Hewlett Packard Enterprise

HPE Technical White Paper

Asset Tracking using RFID and BLE with Edgeline Devices

Author:

Bill Walton (bill.walton@hpe.com)

Technical white paper

Contents

Executive Summary

This paper describes a smart manufacturing solution based around asset tracking using Radio Frequency Identification (RFID) tags and readers, as well as location-based services using devices enabled with Bluetooth Low Energy (BLE) beacons, alongside HPE Edgeline products.

Asset tracking is a very important part of any manufacturing process. Asset tracking provides greater granularity to the customer and the ability to know where inventory is located, thereby ensuring that items are in the correct place at the appropriate time. This can also give more insight into the manufacturing process. As an example of this, if the customer knows that the entire manufacturing process should be complete in one hour but it is taking longer, the customer knows that there is an issue somewhere. With HPE's solution the customer is not only made aware of problems but also given an opportunity to find and eliminate the problem. A smoother running operation that wastes less time will allow for a greater profit margin.

This solution uses Internet of Things (IoT) technology. IoT is built on the concept that everyday objects can have some sort of network connectivity. Through this technology and connectivity customers have the ability to monitor and manipulate these objects (also referred to as the "things" in "IoT"). HPE is offering a new and innovative way to track assets from the assembly line all the way to shipment. For this solution HPE assumes that items have to be assembled in various locations before they are shipped out of the factory.

This solution utilizes RFID to track assets loaded into a cart. This being the case, each asset that is loaded in the cart will have an RFID tag on it with a unique identification number that will allow for more precise tracking and localization. As each cart will need to track the assets, or "things" it contains, the cart will need to be outfitted with some sort of compute solution and an RFID antenna to scan each "thing". At each station, there will be a BLE beacon that will be used to identify that station. The cart will need to be able to detect and identify a Bluetooth signal with the compute solution to ensure feasibility.

This solution utilizes HPE's EL10 Edgeline device, an embedded RFID reader card, and an embedded BLE module. The RFID reader is used to read passive RFID tags that are attached to the assets and the BLE module is used to detect the location of the cart in the facility.

Through the use of this HPE solution, the customer can save money, achieve maximum efficiency, and locate assets at any time throughout the manufacturing process.

Target audience: Executives, Technical, PreSales, and Sales.

Document purpose: The purpose of this document is to describe a solution for connecting to and visualizing "things" that were not previously connected, enabling fast on-the-edge IoT deployment.

Solution Components

Hardware

- **HPE Edgeline EL10:** The HPE Edgeline EL10 Intelligent Gateway is a price / performance efficient and rugged compute solution designed to operate in industrial environments such as manufacturing, smart cities, or oil and gas. This gateway comes optimally configured with CPU, memory, connectivity and an expansive I/O selection addressing a host of Internet of Things (loT) needs. (Intel E3826 dual-core Atom1.46GHz with integral GPU 4GB DDR3L 1067MHz SO-DIMM (8GB CTO Option)). The Edgeline EL10 is pictured in figure 1.

Figure 1. HPE Edgeline EL10 Intelligent Gateway.

- **RFID Reader:** HPE utilized the Skyetek Nova embedded RFID reader. The Nova is an ultra-small, power efficient, EPC Class 1 Gen 2 reader/writer module. A cutting edge ARM Cortex microcontroller and latest UHF transceiver technology coupled with the reader's intelligent operating system makes this module the most feature- rich UHF reader module manufactured in accordance with ISO 9001 and ISO 13485. The Nova adheres to the PCI Express Mini half card form factor. The Nova embedded RFID reader is depicted in figure 2.

Figure 2. Skyetek Nova Embedded RFID Reader.

- **Intel 7620:** HPE utilized the Intel® Dual Band Wireless-AC 7260 802.11ac, dual band, 2x2 Wi-Fi + Bluetooth* adapter for this solution. The adapter has faster speeds (up to 867 Mbps1), higher capacity, broader coverage, longer battery life, and a 4th generation Intel ® Core™ processor. The dual band wireless adapter is depicted in figure 3.

Figure 3. Intel Dual Band Wireless Wi-Fi + Bluetooth Adapter.

