Future Connectivity Real Time Location Services Report

Document management

Revision History

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Future Connectivity Guidance

The Future Connectivity Programme's Connectivity Hub produces, sources and shares expert technical knowledge to support the NHS to plan and implement the right connectivity for local needs.

To target and prioritise the right blend of system knowledge and expert independent advice, we engage with health and care organisations, directly and through surveys, to understand their connectivity challenges and procure and publish externally independent commissioned reports into priority topics.

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Real Time Location Services Report

This document is an independent report into Real time Location Services commissioned by the Future Connectivity programme and produced in collaboration with Qolcom Ltd.

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For clarity any recommendations made in this report are those of the report authors and do not represent any mandatory policy, or requirement from NHS England.

Contents

1. Impact/Benefit Summary

Across the Healthcare sector and specifically the NHS in England, there is a constant drive to make well informed investments in technology solutions, ensuring a return on those investments by considering re-use or re-application of existing solutions and by guaranteeing longevity.

Real Time Location Services (RTLS), if planned and delivered correctly can absolutely deliver on the above criteria and this report will deliver a level of understanding so that NHS organisations can make those informed decisions.

1.1 What is RTLS?

RTLS stands for Real Time Location Services and refers to any system that accurately determines or tracks an item or person's location.

Over time RTLS has become an umbrella term and had its definition expanded to include most IT location services technologies in use today. These technologies are necessarily wireless based, use the radio frequency spectrum and have traditionally leaned heavily on well-known wireless technologies, such as a Wi-Fi and Bluetooth.

The main criteria for defining RTLS solutions are:

- What are you trying to locate, where, and to what accuracy?
- What current infrastructure is in place to help provide an RTLS solution?
- Who will benefit from RTLS?
- Who will maintain and manage the RTLS solution?

1.2 Impact

Applying RTLS to a large hospital site or campus can have immediate and a largely positive impact for clinical and clerical staff as well as patients and visitors. Clinical staff can use RTLS to quickly locate important pieces of medical equipment such as IV Pumps, Heart Monitors and Wheelchairs. Clerical staff can look at the historical movement of beds and the workforce to design better, more efficient processes. Patients and visitors can use wayfinding applications to navigate around large hospital sites to attend appointments and locate utilities. Tracking of human beings either for workflow management analysis or patient tracking is mentioned as secondary applications of RTLS but is not the focus of this guidance.

1.3 Benefits

The benefits of implementing RTLS solutions will manifest as shorter times to find equipment, more efficient use of high value assets and improved patient, staff and visitor experiences.

Current implementations at trusts have notably “reduced the time to find a tagged asset to less than 25 seconds and released over 140,000 hours of clinical time”. Dr Didi Akinluyi, Head of Clinical Engineering at Guys' and St Thomas' is quoted as saying “implementation of asset tracking systems such as RFID potentially can save up to £250k annually for the trust through a reduced need to replace lost medical devices, and through operational efficiency gains.”

Some RTLS solutions can be delivered using existing infrastructure, maximising the use of the existing infrastructure investments and also providing additional cost and efficiency savings that may not be immediately obvious. (See Section 6.)

2. Recommendations for the Report

This summary provides an overview of the recommendations of the report.

If you are considering deploying an RTLS solution, we recommend:

Initial activities:

- Work out what clinical and/or business requirements an RTLS solution would solve.
- If there are many requirements, can a wider RTLS approach across the trust be considered?
- Look to implement a more comprehensive rather than point solution (a solution deployed in a small coverage area, to provide a single RTLS application) if budgets allow to get the most benefit from the investment.

Design

- Consider your current Wi-Fi solution to be a gateway to providing an RTLS solution, however be aware that it may not be able to support a full implementation in its current deployment.
- Consult your current Wi-Fi provider on the feasibility of running an RTLS solution across their infrastructure. Will updates/refresh be necessary?
- Consider hybrid technologies (see Section 9.1), beyond Wi-Fi or Bluetooth, to help with deployment or position accuracy issues and be best suited to your RTLs application(s).
- If a limited point solution is preferred, then make sure consideration is given to integration into a wider solution later.

Implementation

- Phased implementation of RTLS solutions is possible to address requirements sequentially.
- Be aware that implementation may require software development skills to carry out programming tasks such as creating mobile apps, map creation and asset database integration. (See Section 8)

3. Who is this guidance for?

The guidance contained within this report is targeted at ICS or NHS Trust Chief Information Officers and their Network Managers & Service Managers, who may be responsible for defining, supporting and delivering ICS IT strategies for RTLS services across NHS Trusts and ICS Partner organisations.

The emphasis of this report is based around maximising value for money and demonstrating how an RTLS solution may be approached, utilising existing connectivity wherever possible, whilst recognising the impact of RTLS and increasing future digital demand that will be placed on networks.

Whether the trust is at the commencement of planning for an RTLS solution, in the implementation of the solution in a phased approach or currently benefits from standalone solutions, the information provided in this report should be informative and serve as a base for further actions and deliberations. For trusts not planning an RTLS solution, consideration should be given to the content of the report for infrastructure planning and information regarding RTLS applications.

The report considers different NHS environments and the potential benefits of RTLS in each. For example, would the recommended approach for RTLS in a large hospital be the same as in a modern GP surgery or building of older construction, as well as suggesting key recommendations and actions for health organisations looking to implement RTLS technologies moving forward.

As multiple suppliers and different equipment make up the NHS estate, consideration has been given to integration with existing infrastructure and systems and an emphasis on existing open standards, whilst being mindful of data security, privacy and GDPR.

4. RTLS use cases & capabilities

4.1 Purpose of this section

This section will explain what RTLS is and the typical use cases that are relevant to the healthcare environment. Certain vendors will be highlighted that offer solutions for all, or part, of the use cases being discussed, whether in whole or as part of a third-party integration.

4.2 Asset Tracking

Asset tracking as a capability covers the ability to locate healthcare assets when required. The solutions and technologies involved can be split into several sub-categories, as related to different healthcare tracking scenarios.

In general, the information provided by asset tracking answers the following questions about an asset:

- Is it in the right place?
- Where is it now?
- Where was it at a certain time?
- Has it moved to an unwanted location?
- Where was it last?

Asset tracking solutions usually consist of 4 elements: tags, detection infrastructure, management/visualisation application and integration with third-party asset management database.

The asset can be tracked with the attachment of a “tag”. This tag is tracked through wireless technology.

The tag should be:

- Small.
- Suitable in size and shape for the asset to be attached to.
- Lockable or hidden to prevent tampering/removal.
- Able to be detected by a wireless infrastructure nearby.
- Powered, usually by battery or some alternative power source.
- Some tags can be configurable allowing for “ping time” to be adjusted to balance battery life and accuracy.

4.2.1 Mobile Asset Tracking

This represents the most common and feature rich implementation of asset tracking.

Benefits:

- Track valuable assets in real-time.
- Check position of nearest asset of a type (infusion pump, bed etc).

- Asset motion history through the environment.
- Trail map to the assets location.
- Leads to other applications such as Geofencing & Workflow.
- Utilises underlying wireless infrastructure.
- Medical device maintenance & calibration scheduling.

Mobile Asset Tracking revolves around pinpointing active tags attached to assets through an area covered by sensors. These are either represented on a floor plan map, or with those sensors defining geographical zones fed back to an asset register. The extent of the area usually encompasses internal buildings but can be extended outdoors. Sensors tend to be Wi-Fi access points or dedicated gateways linked to the main network.

One key application of Mobile Asset Tracking is the ability to schedule maintenance and calibration of medical devices where the asset medical device can be located and either retrieved or serviced in situ without extended searches. Indeed, if this service is outsourced, visiting engineers could be given access to the tracking system to locate relevant devices without staff intervention.

