WHITE PAPER

LOCATING VALUE

EXTRACTING CONTEXT FROM THE INTERNET OF THINGS TO CREATE REAL ECONOMIC VALUE

aruba
a Hewlett Packard Enterprise company

TABLE OF CONTENTS

INTRODUCTION

The power of the Internet of Things (IoT) comes from extracting and exploiting process, business, and customer data that are locked inside enterprises. Inside devices, inside machines, inside infrastructure. These data boost the productivity of human and capital assets, enhance visibility into processes, help secure enterprises against attack, and drive profitability by identifying new business opportunities.

The IoT value cycle explores how IoT data can improve operations by optimizing four parameters: visibility, security, profitability, and productivity. Enhanced visibility is achieved by securely connecting all data sources to processes, using algorithms to extract value. Security comes from protecting company, employee, and customer IoT data, in-motion or at-rest, from attack, and by governing those data throughout their life cycles.[1] The third parameter, profitability, is achieved by using IoT solutions to better understand customers and their preferences. Productivity, the fourth and final parameter, is achieved by using IoT data to squeeze the most from production processes and empower the people who run them.

figure 1.0_052516_locatingvalue-wpa

Figure 1: Internet of Things Value Cycle

Visibility

- M2M, cellular, and telematics
- Industrial grade wireless
- Switching and data centers
- Remote sites, users, data centers
- Management of devices, users, apps

Security

- Data at-rest and in-motion
- Physical security
- Secure BYOD
- Application security
- Compliance, health, and safety

Profitability

- Service excellence
- Engagement and differentiation
- Ease of use and interaction
- Loyalty and product validation
- Monetization as a service

Productivity

- Uptime, high MTBF, low MTTR
- Customer behavior
- Contractor and staff management
- Kanban, efficiency, and throughput
- Responsiveness

The focus of the value cycle is not on IoT devices per se, but rather on converting the data they generate into actionable insights that expand the value chain. Data lifecycle visibility into the integrity of this process will ensure that the derived business intelligence is both trustworthy and compliant.

The other challenge is how to unlock siloed data. Freed from its shackles, newly liberated data can enrich algorithmic business processes. In algorithmic businesses, enterprises are assessed and valued by how well they transform raw data into actions that improve the customer experience and increase customer impact. The richer the data sets available to business algorithms and machine learning systems, the deeper the potential insights that can be extracted. The ability to assess and handle the volume, velocity, variety, and validity of data all play central roles in this process.

[1] Ruggero Contu and Earl Perkins, *How the Internet of Things Will Impact Cybersecurity*, Gartner, 26 April 2016

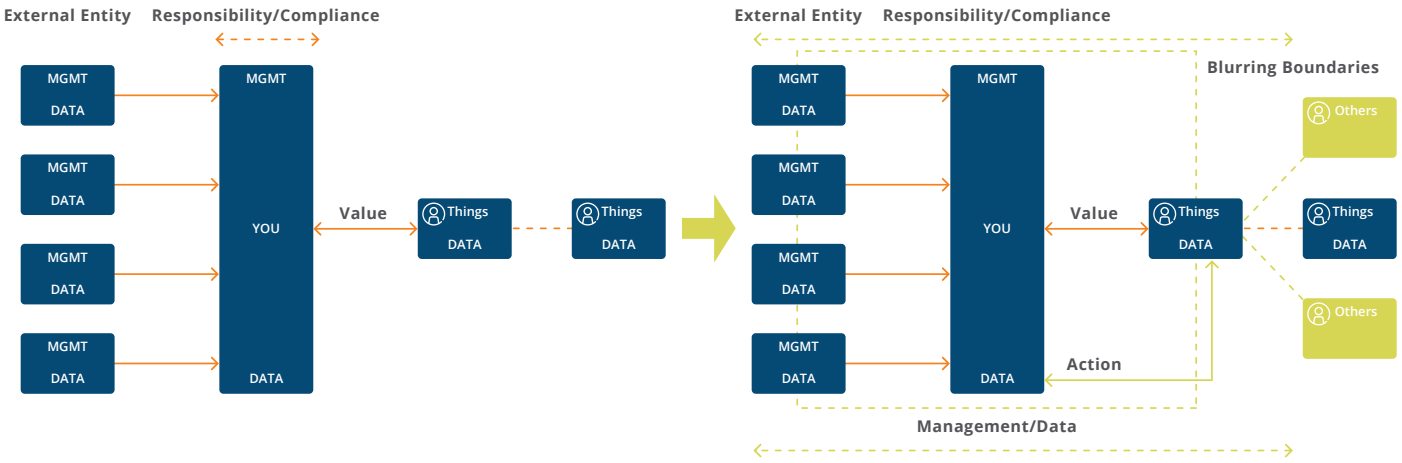

figure 2.0_052516_locatingvalue-wpa

Figure 2: Data Access: Moving From Islands to Oceans of Accessible Data

To their detriment, most enterprises today retain siloed IoT data repositories. Confining operations technology (OT) data, rich with insights, inside individual business units or sites is a common practice. The justification is that these data are needed for process monitoring and improvement, and exposing it more widely could reveal trade secrets or expose the databases to corruption. The downside of confining data is that it deprives the enterprise of valuable insights that can be gleaned from richer data sets, i.e., combined with supply chain, inventory management, predictive maintenance, and other sources. Sharing contextual data – location, users, devices, and applications that originate from IoT devices and the personnel who use and manage them – can significantly enhance business insights.[2]

