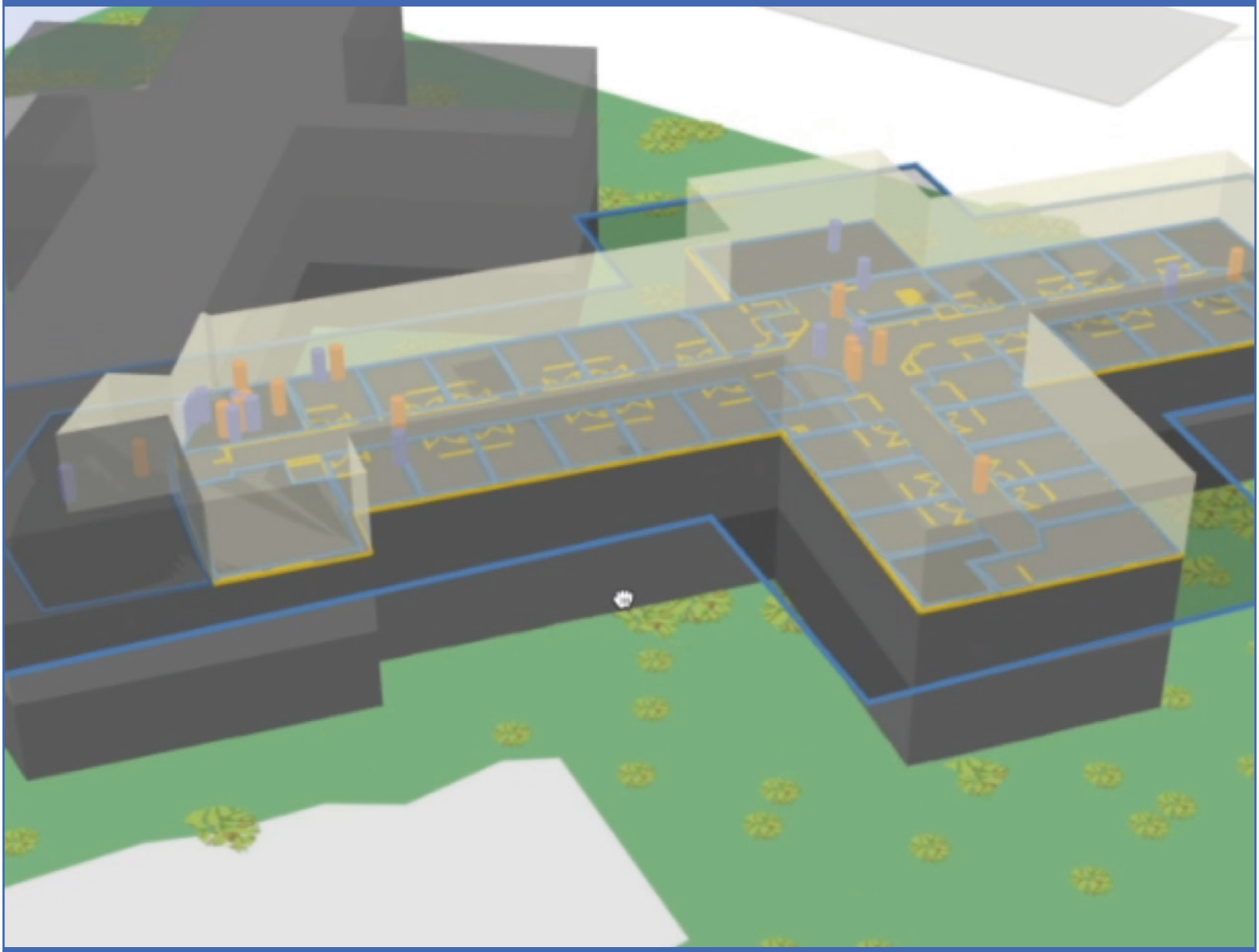
GISinc Indoor Positioning Guidelines



esri Partner Network Platinum

1 Overview

This document will provide guidelines around indoor positioning technology and infrastructures needed to support floorplan mapping, wayfinding, routing and blue-dot positioning. Use this document as a general guide for establishing best practices and baseline comparisons for implementing indoor mapping for your organizational requirements.

2 Questions

It is important to answer a few questions before purchasing or deploying indoor technology for mapping, tracking and monitoring. The following questions will be used to help determine the best technology and walk through the possible options available for implementing indoor technology.