Major Supplier Options:

- Cisco
- HPE Aruba
- Juniper

4.2.1.1 Geofencing

This feature is a subset of mobile asset tracking and is often available within those solutions. It can also be provided as a standalone capability for asset security reasons only, for example creating admin alerts in software if a tagged asset is detected passing a sensor or into an undesired zone.

Benefits:

- Securing assets via alerts on location change
- Securing assets via alerts on perimeter crossing

Major Supplier Options:

- Cisco
- HPE Aruba
- Juniper

4.2.1.2 Workflow management

Though it can be deployed as a standalone capability in the healthcare sector workflow management tends to be a subset of mobile asset tracking. The key difference is what is tracked, and for what reason. The aim of Workflow management is for personnel and their equipment to be tracked in real-time to then provide data for analysis for time and motion studies, identifying bottlenecks and if there are congregation areas causing congestion or inefficient work practices.

Benefits:

- Personnel efficiency
- Time and motion studies
- Social distancing

Workflow management requires a tracking solution in place to track tagged personnel. These tags could range from a mobile phone using Wi-Fi, or a providing personnel with more accurate tagging technology to carry for increased accuracy. Most of the solution is back-end software analysis of movement represented to management teams to be able to show bottlenecks, dwell areas and focus and group dynamics.

Major Supplier Options:

- Cisco
- Juniper
- Ubisense

4.2.1.3 IT equipment tracking

For certain IT equipment, laptops, computers-on-wheels or other devices that are computerised, these can be tracked using the assets own wireless presence. This means that tags may not be required to track this equipment, and simpler location solutions could be employed using the built in wireless management solution to track wireless clients.

Typically, this technology is used for wireless network troubleshooting but can be re-tasked. If tracking of other assets is required, then mobile asset tracking is preferred.

Major Supplier Options:

- Cisco
- HPE Aruba
- Juniper

4.2.2 Fixed asset tracking

Hospitals, clinics and office spaces contain valuable items which are not generally mobile but are important to the provision of healthcare in situ and it is critical that they are regularly checked as being in their correct location for servicing and accurate asset management. Such items may be very high value such as X-Ray machines, high-definition screens or scanning equipment that would be difficult to remove, but not impossible.

Benefits:

- Ability to create census of expensive assets.
- Combine with physical “eyes on” of assets themselves for assurance.
- Integration with Asset Management databases.
- Low Cost.

- Requires no Wireless infrastructure.
- No battery technology or replacement regimen necessary

Fixed Asset Tracking solutions tend to be standalone solutions and are not generally complementary to a wireless infrastructure. They represent a low cost and comparatively easy to implement tracking solution for high value items at the cost of automation of tracking and capturing of real time location data.

One technology is used for this – **Passive RFID**. This consists of two elements: **unpowered tags** and **handheld readers**. Assets are tracked by an operator moving to where the asset, with its tag, should be located and using the scanner would activate the tag in the same way as contactless banking. The scanner can then download its confirmed location of the asset into a provided database or integrated directly into a present Asset Management solution.

A fixed asset tracking solution can be used for Inventory Management as well.

As more accuracy or automation are required this solution is usually superseded by mobile asset tracking solutions that can locate in actual real-time. Combinations of both are possible and generally require both to integrate with asset management solutions to create a combined asset record.

Major supplier options:

- HID Global
- Ubisense
- Securitas

4.2.3 Inventory

Inventory is similar to Fixed Asset Tracking, with the key differences being an emphasis on point locations and a larger scale of similar assets. This approach is generally used in medium/long term storage and Passive RFID tends to be the technology of choice. Assets tracked with this technology are generally kept in bulk, in designated and reasonably secure areas. A method of signing-in and signing-out of assets will use RFID readers to keep track of inventory . Any other asset tracking technology could also be used to provide this service, but likely at a greater cost.

Major supplier options:

- HID Global
- Ubisense
- Securitas

4.3 Wayfinding

The second major application for RTLS is wayfinding. This capability creates a similar environment to your typical Google/Apple maps with a blue dot representing the user in a mapped environment with the ability to be shown in real time a valid route to a known destination that has been looked up.

In the healthcare environment, wayfinding is generally used for outpatient or visitor guidance or for temporary staff to find their way around the trust buildings, as these environments can be large and difficult to navigate for visitors.

Wayfinding RTLS solutions only provide the underlying capability for this application. At its centre is a bespoke mobile application which will either be programmed as an external project or created internally by IT programming resources. This application will link into the RTLS solution via Wi-Fi for the positioning information, but the mobile device itself will measure its position using known RF sensors (such as access points, gateways and beacons).

As the device itself is doing the measurement, the sensors are just providing reference points on the "map" for the device's calculation. Thus, independent devices such as Bluetooth Low Energy (BLE5) beacons can be employed that only periodically send out their IDs or "chirp". These can be battery powered in the same way as tags although they do not move and are positioned on the "map" within the RTLS solution to form reference points. As they are battery powered consideration will need to be given to battery life and recharging or replacing beacons.

Almost exclusively, wayfinding solutions tend to be based on Bluetooth BLE5 technology and extensive use of beacons to provide reference points (exception: vBLE). This prevents the increased deployment of access points that are needed for accurate asset tracking. Also, mobile phones have built in Bluetooth radios for the application to do the measurements necessary.

In general, common wayfinding solutions therefore consist of the following components:

- Access Points supporting BLE5 radios
- BLE5 battery beacons
- Custom Mobile app
- App integration programming
- Custom or decluttered maps

An important consideration is the user experience of the published mobile app so that users will download the app and use it rather than use signage only. Other initiatives such as marketing, useful information and advertising can be included in the app. It is important for the map routes to be clear and easy to read. Most RTLS vendors do have services to "clean up" typical floor plans but there are dedicated mapping companies that can provide a greater experience for the user. It is important to obtain maps in the format supported by the RTLS application.

Within the map will be established "points of interest", usually entrances/exits, stairs/lifts, toilets departments/numbered rooms, receptions and amenities. Guidance paths can then be provided to the user from their current position to the point of interest. This can be done between floors and buildings if necessary.

Most Wayfinding apps can integrate innate GPS input from the mobile phone to guide the user across outdoor spaces but using external access points/beacons is possible as well.

A new alternative to maps is augmented reality where the phones camera is used to produce a real time "see-through" with the route/points of interest superimposed on the screen.

Major Supplier Options:

- Cisco
- HPE Aruba
- Juniper

4.3.1 Proximity

Proximity solutions tend to be a **subset** of wayfinding solutions. An example of this would be a hospital information point that can supply information to a visitor app. This may be about a geographical location such as a static map of toilets or infection controls or even menu details for a nearby cafeteria.
Proximity is about triggering a software reaction in an application when located in a device close to a configured RTLS sensor, typically a BLE5 beacon. The trigger can cause a response on the wayfinding application on the device, an admin alert like geofencing or a supply of information for an information point in a similar manner as an info QR-code.
The triggers can be quite sophisticated as most of the solution is software based. Bespoke solutions are possible and programming services would be required to get full use of the technology.

5. Overview of infrastructure required to provide location data

5.1 Purpose of this Section

This section will discuss the infrastructure technologies that are used by the key vendors to deliver end-to-end RTLS solutions in healthcare and support an understanding of the technologies and which infrastructure can support which RTLS capabilities.

5.2 Introduction

Location data can be accessed in a number of ways from utilising more pervasive radio-based networks, to placing discreet location beacons and/or readers at key points of interest.