With proper data life cycle governance these sources can be safely and securely shared, and that's when the real benefits of IoT can be reaped. A few predictions from Gartner research highlight why islands of insight pale in value compared with access to oceans of exploitable data.[3]

- 2018 – roughly 25% of environmental management decisions will be crowdsourced through IoT sensors
- 2019 about 10% of global enterprises will deploy wearable and IoT technologies to monitor the conditions of vulnerable workers in the extended supply chain
- 2020 – some 35% of the 6.8 billion installed IoT devices will operate with off-grid energy sources

Limiting access to these data would deny us valuable insights about trends in energy consumption, worker time and motion optimization, and enterprises with excessive energy consumption relative to their peers.

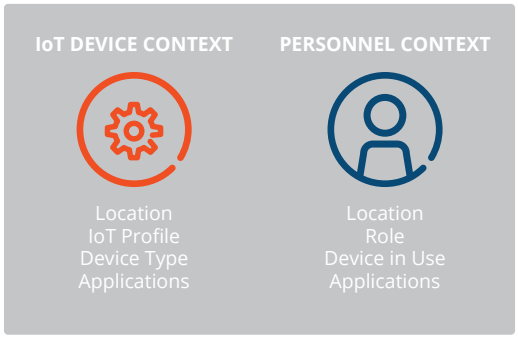

figure 3.0_052516_locatingvalue-wpa

Figure 3: Contextual Data Sources

From among the many types of available contextual data, location data are particularly insightful.[4] Location data can guide us unescorted through facilities, improving our experience without encumbering others to assist us. They can help us keep track of people wherever they work or roam. And they can track capital assets so they can be quickly located, identified, and repaired.

[2] Colin Fletcher and Sanjit Ganguli, *Enhance IT Operations Management With IoT Derived Context and Data*, Gartner, 7 January 2016
[3] Bettina Tratz-Ryan and Pam Fitzpatrick, *Predicts 2016: The Internet of Things as an Enabler for Energy Efficiency and Sustainable Business Acumen*, Gartner, 21 March 2016
[4] Thomas W. Oestreich, *Location, the Next Champion in Analytics*, Gartner, 3 July 2015

The economic impact of IoT location services is substantial. In a 2015 study by McKinsey Global Institute, *Unlocking The Potential of the Internet of Things*,[5] the total economic value by 2025 of IoT was assessed for different vertical and applications. Location-based services have an important role to play in many of the top identified applications as shown in Table 1.

In this paper we will explore Aruba's location-based IoT solutions, and review how they enhance the IoT value cycle.

LOCATION SERVICES

Location services enable us to answer three key questions that are applicable across the entire IoT value cycle: Where am I? Where are they? Where is it? The answers enable us to find, and to be found. They let us navigate sites to reach machines and destinations, and let first responders find mustering points and occupants. Location services also let us find capital assets and inventory.

There are many types of location solutions, and the most applicable one will vary by application. There is no such thing as a one-size-fits-all location solution. Table 2 walks through the list of options, each of which will be investigated in turn in the sections below.

TABLE 1: ECONOMIC IMPACT OF IOT LOCATION-BASED SERVICES

Vertical	Total Economic Impact	Top Applications	Role of Location-Based Services
Factories & Worksites	$1.2T-$3.7T	Operations optimization Predictive maintenance Inventory optimization Health and safety	Improve time and motion paths Guide engineers to machines Audit contractor activity Alert about hazardous areas
Health	$170B -$1T	Monitoring/treating illness	Guide patients to appointments Guide physicians to patients Enable medical staff to quickly find medical equipment Monitor hygiene compliance
Retail	$410B - $1.2T	Automated checkout Real-time promotions Layout optimization	Enable loyalty club offers Push offers by departments Track searched destinations
Offices	$70B-$150B	Activity monitoring Organization redesign Augmented reality Energy monitoring	Guide and monitor paths Assess real estate usage Room configuration by presence Presence detection

