and others) are restricted, meaning that a GRAI-96 identifier must be assigned by the GS1 organization for a specific asset, the decoding of this information is neither proprietary nor hidden.

Consider the example of a GRAI-96 identifying number stored in the EPC memory of a UHF tag. This information is simple hexadecimal information that can be read by any UHF reader that follows the EPC.

Gen2 communication protocol determines the memory capacities and communication between tag and reader (most UHF readers on the market).

When read by any UHF controller, the data contained in the EPC memory will look something like this:

330F 02EB D575 DDC0 0000 07E4

When converted into binary:

00110011000011110000001011101011110101010111010111011101110000000000000000000000000011111100100

The GRAI-96 standard from GS1 follows the basic structure below (this information is available openly from their website)

	Header	Filter Value	Partition	Company Prefix	Asset Type	Serial Number
GRAI-96	8	3	3	20-40	24-4	38
	0011 0011 (Binary value)	8 (Decimal capacity)	8 (Decimal capacity)	999,999 - 999,999, 999,999 Decimal capacity*)	9,999,999 - 9 (Decimal capacity*)	274,877, 906,943 (Decimal capacity)

Partition Value (P)	Company Prefix		Item Reference and Indicator Digit	
	Bits (M)	Digits (L)	Bits (N)	Digits
0	40	12	4	1
1	37	11	7	2
2	34	10	10	3
3	30	9	14	4
4	27	8	17	5
5	24	7	20	6
6	20	6	24	7

Following this basic structure, we are left with:

Header:		00110011
Filter:		000
Partition:		011
	In Decimal:	(3)
Prefix:		11000000101110101111010101011
	In Decimal:	(808369495)
Asset Type:		01011101110111
	In Decimal:	(6007)
Serial Number:		11111100100
		(2020)

What this means is universality

The GRAI tracking standards under GS1, and many more like it, are meant to be truly universal and hardware agnostic. In many situations, from automotive to food and beverage, the same GRAI tracking information will be encoded on a UHF label (EPC memory) as well as a printed 2D data matrix alongside human readable information on the same identifying label. This means that the same information can be gathered through many, if not all, scanning techniques using any manufacturers' hardware.

In automotive, as an example, many primary assembly facilities have begun to introduce strict standards that require the tracking of assets with GS1 GRAI-96 utilizing UHF technology – it is important to remember that most UHF readers on the market today follow the required Gen2 standards to allow for communication with these required tags.

How to get started

Finding the right solution can seem overwhelming. That's why ifm has created a supplemental technical note, "Designing a Custom Tracking Program". This document will help you navigate the next step of asset tracking in creating the proper system design.

About the author

TJ Berlin is ifm's North American Product Manager for Identification Systems, including industrial multi-code readers and LF/HF/UHF RFID tracking solutions for production and intralogistics/logistics processes. With seven years experience as a technical sales engineer, TJ gained extensive exposure to plant operations, improving equipment efficiency, and logistics and supply chain optimization within various industrial markets. Currently focusing on new camera technologies and possessing a comprehensive understanding of RFID in tracking systems for high speed applications, TJ maintains, "I hope to continue to develop and offer solutions that maximize efficiencies in tracking and tracing in the age of Industry 4.0."

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