5.3 Wi-Fi

Wi-Fi data networks are often deployed in a pervasive manner, i.e. to provide as much 'coverage' as possible to ensure availability across large hospital sites or campuses. When designing a Wi-Fi network there is a consideration in the RF planning and design between 3 key factors, being:

- Coverage – where does this Wi-Fi network need to be available?
- Capacity – what are the connectivity and throughput requirements where this Wi-Fi network is used? Note: Capacity does not have to be consistent across the Wi-Fi deployment.
- Cost – The available budget for the network and any potential return on investment will always be a consideration.

Wi-Fi networks tend to be provided by access points populating the coverage area with either a centralised controller appliance (virtual or physical with clustering options) and/or a cloud-based management /controller solution. RTLS Wi-Fi based applications usually require an increase in density of access points over and above data coverage. This is required to support the signal strength and AP positioning requirements of location tracking via Wi-Fi.

For adequate coverage to support data and voice transmission, the minimum RSSI (received signal strength indicator) i.e. the radio signal power to a device from an access point, should be -65dbm. Ideally, Wi-Fi based RTLS should use least 3 access point positions to allow for a client to be positioned using triangulation on RSSI measurement at this signal strength.

5.3.1 Fixed Time Measurement (IEEE 802.11mc)

Recently, there has been a standard released from the IEEE to deal directly with RTLS services over Wi-Fi. Branded as Fine Time Measurement (FTM) & OpenLocate, this seeks to use time metrics rather than signal strength triangulation to position a client device. Both the access points and the device will measure the time taken for data conversations between them. These time measurements with accurately placed access points can produce 1-2m accuracy. This solution requires the client to support the standard as well as the Wi-Fi system for a full implementation.

Accuracy improvements are possible even without client contribution using a combination of GPS and FTM measurements between access points to accurately position them on maps. Using this approach means that Access Point density requirements should be reduced from standard Wi-Fi implementations. It is also likely that FTM-capable solutions will use other hybrid technologies for positioning accuracy.

5.4 Bluetooth Low Energy (BLE)

Bluetooth is a wireless technology that is well known in the consumer and corporate spaces. Typical uses are for headsets, sound bars and In-car entertainment. It utilises the 2.4GHz spectrum but is interference resistant using frequency hopping. With the version 5 of Bluetooth Low Energy (BLE5), the technology has a range of up to 30m. Its low energy profile is also due to the lightweight protocol (less chatty) and lends itself to lower battery power usage for devices. Most such devices should last up to 3-5 years.

Most post-2015 Wi-Fi Access Points from the main Wi-Fi manufacturers include inbuilt BLE5 radios, allowing them to operate those radios for RTLS applications. Activating those radios tends to be software controlled. This means that any Wi-Fi Access Points that have been refreshed since 2015 should be able to support BLE5 capabilities as well as Wi-Fi without any need to add new hardware.

Due to the shorter range and battery possibilities for Bluetooth devices the technology lends itself well to RTLS applications. Within Wi-Fi, the density of access points aids the accuracy of both Asset Tracking and Wayfinding applications (3 APs for triangulation). Almost all implemented Wi-Fi networks are deployed without this density in mind. To subsequently provide this density can be a large cost endeavour.

BLE battery powered “beacons” can be deployed to provide the density necessary for good RTLS accuracy. This generally **only applies to Wayfinding/Geofencing solutions** as asset tracking solutions require enabled access point or specialised BLE gateways to “sense” the asset tag by triangulation.

5.4.1 Virtual BLE

Juniper Networks is the only manufacturer to offer Virtual BLE, a new implementation of BLE 5, which provides beacon-like coverage but directly from the AP. This is done using access points with many directional Bluetooth antenna radios so that location can be determined by arc direction around the access point, rather than just proximity signal power from several points. This makes a BLE 5 implementation possible using solely standard density access point deployments which is a potential cost advantage.

5.5 4G/5G Public Mobile Networks

Everyone is familiar with the mapping functions within mobile phones which can position the user on a live map. This is usually done by a combination of GPS and cell tower triangulation. For external positioning this is ideal and the accuracy of this has improved over the years.

The technology is unlikely to be used for asset tracking both for a lack of coverage for battery powered tags and the fact that assets tend to be located indoors. For internal positioning, the mobile maps are unable to accurately map buildings with multiple floors meaning that the use of cell tower positioning is restricted to external spaces.

The challenge for RTLS vendors is to integrate the external positioning via 4G/5G mobile networks with their internal solutions, using Wi-Fi or BLE5 etc. Trusts should look to evaluate that integration from potential vendors, particularly with regard to deployment in campus environments which include significant outdoor areas.

5.6 Global Positioning System (GPS)

Expanding on the mobile networks above, which apply to GPS capable devices such as mobile phones, increasingly GPS itself is being integrated with RTLS systems to provide greater accuracy for wayfinding and mapping. GPS radios can be included within access points allowing that access point to be positioned accurately on the earth's surface.

If the access point is located by this method, then devices can be placed on wayfinding maps more accurately in the real world. Without this an error is introduced where the solution has the access points placed by "eye" on maps during installation, which if incorrect can reduce the accuracy of location data.

GPS positioning of access points is still rather new to the industry and trusts should look to see if their vendor of choice offers support for it. GPS is important for BLE and Wi-Fi FTM that are currently used for wayfinding.

5.7 RFID

Radio Frequency Identification (RFID) is a well-established technology that does not tie into Wi-Fi solutions and is often deployed in isolation. This technology is used exclusively for Asset Management through tags. There are two main RFID solutions: Passive & Active.

5.7.1 Passive RFID

Passive RFID is commonly used for such consumer systems as contactless bank cards and door security systems. For RTLS, unpowered tags, usually presented as stickers, are placed on the assets. Auditor users then use handheld recording devices to register the presence of the tag and asset. This requires manual effort to keep the presence and location information up to date and as such does not track asset location in real time.

The tags themselves have no power, so do not require batteries, and they operate by RF induction from a reader device, which is powered. There are various RF frequencies used, including 125-134KHz, 13.56MHz & 865-960 MHz.

The passive nature of the solution in respect of the other RTLS systems means that this technology is not suitable for direct integration with Mobile asset tracking solutions. Passive RFID can supplement a mobile system by providing information on fixed assets whose presence needs to be manually taken stock of.

In comparison to other technologies a passive RFID solution can be implemented cheaply and without disruption to any existing Wi-Fi solution.

5.7.2 Active RFID

Representing a halfway house between Passive RFID & RTLS, Active RFID is generally held as a more flexible version of Passive that provides the same solution. The active asset tags used contain batteries and respond to readers from a longer distance than Passive tags (as the reader does not have to power the tag). This reduces the admin overhead and manual scanning to keep the asset information up to date.

The greater scanning distance and the active nature of the tags means that Active RFID can be implemented to be part of a mobile asset tracking solution. It is possible to have Active RFID readers placed in fixed locations and linked to the wider IT network to supplement a Wi-Fi or BLE based RTLS solution.

The technology uses two discrete RF frequencies- 433MHz & 2.45GHz.

6. Getting the best out of existing infrastructure

6.1 Purpose of this Section

This section offers advice to the reader on the considerations regarding the re-use of existing infrastructure to maximise return on investment.

6.2 Introduction

Wi-Fi infrastructures are almost ubiquitous in healthcare environments in 2024, even down to small GP surgeries. Large costs are borne by healthcare trusts to install, maintain and refresh this infrastructure regularly.

It is strongly advised to consider using the current Wi-Fi solution as the basis of any RTLS solution for a trust, thus maximising the investment already made in this infrastructure.

6.3 Consult your existing Wi-Fi infrastructure provider

Depending on the age and capabilities of your existing Wi-Fi infrastructure your current Wi-Fi network may support some or all of the full range of RTLS options possible.