- **RFID Antenna**: For this solution HPE selected the Laird PA9-12. The PA9-12 flat panel directional antenna offers high-gain in a thin, low-profile package. The antenna is constructed of an off-white color UV resistant ASA plastic radome with an aluminum back plate. The antenna can be used in horizontal or vertical polarization. The included heavy duty pole mount bracket allows up or down tilt adjustment and the stainless steel hardware assures a long service life. The antenna can be wall or pole-mounted. The PA9-12 comes with an integral N female connector standard. The PA9-12 is depicted in figure 4.

Figure 4. Laird PA9-12 Flat Panel RFID Antenna.

- **RFID Tags:** RFID tags emit a RFID signal that can be received by the RFID antenna. Small and easy to mount on whatever needs to be tracked, RFID tags are not brand-specific for this solution. A typical RFID tag is pictured in figure 5.

Figure 5. RFID Tag (typical).

- **Estimote BLE Beacons:** BLE beacons are tiny, low power computers usually attached to walls or objects in the physical world. Using proximity technologies they detect human presence and behavior and trigger pre-programmed actions delivering contextual and personalized experiences. Examples of Estimote BLE beacons are pictured in figure 6.

Figure 6. Estimote BLE Beacons (typical).

- **Rechargeable Battery Pack**: For the purposes of this solution HPE utilized the TalentCell rechargeable 72W, 12V, 11000mAh lithium ion battery pack. The battery pack provides power to the HPE Edgeline EL10 while maintaining portability. The TalentCell battery pack is pictured in figure 7.

Figure 7. TalentCell Rechargeable Lithium Ion Battery Pack.

Software

- **MySQL:** Database used by the applications to store information about the RFID tags that are tracked by the system.
- **Backend Application (C#):** This application runs on the EL10. It connects to the RFID reader and BLE hardware and detects whenever a RFID tag or a BLE beacon is manipulated. Based on the signal strength of the BLE beacon, the application determines where the beacon is located in the facility. Whenever a RFID tag is discovered, the application updates the location of that tag with the location of the cart in the database.
- **Frontend (NodeJS and HTML):** The frontend is a NodeJS application that pulls device data from the database and displays it on the user interface (UI). Individual RFID tags are displayed on the frontend in separate boxes where the RFID tag is determined to be. The RFID tag is represented by its tag identifier (TID), which is unique number assigned to each tag from the factory.

Hardware

- **HPE Edgeline EL10:** The HPE Edgeline EL10 Intelligent Gateway is a price-efficient, high-performance, and rugged compute solution designed to operate in industrial environments such as manufacturing, smart cities, or oil and gas. The EL10 gateway comes optimally configured with CPU, memory, connectivity and an expansive I/O selection addressing a host of Internet of Things (loT) needs. (Intel E3826 dual-core Atom1.46GHz with integral GPU 4GB DDR3L 1067MHz SO-DIMM (8GB CTO Option)). The HPE Edgeline EL10 is pictured in figure 1.

Figure 1. HPE Edgeline EL10 Intelligent Gateway.

- **RFID Reader:** HPE utilized the Skyetek Nova embedded RFID reader for this solution. The Nova is an ultra-small, power efficient, EPC Class 1 Gen 2 reader/writer module. A cutting edge ARM Cortex microcontroller and latest UHF transceiver technology coupled with the reader's intelligent operating system makes this module the most feature- rich UHF reader module manufactured in accordance with ISO 9001 and ISO 13485. The Nova adheres to the

PCI Express Mini half card form factor. The Nova embedded RFID reader is depicted in figure 2.

Figure 2. Skyetek Nova Embedded RFID Reader.

- **Intel 7620:** HPE utilized the Intel® Dual Band Wireless-AC 7260 802.11ac, dual band, 2x2 Wi-Fi + Bluetooth* adapter for this solution. The adapter has faster speeds (up to 867 Mbps1), higher capacity, broader coverage, longer battery life, and a 4th generation Intel ® Core™ processor. The dual band wireless adapter is depicted in figure 3.

Figure 3. Intel Dual Band Wireless Wi-Fi + Bluetooth Adapter.

