Harvard Extension Hospital:

Digitization of Medical

Asset Management

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12/13/2018

ISMT E-599: Capstone Seminar in Digital Enterprise

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Executive Summary

The Shepherd Asset Management (SAM) ecosystem is designed to help hospitals manage portable medical equipment and provides three key benefits: reduce time wasted by staff searching for portable medical equipment, improve equipment utilization, and prevent loss of mobile medical equipment. This is accomplished by providing Bluetooth LE beacon tags, access points, web applications, and analytics. The beacon tags are attached to equipment and various perimeters are defined. Once the hardware is in place and the software is configured, theft or improper storage alerts will help track and secure the equipment, mapping and reservation systems will help locate and schedule equipment, and utilization data analytics will help manage equipment inventory.

The Client Company

Harvard Extension Hospital (HEH) is a mid-scale hospital looking to reduce costs and achieve operational excellence. HEH is a five floor, 300 bed hospital with all major medical and back office departments. To service patient care, the hospital relies on portable medical equipment, i.e. EKG, ultrasound, and infusion pump machines, that is shared across multiple departments.

Information Technology Supplier/Vendor

Gloco specializes in digital asset management solutions for the healthcare industry, from small to large hospitals, providing consulting, planning, technical design, implementation, and support services. Gloco partners with leading industry hardware vendors, cloud providers, and network solutions providers for a complete turn-key system. Gloco also develops and licenses applications, as part of a turn-key system, when industry applications do not meet customer needs.

Business Goal and Problem

HEH uses portable medical equipment to facilitate a high level of care and operational efficiency. Throughout a typical day, the medical equipment is routinely moved from one location to another in order to provide clinical services at patient or diagnostic rooms. Portable

medical equipment can be difficult to locate especially if equipment storage processes have not been established or consistently adopted. HEH administration recognizes the significance of this issue and is looking for a technical solution that will solve the business problem.

Clinical staff, struggling to locate medical equipment, would like a simplified means of locating durable equipment in real-time so they can spend more time caring for patients and less time searching for equipment. In addition, due to HEH's growth and manual processes, medical equipment management is inefficient and error prone.

By introducing automated and digital solutions to manual asset management processes, HEH's goals are:
- Reduce time wasted searching for portable medical equipment
- Increase utilization of existing equipment and reduce unused equipment
- Prevent loss and theft
- Provide real-time business intelligence and analytics dashboard features to management

Technology Solution to Solve the Problem

Gloco's Sheppard Asset Management (SAM) ecosystem is a fully integrated hardware, software, and analytic platform, that provides real-time positioning capabilities. Gloco partners with hardware manufacturers that provide the Bluetooth Low Energy (BLE) beacon tags, access points, and cloud based triangulation services. The SAM application suite, developed by Gloco, provides end-user interfaces for location awareness and device tracking via a mobile and web application.

How the SAM System Will Be Implemented

The SAM ecosystem starts with bluetooth antenna array access points obtained from Mist Systems. These access point devices will be placed in the ceiling alongside existing Wi-Fi access points. The SAM web application will be installed within the existing HEH data center solution. The SAM Mobile will be published to the HEH internal app store and will be available to users to download and install. Identified durable mobile medical equipment will then be affixed with a beacon tag, supplied by Kontakt.io. The tags will be programmed and configured using

the SAM application. The beacon tag will be cataloged and linked to the existing HEH ERP inventory.

Measuring Success

After the pilot implementation, metrics will be analyzed on user adoption, device utilization, and equipment location via the SAM analytic service, and coupled with user surveys, success metrics will be determined for the pilot. A 3-month pre-pilot average baseline will be benchmarked against a 3-month post-implementation average.

Expected Results for the HEH Pilot

After the 3 month post-implementation average is compared against the baseline, hospital staff will be able to reduce their time to locate durable mobile medical equipment by at least 40%. The hospital will be able to increase equipment utilization within the pilot sample to at least 55%, which is 10% above the national average (Locatible, n.d.). Hospital equipment, added to the SAM network, will have a theft reduction of 70%. On-time delivery of hospital equipment to the next patient will increase by 85%.

The resulting benefits for Harvard Extension Hospital will be:
- Reduced time spent locating the necessary equipment, allowing for more time to spend with patients and to improve patient outcomes
- Improved equipment utilization, so that administration better understands how equipment is used, what they need more of, and what they have too much of, improving cost savings

Business Requirements

Business Context

As-Is

The current business processes at Harvard Extension Hospital relies on disjointed and manual efforts for mobile medical device searches, device security, and asset utilization management.

Device Search

Clinical staff have the primary responsibility for tracking mobile medical devices. A device might be placed in a standard storage area but could also float anywhere within a department, or throughout the hospital. Each time a device is needed, an ad hoc, floor-walking investigation takes place. First, the staff searches a common areas where unused devices are typically stored. If no functioning device is found, the search expands to secondary storage areas. If still not found, additional staff help out with the search efforts. This process is often a repetitive loop that expends a large amount of time until an available device is located. Refer to Exhibit 1 in the Appendix for a flowchart showing the as-is device search process for clinical staff.

Device Security

The hospital has many points of egress and currently employs a limited security team. The current equipment security process relies on medical and administrative staff to proactively protect the assets by reporting misuse and suspicious activity. With multiple points of egress and a limited security process, the hospital has a high risk of device theft not only from outside threats but potentially from internal staff as well. Equipment loss is often noticed weeks after the device has gone missing. Refer to Exhibit 2 in the Appendix for a flowchart showing the as-is process for business administration and security staff when a device cannot be located.

Asset Utilization Management

In the current business processes, the administrative staff is responsible for asset utilization management. This is currently accomplished via non-standardized reports that have lagging

indicators, aged data (days or weeks old), and data points from inconsistent sources. Although some connected devices can provide utilization statistics, the predominant process is a manually intensive and error prone process to determine usage that entails walking the floors and informal staff surveys. Utilization analysis is highly dependent on the skills of the administrative staff and can greatly differ depending on the individual performing the analysis. This unstandardized approach results in inconsistencies among reports.

To-Be

The SAM ecosystem will provide a future state based on the digitization of the mobile medical device location tracking process by leveraging beacon positioning technology.

Hospital Mapping

Stationary Bluetooth access points will be deployed in HEH to provide sufficient coverage to allow triangulation of equipment tags. This will ensure complete area coverage for locating tagged devices on hospital floors while also providing the ability to place perimeter limitations for devices to cover points of egress.

Device Monitoring

Beacon Bluetooth LE (BLE) tags will be attached to the mobile equipment targeted for this pilot project. Equipment identified for the pilot project will be determined by the hospital administration staff. The equipment must meet a replacement expense threshold or have a utilization factor such that a significant amount of time is spent by staff routinely searching for the device.

Device Search

Upon querying for a device, a user will be presented a floor map of nearby devices with current utilization information relative to the user's location on the map. The search results will also be presented in a list form based on user preference. When the search results do not return any devices, the staff member can submit a request to be alerted when a device becomes available. This same process works similarly to reserve a specific device. The staff is able to clear the request/reservation at any time. Refer to Exhibit 3 in the Appendix for a flowchart showing the to-be device search process for clinical staff.

Device Security

Administrators can set configuration parameters to restrict device movement to permitted hospital locations. Administrators and security staff can be alerted in real-time when a device crosses certain perimeter boundaries. This is primarily used to prevent theft from the hospital premises and to ensure that equipment is returned to proper stations. Refer to Exhibit 4 in the Appendix for a flowchart showing the to-be process for business administration and security staff when a SAM alert has been generated.

Additionally, the BLE tags have a tamper detection capability that will trigger an alert should anyone attempt to remove/disable a beacon. This will mitigate risks of beacons being removed prior to equipment being stolen and will also ensure that accidental damage to beacons are detected for resolution.

Asset Utilization Management

BLE tags have a status indicator that communicates whether a device is in use or available. With the digitization of device status, users are able to determine the availability of devices in real-time as well as run utilization reports and trend analysis. The SAM ecosystem also provides an analytic service that consumes device utilization statistics, location data, and reservation data to provide hospital administrative staff real-time reports on device utilization by location, usage trend analysis and recommendations on device storage locations to maximize operational efficiencies. Staff will either log that a device is being used or no longer in use by toggling a switch on the side of the beacon tag.

Daily Work

Clinical staff will access the SAM application to search for medical equipment, as needed for patient services. Users can view the location of the medical equipment on the hospital map and will then walk to the precise location to pick up the equipment, eliminating time wasted by physically searching for it or interrupting colleagues to ask where it is. Users with known equipment needs in advance can reserve equipment for future appointments. Highly utilized equipment can be waitlisted and users will be notified once it comes available.

Business administration staff will access the SAM application, on an as-needed basis, to view, generate, and download real-time inventory and utilization reports from the analytics module of the SAM application. In addition, business administration and designated security members will be alerted by SAM via text messages, email, and application popups if an equipment's physical location has a security breach.

Epic For Clinical Staff and Administrators

Epics have been created for HEH based on a common objective for clinical staff and one for administrative staff. The epics are further broken down into specific user stories as well as a list of features per story.

Epic: Clinical staff equipment search and productivity improvement.
User story:
As a clinical staff member I want to know the location of a mobile device so I do not waste time searching the facility.
Features:
- The device location can be found via a web-based or mobile application.
- The applications will provide a search query page.
- The device search will return results within 5 seconds.
- Search results will include device availability status.
- Search results will provide a device location map.
- Search results will provide a list of devices with device details.

User story:
As a clinical staff member, I want to be alerted when a mobile medical device becomes available so that I can guarantee that I will have use of the equipment upon next availability.
Features:
The clinical staff can enter his or her name on the system's equipment waiting list.
- Then the clinical staff will receive an alert notification when it becomes available.
- The clinical staff can release the equipment request on demand.
- Unclaimed equipment will be automatically removed from waitlist after a period of time.

Epic: Medical equipment management for hospital administrators

User story:

As a hospital administrator, I want to know the clinical staff's ability to locate equipment so that I can improve operational efficiencies.

Features:

- The hospital administrators can keep track on the equipment status through the web-based or mobile application.
- The application would display time to locate statistics.
- The application will display time and distance to retrieve equipment.

User story:

As a hospital administrator, I want to analyze mobile medical equipment utilization so that I know which equipment is under- or over-utilized for purchasing decisions.

Features:

- The hospital administrator can analyze the usage of equipment in realtime.
- Graphical and statistical data can be displayed on a dashboard or a tabular layout.
- Dashboard and tabular data can be exported to Excel, CSV or PDF formats.
- The administrator can create custom reports.

User story:

As a hospital administrator, I want to be alerted when mobile medical devices are removed from department/hospital premises so that I can reduce shrinkage loss in the act.

Features:

- The application will allow administrators to define boundary premises for equipment.
- Equipment removed from the defined boundaries will trigger system alert notifications to the hospital administrators and/or security staff.

Non-Functional Requirements

- Performance - SAM must be able to positively identify theft attempts within seconds and SAM must perform consistently and reliably regardless of concurrent peak usage.