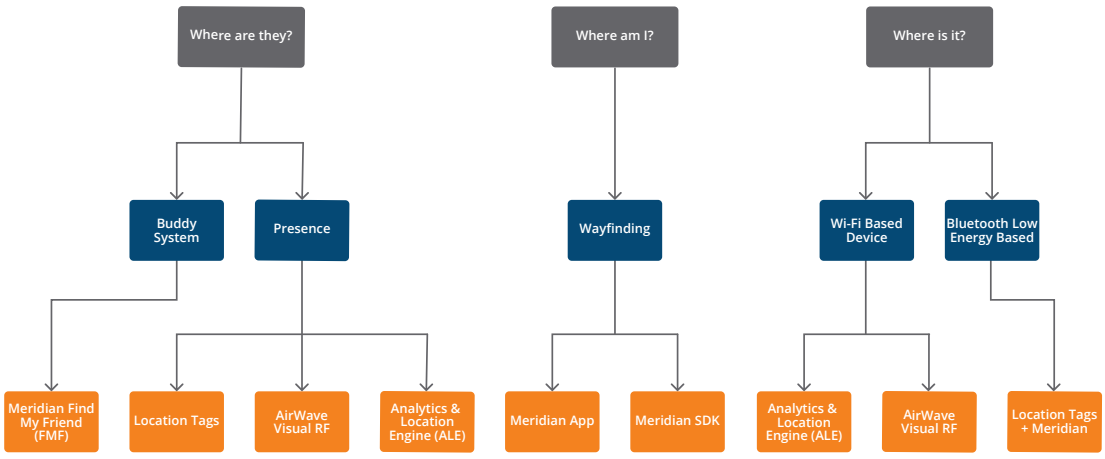

figure 4.0_100417_locatingvalue-wpa

Figure 4: Economic Impact of IoT Location-Based Services

[5] James Manyika, Michael Chui, Peter Bisson, Jonathan Woetzel, Richard Dobbs, Jacques Bughin, and Dan Aharon, *Unlocking The Potential Of The Internet of Things*, McKinsey Global Institute, June 2015

WHERE AM I?

Sports arenas, shopping malls, airports, campuses, logistics yards, hospitals, and industrial sites are often very large and difficult to navigate. If someone is delayed or lost traversing the facility the consequences can range in severity from lost revenue or time to loss of life. Employees, guests, contractors, public safety officers, and visitors can all benefit when a self-navigation solution – commonly called "wayfinding" – delivers them to their destinations quickly and unassisted.

Additionally, the contextual data generated along the way can be mined for business-relevant information. Examples include the most preferred destinations, areas in need of maintenance due to wear and tear, rent optimization based on traffic levels, HVAC setbacks and light dimming based on occupancy, hazardous areas that require safety gear, and areas that are occupied in the event of an emergency. The more extensively a wayfinding system is deployed, the wider and deeper the insights that can be mined.

Meridian Platform

Meridian is a mobile application IoT platform that provides self-guided wayfinding, geofencing, push messaging, and asset tracking services for a broad range of vertical applications. The system consists of the following components:

- Aruba Beacons
- A mobile application that runs on iOS or Android devices leveraging the Meridian Software Development Kit (SDK)
- Aruba Tags
- Meridian application or Software Development Kit (SDK) that run on iOS or Android devices
- Meridian cloud and Campaign services

Beacons and tags use Bluetooth Low Energy (BLE) for mobile engagement and asset tracking. A beacons range is adjustable from roughly one centimeter to thirty meters. The mobile app updates its location with help from the cloud service, which can push messages back to the app – or update business applications - using the Meridian Campaign service. The cloud service can also remotely manage beacons by providing battery levels, allowing their range to be changed, and to globally update software.

Aruba Tags use BLE-enabled Aruba APs to locate tagged assets. The Meridian cloud service is leveraged for mapping and SDK services.