- **RFID Antenna**: For this solution HPE selected the Laird PA9-12 RFID antenna. The PA9-12 flat panel directional antenna offers high-gain reception in a thin, low-profile package. The antenna is constructed of an off-white color, UV resistant, ASA plastic radome with an aluminum back plate. The antenna can be used in horizontal or vertical orientation. The included heavy duty pole mount bracket allows up or down tilt adjustment and the stainless steel hardware assures a long service life. The antenna can be wall or pole-mounted. The PA9-12 comes with an integral N female connector standard. The PA9-12 is depicted in figure 4.

Figure 4. Laird PA9-12 Flat Panel RFID Antenna.

- **RFID Tags:** RFID tags emit a RFID signal that can be received by the RFID antenna. Small and easy to mount on whatever needs to be tracked, RFID tags are not brand-specific for this solution. A typical RFID tag is pictured in figure 5.

Figure 5. RFID Tag (typical).

- **Estimote BLE Beacons:** BLE beacons are tiny, low power computers usually attached to walls or objects in the physical world. Using proximity technologies they detect human presence and behavior and trigger pre-programmed actions delivering contextual and personalized experiences. Examples of Estimote BLE beacons are pictured in figure 6.

Figure 6. Estimote BLE Beacons (typical).

- **Rechargeable Battery Pack**: For the purposes of this solution HPE utilized the TalentCell rechargeable 72W, 12V, 11000mAh lithium ion battery pack to power the Edgeline EL10 while maintaining portability. The TalentCell battery pack is pictured in figure 7.

Figure 7. TalentCell Rechargeable Lithium Ion Battery Pack.

Software

- **MySQL:** Database used by the applications to store information about the RFID tags that are tracked by the system.

- **Backend Application (C#):** This application runs on the Edgeline EL10. It connects to the RFID reader and BLE hardware and detects whenever a RFID tag or a BLE beacon is manipulated. Based on the signal strength of the BLE beacon, the application determines where the beacon is located in the facility. Whenever a RFID tag is discovered, the application updates the location of that tag with the location of the cart in the database.
- **Frontend (NodeJS and HTML):** The frontend is a NodeJS application that pulls device data from the database and displays it on the user interface (UI). Individual RFID tags are displayed on the frontend in separate boxes where the RFID tag is determined to be. The RFID tag is represented by its tag identifier (TID), which is unique number assigned to each tag from the factory.

Solution Overview

RFID Asset tracking

Asset location knowledge using asset tracking throughout the manufacturing process provides multiple advantages. HPE's solution can track product from manufacturing through to shipment. This knowledge eliminates misplaced goods and the wasted time associated with finding them.

Another aspect of asset tracking is the ability to track tagged items such as tools or machine parts. This helps prevent misplacement of costly tools used for repairs. It also provides the exact location of any specific piece of tagged material or asset making it easy to determine the status of equipment in maintenance or in transit.

Visualization is an important aspect of this solution. HPE found two ways to visualize this solution. One way is to utilize a web browser of the customer's choice. The other way is to utilize virtualization software like PTC's ThingWorx. The web browser user interface is free and created by the developer, whereas ThingWorx is a software package with an end-user license for which the developer would pay. ThingWorx allows the customer to create a mashup. A mashup takes data and information that is pulled from a specific location (in this case a MySQL database) and makes it more appealing to the eye, as well as a little easier to understand, through visualization tools.

Two different examples are provided to show the versatility of the solution. The first solution is optimized for a larger facility that would require more processing power. The HPE Edgeline EL1000 would be utilized for the compute solution with an external RFID reader connected to multiple RFID antennae.

The second solution is optimized for a smaller facility and utilizes the smaller HPE Edgeline EL10 for the compute solution with an embedded RFID reader and an attached antenna. These solutions differ in scale but operate using the same basic functionality. Both solutions utilize a similar process comprised of RFID tags, a RFID tag reader, a few Python scripts, a MySQL database, and a small C# program.