- Capacity - SAM ecosystem must be able to consistently process bluetooth network traffic at expected peak usage in a timely manner and support growth with additional beacon transmitters.
- Usability - SAM application must support single sign-on and have different user roles to support interfaces and functionality for hospital administrators, clinical staff, and IT.
- Availability - SAM must be available 24x7 with no more than one hour downtime once per week for system upgrades.
- Maintainability - SAM application must be configurable and maintainable by HEH IT staff. Major application upgrades and patches must be available for download by HEH IT. Hardware and consumables (i.e. batteries) must be replaceable by HEH IT.
- Security - SAM implementation must comply with HEH's CSO policies and procedures for data in flight and at rest, as well as the HIPAA Security Rule, electronic Protected Health Information (ePHI), and HEH's multi-factor authentication (MFA) requirements.
- Regulatory - SAM must comply with HEH's IT governance policies and procedures, HIPAA Privacy Rule and Protected Health Information and local government regulations.
- Environmental - SAM must integrate with existing IT infrastructure and not interfere with communication signals of other medical equipment. Beacon transmitter/receivers to detect and report interferences. Hardware must be moisture and shatter resistant.
- Interoperability - SAM must interoperate with HEH's existing network topology and existing ERP applications

Assumptions

- The initial implementation of the SAM ecosystem will be limited to HEH's first floor internal medicine department, 100 clinical staff users, and 37 medical devices
- For mobile device usage, clinical and administrative staff must have bluetooth enabled and the SAM mobile application must be pre-installed on the mobile device
- Users are granted permissions to use the SAM interface
- Beacon tags are tamper-resistant
- Scaling is managed by HEH IT, where additional sets of devices are allowed to be added to the SAM system at any time
- Security is integrated into SAM with support for multi-factor authentication or security certificates

Financial Cost/Benefit Analysis

Shepherd Asset Management ecosystem consists of Beacon Bluetooth Low Energy (BLE) transmitters, access points, web-based applications, mobile apps, an analytics platform, and cloud data and backup costs. Gloco will configure the mobile and web applications as necessary so that SAM integrates with HEH's ERP, security, and network systems.

Gloco will provide two on-site trainers for a week of training, divided by user roles. On-site training fees are $250/hr per trainer. Additional estimates are provided for staff productivity loss for training requirements:

- Clinical staff = 600 > avg $37.5/hour
- IT Staff = 4 > avg $50/hour
- Administrators = 10 > avg $50/hour
- Security = 10 > avg $20/hour

Training calculation = (600* $37.5 * 4) + (4 * $50 * 8) + (20 * $50 * 8) + ($20 * 20 * 4)

= $101,200 + $20,000 Gloco trainers = $121,200 total

Estimates in the benefits chart include the following assumptions based on similar-sized hospitals:

- Reduce time to find equipment by 40%
- Decrease theft by 70%
- Increase on-time delivery by 85%
- Assume $4,000 per bed in lost/stolen assets per annum

Financial Cost/Benefit Analysis Table

	2018	2019	2020	2021
Benefits				
Reduce time to locate medical equipment	$1,397,043	$1,397,043	$1,397,043	$1,397,043
Increase equipment utilization rate	$250,909	$250,909	$250,909	$250,909
Reduce incidences of equipment theft	$360,000	$360,000	$360,000	$360,000
Total benefit/year	$2,007,952	$2,007,952	$2,007,952	$2,007,952
Costs				
SAM application licensing	$100,000	$100,000	$100,000	$100,000
SAM application implementation and integration	$500,000	$50,000	$50,000	$50,000
Technical staff and training	$121,200	$20,000	$20,000	$20,000
Mist cloud data storage, backup & analytics & support	$200,000	$300,000	$350,000	$400,000
Mist access points and support	$100,000	$100,000	$100,000	$100,000
Kontakt.io beacon tags and support	$5,000	$5,000	$5,000	$10,000
Total costs/yr	$1,026,200	$575,000	$625,000	$680,000
Profit/Loss	**$981,752**	**$1,432,952**	**$1,382,952**	**$1,327,952**

Metrics for Success

The following table shows the dollar savings potential for HEH based on achieving the expected success metrics.

Success Metrics Table

Success Metric	Current	Expected	Potential for HEH
Reduce time to locate medical equipment	30%	18%	$1,397,043
Increase equipment utilization rate	45%	55%	$250,909
Reduce incidences of equipment theft (per yr)	20%	6%	$360,000
On-time delivery of equipment to patient	65%	85%	*Patient Satisfaction*
Estimated annual benefit to HEH			**$2,007,952**

Initial Cost Benefit Metrics

The estimated costs for implementing SAM is a total of $937,800. After using SAM for one year for the return on investment not only break even but will have a positive return that is 2.14 times greater than the initial investment.

Cost Benefit Metrics Table

Financial Analysis	Description/Calculation	Total
First Year Costs for SAM Ecosystem	Hardware, software, licensing, data storage/backup, analytics, training, and support	$1,026,200
First Year Benefits of SAM Ecosystem	Improve time to find devices, increase equipment utilization, theft reduction	$2,007,952
Average Monthly Savings	($2,007,952-$1,026,200)/12	$81,813
Break Even Point	$$1,026,200/($2,007,952/12)	6.1 Months
First Year Bottom Line Benefit	**$2,007,952-$1,026,200**	**$981,752**
First Year ROI %	**(($2,007,952-$1,026,200)/$1,026,200)*100**	**95.7%**

Technical Specification

The SAM ecosystem is a suite of tools architected to save time locating equipment, improve equipment utilization, and reduce equipment loss due to theft.

Architectural Approach

The SAM ecosystem is composed of third-party vendor access point and beacon hardware, and cloud services, coupled with the Gloco-developed SAM application suite.

Solution Components

Access Points and Beacons

A Bluetooth Low Energy (BLE) Access Point has a Bluetooth antenna array that listens for transmitted signals from BLE tags. The access point transmits data collected from the beacon tags to the Mist Systems (Mist) cloud based servers. Machine learning services in Mist's cloud process the collected data and generate triangulated locations for each beacon tag. Mist also provides the ability to automate site surveys and generate floor plan maps. The access points have ranges comparable to Wi-Fi ranges, and the network and electrical connections will use existing installation wiring connection points.

Bluetooth beacon tags provide medical equipment asset identification and their real-time whereabouts. Each tag has wireless transmitters that sends BLE radio signals at regular intervals received by the BLE access point antennas. Tags are fixed to the hospital's mobile medical equipment that will be tracked.

Mapping Solution

The mapping solution is used to create a virtual layout of the hospital. It provides medical and administrative staff with a visual layout of the hospital floor plan and pinpoints the location of each beacon and tagged device.

Data transmitted by the tags are received by the access points which then feed the data to Mist's cloud servers. This data is available via REST API to the SAM client applications which will then pinpoint the tag locations on a hospital floor map.

Analytics Solution

SAM application includes analytical insights of assets in order to help hospital administrators make data-driven decisions about the procurement of new assets. Data on device usage, location of device over time, and device search will be collected from the Bluetooth LE beacon tags via HTTPS. This data is stored on the MIST cloud database which feeds Mist's analytics platform in order to generate graphs for data exploration. Analytics dashboards are presented in SAM with the following four metrics: utilization, inventory status, alerts, and equipment location over time. Each dashboard has configurable filter and sort parameters for further refinement.

User Interface

The primary user interface (UI) for SAM is the mobile application for clinical staff, due to the mobile nature of their work processes, whereas the web application is used secondarily. However, the administrative and IT staff use the web application as the primary interface.

The UI has large tiles and large font links, to accommodate various dexterity needs of clinical staff, especially when wearing gloves or multitasking. UI functionality is modeled from well-known industry apps (i.e. Google maps) and modern web features (i.e. Bootstrap and AngularJS) in order to leverage user familiarity from popular mobile and web applications. In addition, to ensure a consistent experience across the mobile and web applications, the same look and feel, color scheme, and layout is used, and the SAM application is built based on a responsive design approach. Refer to the Solution Demonstration section below for user interface examples and details.
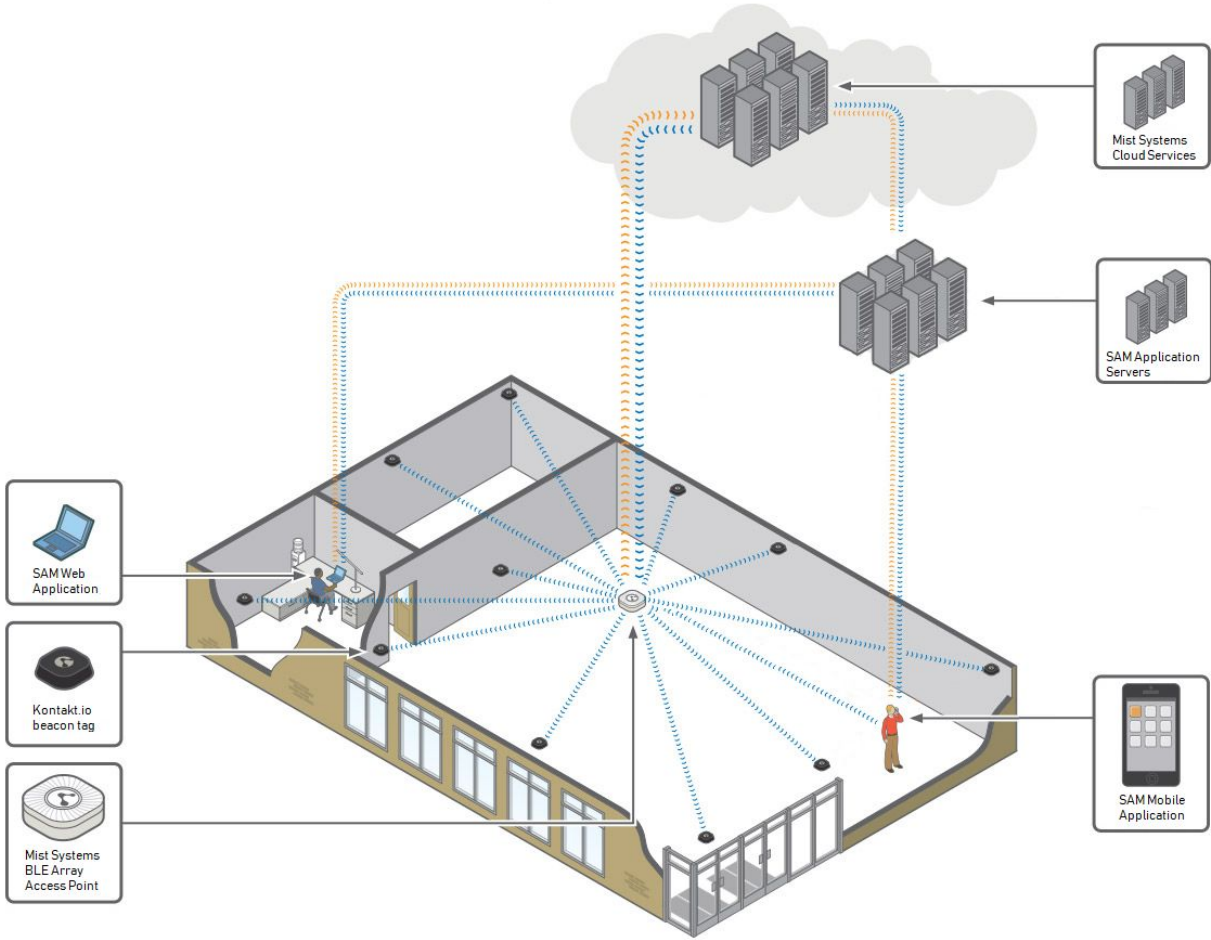
System Architecture

SAM will be deployed into HEH's existing IT intranet infrastructure. Users access the SAM application via SSO from the hospital portal. Authentication and authorization will be handled by integrating SAM with HEH LDAP. The on-premise SAM application integrates with existing HEH