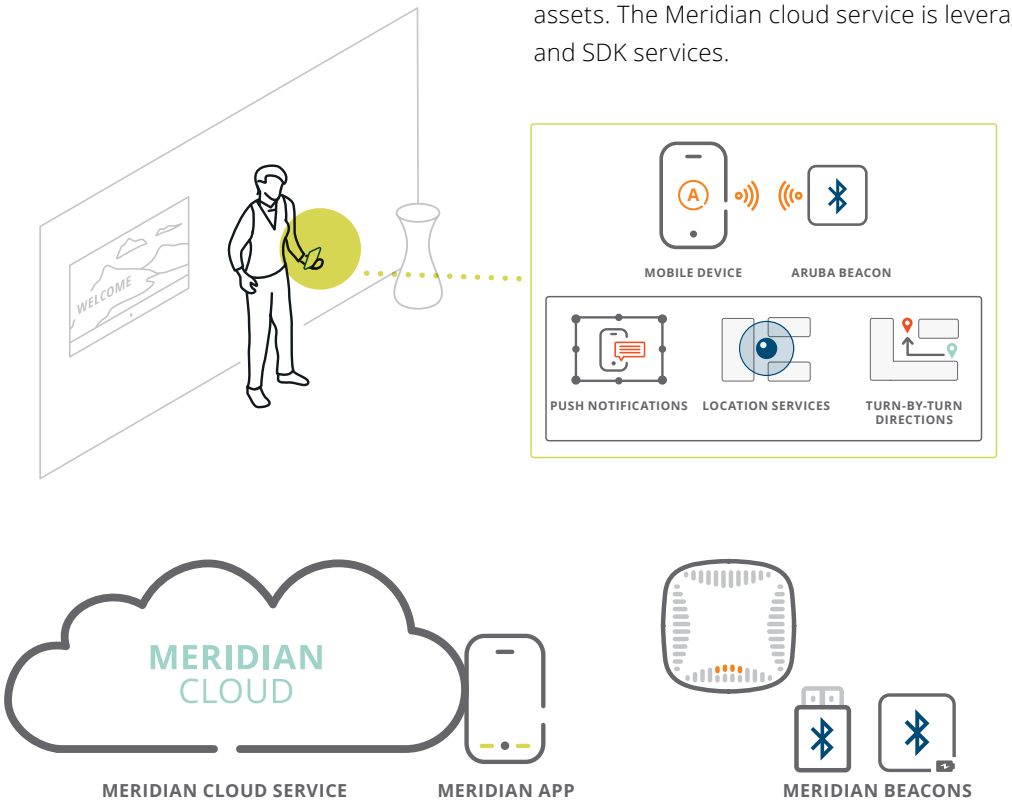

figure 5.0_100417_locatingvalue-wpa

Figure 5

Beacons are built into Aruba's latest generation of 802.11ac Wave 2 Wi-Fi access points. External beacons are available in both battery and USB powered versions. USB Beacons operate from any standard USB port, including point of sale machines and intelligent displays. Available ruggedized enclosures allow Beacons to be used outdoors or otherwise be directly exposed to the elements.

Mobile Engagement

Typical IoT wayfinding applications for IoT include guiding service personnel to machines in need to repair, guiding employees to muster points, and allowing visitors self-service access to large facilities. Self-guided wayfinding directs users or autonomous equipment to a point of interest, and offer a simple way to pinpoint their current location, search for points of interest, and access turn-by-turn directions, inside or outside, using either personally- or corporate-owned mobile devices. A glowing blue dot shows the user's location on a map, and tracks their progress along the route. Users can retrieve turn-by-turn directions from their current location without entering a starting point, an important time saver in emergencies that require mustering to safe areas or during lock downs.

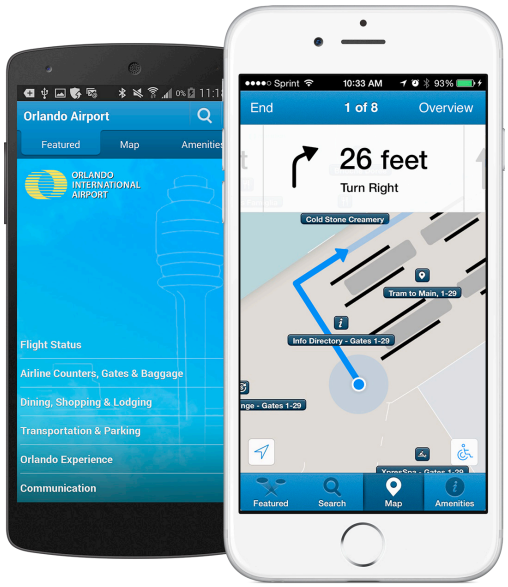

Figure 6: Meridian Wayfinding

Wayfinding also enables contractors, auditors, and visitors, and guests to navigate sites without assistance, conserving operational and administrative resources from acting as guides. Once at their destination, additional information can be recalled/displayed about machines or points of interest, with quick access to additional content – user's guides, nearby hazardous materials, local services like restaurants – available by using the search feature within the app or directly from a map.

Meridian Geofencing & Push Messaging

A Meridian geofence is a virtual boundary around an area that is triggered when the mobile device running the Meridian app crosses the perimeter. The tightly controlled RF range permits a geofence to trigger when an engineer arrives at a specific machine, a visitor stands in front of a kiosk, or a guard makes appointed rounds to locations around a facility.

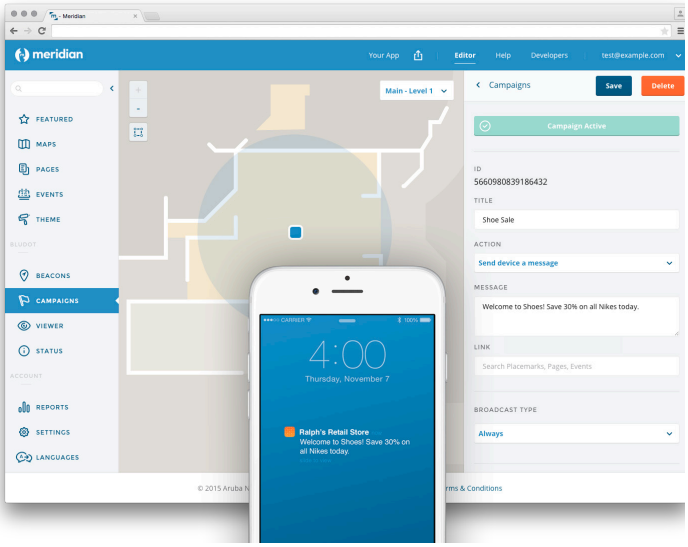

Figure 7: Meridian Geofencing

Activating a geofence can trigger a contextually-relevant push message or notification to a third party application using the Meridian Campaigns service. For example, Campaigns can initiate an action like a CRM, unified communication system,[6] or database lookup prior to pushing a message to a user. The arrival of a patient at a hospital can prompt a patient record look-up, followed by a push message reminding them of the location of their lab appointment. Similarly, a maintenance log could be pushed to a jet mechanic upon accessing the tarmac, or an instant replay could be activated for a sports fan upon reaching his or her seat.