For the first scenario RFID tags are attached to the assets that the customer is wants to track. Each tag has a unique identifier. The MySQL database is populated with the list of tags that are associated with the items being tracked. An RFID reader is placed centrally in whatever area in which assets need to be tracked. Antennae are then run from the RFID reader to choke points such as doors

leading to different areas of the facility in order to ensure that the tags are tracked as they transition from one area to another. Through the use of the C# program the RFID reader is polled and the information is updated in the MySQL database. As each tag passes by a RFID antenna, the database is updated with the new location to allow the customer to see the item's new location. In order for this information to be easily accessible, a web interface was created that uses the information in the MySQL database to place pictures of items on a map that represents the floor on which items are being tracked. An example of a web user interface appears in figure 8 below.

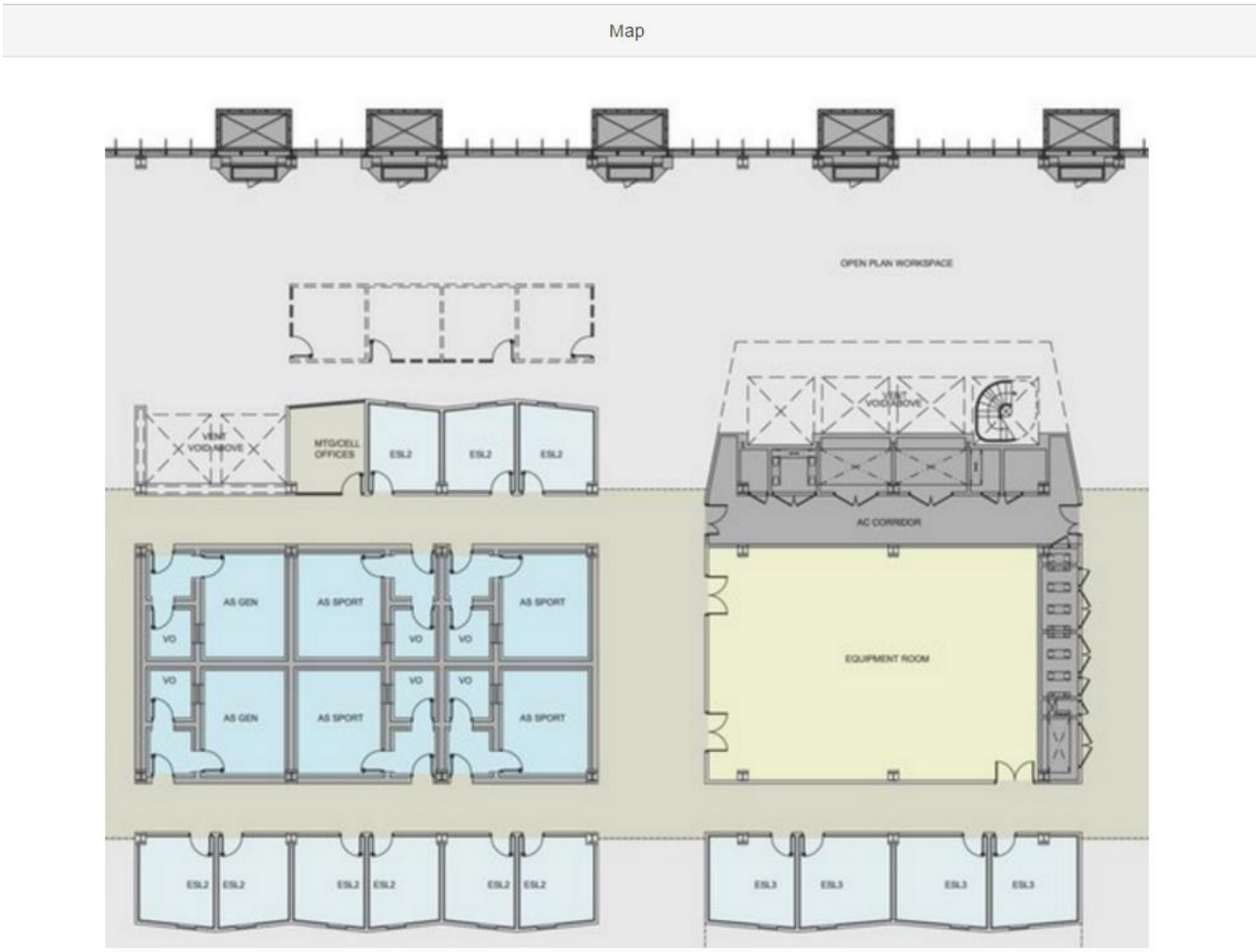

Figure 8. Example of a web user interface map display.