To determine the level of support required, it is important to consult your current provider to better understand the following:

- Does the solution have the capability to support integral or third-party Wi-Fi device positioning?
- Are there BLE5 radios available on their current access points?
- Can it support an integral wayfinding or asset tracking RTLS solution?
- Does the current solution support any third party RTLS solutions?
- Is the current distribution of access points of sufficient density to support asset tracking?
- What would be the cost to update the solution?
- What technologies would that update then support?

The answers to these questions will then inform next steps. Note: data capacity on your Wi-Fi network is not a consideration when deploying RTLS capabilities, as the technologies are quite lightweight in their data throughput requirements.

6.4 Updating your existing infrastructure

If updates to existing infrastructure are necessary and the refresh cycle is prohibitive, then look to see what other solutions, features or opportunities are available. For example deployment of a passive RFID solution should not require any involvement of the existing wireless infrastructure, but due to its nature this solution requires regular human intervention (use of handheld readers to register tags) to be an effective solution its cost will be ongoing.

If it is not possible to deploy a full RTLS solution it may still be possible to deploy a small RTLS tracking solution covering certain critical area(s) that can be expanded in the future. Any infrastructure costs will be less than a blanket coverage and the number of tags will be smaller. This solution should include geo-fencing

so that you are alerted when assets are removed from the RTLS tracking coverage area.. Do note that this deployment would then likely lock the vendor and technology to be used in any future expansion, so wider technical considerations should still play a part in vendor and solution choice.

Alternatively looking at a RTLS vendor rather than a Wi-Fi vendor may be more cost effective if the RTLS vendor solution has the potential to integrate with your Wi-Fi solution in the future when budget allows refresh of the Wi-Fi infrastructure.

If budget and management approval from relevant departments allows a full deployment, then a full or partial Wi-Fi equipment refresh may be required if the current Wi-Fi solution does not support an RTLS solution. Then the RTLS requirements would become a requirement of a wider refresh.

6.5 Local Virtual/Cloud resources

If the RTLS solution operates as part of your Wi-Fi deployment, attention should be paid to what data management components are required to manage the RTLS capabilities. This may require on-site virtual server resources, or the data management may be based in the cloud and included in the costs of deployment. If local virtual resources are limited, this may affect the RTLS solution choice, or the costs of adding further local resources will need to be taken into account.

7. Mapping of infrastructure to RTLS use cases

7.1 Purpose of this Section

Now that the RTLS use cases and required infrastructure and technology components are understood, this section shows which components are required to deliver the required outcome.

Application/Technology Matrix										NHS England RTLS Guidance
H= Hybrid solution (Multiple technologies including emerging tech).			Wi-Fi	FTM (802.11mc)	Bluetooth Low Energy (BLE)	4G/5G Public Networks	GPS/GNSS	Passive RFID	Active RFID	Considerations
Asset Tracking	Fixed Asset	Tracking assets which tend not to move. For security proposes.								RFID gives cost benefits vs point solution.
	Mobile Asset	Tracking assets within a coverage area.				Outdoor	Outdoor		H	Accuracy
	IT Equipment	Tracking assets that have their own RF capabilities.								Use existing Wi-Fi implementations
	Human	Tracking people: Staff/Patients.	H	H	H	Privacy	Privacy			Privacy considerations
	Geofencing	Detecting assets crossing boundaries.				H	H			
	Workflow	Analysis of asset motion efficiencies.	H	H	H	Privacy	Privacy		H	Privacy considerations
Wayfinding	BlueDot	A Mobile app that can direct the user via a live map.				Outdoor	Outdoor			
	Augmented Reality	A Mobile app that directs the user by superimposing info on view.		H	H	H	H			New Technology
	Proximity	App responses on approaching a sensor device.								FTM too new.
	Inventory	Secure asset storage in bulk - check in/out.								RFID gives cost benefits vs point solution.

Valid Technology for Application Valid with restrictions Invalid Technology for Application

7.2 Mobile Asset Tracking/Geofencing/Workflow Management

These RTLS applications require high accuracy in location and require a radio “tag” to allow the solution to operate effectively. Detection of the “tag” requires RF sensors located in a coverage pattern over the geographical location. The following infrastructure provides the solution:

- Wi-Fi or BLE5 enabled Access Points that can forward location data to RTLS solution.
- Wi-Fi or BLE5 enabled tag
- Possibly a map

Note: Wi-Fi tags consume a lot of power and will need regular recharging. Most solutions should use BLE5 to minimise this.

7.3 IT Equipment Tracking

This capability tracks equipment that inherently contain RF technology. Usually this would be Wi-Fi enabled equipment and as such no tag would be necessary in this case, and it represents a low-cost solution to implement for its use case.
The following infrastructure provides the solution:

- Wi-Fi solution that can forward location data to RTLS solution.

Note: As IT equipment will not require tags, this application is more likely to support a Wi-Fi only solution. The IT equipment will have batteries for their operation hence this solution is generally handled within an existing Wi-Fi solution.

7.4 Fixed Asset Tracking

Tracking of valuable assets that should not travel. Confirmation of the presence of the asset and its correct position.

Either:

- Wi-Fi or Bluetooth BLE 5 enabled Access Points that can forward location data to RTLS solution.
- Bluetooth BLE 5 or Wi-Fi Tags
-

Or

- Passive or Active RFID Tags and Readers

This requirement lends itself to an RFID solution as a standalone system. When part of a wider asset tracking solution this can be incorporated into a Wi-Fi or BLE5 based solution.

7.5 Wayfinding

Wayfinding uses the mobile application as the focal point of location determination; therefore, it picks up the transmissions from the access points and beacons. Generally, it is preferable to use BLE5 transmissions as the Bluetooth radio uses less power. Another advantage is that the accuracy can be improved by deploying battery powered BLE beacons rather than denser deployments of access points. This wayfinding is currently the sole domain of BLE5 solutions., however the introduction of FTM (802.11mc) will allow this t be provided via Wi-Fi and may change this dominance. The main components are:

- Wi-Fi solution that cansend location data to the RLTS solution.
- Bluetooth BLE 5 enabled Access Points
- Battery BLE Beacons
- Bespoke Mobile Application with integration with solution Software Development Kit (SDK)
- Custom maps for application

Wayfinding is increasingly using newer emerging device technologies such as barometric and geomagnetic information as well as GPS. FTM (802.11mc) will become more prevalent as the OpenLocate standard is adopted. See section 10.2 for further detail.

7.6 Proximity

Proximity relies on the mobile application to respond to data from a designated BLE5 beacon to trigger a response in the application,response indicates that the mobile device is within a certain defined proximity of the beacon. Proximity is exclusively a BLE5 based application and would require:

- Battery BLE Beacons
- Bespoke Mobile Application with integration to the Proximity solution Software Development Kit (SDK)

In most cases Proximity will be offered as part of a wayfinding solution. There may be a standalone requirement using the application for info points with a non-wayfinding app. A phased RTLS implementation approach may lead to this outcome.

7.7 Inventory

Inventory RTLS is used for static tracking of items using tags, usually to aid storage organisation and tracking of stock levels.

Either

- Passive or Active RFID tags
- Passive or Active RFID Readers

An Inventory only requirement can be fulfilled using Passive RFID, as movement tracking is not required, and any relocation can be dealt with by a reader or manual annotation. For large or extensive storage needs than Active RFID could be more convenient but comes at a higher cost and requires more administration.

If there is a wider requirement that includes inventory, the need can be met using a Wi-Fi or BLE solution, but the cost would be much higher than an RFID solution.

8. Implementation considerations

8.1 Purpose of this Section

This section highlights the considerations that should be made before undertaking the implementation of an RTLS solution.