IT security, logging and monitoring services. SAM-specific data will be stored in a database provisioned alongside other hospital non-clinical databases. HEH IT Integration information is discussed in the Integration section below.
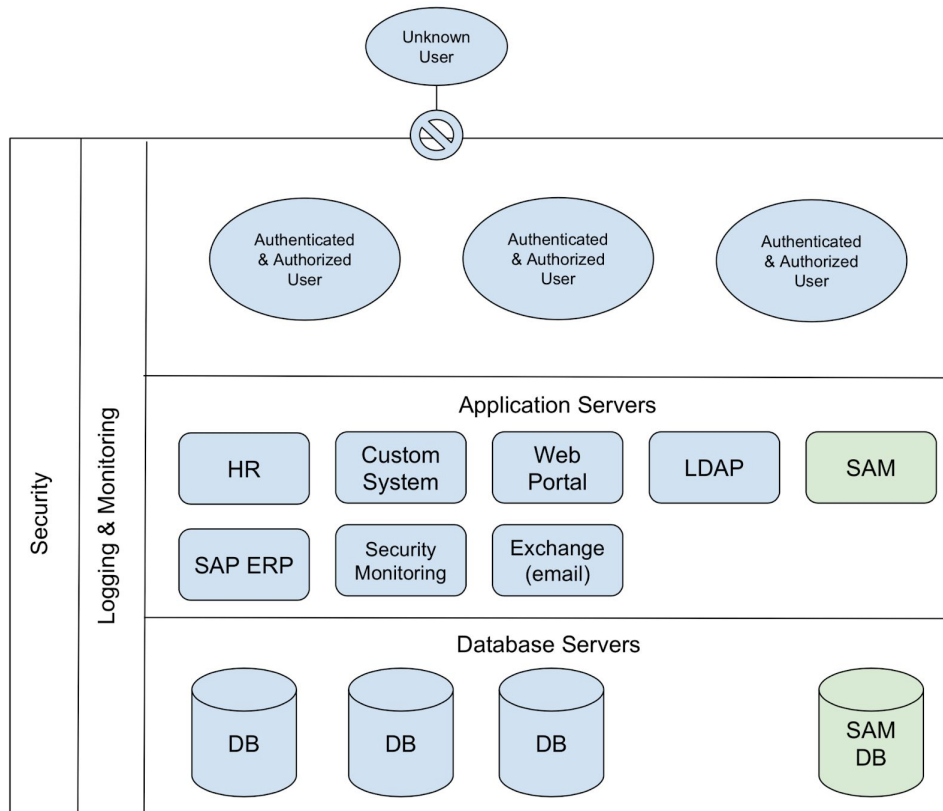
Deployment Architecture

The diagram below is a visual depiction of deployment of a BLE access point, beacons and staff interacting through the SAM web and mobile applications. In this example, for every 3,000 square foot office space, only a single BLE access point is required to be installed.

Mist Systems (n.d.).

Component Connector Architecture

Mist BLE access points will be deployed throughout the hospital, and portable medical equipment will be tagged with Kontakt.io beacons. Beacon tags transmit over BLE to the BLE access points, communicating usage data and equipment location. Mist cloud services receive, process, and store beacon tag data from the access point. The SAM application in the HEH data center connects to Mist cloud via HTTPS. Within HEH's data center, SAM integrates with SAP, Exchange Server, and LDAP providers. The SAM application is exposed to internal hospital staff via the hospital portal and is secured with SSO.
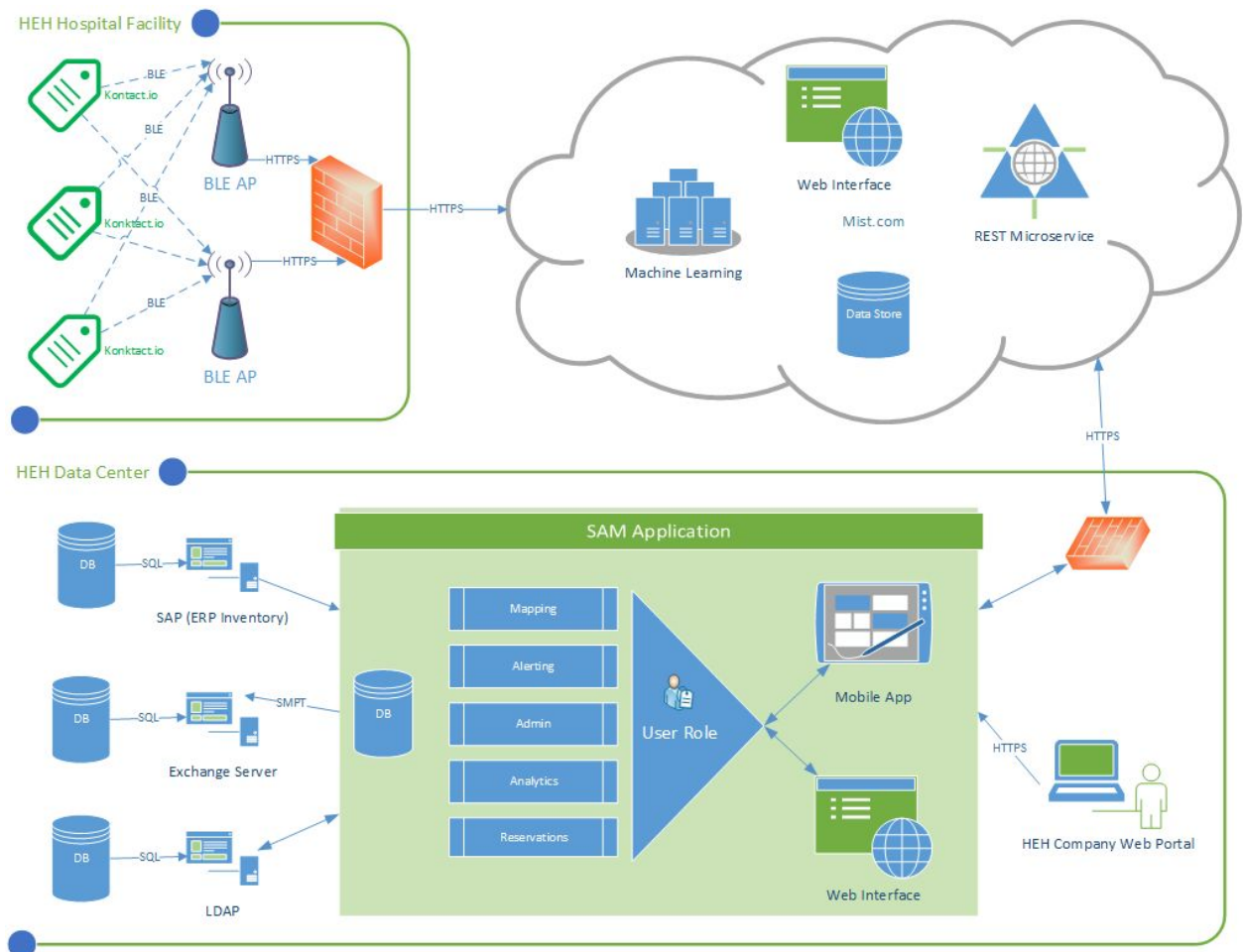
Software Solution

Vendor Selection

The vendor procurement process is based on strict value and functional criteria using a weighted rating system, based on a Pugh matrix. Vendors for each component of the SAM ecosystem were carefully chosen to ensure that the best fit for each component is selected. A large number of possible vendors was narrowed down to four industry leaders based on product availability, industry reputation, scalability, and support level agreements. Refer to Exhibit 5 in the Appendix for supporting vendor selection matrices.

The results from the evaluation determined that Kontakt.io's beacon tags best fit HEH's needs. The service and support benefits that this vendor offers meets HEH's service level requirements. In addition, their beacon tags have short product delivery lead times, offer widespread interoperability with other beacon technology, and have proven durability in healthcare settings.

The team also reviewed individual vendors for access points, mapping, and analytics, however Mist's integrated approach, to meet and support HEH's needs as a single product offering, earned the highest evaluation score. The radio range of the access points provided by Mist has longer distances compared with competitors. Mist's approach requires fewer devices (a single access point replaces the need for a hundred and fifty beacon receivers that other vendors require) and eliminates the need to replace batteries in stationary receivers. Triangulation data from access points are processed by machine learning algorithms in Mist's cloud service eliminating the need for site surveys and adjustments based on beacon signal strength differences and interference. Lastly, Mist provides a REST API and an SDK for integration with the SAM application. The Mist platform provides the most mature and visionary solution for the initial phase of this project and future phases.
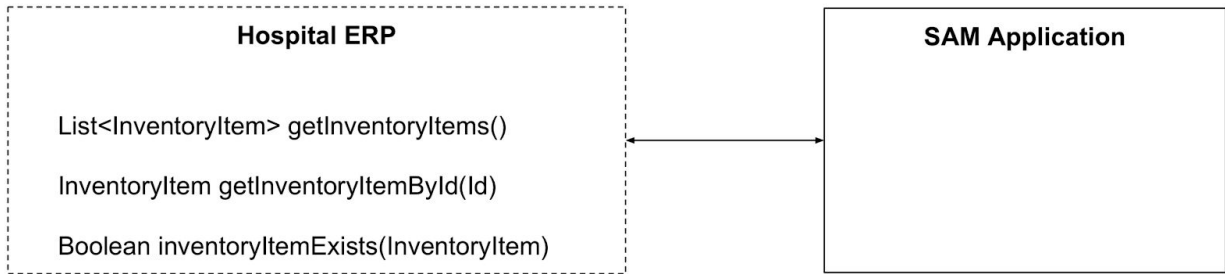
Integration

LDAP Integration
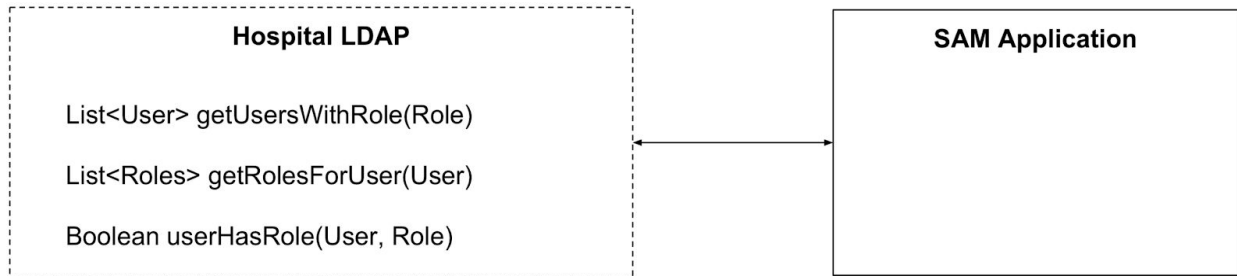
SAM application will integrate with Harvard Extension Hospital (HEH) LDAP for authentication and authorization. SAM will use LDAP to determine who has access to what resource within the system. This integration will be a custom software connector between the SAM application and exposed LDAP APIs.

ERP Integration

SAM application will integrate with the hospital's existing ERP solution provided by SAP. SAM will also integrate with SAPs asset management APIs to apply specific tags to specific devices.

Existing Hospital & User Device Integration

The SAM clinical staff and hospital administrator user interfaces integrate with existing hospital and user mobile devices. The primary application delivery platform will be the web browser.