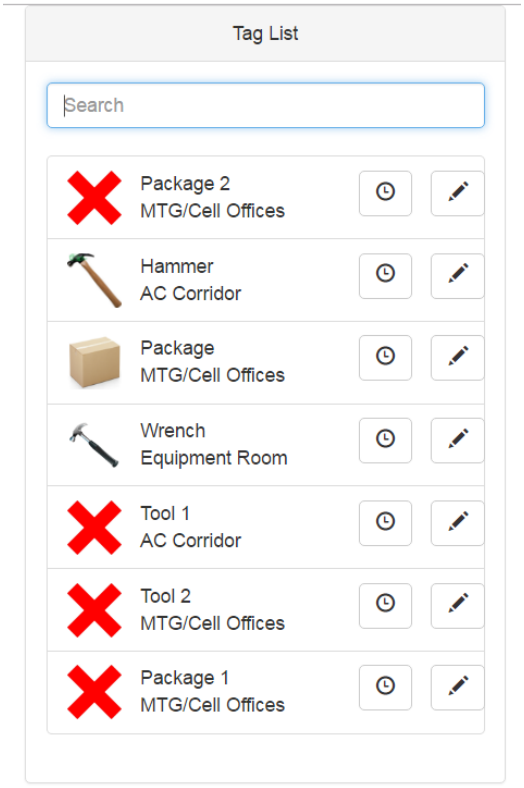

Figure 9. Example of a tag list in the web user interface.

Another way that a graphical representation can be displayed is through the use of ThingWorx. A ThingWorx mashup was also created in order to show the versatility of this solution. ThingWorx queries the MySQL database to obtain the information needed to display the location of tagged items. That information is loaded into the database as described above. That representation is shown in figure 10 below.

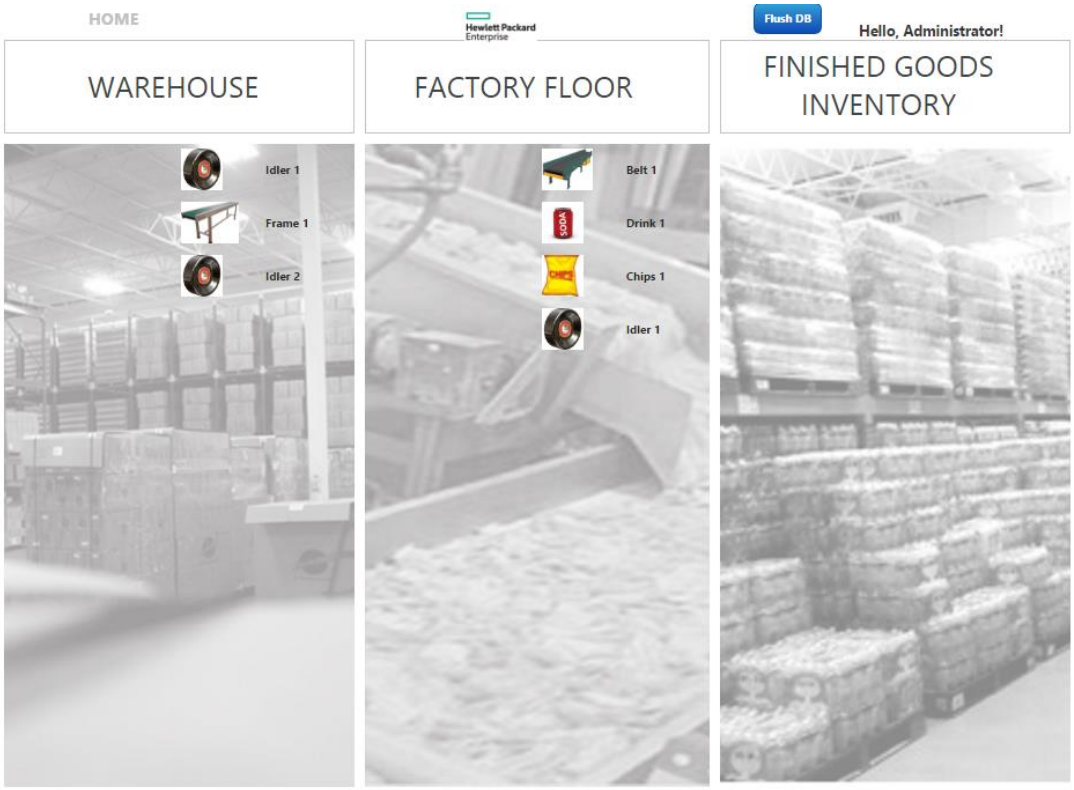

Figure 10. Example of a Thingworx mashup user interface.