The power of Meridian comes from the context it applies to user engagement, the precision of its geofencing, and the flexibility with which it can interact with other systems.[7] How Meridian is applied will vary by the industry in which it's used. Let's consider a few representative examples.

Machine Service and Automated Auditing

- HPE EdgeLine servers running Vertica analytics applications identify three electrically-actuated pumps on a manufacturing site that are drawing too much current and in need of service.
- A service technician with a tablet running the Meridian app is dispatched to the site. On leaving the service van – which contains a Beacon – a geofence notification triggers Meridian Campaigns to notify a project accounting application of the time the job commences.
- The technician is presented with step-by-step instructions to the first machine. On arrival a geofence at the machine is triggered, the accounting application is again notified, and a link to the service manual for that model of pump is presented to the technician. After completing the repair the technician heads for the second pump, and the geofence on the first machine triggers a notification indicating the completion time. The same routine is followed for the second and third machines. Vertica confirms to the data center that the pumps are now fully operational.
- Upon entering the service van the vehicle geofence is again triggered, and the accounting app now has a complete record of how time was spent on site.
- As part of a continuous improvement program a service analytics application automatically assesses the efficiency of the technician compared to previous visits and other comparable machines, while the customer receives a copy of the time sheet with the invoice to justify the hourly billing time.

Healthcare Wayfinding and Hygiene Compliance

- A visiting physician arrives at a hospital to make rounds carrying a personally owned tablet running the hospital's app. On arrival a geofence at the hospital entrance triggers Meridian Campaigns to notify the patient accounting application and ClearPass guest access, granting the physician temporary access to the patients' records.
- The physician is presented with step-by-step instructions to the first patient, who changed rooms during the evening shift.
- On entering the patient ward another geofence is triggered reminding the physician to visit the handwashing station, where another geofence is triggered confirming compliance.
- Geofences are again triggered when the physician enters and exits the patient's room, updating the patient's medical record, and prompting another invitation on departure to visit the handwashing station. The situation is repeated as the physician visits other patients.
- Upon departure from the hospital a geofence prompts ClearPass to disable guest and patient record access, and the hospital billing system to note total time on site and per patient.

Contractor Auditing and Order Reconciliation

- Due to past billing reconciliation issues, an oil company mandates that to be paid for services all contractors must download and use the company's logistics app when they pick up or drop off loads.
- A truck driver with a load of pipes drives up to the front gate of the oil company's logistics warehouse, triggering a geofence established by a Beacon at the gate.
- Meridian Campaigns notifies the purchasing application to look up relevant purchase orders for the driver's firm. The logistics app lists open orders and askes the driver to select the pertinent one.
- After doing so the driver continues on to the loading dock and parks over a scale. A load sensor interfaced with an EdgeLine server weighs the truck and sends the gross weight to Vertica in the data center.
- After unloading the truck stops at the exit gate, triggering another geofence that prompts the EdgeLine server to measure and forward the tare weight. Vertica calculates the net weight and compares if the expected and actual weights align, indicating both that the correct item was delivered and that no additional items were inadvertently or intentionally loaded on the truck. The accounting application is then updated and signals the site guard to open the gate so the driver can exit the facility.

[6] Bern Elliot and Adam Prese, *Reimagine Workplace UCC by Leveraging Digital and Physical Convergence*, Gartner, 1 April 2015
[7] Nolan Greene and Matthew Marden, *Realizing Business Value by Moving to a Digital Workplace*, IDC, May 2016

These examples highlight the benefits that can be obtained when location data are shared with other systems that might previously have been siloed. Efficiency can be improved, compliance ensured, and accountability enforced.

Now that we know how to find ourselves, let's turn our attention to finding others by answering the question, Where Are They?

WHERE ARE THEY?

Using IoT solutions to locate people has a wide range of applications: time and motion analyses to improve productivity, reducing retail abandonment rates by optimizing the ratio of shoppers to associates in real time, triggering person-down alerts , and improving first responder efficiency by identifying occupied areas without having to first enter an area. The systems that accomplish these tasks fall into two categories: buddy systems and presence detection.

Buddy systems enable a pair or team of individuals to directly observe each other's location. Buddy systems are typically deployed to improve safety and productivity by highlighting one's location to others nearby without any manual intervention on the part of person being observed. That characteristic makes buddy systems ideal for monitoring staff in areas without direct line-of-sight visibility – hospitals, big box retailers, logistics yards, transportation facilities, manufacturing plants. In large facilities it provides additional utility in identifying occupants in the event of lock-downs or sieges.