Users access the SAM system via the HEH web portal and are authenticated using Single Sign-On (SSO).

Role Based Access Control (RBAC)

Permission	Role		
	sam_clinical_user_role	sam_hospital_administrator_role	sam_it_administrator_role
List as device locations	X	X	X
Find device by type	X	X	X
Create, View device usage reports		X	X
Create, edit, delete device perimeter boundaries		X	X
Add, edit, delete device from network			X

Design and Data Management

Data is generated by the beacon tags and collected by the Mist access point. This data is then transferred to the Mist servers where it is processed by their machine learning algorithms. The data on the Mist servers is consumed by the SAM application by way of the REST API services provided by Mist. Inventory data flows into SAM from the HEH ERP system. User data comes into SAM from the LDAP server. SAM alerts are sent via the email Exchange server.

Solution Demonstration

Currently, the HEH Intranet is the communication hub for all staff in the hospital and is a launch point for many enterprise applications within the hospital, including the SAM web application, which is a shepherd dog icon on the intranet home page (see Appendix, Exhibit 6). By clicking on the SAM icon, users will automatically login to the SAM web application via single sign-on.

After logging into the SAM application, users will land on the main SAM application home page. Depending on user roles and permissions, the main application page will dynamically change

and the available activity tiles will be security trimmed. For example, the main page for the clinical staff role will only allow users to access the Assets Near Me, Map Assets, and My Reservations web tiles. In addition, the hospital administration role will be able to see Analytics and Management Reports, while the IT Administration role will see the entire tile suite.
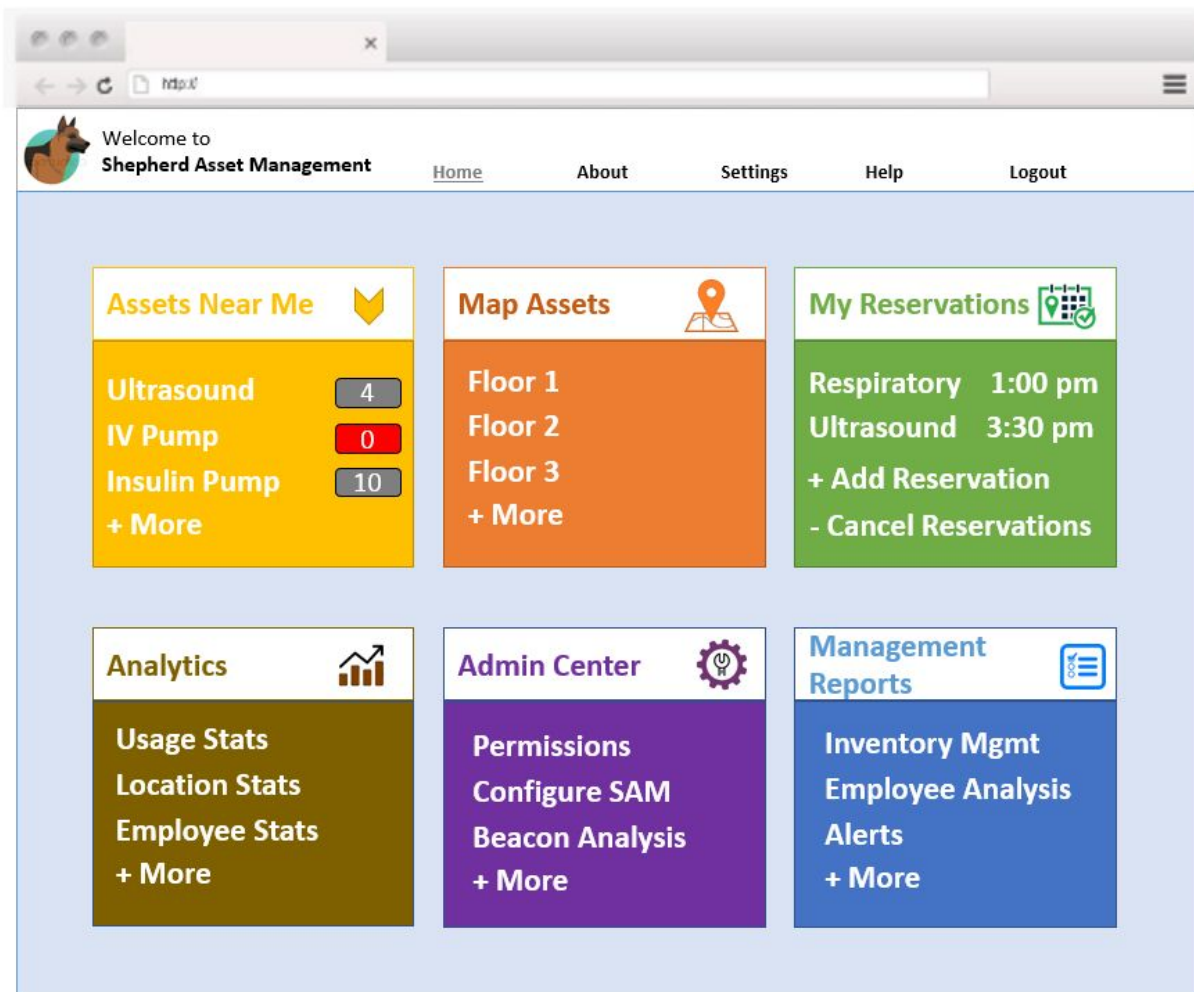
To locate equipment via a visual map, clinical users will click on Floor 1 under Map Assets. A floorplan map will be presented with asset locations marked as red square icons. Users can tap an asset icon and an overlay will popup with detailed information.
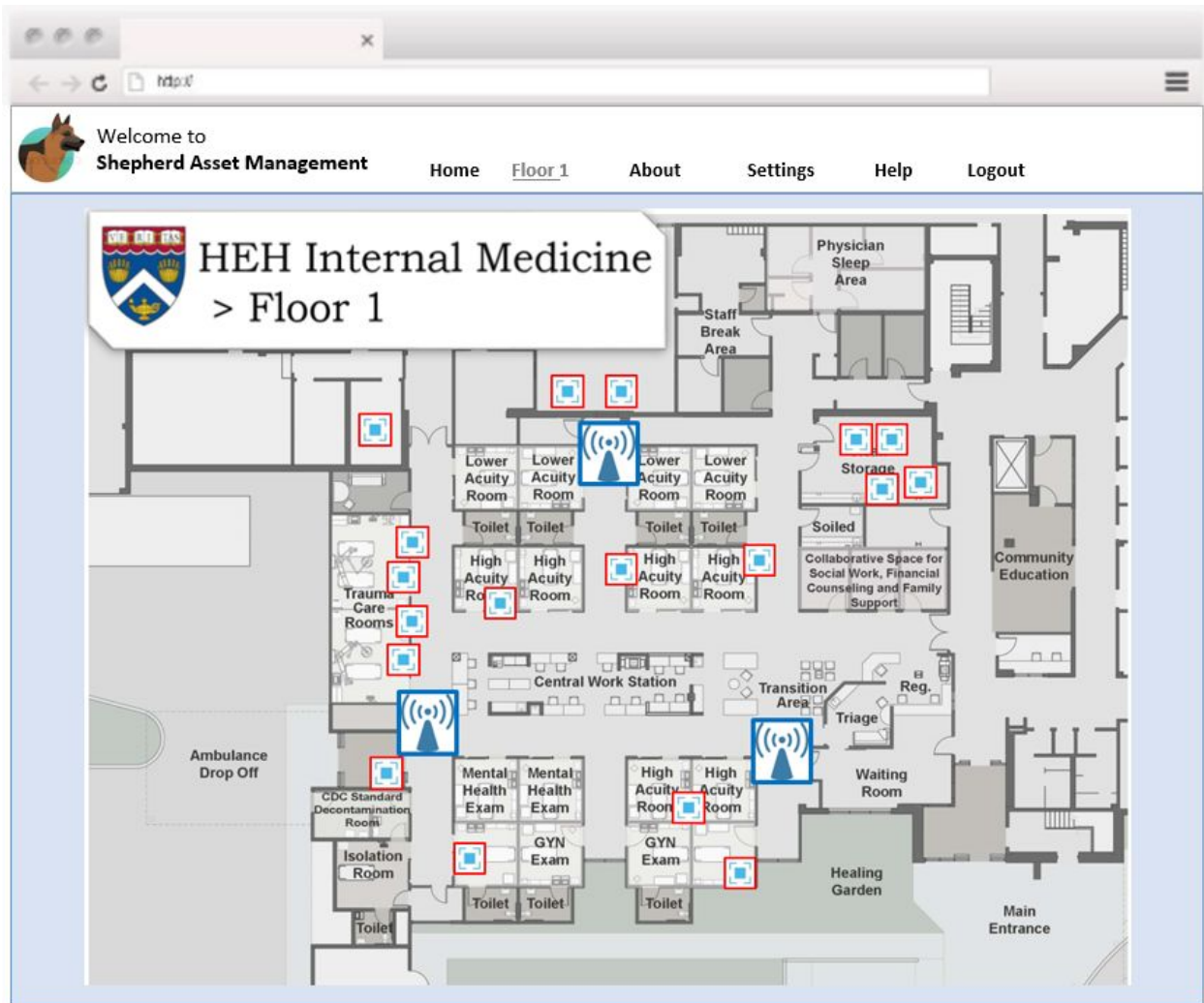
Clinical staff will search for nearby medical equipment by clicking on an specific asset type under Assets Near Me. For instance, if a user clicks on Ultrasound, a list of ultrasound equipment will appear, including model number, physical location, reservation times, and links to user guides. Users also have the capability to reserve one or more assets at a time by checking the boxes and clicking on the Reserve link.

