IoT Infrastructure: Asset Tracking Use Case

ATARC Internet of Technology Working Group

Contributors: *Eveth Joseph, GSA; Emory Miller, Cisco; Doug Natal, Sumo Logic; Joseph Ronzio, VA; John Quezada, Gigamon; Ellery Taylor, GSA; Marvin Woods, FAA; Mimie Woods, GSA*

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Federal agencies are in a unique position to benefit from the opportunities presented by the Internet of Things (IoT). While the term IoT itself may be amorphous, NIST offers a practical definition: IoT technology "bridges operational technology such as sensors and actuators with information technology such as data processing and networking."[1] This includes the transmission of data or the initiation of a physical action which can be viewed from an intelligent system to maximize efficiency. The data processing and networking technology is enhanced by the sensors and actuators from an IoT system.

This definition makes clear how federal agencies – with hundreds of thousands of fixed and mobile assets, thousands of buildings and campuses around the country and world, and missions to deliver real-world services – can benefit by bridging operations and information technology. According to the Government Accountability Office, many federal agencies are aware of this opportunity: over 60% of agencies are currently deploying or exploring IoT-related projects in three primary areas: controlling or monitoring equipment or systems, controlling access to devices or facilities, and tracking physical assets.[2]

Realizing benefits to the organization, however, is not simple. There are several challenges that agencies must overcome – diffuse ownership and control of assets (both sensors and systems), budgetary constraints, legacy information technology systems, cyber security concerns, and employee skills. This primer, constructed by the ATARC Internet of Things Working Group, hopes to provide a high-level overview to federal agencies on one of the GAO's identified focus areas: asset tracking.

How?

Technology alone isn't the answer to the asset tracking question. Agencies must consider how people, processes, the specific case, and technology all combine to provide an effective solution. For example, a passive Radio Frequency Identification (RFID) solution enables location tracking and inventorying. However, the ability to deliver the desired outcome depends entirely on a process that brings assets within range of a scanner, understanding of physical infrastructure, and understanding of individual workflows. If this process is removed or not followed the technology alone is unable to deliver the desired outcome. Consequently, agencies must both understand the problem they are trying to solve and their own organizational capabilities and limitations. From this understanding, agencies can begin to explore the technologies that will enable their desired outcome. Developing that organizational

[1] NIST SP 800-213
[2] https://www.gao.gov/products/gao-20-577

understanding is beyond the scope of this primer, but our working group can help guide the discussion and is willing to iterate for future beneficial updates.

Enabling Technologies

There are several enabling technologies for asset tracking projects. It's important to understand that each technology approaches the problem differently and, consequently, has different capabilities, limitations and costs. When evaluating enabling technologies, it's helpful to keep the following topics in mind, as they will narrow the scope of effective solutions. Further, developing a firm understanding of both the desired outcome and the appropriate enabling technologies early in the planning process can streamline the contracting process.

The use case. What asset are you tracking? How important is it? Where might it go? How often do you need to know it's location? And how precise to you need the location to be?

Deployment. Is the asset mobile? Will it pass through a control point? How far will antennas realistically be from the asset and sensor? How will both sensors and antennas be powered and connected to the network?

Spectrum requirements. What spectrum do you have available? Is it licensed or unlicensed? Do you need to consider emission control or security concerns?

Cost of ownership. Will this system stand alone, or will it be incorporated into your existing infrastructure? How could the cost change as the project scales? How will the location data be visualized?

Risk management. Will this system be inside your authorization boundary? Or will it be a standalone system? How does this project affect your overall cyber risk posture?

The table below provides an overview of some of the most common enabling technologies and is influenced heavily by research done by Deloitte.[3]

Technology	Description	Range	Accuracy	Capabilities	Limitations
Barcode	Printed code read by optical scanner	< 50'	-	Low-cost system Familiar technology	Limited range Line of sight dependent
Passive RFID	Electromagnetic pulse from reader triggers tag to send data	< 30'	-	Very low-cost tags Familiar technology	High-cost readers Provides static location data

[3] https://www2.deloitte.com/content/dam/Deloitte/nl/Images/inline_images/deloitte-nl-eri-asset-tracking-overview-technologies-inline2.png

Technology	Description	Range	Accuracy	Capabilities	Limitations
Bluetooth Low Energy (BLE)	Wi-Fi access points or BLE reader triangulates signals	< 330’	< 5 ft	Low-cost sensors Low power consumption	Battery powered sensors High infrastructure requirements
Wi-Fi	Wi-Fi access points triangulate position or calculate proximity	<500’	10 – 15 ft	Allows high data throughput Familiar technology	Higher-cost system High battery usage
Ultra-wide band (UWB)	Pulses read by receiver to calculate distance	< 100’	< 5 cm	High accuracy Not susceptible to interference	Higher-cost system
LPWAN	GPS or triangulation and transmits data over LoRa network	5 miles	< 15 ft	High range No transmission cost	Higher-cost sensors
Cellular	GPS or cellular triangulation and transmits data over cellular network	Limited by network coverage	< 15 ft	Potentially unlimited range No infrastructure required	Spectrum dependent, high transmission cost Medium-cost sensors
GPS	GPS and transmitted using Wi-Fi	Limited by coverage	< 15 ft	No transmission cost Low battery usage	No off the shelf system
Satellite	GPS and transmitted using satellite	Limited by coverage	< 15 ft	Low battery usage One frequency	Requires line of sight to asset

A Note on the Application Side

This primer focused primarily on the infrastructure layer of the asset tracking use case. This focus by no means implies the application layer of the solution is insignificant – in fact, incorporating the location data into an easy-to-use application that solves organizational challenges is probably the most important facet of a solution. However, most enabling technologies allow the data to be transported in industry-standard protocols like HTTPS or MQTT, allowing organizations to send that data to any application that is standards-based.

Additional Resources

The ATARC IoT Working Group is a resource to help agencies as they deploy or explore IoT-related projects. With members from government and industry, the group provides a unique mix of experience that can compile lessons learned and connect agencies with resources. We’ve compiled a few useful documents below to help continue this primer, but please reach out to us with any questions:

Government Accountability Office, “Internet of Things: Information on Use by Federal Agencies,” 2020, https://www.gao.gov/products/gao-20-577

NIST, “Draft Guidance on Internet of Things Device Security,” 2020, https://www.nist.gov/news-events/news/2020/12/nist-releases-draft-guidance-internet-things-device-cybersecurity