Meridian Find My Friends

Meridian incorporates a buddy system through a feature called "Find My Friends" (FMF). FMF can locate colleagues on a digital map and access directions to their exact locations wherever Meridian Bluetooth Beacons have been deployed: underground, in buildings, and in and around industrial plants – all locations in which GPS is unavailable to support traditional mapping applications. An SDK enables FMF functionality to be added to existing applications that would benefit from a buddy system approach, including contractor, maintenance, and construction management systems.

FMF leverages a location sharing API that updates in the foreground, as shown below, and to background apps. Location data are shared only among those who have mutually opted into the system at a specific location.

Trilateration

Another way to track people is via presence detection. In this context "presence" is defined as the location on an x/y plane of a Wi-Fi enabled device using signal trilateration. Trilateration determines the location of a Wi-Fi device by

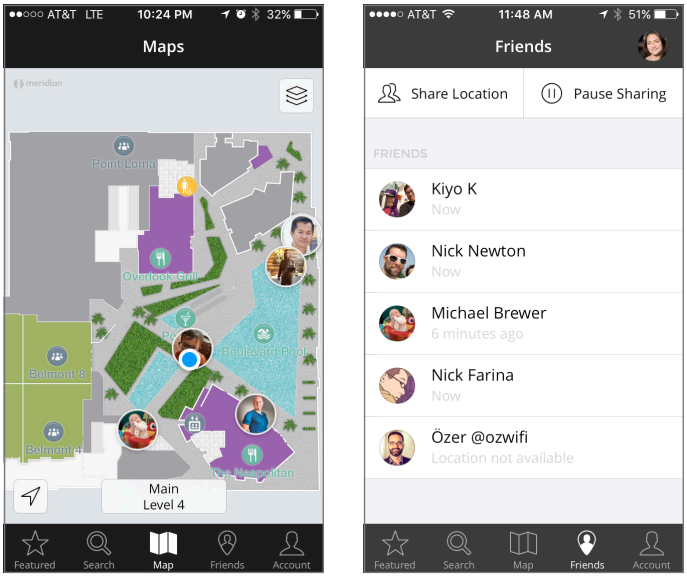

Figure 8: Meridian Find My Friend Feature

algorithmically processing the signals picked up from that device by a minimum of three Wi-Fi access points, and plotting them in x/y space on a site map. Location can be calculated from the probe requests that Wi-Fi devices periodically send to identify nearby networks, even if they don't connect – or more precisely, associate – with the network. The location of associated (connected) Wi-Fi devices are also calculated.

Probe requests are discarded by most Wi-Fi networks if the client device does not connect to the network. And yet, these simple transactions from unassociated client devices can yield important, business-relevant information. Probe requests can show when a room or area is occupied, how many people are walking by vs. thru a doorway, dwell time, and, if they leave and return, the recency, frequency, and timing of their visits.

There are three basic trilateration solutions, all of which use the same technique but with different Wi-Fi devices, or on different processing platforms: VisualRF, Analytics & Location Engine (ALE), and Wi-Fi location tags. Let's consider each in turn.

VisualRF, an application within Aruba's AirWave network management solution, collects and displays trilateration data captured by nearby access points from any Wi-Fi enabled devices connected to – or, more precisely, associated with – the Wi-Fi network. VisualRF is a historical reporting tool, not a real-time monitoring system, as it can take several minutes for the data base to be updated. The key advantage of VisualRF is that it does not require any client device software, and tracks any person carrying an active, associated Wi-Fi device.

Industrial tablets, bar code scanners, wireless heart rate monitors, smart phones – all can be tracked, displayed on site maps, and historically reported by VisualRF. A playback feature allows movement of a device to be replayed, a useful tool for assessing traffic flows and tracing the path of misplaced or stolen devices.

ALE is the right tool to use for real-time location tracking of unassociated and associated client devices – or the people carrying them. ALE pulls presence data from the Aruba infrastructure, calculates positions in real-time, and makes those data available through APIs for consumption by external applications and analytics engine like HPE Vertica, SkyFii, and Software AG APAMA, among others.

ALE's ability to monitor probe requests makes it well suited for retail and hospitality applications. A data anonymization feature will mask MAC addresses to meet local privacy rules.

For devices that associate with the Wi-Fi network, ALE can gather additional contextual information including user identity, roles, device type, operating system, applications in use, browser user-agent, and urls visited. It can also pull floorplans from AirWave and spatially place the monitored devices on the floorplan in real-time.

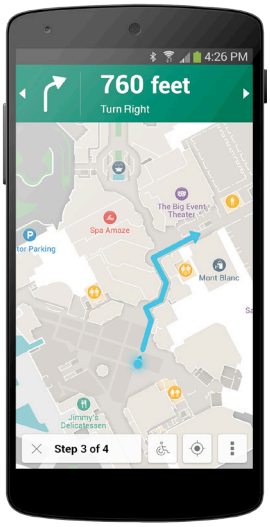

Figure 9: ALE Location Data Presented on the ALE Android App

API data feeds from both associated and unassociated devices have utility for a wide range of location-based services: branding and marketing,[8] energy management presence detection,[9] establishing rental rates based on actual traffic flows, e911 call origination, identifying occupied areas to first responders, real estate utilization, and queue busting. Taken in combination, ALE's features make it ideal for extracting real-time contextual data for consumption by a wide range of applications and analytics engines.