The SAM application functionality is also extended to a mobile app, where clinical staff can see a list of equipment or mapped equipment near them. In the list version, colored indicator lights show which equipment is currently in use (red light), which is available (green light), and which one has an upcoming reservation within the next 30 min (yellow light). Users can then tap assets to get more details, and they can zoom in/out on the floor maps.
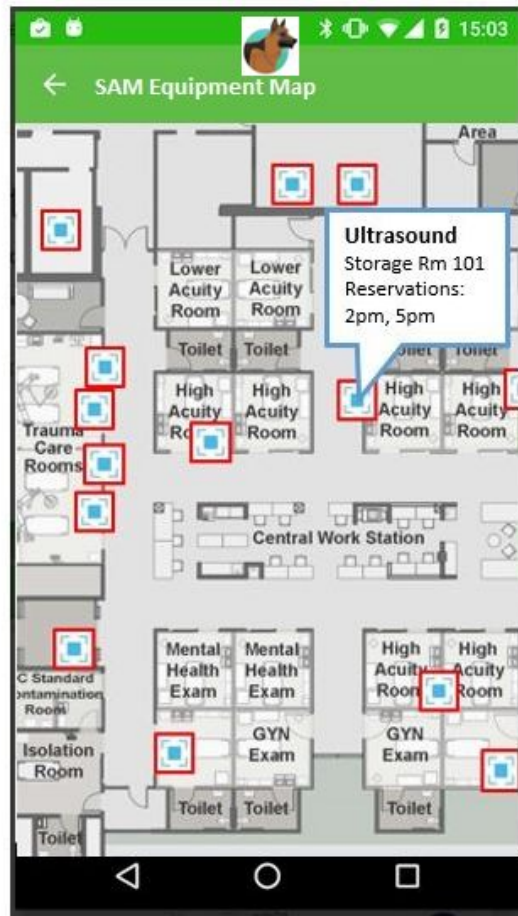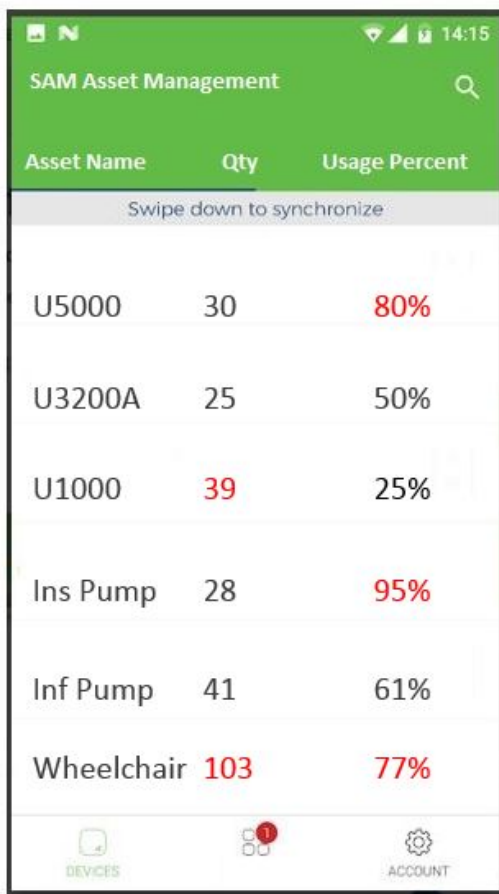
Hospital administration staff use the links under Management Reports. Inventory Mgmt link goes to a list layout of medical equipment inventory. The equipment model, current stock quantity, last month's stock quantity, current location links, yearly loss rate percentage, peak usage summary, top usage by floor location are listed. If the stock quantity has dropped, colored number indicators are used to draw attention to the administrator. In addition, links to current location, peak usage and top floor usage goes to additional maps and drill-down dashboard reports.

HEH administration staff is able to view equipment inventory statistics from the mobile app, as well as tap any asset to view details. In addition, when a piece of medical equipment has been placed in the wrong location or is about to leave the premises, mobile notifications will appear on the smartphone, with a link to the floor map of which location/exit point the equipment is entering. Additional alerts are configurable, such as email and SMS alerts.
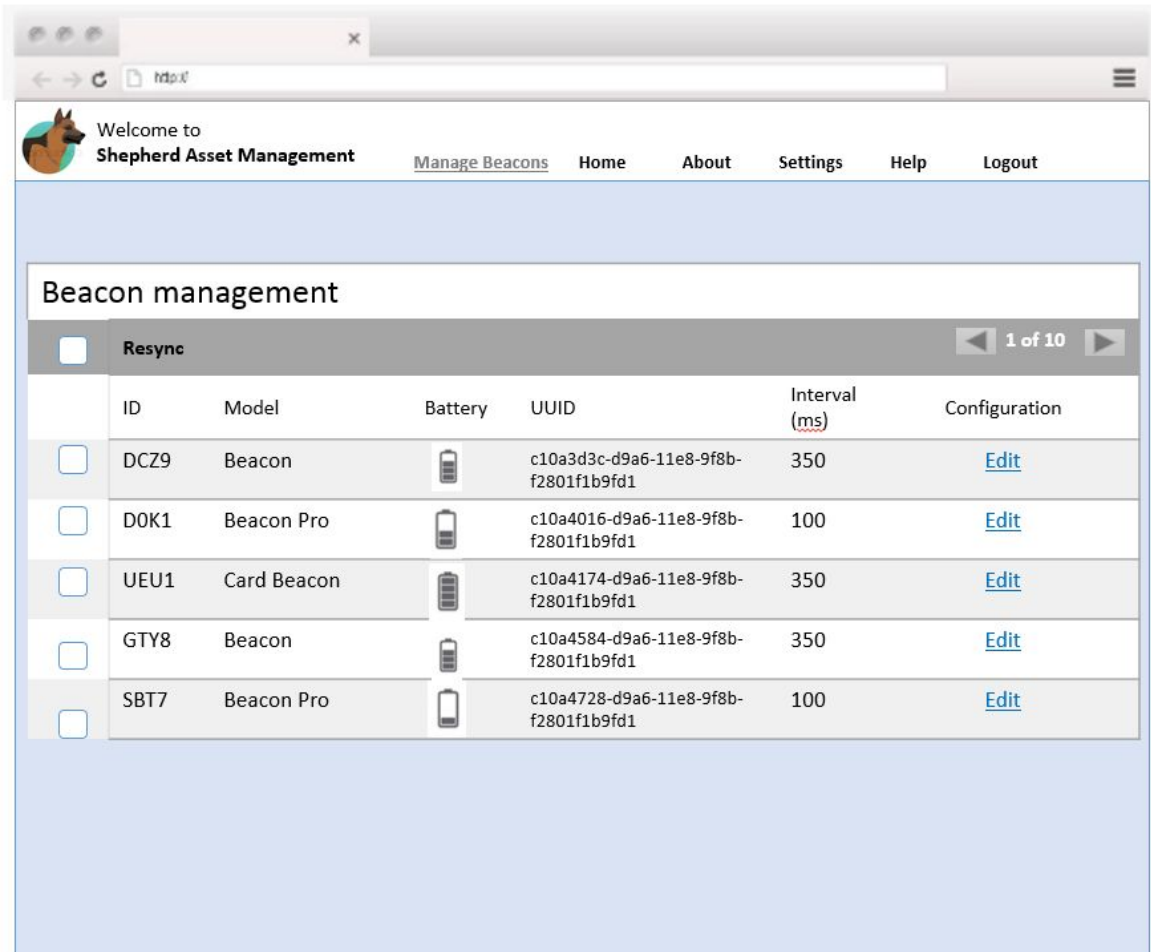
For HEH IT staff, there are beacon management reports that capture all of the beacon models, the battery levels, UUIDs, signal intervals, and configuration links, with more details for each beacon. This report supports IT in managing the physical beacon fleet.

HEH IT staff also has access to physical beacon information via the mobile app, where the physical beacons in the fleet are listed and configuration details are shown, when tapping on a particular beacon.
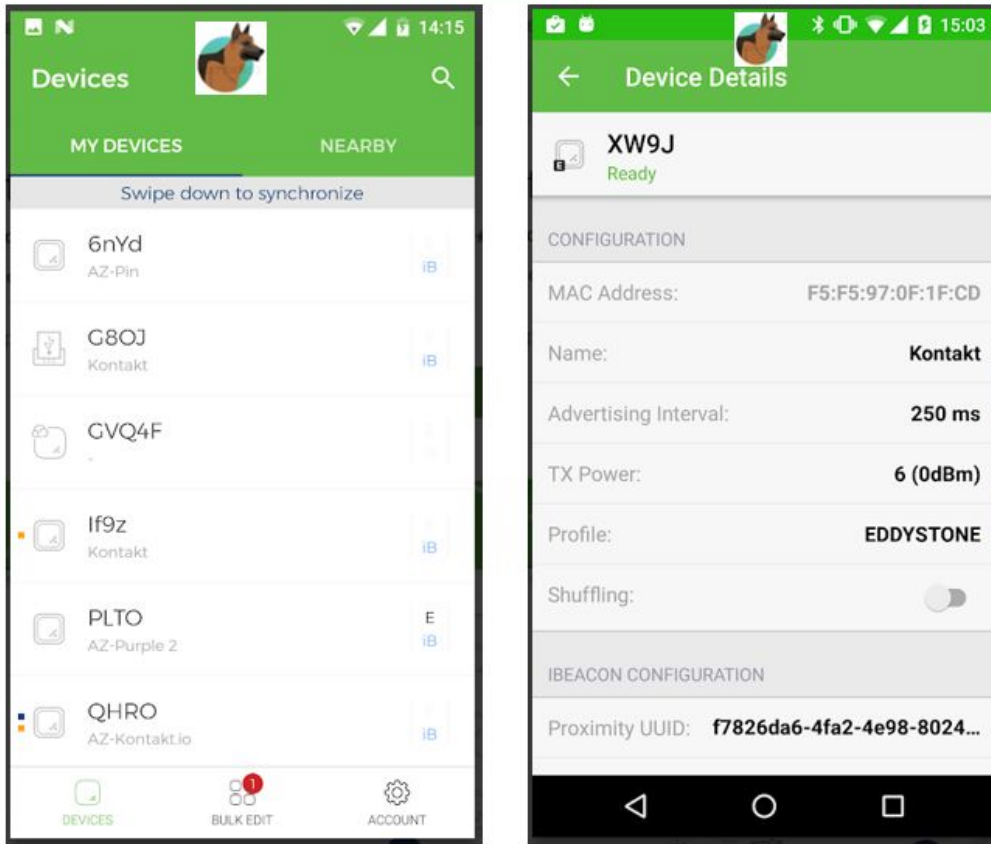
Implementation Plan

Solution Delivery Roadmap

The Shepherd Asset Management system is a turnkey solution that requires minimal setup and implementation for the customer. The product's implementation can be broken up into three functional milestones and a final launch milestone to gather learnings about what went well and what did not.

The Phase 1 pilot at HEH will be conducted within the internal medicine department and limited to portable EKG machines, infusion pumps, and ultrasound machines which is defined in Business Requirements. The pilot will be physically limited to the confines of the internal medicine department which is on the first floor of the hospital and access points will be installed on the ceilings to ensure complete coverage of the floor plan, but limit the overlap in coverage among access points. This will ensure there are no dead zones for beacon reception, but it will also ensure the most accurate triangulation due to limited overlap in access point coverage. The equipment that will be tagged for the pilot will be limited to the internal medicine department for the duration of the pilot program - no equipment will be shared outside the internal medicine department. This will ensure the pilot simulates a full scale deployment of beacon tracking within the hospital.

Equipment to be Beacon Tagged in Phase 1 Table

Equipment	Quantity
EKG machine	15
Infusion pump	12
Portable Ultrasound machine	10

Milestone Responsibilities

Prior to starting any implementation changes or user access, the project kickoff will start by defining who will be part of the pilot, the hardware necessary for the internal medicine department, and the resource dependencies at HEH.

The implementation of the pilot program at HEH will be completed in four milestones, each dependent upon the completion of its predecessor. The milestones will be split based on the logical order of implementation to ensure the system is ready and tested prior to user training and the user acceptance testing. The user acceptance testing will also be a predecessor to the full go live of the pilot. Each milestone, defined in the table below, will have clearly defined deliverables that the responsibility owner must get signed-off by the project manager prior to proceeding to the next milestone to ensure the best success for rolling out the pilot to users at HEH.

Milestone Responsibilities Table

Milestone	Deliverable	Responsibility
1 Pre-implementation	Project scheduling - Project team members appointed at HEH (Planning) - Project kickoff planning with timeline and resources requirements (Planning) - Schedule pilot team training (Planning) - Hardware installation coordination with HEH operations and facilities departments - Collect pre-pilot 3 month baselines for success metrics (Baseline SM will extend to milestone 1 and 2)	HEH and SAM
2 Implementation: Hardware	- Access point installation - Beacon/tag attachment & assignments - Configure and sync beacon tags	SAM
3 Implementation: Software	- ERP integration - LDAP integration - Wireless/network provisioning and setup - Install on-premise SAM components - Desktop, laptop, and tablet device software installation	HEH and SAM
4 UAT and Go-live!	- User acceptance testing - UAT review and adjustments - Go-live support for staff - Pilot success metrics review - Planning for post-pilot Phase 2 rollout	HEH and SAM

Schedule of Deliverables

The schedule of deliverables by milestone chart, shown below, shows the breakdown of major deliverables by month, indicating the maximum time available (gray) versus the estimated duration (light blue). This allows room for delays or issues that might occur, while still being on schedule overall. The total time allotted for the implementation of Phase 1 is nine months but success metrics will require collecting data for 3 months after go live.