8.2 Introduction

When an NHS organisation is evaluating the introduction of an RTLS solution of any type (with the exception of Passive RFID), there are several challenges to address even before implementation starts. The primary one being the setting of goals for the RTLS application:

- Which users will benefit? Staff? Patients? Management?
- In what ways will their user experience improve?
- What are the things you do not want the application to address?
- Have point RTLS applications been in use at the Trust in the past? At present? What is their remit?
- What non-IT stakeholders should there be?
- What network enhancements are required? Additional access points? Power over Ethernet considerations? Cabling?

8.3 Current Wireless status

Critical to the implementation of a successful RTLS solution should be the suitability of the current Wi-Fi infrastructure. Wi-Fi infrastructure tends to be refreshed in 3-7 year cycles and the position within that cycle will determine the investment size and budget requirements of the RTLS solution. If the current Wi-Fi solution lacks certain technologies, generally because of access point functionality (e.g. Bluetooth BLE 5) then there will be a natural reduction in the choices and capabilities of the RTLS solution.

Comparison of the refresh cycle to the current suitability of the operational Wi-Fi solution will illustrate the major decision on budget creation and project commencement, namely, should the RTLS solution wait for the next refresh cycle, is it able to be deployed on the current solution or will it require an independent enhancement of the current solution. Budget constraints may also “force the hand” on this.

Beyond the technological suitability of the current wireless solution, if an increased number of access points are required, to provide coverage for asset tracking mainly, this will require not only budget for the items but also:

- Site survey services
- Network switching capacity
- Power over ethernet
- Cabling

If site surveys had been completed prior to the current installation, then they can be used to guide the suitability of the network for the RTLS applications required.

8.4 Consultation

Even though an RTLS solution is an IT based solution, it combines application with infrastructure. As such, decisions on its scope, reach and content will require wider input to ensure it adequately covers its full usefulness to the Trust. Departments to be consulted will differ depending on where RTLS capabilities will be deployed, who and what it will track and other local considerations, but would generally include those responsible for:

- Clinical – particularly nurse practitioners.
- Medical equipment management – for asset management & device calibration.
- User (staff & patient) experience – for wayfinding.
- Environmental & Estates.
- Bed management.

8.5 Scope and reach

RTLS solutions can become quite involved and garner a lot of human resources in training, implementation, maintenance & programming. It is important that the initial scope of the solution is both achievable and achieves goals that will enhance the service provision of the trust. Thus, it is necessary to baseline what the solution will provide and what it won't. As can be seen elsewhere in this report each RTLS application can be taken on its own merits and many applications may be relevant. For each application added to the project, the complications, dependencies and involvements will increase the difficulty of the implementation.

8.6 Phasing

Because of the different applications possible with RTLS, Trusts can look at phasing any implementations by prioritising their requirements. This way infrastructure can be built up over time, e.g. access point density, so that RTLS capabilities can be added.

Planning in this manner may allow for a long-term approach to the area of RTLS. For example, if asset management is primary but the current Wi-Fi solution is inadequate then looking at passive RFID immediately but then looking to implement mobile asset management when a Wi-Fi refresh cycle is due. Looking further ahead a wayfinding capability could be introduced as a later implementation phase reducing the complexity of the installation, at the cost of delayed implementation of some lower priority capabilities.

It is important when using a phased approach to RTLS implementation to future proof the infrastructure as you go and make sure that the RTLS solutions adopted over time are complimentary and able to use the phased infrastructure changes as they arrive.

8.7 Amalgamating previous RTLS point solutions

Some trusts may have already invested in point RTLS solutions, these are most likely to be RFID or ad hoc workflow applications. There is no need to replace these with an overall solution and integration services can be used to make the information from these solutions remain useful and allow them to be presented together with the new capabilities. However, the addition of a comprehensive RTLS solution which could provide the same service may have admin advantages if the existing point solutions are dispensed with.

8.8 Establish the core requirements

RTLS applications can supply a plethora of applications, as outlined in this report. Establishing the core requirements and ruling out what is not required is important to prevent the implementation becoming unwieldy and needing a large amount of training.

8.9 GS1 Standards

When using asset tracking solutions, considerations should be given to implement General Specifications 1 (GS1) standard for identification of assets, particularly RFID asset names as translated to barcodes. The use of barcodes with such new technologies as Computer Vision using images to identify assets may mean you need to label assets to follow GS1 standards.

https://www.gs1.org/standards/barcodes-epcrfid-id-keys/gs1-general-specifications

9. Future/ How are the capabilities developing?

The newer technologies associated with RTLS are starting to have an effect on mainstream RTLS solutions within healthcare. Over the next 1-2 years they are likely to become a consideration for Trusts looking for comprehensive or point solutions within their organisations.

9.1 Hybrid technologies

New RTLS technologies are applying themselves to the healthcare arena, particularly from the manufacturing sector where RTLS is used to control and locate autonomous devices. These technologies are generally to be used in conjunction with Wi-Fi/BLE solutions and the major Wi-Fi vendors maintain partnerships with other RTLS vendors, such as those mentioned in Section 9.4.

These are in two main areas. Technologies within mobile devices that can be applied to wayfinding type applications and new detection technologies for asset tags, using new radio spectrum of new methodologies. In both cases, though these technologies can stand on their own, for healthcare applications they have the capability to be integrated with Wi-Fi/BLE solutions to improve location accuracy. Technologies already explored such as RFID can be used as a hybrid technology.

These technologies are:

9.1.1 Ultra-Wide Band (UWB)

This is a short-range wireless technology that utilises a frequency band of 3.1 – 10.5 GHz using a wide spectrum in very short pulses of data. The power used is very low but is interference resistant due to using a wide spectrum. Thus, it can co-exist with Wi-Fi/BLE solutions if required.

The technology has current wide use in manufacturing for managing spaces where large machinery and moving parts are present. An RTLS solution can then support UWB as one of the positioning metrics for assets or for wayfinding. UWB radios have started to appear in mobile phones and the technology will be used for a wide range of applications in the future. It is likely that RTLS will increasingly use UWB as a supplementary radio technology.

9.1.2 Geomagnetic/Barometric

These technologies, detecting air pressure and the Earth's magnetic field are present in modern mobile devices and can aid wayfinding app devices to position themselves and detect the motion of the device on the map due to measured changes. This information alone would not produce an RTLS solution but will help to enhance an applications measurement using BLE, Wi-Fi or GPS; so, their positioning calculations can be made more accurate by using these extra positioning data. Barometric information can be used to detect a change in floor levels, for example.

9.1.3 Computer Vision

This technology covers the use of visual pictures and cameras to do two things.
1.For asset tracking, barcodes on tags can be scanned from afar. This will provide an alternative to Passive RFID as no power is needed and camera armed mobile devices can be distance readers or even CCTV installations.

2.A device’s camera can be used to deliver an augmented reality experience on a wayfinding app by using the back camera of a phone showing the image on the screen with points of interest and/or path directions superimposed by the app. This vastly improves the user experience of a wayfinding app.

9.1.4 Ultrasound

Ultrasound pulses from exciter units can be sent out to “excite” an ultrasound tag to respond in a similar way to RFID. Again, this can be a complementary technology in the future alongside Wi-Fi/BLE to locate assets. In practice, ultrasound exciters can transmit sound to a room to then prompt any tag there to report its position through its Wi-Fi connection. This is very useful as a fixed asset or inventory check application. Also, exciters can be installed at geofencing limits to report suspicious movement of assets.

9.2 Artificial Intelligence

Within Asset Tracking solutions are essential big data solutions giving location information for assets, The use of AI reasoning is starting to be applied to sourcing asset information and even spotting issues with assets. Complex questions can be asked of AI to, for example, list all the assets that are in a particular location that are of three certain types or where is the nearest etc.

Also, suspicious movements or loss of tracking can lead AI to alert on complex combinations of factors. This will be particularly useful in workflow management as well.