The third trilateration solution – Wi-Fi location tags – are designed to track people and assets that don't carry or have embedded Wi-Fi based devices, respectively. Wi-Fi tags are battery powered and transmit an RF identifier, and sometimes additional information like temperature or humidity, that is picked up by nearby Wi-Fi access points and conveyed to a location application. The application calculates and displays the tag location on a site plan.

Figure 10: Intrinsically Safe Wi-Fi Tag and Aruba AP In A Class 1 Division 1 Housing

Wi-Fi location tags are widely used in healthcare-, manufacturing-, and safety-related applications, and are available with intrinsically safe packaging for use in explosive environments. Their chief utility is their adaptability. Tags can be strapped to newborn infants and the infirm, worn on a belt loop by contractors, and even embedded in other devices – like toxic gas detectors. Tags provide a simple and easily deployed means by which to derive contextual location data across a broad range of uses.

[8] Thomas Husson, *The Internet Of Things Redefines Brand Engagement: Connected Objects Will Deliver The Brand Experience Of The Future*, Forrester, 21 April 2016
[9] Bettina Tratz-Ryan and Pam Fitzpatrick, *Predicts 2016: The Internet of Things as an Enabler for Energy Efficiency and Sustainable Business Acumen*, Gartner, 21 March 2016

WHERE IS IT?

Many of the same solutions discussed above can also be applied to tracking capital assets – forklifts, pallets, chemical reactor vessels, infusion pumps, wheelchairs, to name a few. These applications fall into two categories: those with Wi-Fi enabled devices and those without.

Many machines use Wi-Fi as a secure backhaul for data communications. Bar code scanners, mobile point of sale tablets, heart rate monitors, mobile voice over IP phones – all are available with built in Wi-Fi. The location of all of these devices can be tracked using VisualRF, which records and can play back location history. As noted above, VisualRF is not a real-time system, and is best suited for assessing traffic patterns and monitoring shrinkage.

For real-time tracking of valued assets that may or may not be connected to the network, Aruba's asset tracking solution is ideal. By affixing a small Bluetooth Low Energy (BLE) tag to valued assets, the location of the asset can be known in real-time. Built-in BLE radios in the latest Aruba Access Points can listen for the BLE tags and report their location. With an accuracy of around 3-5 meters, the asset can quickly be located on a map. Zones can be set up to enable PAR-level (Periodic Automatic Replenishment) management of assets to ensure the right number of a particular asset are always available.

In healthcare this allows maintenance teams to quickly find a piece of equipment due for calibration to ensure they are compliant. It enables a nurse to quickly find an ultrasound machine he need for a patient. Operations teams can ensure the right number of beds are in the right area at the right time.

Aruba's Analytics & Location Engine is another platform for monitoring device location in real-time, and includes some unique features for theft detection. In addition to calculating the x/y position of the device and forwarding it via an API, ALE also gathers and forwards device-specific information: manufacturer, model number, and operating system. These data allow back-end applications to quickly understand what type of device is in use and mobile.