Schedule of Deliverables Chart

	Milestone 1: Planning		Milestone 2: Implement Hardware		Milestone 3: Implement Software			Milestone 4: UAT and Go-Live!	
	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9
Planning									
Installation planning									
Baseline SM									
Install access pnts									
Install tags									
SAM app install									
HEH Integrations									
Client app install									
Training									
UAT									
Go Live!									
Retro review									

Project Risks

To reduce risk, the SAM Phase 1 rollout is a pilot implementation limited to a single department, on a single hospital floor, with a limited number of portable equipment devices. The table below highlights the project risks, the level of impact (if the risk did occur), likelihood of occurrence, and the mitigation plans in place.

Project Risks Table

Risk	Impact	Likelihood	Mitigation Plan
Hardware installation approvals delayed/not provided	High	Low	Hardware installation plans require minimal approvals.
Beacon theft/damage/loss	High	Low	Tags have an attachment sensor that is capable of detecting removal/ tampering. SAM application provides beacon monitoring and notifications for beacon presence.
Non-functional beacons/tags	High	Low	A 10% overage of tags is ordered to mitigate this risk and also provide HEH with replacement devices as needed after launch. Battery alerts setup to ensure beacon tag power source is not ever drained.
User adoption and process change resistance	Medium	Low	The Gloco consulting team has a well-established training methodology for SAM ecosystem rollouts built from best-practice training and feedback. HEH super users and user success stories will champion/encourage SAM adoption.
Integration incompatibility	Medium	Low	SAM provides standardized interfaces to the SAP ERP and Microsoft LDAP providers. HEH IT has escalation paths with SAP and Microsoft, if needed.
Poor network performance	Medium	Low	Gloco and HEH IT to run simulated network load and performance testing prior to go-live
Tags not tracking equipment in real-time	Medium	Low	HEH IT to setup event monitoring and alerts of beacon identification status, as well as develop a process to escalate Kontakt.io or Mist systems support
Access point floor plan coverage	High	Medium	HEH IT to install additional access point or modify the access point signal configurations options based on Mist recommendations
Pilot equipment is required to leave internal medicine	Medium	Low	In the event a piece of equipment must leave internal medicine, i.e. attached to a patient that is rushed to another department, it will be tracked via the legacy system until returned to internal medicine. The equipment should be swapped out for a non-internal medicine unit ASAP and return to internal medicine. When the theft alert triggers as the equipment leaves the perimeter of internal medicine, the SAM hospital administrator will need to document a temporary loan of the equipment in the SAM application.

Stakeholders and Responsibilities

The anticipated stakeholders and project deployment groups are listed in the table below. Each stakeholder group is responsible for specific deliverables. This should only serve as a starting point for full project management planning.

Stakeholders and Responsibilities Table

Stakeholder	Owner	Responsibilities	Man Hours (FTE days)
Project Lead	Gloco	Project management	90
Network Admin	HEH	Access point deployment and configuration	30
Application Engineer	Gloco	Application installation and configuration.	90
Service Catalog Administrator	HEH	Service catalog changes	15
System Administrator	HEH	Server setup and configuration	30
QA	Gloco	Test management Performance testing	45
Trainer	Gloco	Training and educational material Delivering training	20
Clinical SME	HEH	UAT testing	15
Business SME	HEH	UAT testing	15
IT End User Services	HEH	UAT testing Beacon tag hardware configuration and support	30
HEH Business Governance Team	HEH	Project oversight and approvals	30
DBA	HEH	Database configuration and set up	15
SAP engineer	HEH	SAP configuration and interface testing.	15
LDAP engineer	HEH	LDAP authentication support and testing.	10

Operationalization

Governance

Governance of the application will be headed by an HEH business governance team. This group will be responsible for approval of SAM ecosystem change requests and approving user access requests. The business governance team will be responsible for developing and maintaining any business level workflow processes associated with the ecosystem.

IT support will be coordinated by a newly created HEH SAM application support team. The application support team will report up to the HEH IT application support director. The IT application support director will be held accountable for SAM operations by the HEH business governance team.

Service Design

Support of the SAM ecosystem will fit within the current HEH IT service portfolio and will be moved from the service pipeline to the service catalog at go-live.

Service Catalog

The HEH service catalog will be updated to include the SAM ecosystem components. Configuration items will be added to the CMDB which include Mist access points, Kontakt.io beacon tag hardware and the SAM web and mobile applications. These items will be linked to an application support group will be created to service all incoming IT work related to the SAM ecosystem. The SAM application team will be responsible for coordinating any involvement with the third party vendors, Mist Systems and Kontakt.io. Any activity that requires configuration updates on the Mist Systems platform will be handled by the SAM application support team.

Service Level Agreements

The SAM mobile and web application will follow the uptime requirements set forth by HEH that apply to other similar applications. Planned outages will be restricted to change windows

approved by the business owners and be restricted to the the smallest required window. Communications will be sent out prior to changes to give users advance warning of any potential planned down time. Incident resolution will follow standardized HEH SLA agreements.

SLA Table

Description	SLA
SAM application page load	Time < 1.25 sec
SAM ecosystem failure	Mean time to repair (MTTR) < 4 hrs
SAM application feature failure	Mean time to repair (MTTR) < 24 hrs
Quality of data delivery	Real-time data accuracy <= 15 sec delay

Knowledge Base

ServiceNow will host applicable knowledge base articles that will be jointly contributed by HEH IT support teams and the SAM business owner group. The knowledge base will be available to both end users and IT support staff to encourage self-resolution of issues.

Change Management

HEH business governance team will be responsible to approve any changes prior to any work. Change management for the SAM ecosystem will be facilitated by the SAM application support team. Incoming change requests for the SAM applications will be logged in ServiceNow by the SAM application support team and be escorted through the normal change review process. Changes will follow standardized HEH processes and require risk assessment, deployment and rollback plans prior to approval for release.

Release Management

Releases will be communicated to all applicable stakeholders prior to release. Releases will be restricted to an approved change window that will be be limited to the least downtime as necessary. Releases are required to follow the standard change management ticket and approval processes prior to release. Releases will be planned on a quarterly basis, however emergency fix routines are available provided that escalated approvals have been added.

Request Management

Configuration changes that do not require prior approval will be handled as requests. This will include user access requests, deploying additional beacon tags or changing beacon tags. The SAM application support team will be responsible for completing any necessary coordination with other teams to achieve resolution. User access requests must originate from a user's manager or supervisor and approved by a SAM business governance team member.

Incident Management

Incidents will be reported to the HEH helpdesk and logged in ServiceNow. Tier 1 incident, i.e. user access issues and minor issues, will be handled by the HEH helpdesk. The HEH helpdesk is staffed by a combination of onshore and nearshore call center to ensure 24-hour coverage. Incidents beyond Tier 1 that cannot be solved with this first contact will be escalated to the HEH SAM application support team who will be responsible for resolution and potential coordination with HEH IT and/or third-party vendor support teams. The HEH SAM application support team is a local support group that will be able to solve hardware and software issues within agreed SLAs. Additionally the desktop field services group who are responsible for hospital desktop hardware resolution will also be trained to replace batteries and troubleshoot beacon tag hardware.

Infrastructure Operations

Monitoring

The SAM application website will be monitored with the HEH standard end user business process monitor tooling, simulating typical end-user behavior and reporting response times. The end user performance of the application will be logged and tracked over time. Monitors will be applied to the servers and services for the SAM web application and database servers.

Event Management

Exceptions to the SLA for page response times, as well as servers and service outages, will automatically trigger an incident in ServiceNow.

Availability and Performance Reporting

Reporting on uptime availability will be created by using the logs of the business process monitors and server monitors. Weekly, monthly and yearly reports will be available to IT and business governance users.

User Enablement

User Rollout Plan

The user rollout plan includes defining new daily work process flows, user acceptance test sessions, communication plans, knowledge transfer and training sessions, and user access roles and responsibilities. Detail for each deliverable are defined in the sections below. The following table lists the months during which the deliverable will be rolled out.

User Rollout Table

Rollout Deliverable	Timeline (Month During Phase 1 Project)
Communication	1 - 9
User Access	7 - 8
User Acceptance	8 - 9
Knowledge Transfer/Training	8 - 9
Daily Work Process Change	9

User Acceptance

Three to eight weeks prior to roll out, three groups of users will be invited to user acceptance testing (UAT) sessions. Business analysts on the SAM project team will develop scenario specific test scripts that users will follow during UAT.

- UAT Session 1: Clinical staff, 3 testers - Test the SAM desktop and mobile app to meet the criteria for medical device mapping, medical device reservations, and medical device searches.
- UAT Session 2: Business administration staff, 3 testers - Testing focused on real-time medical asset inventory management, medical asset alerts, and medical asset usage and analytics dashboards
- UAT Session 3: IT Staff, 2 testers - Test Kontakt.io beacon tag management, Mist Wireless Access Point management, and SAM administration panel.

Communication

The overall objectives of the communication plan is to create an awareness of SAM, to relay to stakeholders changes and benefits, and to create sense of urgency for a new and/or changed work process. The communication plan will include the following:
- Awareness about why the new SAM ecosystem is necessary to implement and how it will benefit staff and management
- Information about how the ecosystem will function and any new procedures
- Information about the pilot project rollout timeline
- Transparency to stakeholders, keeping them in the loop throughout the rollout process, with links to provide their input and feedback

The HEH project team members will draft department-wide communication messages, but the HEH project manager will own the final communication sign-off. Business administration staff is responsible for bi-weekly communication of the project impact to clinical team members during staff meetings. Refer to Exhibit 7 in the Appendix for the Phase 1 communication chart.

Knowledge Transfer and End-User Training Plan

The guiding principles for knowledge transfer and training include:
- Transfer knowledge from Gloco to HEH IT operations to be able to independently manage the SAM ecosystem.
- Provide a hands-on training environment to build confidence and experience.
- Measure training results via quizzes to gauge understanding and adoption.

- Develop a group of super users who learn SAM in-depth who are resources for answering questions and sharing knowledge to other users.

Gloco will provide their training materials for hands-on instructor-led training (ILT) sessions, based on a staff member's primary job role, and will be available across three HEH work shifts. Upon ILT completion, users will have access to self-help user guides in the knowledge base and web-based training (WBT). WBT is available year-round as a refresher course, for new hires, and as delta training for major SAM application updates (see Appendix, Exhibit 8).

User Access

Users interact with the SAM ecosystem via either the SAM web application or the SAM mobile application. To access the web application, users log on to the HEH intranet portal and click the SAM icon. The icon will only be available for those users who have been provisioned by the HEH IT team to participate in this pilot study. Refer to Exhibit 6 in the Appendix to view the HEH intranet portal and SAM icon.

The SAM mobile application is preconfigured per implementation customer to connect to their intranet and authenticate via their identity provider (IDP). To access the mobile application, users must first download it from the HEH intranet mobile app store. After installation, users will be able to log in to the application via their IDP user credentials.