10. Other Considerations:

10.1 Map creation

For wayfinding/workflow solutions, and often for asset tracking solutions, tailored maps need to be part of the system. As wayfinding is a staff/patient facing system, the maps in the mobile app will need to be clear, engaging and have any extraneous information excluded for your typical floor plan. Particularly doors, sample furniture and dimension measurements. The extraneous information can confuse the routing and positioning of the user.

Some Wi-Fi vendors can provide services to make maps suitable for use in the solution. However, there are many mapping companies that specialise on production of appropriate maps for RTLS solutions. These generally are completely compatible with any vendor and for wayfinding are very important in helping application adoption by non-IT staff, particularly patients.

10.2 Battery Management/Maintenance

When using active tags, be they RFID, BLE5 or Wi-Fi or BLE5 beacons, battery management will play a part in managing the solution. Wi-Fi tags require almost daily charging, which is one of the major drawbacks along with accuracy of using that technology.

Active RFID and BLE5 batteries need to be changed usually by 3-5 years. This can involve replacing the tag/beacon altogether or just replacing the battery itself. The batteries can perform quite differently in different environmental conditions. Cold temperatures, particularly, have a large impact on battery life. Consideration should therefore be made with the storage of tags when not in use to preserve battery life. Once the unit has reached end of battery life and will be replaced, safe disposal of the beacons/tags will need to be arranged to prevent any environmental damage. Suppliers of the beacons/tags may offer a disposal/replacement service.

The important issue is working out when batteries need replacing when the item is not connected to the solution other than to respond with its ID as part of RTLS operation. Some beacon/tag solutions can report battery status but not all, some solutions may require a reader connection (RFID) and some Wi-Fi vendors can receive reports from access points in the vicinity of the items. It is advised to work out what battery management protocols will need to be made, if any, before the RTLS solution is deployed.

11. Glossary of Terms

Access Point	Network attached device with radios capable of data transfer to client devices.
Asset	Valuable item that it would be advantageous to track its position**.**
Asset Management	IT application database used to register and manage assets.
Asset Tracking	RTLS applications used to track the location of assets with an attached tag.
Battery	Single use of rechargeable power for mobile device without fixed power source.
Beacon	Battery based independent Bluetooth transmitter used to mark position in coverage area for reference.
Bluetooth Low Energy (BLE)	Short range low power data communication technology using frequency hopping algorithms.
Coverage Area	Extent area of radio resolution of a RF data system to allow reliable data communication, generally by a population of access points.
Fixed Time Measurement (802.11mc)	New Wi-Fi based RTLS standard using data transfer times to measure distance.
Geofencing	RTLS application alerting when asset tags are moved outside a software designated area.
Map	Floor map used to show device location in real time.
Point Solution	Solution deployed in a small coverage area to provide a single RTLS application.
Proximity	RTLS application which uses BLE beacons to trigger software activity when a device is close.
Reader	Handheld device used to activate passive RFID tags to then register their location.
Real Time Location Services (RTLS)	Technologies to allow accurate positioning of devices within a coverage area.
Radio Frequency Identification (RFID)	Technology to register asset presence by scanning for its tag through a reader device.

Software Development Kit (SDK)	Instructions to integrate two applications to interact through an Application Programming Interface (API).
Tag	Radio device attached to an asset so it can be sensed by an RTLS application.
Third Party	A second RTLS vendor's product that is supported to integrate with a first RTLS vendor's product.
Ultrawide Band (UWB)	Short range communication technology using short pulses over a wide spectrum.
Vendor	Manufacturer of RTLS solutions.
Wayfinding	RTLS application that enables a mobile device with developed app to locate itself on a map and provide directions to points of interest.
Wi-Fi	Radio data communications using technologies governed by the IEEE 802.11 committee and the Wi-Fi alliance.
Workflow Management	RTLS application that analyses motion of people and assets in a coverage area to determine efficiency of operation.

12. References

Document: Gartner Magic Quadrant for Indoor Location Services - Published February 2024

Document: https://transform.england.nhs.uk/blogs/embracing-digital-tools-to-improve-efficiency-productivity-and-patient-safety/

Website: https://spaces.cisco.com

Website: https://www.juniper.net/us/en/the-feed/topics/wireless/indoor-location-services-juniper-networks-introduction.html

Website: https://www.arubanetworks.com/products/location-services/

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Website: https://www.securitashealthcare.com/

Website: https://www.blyott.com/

Website: https://www.indooratlas.com/

Website: https://ubisense.com/healthcare/

Website: https://en.wikipedia.org/wiki/Ultra-wideband

Website: https://rfid.net/what-is/what-is-rfid

13. Appendix A: Supplier Details

13.1 Purpose of this Section

This section provides information about the two main supplier types that are considered as part of an RTLS solution, Wi-Fi/Network Vendors and the RTLS solution vendors.

13.2 Introduction

Leading suppliers in the RTLS space can be split into two categories. Pure RTLS vendors, who focus on the RTLS applications and can include hardware, particularly asset tags, and major Wi-Fi network vendors such as Cisco, HPE Aruba and Juniper Networks, which Trusts may already have investment in infrastructure with and can apply their infrastructure in major ways to RTLS applications.

This list is not exhaustive and represent the vendors with major healthcare focus in the UK and EMEA. Other vendors are available and may offer solutions that could suit the healthcare market.

We see the typical NHS trust implementation to involve the following supplier categories:

- Existing or new Wi-Fi network vendor
- Mapping vendor - for wayfinding application – user experience
- Optional enhancement from a niche RTLS Vendor
- Integrator services with existing NHS IT – app programming or asset database integration
- Device maintenance services – battery, replacement.

As can be seen, not all of these may apply for each Trust's requirements.

Integrator and maintenance services are not outlined in depth regarding distinct providers. The providers are likely to be resellers of RTLS/Wi-Fi Vendors and therefore linked to them as experts in integration & service. The capabilities of a vendor's resellers should be critically assessed as part of procurement of an RTLS solution.

13.3 Key Procurement Questions

Before undertaking a procurement, we recommend contacting RTLS suppliers about their solutions and how they may fit with your currently deployed infrastructure. Asking potential suppliers the below questions should give you a good idea of if they can meet your requirements:

1. Is our current infrastructure adequate as a basis for implementing your RTLS solution? If not, then what enhancements are required?
2. What RF technologies do you use utilise for your solution?
3. Do you have partnerships with other vendors to fulfil RTLS requirements?
4. What positioning accuracy do you offer with your RTLS solution? Is this configurable?
5. Do you offer ancillary services such as battery management, integration with asset databases, wayfinding app creation/integration?

13.4 Wi-Fi Network Vendors

This report focuses on utilising existing investments in infrastructure to deliver real time location services (RTLS). Predominantly this looks at the fixed and most importantly the wireless network infrastructure that already exists within hospitals. These networks are often pervasive, in terms of internal coverage, as they have been designed to service the needs of staff and patients. This very pervasiveness is key to their re-use when it comes to RTLS solutions.

As part of the discovery exercise for this report a questionnaire relating to RTLS technologies and use cases was sent to Cisco, HPE Aruba and Juniper Networks, being the major manufacturers of Wi-Fi networks in UK healthcare arena and are the most likely to be already or soon to be installed. The scope of this report precludes all such Wi-Fi manufacturers being included and readers are encouraged to widen their research if needed. The supplier/vendor information below is a combination of industry analysis and the returned results from those questionnaires.