For the second scenario the EL10 and its embedded RFID reader are attached to a cart that will be used to move the assets being tracked. A battery pack (see figure 7) is used to power the EL10. To take advantage of the embedded RFID reader we attach an antenna to the EL10 and place one at the top of the cart. By monitoring the RFID tags on the cart, instead of having antennas at choke points, the customer is given more in-depth information about where exactly their tagged assets are located. BLE beacons are placed on the test bays into which the tagged assets are being loaded. The EL10 uses a C# application to capture the BLE TID and received signal strength indication (RSSI) values. The application also updates the MySQL database with the data received from the BLE tags. The EL10 constantly polls the cart to see which tagged assets are located on it. Once a tagged asset is removed from the cart, the tag stops being read. If the RFID reader is no longer able to receive signal from the tag, it displays the last known BLE tag location as the current location of the tagged asset. The UI to display this information is made from NodeJS and HTML. An example of the UI is depicted in figure 11.

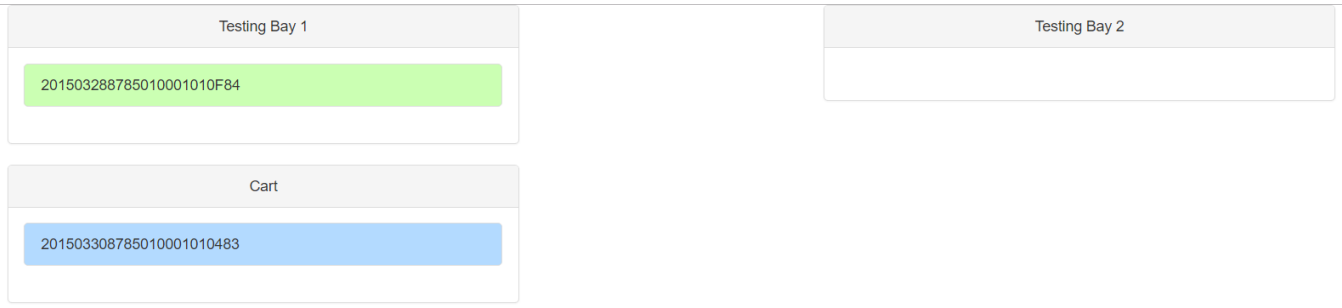

Figure 11. Example of a custom browser user interface.

Capacity and Sizing

The sizing of this solution is variable based on customer requirements. This particular proof of concept was implemented twice in different scales utilizing different compute solutions. A single HPE Edgeline EL10 was used for one implementation. A single HPE Edgeline EL1000 was used for the other implementation. Exact capacity scaling figures for these solutions are not available at this time.

Analysis and Recommendations

This RFID solution can be implemented for different scaling requirements as needed. Implementation for small setups can be achieved using a single HPE Edgeline EL10 or EL1000. Implementation for medium-size setups can be achieved by substituting HPE Edgeline EL20s and EL1000s. Large and very large setups can be implemented by using multiple HPE Edgeline EL20s and EL1000s. In each case the rest of the network would have to be able to provide and maintain enough connections for all assets to be tracked.

The combination of RFID and BLE tracking can be implemented on a small scale using a single HPE Edgeline EL10. If the solution is to be larger, multiple EL10's should be utilized and potentially an HPE Edgeline EL1000 to coordinate the multiple machines.

This IoT solution utilizes well-documented and supported software and hardware enabling HPE to deliver the best IoT solution for a customer easily and efficiently.

Summary

HPE now offers an innovative solution to improve manufacturing through the use of RFID asset tracking and BLE location-based services.