Since the SAM application suite leverages the HEH IDP, IT administrators are able to provision users, add users to defined groups, which are assigned roles. Roles are a defined set of system permissions within the SAM application suite. The details of the roles and permissions are listed in the User Roles Table (see Appendix, Exhibit 9).

Promoting SAM

To continually promote SAM and ensure end user adoption metrics remain high, user success stories and benefits will be promoted via the HEH intranet portal landing page, Corporate News section. In addition, gift cards will be presented to users who provide feedback to SAM, where that input gets added as a system feature, and to users conducting the most equipment

searches or equipment reservations. Low adoption users will be contacted by a super user who can help users overcome adoption hurdles.

Success Metrics

The success metrics from the Phase 1 pilot rollout will contribute to our overall estimated annual benefit to HEH, as shown in the table below.

Success Metrics Table

Success Metric	Current	Expected
Reduce time to locate medical equipment	30%	18%
Increase equipment utilization rate	45%	55%
Reduce incidences of equipment theft	20%	6%
On-time delivery of equipment to patient	65%	85%

Collecting and Reporting Results

Application usage statistics will be collected and measured via the analytics module in the SAM application. Business administrators and IT will be able to generate on-demand reports exportable as CSV, XLSX, or PDF file.

User perception and other statistics will be gathered via web based surveys sent via email to all SAM users. Surveys will be created by HEH business management and sent to clinical staff teams via survey link in email, using the HEH MySurveyLab application. Surveys will be sent one month after go-live for initial user experience feedback and then annually for continuous improvement feedback. When a survey ends, business administrators will be emailed results as an XLSX file.

Measuring Benefits

Benefits of implementing the SAM ecosystem will be measured by establishing baselines prior to the start of the pilot. A 3 month average will be collected to determine the baseline for each success metric and a 3 month average will be used to determine the pilot resulting metrics.

- Reduce time to locate medical equipment
    - Time wasted looking for medical devices improves by greater than 40%
- Increase equipment utilization rate
    - Equipment utilization improves by 55%
- Reduce incidences of equipment theft
    - Inventory loss improves by 70%
- On-time delivery of equipment to patient
    - Equipment is delivered to patients on-time at least 85% of the time

Additional Business Benefits Measured

There are additional business benefits that will be measured outside of the project success metrics that will be used to provide project momentum post-phase 1 pilot. These metrics will help "sell" adoption of the SAM ecosystem to additional departments throughout HEH.

- System adoption:
    - System adoption is greater than 90% first 2 weeks, 100% first 30 days
    - Clinical staff use SAM for device searches by 90% or greater
    - Clinical staff reserve medical devices for over 30% of device usage
- System operation parameters:
    - Business Process Monitor Tools: Test page load times meet load time SLAs
    - ServiceNow Reports: Ensure that the MTTR for ecosystem, application or bug SLAs are being met within the defined hours; hold teams and managers accountable for MTTR SLAs
    - Mist Systems Diagnostics and SAM Application Logs: Ensure that the SLA for quality of data delivery SLAs are met
- Project implementation metrics
    - SAM functionality meets user stories = 100%
    - Employee satisfaction score >= 80%
    - Accurate time estimates of project deliverables >= 85%
    - Project implementation cost variance <= 10%
    - Scope creep increase of work tasks <=10%

Post Go-Live Next Steps

The go-live rollout plan will be divided into phases in order to reduce risk and so that a limited staff size will have enough time to adopt the new system. After Phase 1 is complete and initial 30-day reporting and surveys have been conducted and analyzed for improvements, Phase 2 will go live 60 days later. Phase 2 rollout will include the same equipment type for Floor 1, EKG machines, infusion pumps and ultrasound machines, but will expand to HEH Floor 2. It will also test the SAM system-wide abilities for inter-floor asset tracking. Two months after the Phase 2 go-live, SAM will begin a Phase 3 go-live.

Phases 1-4 Timeline Table

Phase	Equipment	Floor	Users Impacted	Timeline
Phase 1	EKG machines, infusion pumps & ultrasound machines	Floor 1 (Internal Medicine)	100	Jan 2019
Phase 2	EKG machines, infusion pumps & ultrasound machines	Floor 2	125	Apr 2019
Phase 3	EKG machines, infusion pumps & ultrasound machines	Floors 3, 4, & 5	375	July 2019
Phase 4	All mobile medical devices >= $500	Floors 1-5	600	Oct 2019

Appendix

Exhibit 1

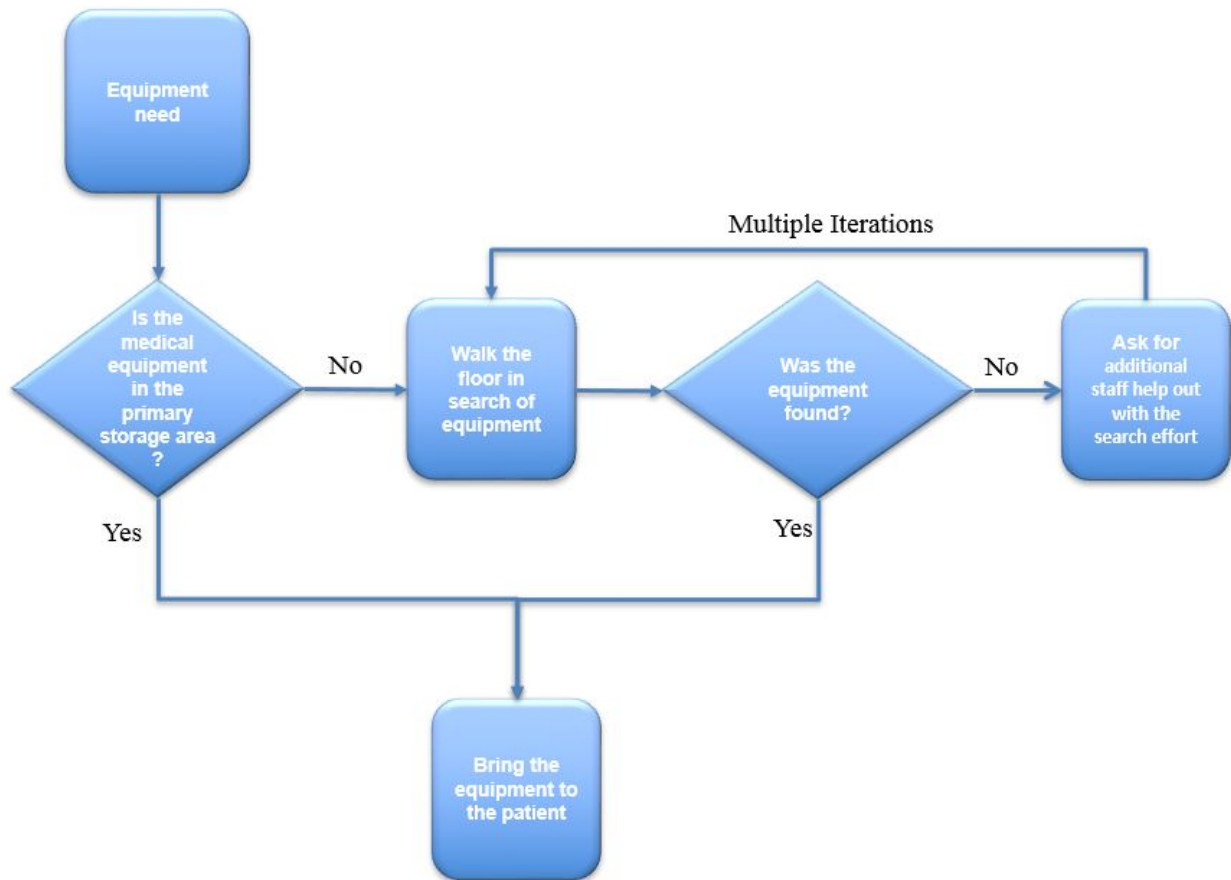*As-Is Daily Work Process for Clinical Staff*

Exhibit 2

As-Is Daily Work Process for Business Administration and Security Staff - Device cannot be located
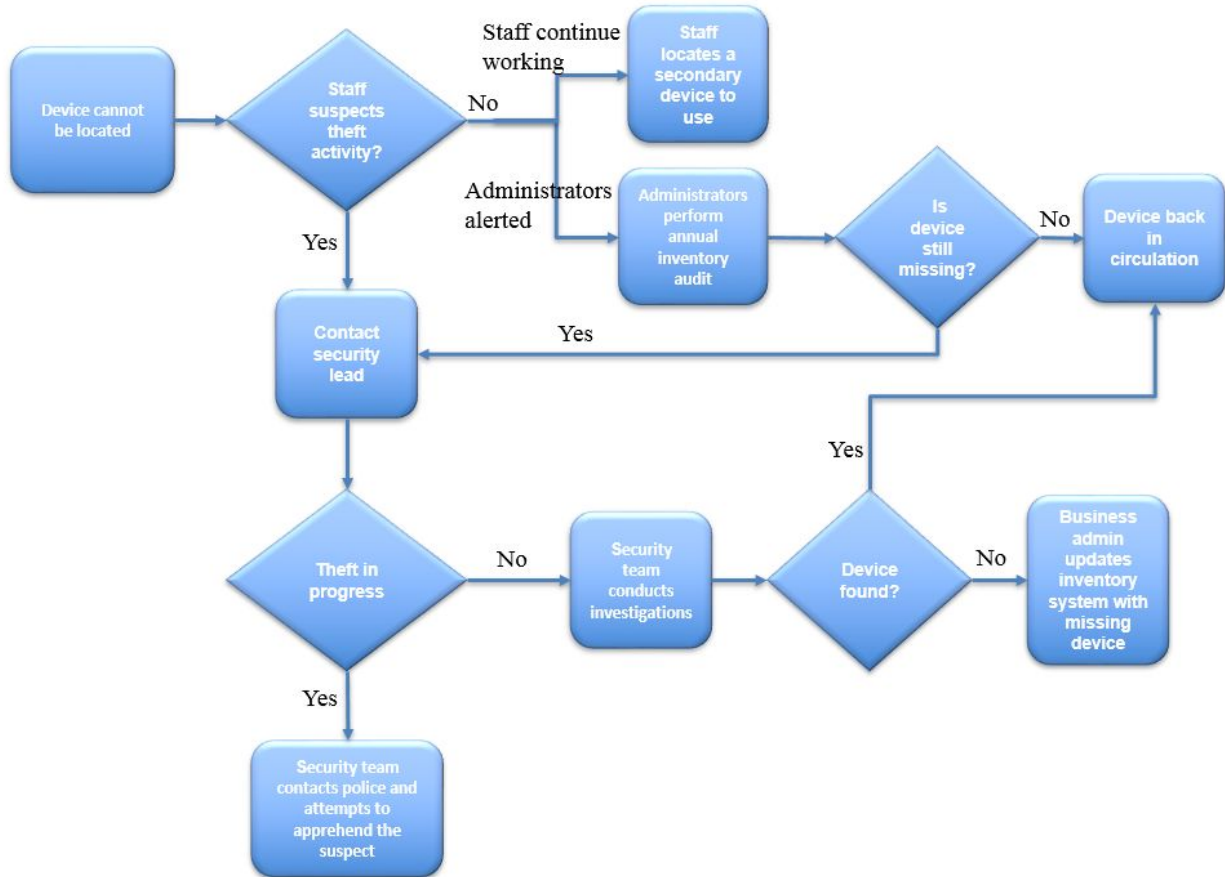
Exhibit 3
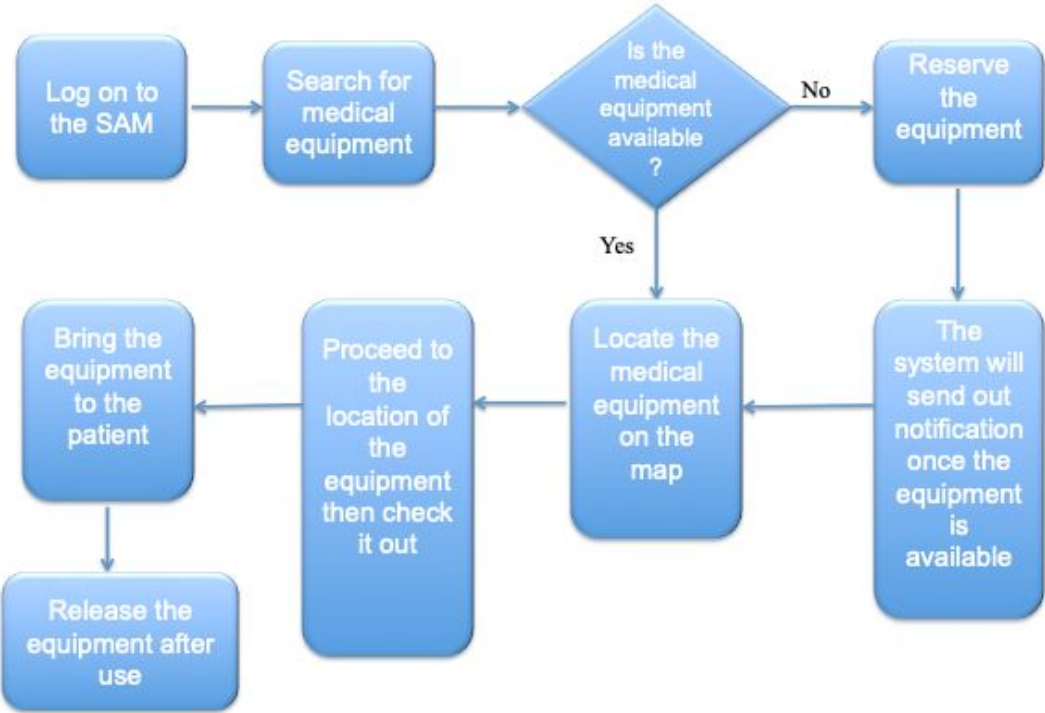
To-Be Daily Work Process for Clinical Staff