WLAN Vendors RTLS Capabilities						NHS England RTLS Guidance
			Cisco	HPE Aruba	Juniper Networks	Considerations
Asset Tracking	Fixed Asset	Tracking assets which tend not to move. For security proposes.				Application dealt with by mobile tracking or third party.
	Mobile Asset	Tracking assets within a coverage area.				
	IT Equipment	Tracking assets that have their own RF capabilities.				Can use management platforms for reduced cost.
	Human	Tracking people: Staff/Patients.				
	Geofencing	Detecting assets crossing boundaries.				May involve 3rd party technologies to be effective.
	Workflow	Analysis of asset motion efficiencies.				Third Party integrations required.
Wayfinding	BlueDot	A Mobile app that can direct the user via a live map.				
	Augmented Reality	A Mobile app that directs the user by superimposing info on view.				Generally available through third party integrations.
	Proximity	App responses on approaching a sensor device.				May involve 3rd party technologies to be effective.
	Inventory	Secure asset storage in bulk - check in/out.				Mobile Asset solutions can provide.
Technology	BLE5	BlueTooth Low Energy 5 embedded in access points.				Juniper vBLE gives deployment advantages.
	Passive RFID	Passive RFID reading embedded in access points.				Some third party hardware available.
	Active RFID	Active RFID reading embedded in access points.				Some third party hardware available.
	FTM (802.11mc)	Fixed Time Measurement available.				Aruba offer client based rather than AP positioning.
	GPS	GPS radios in access points.				
	Minimum Requirements	Full RTLS capabilities on all access points including legacy.				Juniper vBLE only on latest access points
	Outdoor use	Outdoor capabilities of solution.				Outdoor access points have BLE radios.

Full support Some support (incl. 3rd Party) Supported through 3rd parties

13.4.1 Cisco

13.4.1.1 RTLS Solution Support

Cisco uses Cisco Spaces to deliver much of its location based services portfolio, and has the following support for the use cases identified in this report:

- Cisco Spaces supports:
    - fixed asset tracking
    - mobile asset tracking
    - IT equipment tracking.
- GeoFencing - Cisco Spaces supports zones, which are polygons drawn on floorplans which allows you to automate notifications to alert Admins when an asset leaves an area, report on number of devices and dwell time in an area etc.
- Wayfinding using Blue Dot - Cisco Spaces has native wayfinding experience solution with a blue dot using BLE technology. Cisco Spaces also has ecosystem partners who combine a number of location technologies.
- Wayfinding with Augmented Reality - Cisco Spaces does not support any augmented reality wayfinding, however, leveraging the ecosystem, there are partners who do. One example of these partners is Pointr.
- Human Tracking – through the use of an asset tag as a lanyard or wristband. Also, through the tracking of personal mobile devices.

13.4.1.2 Available Technologies

Cisco Spaces supports the following natively:

- Wi-Fi
- BLE
- Active RFID
- 802.11mc for AP Placement on floorplans

Cisco Spaces supports UWB natively within a limited testing environment with a full solution to be implemented imminently. This is implemented through an external radio to the access point.

The ecosystem of partners can integrate to deliver:

- Infrared
- Passive RFID
- GPS/GNSS

13.4.1.3 3rd Party Integrations

Cisco Spaces supports a large number of third-party integrations. Integrations on both the hardware side (Kontakt.io, Haltian, ENOcean etc), as well as the software side (Securitas Stanley, Centrak, Pointr, Mazemaps). Some vendors such as Kontakt.io, AiristaFlow and Securitas Stanley integrate on both the hardware and software side for an end to end solution.

The Cisco Spaces application integrations page lists the following technology partners that deliver Location services that are specific to Healthcare:

- AeroScout Links
- AiRISTAFlow
- CenTrak
- ESRI

- GuardRFID
- IPera
- Infor
- Midmark RTLS Solutions
- Pointr Deep Location
- PoleStar
- Kontakt.io
- Stanley Healthcare RTLS
- TAGNOS
- Trackerwave

13.4.1.4 Minimum Requirements

Cisco Spaces only supports Cisco access points. The minimum version of code supported on the Wireless LAN Controller is 8.5.

To support IOT Services (onboarding and management of IOT devices), there is a minimum of 9800 Wireless LAN Controllers, 9100 Access Points, and Spaces Connector 3.0.

13.4.1.5 Components for an RTLS solution

Cisco Spaces can either be Catalyst or Meraki Wireless infrastructure.

For Catalyst infrastructure, a small virtual machine known as a Spaces Connector is required. The role of the connector is to help funnel data from WLC and APs, up to the cloud in a secure manner. There is also a reliance on mapping, which can come from Prime Infrastructure, or Catalyst Center. DWG floorplans can be imported directly into Cisco Spaces, in which there is limited need for Prime or Catalyst Center.

For Meraki deployments, there is no additional software or hardware needed. The APIs available in the Meraki dashboard are leveraged to consume wireless data and mapping information.

13.4.1.6 Design Criteria for RTLS Solution

Cisco Spaces is an RTLS style solution, and thus relies on using access points to calculate where client devices are. It is recommended that customers opt for a location design when deploying their access points, to give the best levels of accuracy.

13.4.1.7 Support for outdoor implementations

Cisco Spaces is designed as an indoor location services platform. Although this is its design, there is nothing limiting Spaces to be deployed external to a building. It should be noted that any customer planning to deploy Spaces externally the impact things like directional antennas may have on location accuracy.

13.4.1.8 Real World Examples

1. NHS Calderdale and Huddersfield https://spaces.cisco.com/nhs-foundation-trust-relies-on-asset-tracking-to-keep-critical-care-equipment-within-reach/
2. Gartner Reviews for Healthcare and Biotech https://www.gartner.com/reviews/market/indoor-location-services/vendor/cisco/product/cisco-spaces/reviews?marketSeoName=indoor-location-services&vendorSeoName=cisco&productSeoName=cisco-spaces&sort=-helpfulness&pageNum=2&industry=265
3. Adventist Health https://spaces.cisco.com/openroaming-ensures-automatic-wi-fi-onboarding-seamless-connectivity-at-adventist-healths-rural-centers/

13.4.2 HPE Aruba Networks

13.4.2.1 RTLS Solution Support

Aruba has been providing indoor location services for over 10 years, through the use of their Location Engine software, both on premise and in the cloud, to provide Wi-Fi based location information, and also through the 2014 acquisition and integration of the Meridian Cloud platform for Bluetooth Low Energy location-based services such as user engagement and asset tracking use cases. They have an ecosystem of partners with software integrations and hardware to further enhance the offerings:

- Fixed asset tracking
- Mobile Asset Tracking
- IT equipment tracking
- GeoFencing (theft & relocation) – with SDK integration to 3rd party mobile App
- Wayfinding Blue Dot
- Wayfinding Augmented Reality – with SDK integration to 3rd party mobile App
- Human Tracking

Note: The tracking capabilities may still require additional 3rd party software to present the data in the correct format for the particular use case.

13.4.2.2 Available Technologies

The Aruba wireless access points have the following inherent technical capabilities:

- Wi-Fi (up to 802.11ax/Wi-Fi 6e)
- BLE
- 802.11mc internal (FTM) – for AP and client positioning on floor maps
- GPS/GNSS – Internal
- The USB Port can be used for various digital and analogue sensor and radio connectivity which may have use cases in RTLS

13.4.2.3 3rd Party Integrations

The HPE Aruba Networking Technology Partner Program site lists the following technology partners that deliver Location services that are specific to healthcare:

- 911 Inform
- Accenture
- AiRISTA
- Atoll Solutions
- AWS
- Bastille
- Blyott
- Borda IoT for Healthcare
- Centrak
- Johnson Controls
- Critical Arc
- Cxapp
- Datavalet
- Datawifi
- Deloitte
- Ekahau
- Emerge Interactive
- Flame Analytics
- HID
- IndoorAtlas
- Mobile 72
- MobiMESH inPiazza
- Mutrack
- Patrocinium Systems
- Pole Star
- reelyActive
- Robin
- Safectory
- Syook
- Thermokon Sensor Technology
- Thinaer
- WinShine
- Wizzie Analytics

Aruba's focus for delivering location-based services is to utilise the Wi-Fi and BLE radios within the access points to deliver solution alongside ecosystem partners specialised in healthcare, for example, Blyott.