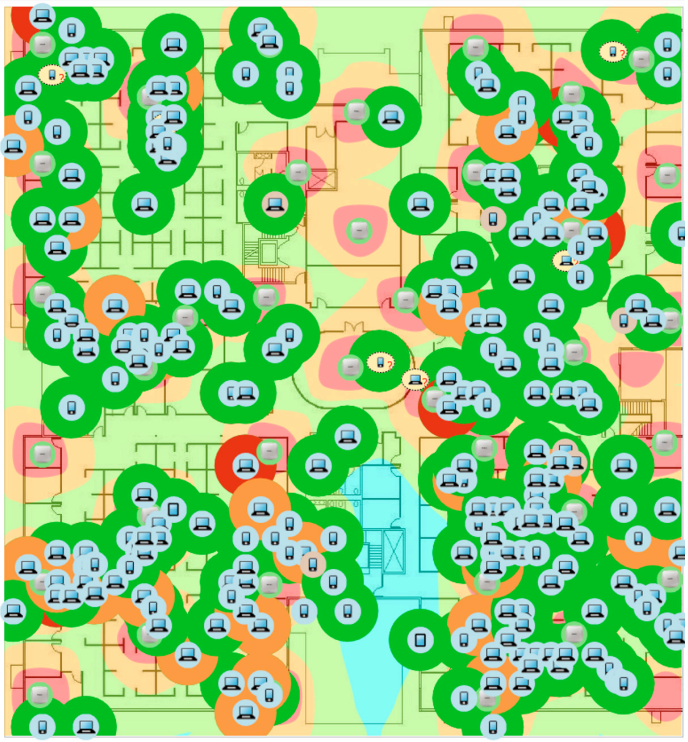

Figure 11: VisualRF Device Tracking

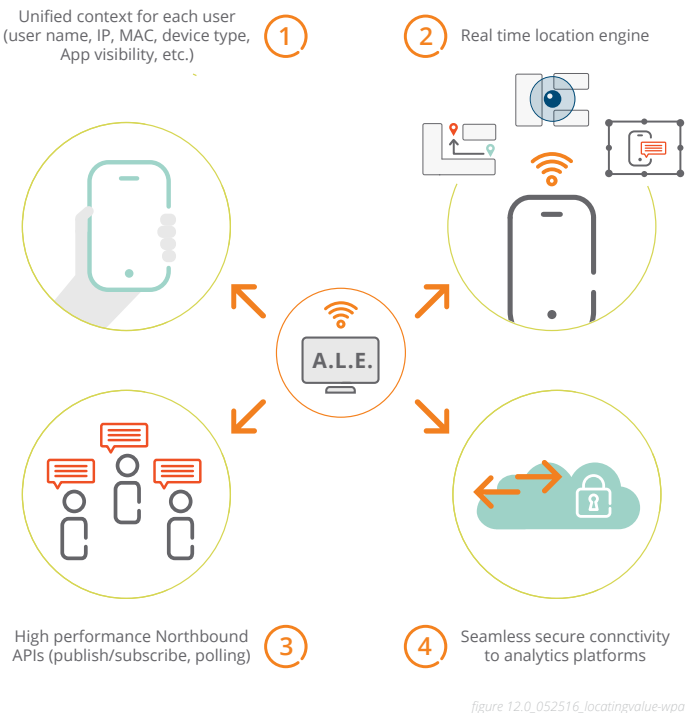

Figure 12: ALE Device Tracking

Used in conjunction with AirWave, ALE offers a geofencing feature that will trigger unique events when a device crosses a geofence, and will also provide the dwell time within the fenced area. These features enable back-end applications to differentiate between, say, an infusion pump entering a service depot and a laptop that is walking out the door. They can also trigger building lighting and heating systems when an area is occupied, and set them back when the area is vacated. Exclusions zones can also be established in which devices will not be tracked.

Just as Wi-Fi tags can track people, they can also be affixed to and help track machines, pallets, and other inanimate objects. Tag pings, either Wi-Fi or Bluetooth, are relayed over Aruba infrastructure and processes by a back office location engine that presents location in real-time, and can trigger alerts when geofences are crossed.

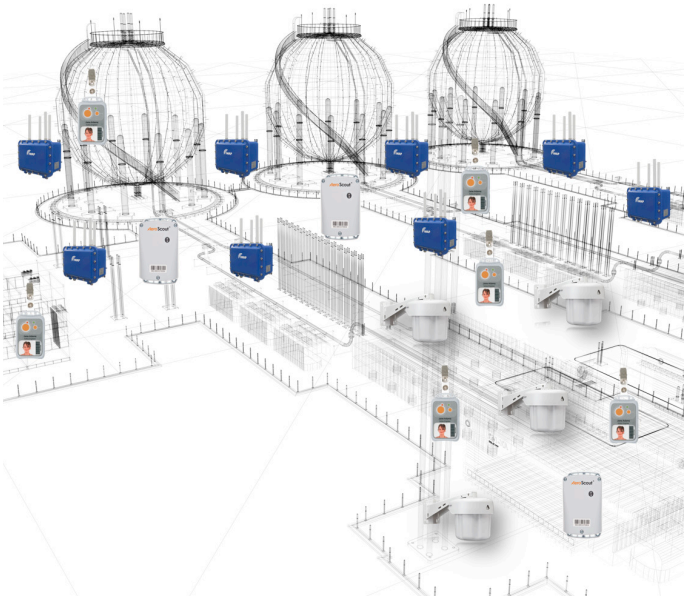

Figure 13: Wi-Fi Tag Asset Tracking in a Typical Deployment

Note that the accuracy of Bluetooth and Wi-Fi location tags is typically higher in controlled indoor environments than in outdoor locations with a lot of nearby metal. The cost of deployment varies considerably, too, since outdoor access points are more expensive than indoor units, especially dressed for Class 1 Division 1 or 2 explosive environments. Bluetooth and Wi-Fi location tags have an important role to play in identifying, finding and retaining capital assets.

CONCLUSION

Unlocking siloed contextual IoT data helps businesses transform data into actions that improve efficiency, productivity, and customer/employee experiences. Contextual data, like location, are rich with insights, and once we sort through the volume, velocity, variety, and validity of data we can start leveraging them to our advantage.

Aruba helps companies extract location, user, device, and application oriented contextual data that originate from IoT devices and the personnel who use and manage them. These data can then be securely handed off for consumption by analytics, machine learning, and business intelligence applications from HPE and other vendors.

By boosting the productivity of human and capital assets, enhancing visibility, helping to secure enterprises against attack, and driving growth from new business opportunities. It is at this stage that the true potential of the Internet of Things will be unlocked and the economic value realized.

aruba
a Hewlett Packard Enterprise company

3333 SCOTT BLVD | SANTA CLARA, CA 95054
1.844.473.2782 | T: 1.408.227.4500 | FAX: 1.408.227.4550 | INFO@ARUBANETWORKS.COM

www.arubanetworks.com