Exhibit 4

To-Be Daily Work Process for Business Administration and Security Staff - SAM Alert Generated
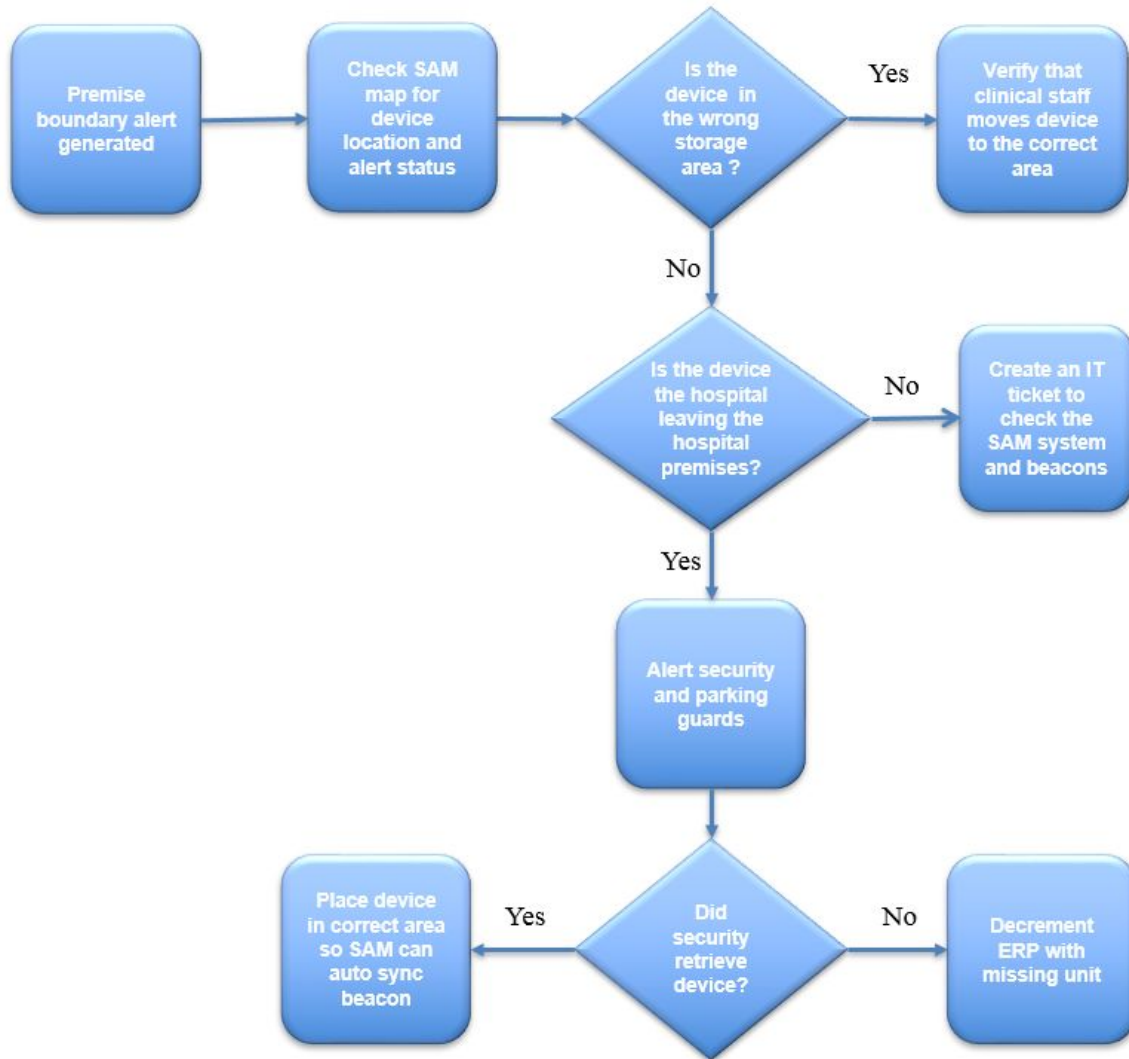
Exhibit 5

Vendor Selection Matrices

Vendor and device ratings are based on the following scale:

Score	Description
1	Does not meet needs/standards
2	Meets some needs
3	Meets 50% of needs
4	Meets most needs
5	Exceeds expectations

Gateway/Access Point

	Weight	Kontakt.io	AirFinder	Mist
Hardware	2	3	3	5
Ease of Installation	2	3	2	5
Initial Cost	1	4	3	5
Yearly Cost	2	3	3	3
Interface/Administration	3	4	3	5
Create Asset Groups	2	5	5	5
Support & Maintenance	1	4	2	5
Scalability	3	4	4	5
Integration with other vendors tags	3	2	3	5
Totals	95	66	61	91

Beacon/Tags

	Weight	Kontakt.io	AirFinder	Bluvision
Sterile coating or ruggedized	3	4	3	3
Tamper-evident	2	1	1	5
Battery life	2	5	4	3
Cost per tag	1	3	3	3
Ease to install	2	5	4	2
Support & Maintenance	3	5	3	4
Total	65	52	39	44

Location/Mapping Solution

	Weight	Kontakt.io	AirFinder	Mist
Location support (mapping)	2	4	4	4
API (open)	3	5	4	5
Reporting capability	1	4	5	5
Alerts	1	5	5	5
Easy to install	2	3	4	5
Setup Site Survey	2	2	2	5
Support & Maintenance	2	4	3	4
Scale	3	5	5	4
Cost	2	3	4	4
Total	90	71	71	81

Analytics Platform

	Weight	Kontakt.io	Custom Build	AirFinder	Mist
API (open)	3	5	3	4	5
Reporting Capability	2	4	1	5	5
Alerts	1	5	1	5	4
Ease of Installation	1	5	1	4	5
Support & Maintenance	2	4	1	3	5
Scale	1	5	1	5	5
Cost	2	3	1	4	4
Total	60	52	18	50	57

Exhibit 6

HEH Intranet Portal and SAM Login Icon

Exhibit 7

Communication Stakeholders Table

Stakeholder	Objective of Communication	Medium	Frequency
All HEH Staff	Create positive energy within HEH about a new technology to solve a current problem	*News story published on the HEH Intranet Portal	Monthly, up until the SAM rollout
Internal Medicine Clinical Staff	Build awareness about SAM and how it will benefit their work and their patients	*Email announcements *Staff meeting announcements	Bi-weekly
Business Administration Staff	Build awareness about SAM and benefits to HEH and their clinical team. Create management champions to support SAM roll-out.	*Face-to-Face meetings *Email announcements	Weekly
IT Administration	Relay key changes, impact, technical, and support requirements	*Face-to-face meetings *Email announcements *Published documents and guides	Weekly

Exhibit 8

SAM Training Table

Staff Role	Training Topic	Medium	Availability
Internal Medicine Clinical Staff	*SAM web app and mobile app end user training	*Instructor led training (ILT) *Web based training (WBT)	*ILT - 2 hours, sessions offered 3 times/day, 3 days/week, running for 3 weeks prior to rollout *WBT - 2 hours
Business Management Staff	*SAM web app and mobile app end user training *Analytics dashboard *Asset management unit	*Instructor led training (ILT) *Web based training (WBT)	*ILT - 8 hours, sessions offered 2 times/week, running for 3 weeks prior to rollout *WBT - 6 hours
IT Administration	*SAM web app & mobile app end user training *Analytics dashboard *Asset management unit *Hardware management unit *SAM configuration	*Instructor led training (ILT) *Web based training (WBT) *Knowledge bases access *Support accounts with Mist and Kontakt	*ILT - 3 days, 1 session offered, starting 4 weeks prior to roll out, required to attend *WBT - Access to Mist's and Kontakt's knowledge base portals and documentation

Exhibit 9

User Roles Table

User Groups (Clinical, Business, IT)	User Role	System Permission	Detailed Permission Privileges
C, B, I	sam_clinical_user_role	List devices	Lists devices and locations
C, B, I	sam_clinical_user_role	Find devices	Search and map device locations
C, B, I	sam_clinical_user_role	Reserve assets	Schedule and cancel asset time slot reservations
B, I	sam_hospital_administrator_role	Manage assets	Add or remove available assets; view asset inventory status; add content asset notifications
B, I	sam_hospital_administrator_role	Analytics viewer	View Analytic dashboards and reports for asset usage (Business) or SAM beacon and access points (IT)
I	sam_it_administrator_role	Create, edit, delete geo-fence	Plan and map the physical perimeter where each asset location is allowed or not allowed
I	sam_it_administrator_role	Add, edit, delete device from network	Add, edit, or remove devices from inventory to an associated beacon tag
I	sam_it_administrator_role	Beacon manager	Manage, track and scan beacon tags. Add or remove beacons.
I	sam_it_administrator_role	Access point Administrator	Configure Mist access points and cloud application
I	sam_it_administrator_role	SAM administrator	Configure the SAM application, including privileges and settings

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