13.4.2.4 Minimum Requirements

Aruba currently has two software trains, AOS8 and AOS10. The location services features and integrations are predominantly available in both versions.

13.4.2.5 Components for an RTLS solution

The key Aruba components for an RTLS solution are as follows and can be used in various combinations depending on the use cases:

- Wi-Fi for triangulation
- BLE for triangulation and polling
- IoT Operations
- Locations Engine (On premise and Aruba Central Cloud platform)
- Aruba Meridian Cloud Platform

Many full solutions will require the integration of third-party software and tag vendors.

13.4.2.6 Design Criteria for RTLS Solution

No response from Vendor.

13.4.2.7 Support for outdoor implementations

Aruba has a large range of outdoor access points that are configured and managed via the same platforms as the indoor solutions and offer the same location-based services.

13.4.2.8 Real World Examples

No response from vendor.

13.4.3 Juniper Networks

13.4.3.1 RTLS Solution Support

Juniper's wireless network platform, Juniper Mist, has an Asset Visibility subscription service that opens up the integration of their virtual Bluetooth Low Energy (vBLE) technology which is integrated in the Juniper Mist access points. The vBLE concept is an array of BLE radio within the access point that will simulate the placement of discreet, individual beacons to enable location-based services such as wayfinding and user engagement applications. The vBLE solution will also interact with BLE asset tags and mobile devices with Bluetooth radio to provide Asset based solutions meaning the Juniper Mist wireless platform can support the following RTLS use cases:

- Fixed asset tracking
- Mobile Asset Tracking
- IT equipment tracking
- GeoFencing (theft & relocation) – with SDK integration to 3rd party mobile App
- Wayfinding Blue Dot – with SDK integration to 3rd party mobile App
- Wayfinding Augmented Reality – with SDK integration to 3rd party mobile App

- Human Tracking

Note: The tracking capabilities may still require additional 3rd party software to present the data in the correct format for the particular use case.

13.4.3.2 Available Technologies

The Juniper Mist access points have the following inherent technical capabilities:

- Wi-Fi (up to 802.11ax/Wi-Fi 6e)
- BLE – vBLE arrays
- 802.11mc – for AP self-positioning on floor maps
- The IoT Port can be used for various digital and analogue sensor connectivity which may have use cases in RTLS (AP43 model only)

13.4.3.3 3rd Party Integrations

Juniper lists the following technology partners that deliver asset visibility and mobile engagement that are specific to healthcare:

- Airial WiFi Motion Analytics
- Agreefy
- AiRISTA Location. Insight. Visibility.
- Blyott
- Connexient
- Converge Technology Solutions
- Criticalarc
- Drager
- Energous
- Entappia
- Forkbeard
- Gozio Health
- Guard RFID
- HID
- Inpixon Indoor Intelligence
- IP Fabric
- Kloudspot
- Kontakt.io
- Mapwize
- Medrics
- PenguinIN
- Phunware
- Solis Energy
- Speak to IoT
- Spreo
- Tag-N-Trac

- TAGNOS
- Thinaer
- Vocera

13.4.3.4 Minimum Requirements

The Juniper Mist AP firmware version 0.8 or higher is required to support the RTLS use cases. If the vBLE features are required for tracking and mobile engagement applications then and AP with vBLE capability must be selected, which includes the AP45, AP63, AP43 and AP33 in the current range.

13.4.3.5 Components for an RTLS solution

Any Juniper Mist access point with the built in Virtual Bluetooth (vBLE) capability provides the RTLS infrastructure which third-parties software and tag vendors can take advantage of to provide a full RTLS solution.

13.4.3.6 Design Criteria for RTLS Solution

A good and reasonably dense wireless AP design will result a workable RTLS design utilising the vBLE array in each access point. The Mist portal allows for vBLE coverage planning by using the uploaded, scaled plans and correct AP placement, the operator can place and see the predicted BLE coverage from virtual beacons:

- Enabling the 'show Virtual Beacon Coverage' option
- Add virtual beacons to the plan
- Edit Transmit power to 17dBM and ensure that the "near" value is 14.3 meters
- When these virtual beacon location are saved you can view the coverage predicted on the plan

Note: for room level accuracy an AP is required in each room.

13.4.3.7 Support for outdoor implementations

Juniper offer outdoor solutions for Virtual BLE and standard BLE deployments.

13.4.3.8 Real World Examples

The Orlando Veterans Administration Medical Center - https://www.juniper.net/us/en/customers/orlando-veterans-administration-va-case-study.html

13.5 RTLS Vendors

It is understood that almost all implementations of RTLS in the Healthcare space would be based on and existing or new Wi-Fi vendor's infrastructure. Consideration is advised for refinement of solutions, if required, by utilising niche RLTS vendors who can enhance infrastructure, leverage non-Wi-Fi technologies, healthcare focused devices and improve experience.

13.5.1 HID Global

https://www.hidglobal.com/solutions/healthcare-medical-asset-management
https://www.hidglobal.com/solutions/rtls-healthcare

HID Global is a leading provider of RFID active & passive tags and BLE5 beacons and tags. To support these HID Global offer RFID Reader guns and BluZone BLE5 RTLS software. The BLE5 tags and beacons can be used by third party Wi-Fi vendors such as Juniper for a complete solution. HID Global tag range is more extensive than the Wi-Fi manufacturers like card badge beacons. The company also has beacon battery management sensors that show battery life on installed beacons.

Infant tracking and health monitoring are also solutions provided.

HID Global's RFID tags and reader solution is very mature and is used in a wide range of markets including Healthcare, Manufacturing and hazardous environment.

13.5.2 Ubisense

https://ubisense.com/healthcare

Ubisense is a UK company that specialises in RTLS solutions for industry and Healthcare. They support Asset tracking and workflow analysis. Ubisense also can provide hardware that supports not only Wi-Fi and BLE5 but also Ultra-Wide Band (UWB), Active and Passive RFID and GPS and 5G. Ubisense can supply tags for each of these technologies. Its proprietary UWB Dimension 4 tags provide combinations such as UWB + BLE5, UWB + GPS and UWB +Wi-Fi. Ubisense Smartspaces location software platform can provide real-time location information and workflow efficiency analysis.

13.5.3 Securitas Healthcare

https://www.securitashealthcare.com/hospitals-clinics

Formerly Stanley Healthcare, they support focused healthcare asset tracking, patient & staff workflow using both Wi-Fi and BLE5 technology. Securitas have point solutions for infant and wandering patient functions that integrate with the larger asset tracking solutions. Securitas also offer integrations with other healthcare point solutions as well as Wi-Fi vendors. Also available are staff patient protection and environmental alerting features.

13.5.4 Blyott

https://www.blyott.com

Blyott have exhibited expertise in the healthcare asset tracking space offering BLE5 tags of convenient formats. Blyott does not offer a mapping function and uses single BLE5 sensors as locators to return room Ids as locations. With an Open API integration with most asset management systems, Blyott offers a convenient and simpler healthcare focussed asset tracking solution. Blyott also integrates with third party access points with BLE5 radios to deliver telemetry to its cloud management solution. Tags can be used to enable triggers for integrated software activities.

13.5.5 Indoor Atlas

https://www.indooratlas.com/platform

Indoor Atlas specialises in wayfinding solutions across market sectors as a software solution integrating with leading Wi-Fi vendors. Indoor Atlas supports hybrid location sensing using both BLE5 and 802.11mc FTM and using device-based metrics such as air pressure and internal GPS.