The HPE IoT solution provides manufacturers with the opportunity to save time and money by improving asset location knowledge throughout the entire production process. RFID is used to track assets moving through the process, which improves process monitoring and control. BLE allows for quick and easy tracking of tagged assets within the factory, be they raw materials, tools, machine parts, entire machines, or any other product, equipment, or asset the customer wants to be able to monitor or control. These technologies combine to improve manufacturing efficiency, reduce waste, and provide process oversight, and monitor resources in real time.

Implementing a Proof-of-Concept

As a matter of best practice for all deployments, HPE recommends implementing a proof-of-concept using a test environment that matches as closely as possible the planned production environment. In this way, appropriate performance and scalability characterizations can be obtained. For help with a proof-of-concept, contact an HPE Services representative (hpe.com/us/en/services/consulting.html) or your HPE partner.

Appendix A: Bill of Materials

	Qty	Part Number	Description
Hardware	1	847976-B21	HPE EL10 4GB 32GB w/o OS Gtwy
	1	**	Skyetek Nova module
	1	814688-B21	HP ProLiant m510 Server Cartridge
	1	862163-B21	HPE 1024GB PCIe M.2 2280 SSD Kit
	2	866842-B21	HPE 120GB SATA M.2 2242 SSD Kit
	4	854596-B21	HPE 32GB 2Rx4 PC4-2400T-R Kit
	*	**	RFID tags
	*	**	BLE Beacons
	1	**	RFID Antenna
	1	845778-001	Intel AC7260 WiFi+Bluetooth
	1	**	Battery Pack
	1	845887-001	Antennae, WiFi 2.4/5 GHz, flexible

* - Denotes that the customer can specify item quantity desired based on solution sizing. In this specific solution, three (3) BLE beacons and six (6) RFID tags were utilized.

** - Denotes that this item is not an HPE product and can be purchased externally.

Appendix B: Glossary

API- Application Programming Interface

ARM- Advanced Risk Machines

ASA Plastic- Acrylonitrile styrene acrylate

BLE- Bluetooth Low Energy

CPU- Central Processing Unit

CTO- Configure to order

DHCP- Dynamic Host Configuration Protocol

Dual-band- Capable of communications in two separate frequency bands

EL10- HPE Edgeline 10

EL1000- HPE Edgeline 1000

EPC- Electronic Product Code

GB- Gigabyte

Gb- Gigabit

GHz- Gigahertz

GUI- Graphical User Interface

HTML- HyperText markup language

IoT- Internet of Things

ISO 13485- Quality management protocol

ISO 9001- Quality management protocol

LAN- Local Area Network

Mashup- A method of displaying visualized IoT data

mAh- milliamp hour

MHz- Megahertz

MySQL- My Structured Query Language

PCIe- Peripheral Component Interconnect express

PoE- Power over Ethernet

REST API- Representational State Transfer Application Programming Interface

RFID- Radio Frequency Identification

RSSI- Received Signal Strength Indication

TB- Terabyte

TID- Tag identifier

UHF- Ultra high frequency band (300 MHz to 3GHz)

UI- User interface

UV- Ultraviolet

Resources and additional links

HPE Converged Infrastructure Library
hpe.com/info/convergedinfrastructure

HPE Servers
hpe.com/servers

HPE Storage
hpe.com/storage

HPE Networking
hpe.com/networking

HPE Technology Consulting Services
hpe.com/us/en/services/consulting.html

To help us improve our documents, please provide feedback at hpe.com/contact/feedback.

References:

EL10 - https://www.hpe.com/h20195/v2/GetPDF.aspx/c04884747.pdf

Skyetek Nova - https://skyetek.zendesk.com/hc/en-us/articles/212226006-Nova-Brochure

RFID antenna - https://www.atlasrfidstore.com/laird-pa9-12-lp-outdoor-rfid-antenna-fcc/

Intel 7620 - http://www.intel.com/content/www/us/en/wireless-products/dual-band-wireless-ac-7260-bluetooth-brief.html

BLE beacons - https://estimote.com/

Sign up for updates

★ Rate this document

Hewlett Packard Enterprise

4AA4-xxxxENW, Month 20XX, Rev. #