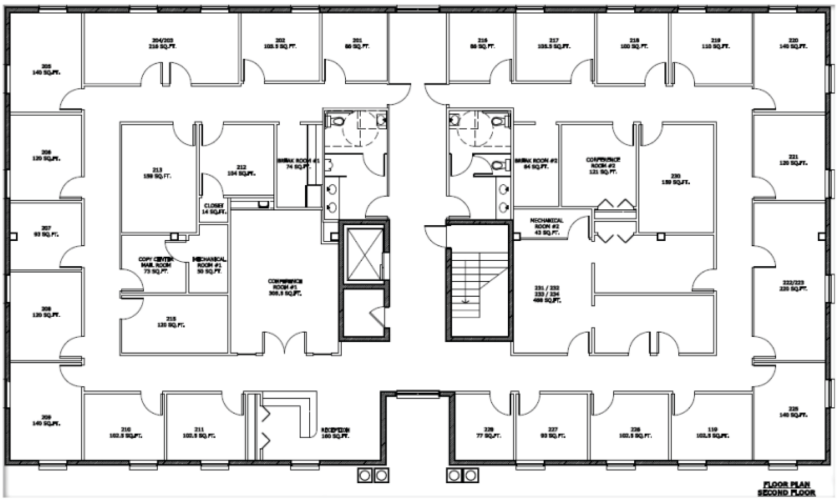
- What maps will be required?
- What will be monitored?
- What level of positional accuracy is needed?
- How often is monitoring required?
- What can the facility support for indoor technology?
- Are there other business systems that need integration?

Let's take each question and define the possible options.

What maps will be required?

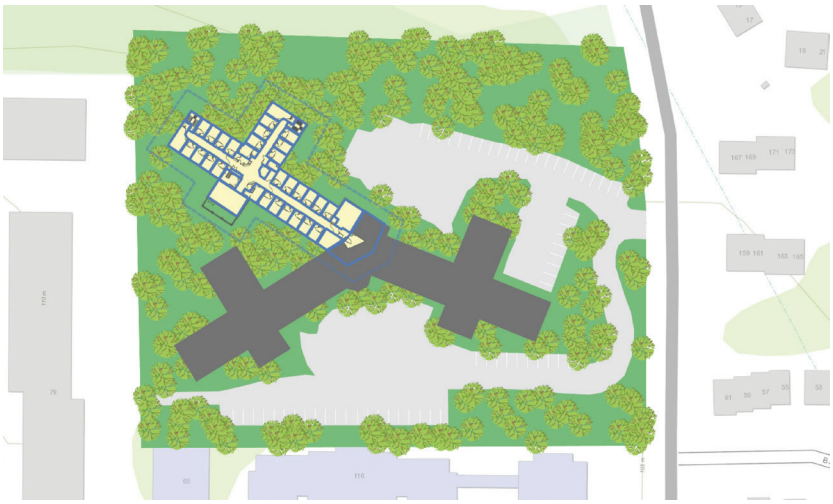
When it comes to indoor mapping there may be a misunderstanding that only a floor plan reference map is required. However, if your project requires the user of the system to move from outdoors to indoors or through a campus-like environment then you need to make sure to include maps that reference both spaces.

The following image is an example of an indoor referenced map of a floor plan only, the user of this system would start indoors and typically this type of map returns Cartesian coordinates in the form of X and Y.



However, in some circumstances a floor plan map is combined or registered with a topographic map which returns projected coordinates in the form of Latitude and Longitude like the flowing map.

In either situation, reference maps are a necessity for indoor mapping. This is what allows location information to be displayed and referenced visually. There are many ways to create and manage these reference maps as well as taking advantage of online mapping services as a supplement to floor plans until one can be created.



Esri's ArcGIS Online is an excellent starting place to learn more about these types of services.

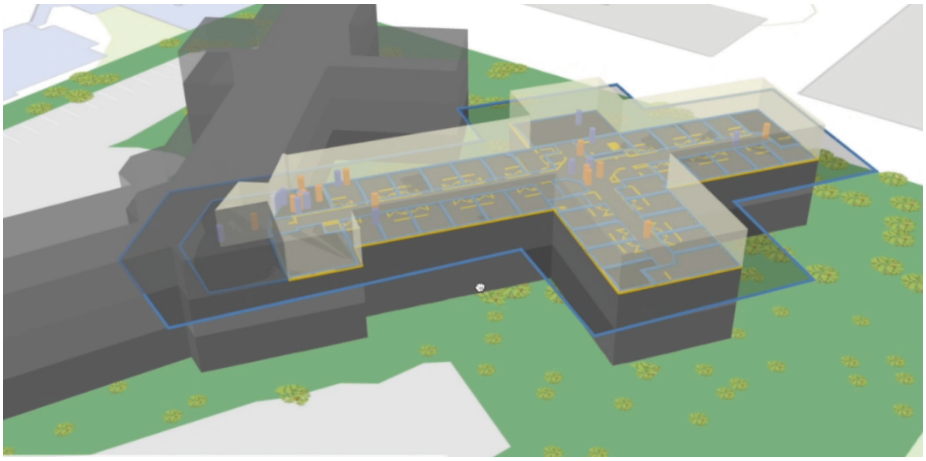
When it comes time to creating and managing floor plan maps, you can use tools like ArcGIS Desktop to help create these floor plans either from scratch or by importing CAD or raster files.

Another consideration is the use of 3D reference maps. 3D brings a different level of visualization and understanding of multi-floor structures. 3D representations of floor plans can be created and managed in different solutions such as Esri's City Engine or ArcGIS Pro. To learn more about building 3D views visit 3D GIS.

What will be monitored?

Typically, this boils down to either people or assets. If monitoring assets a BLE (Bluetooth Low Level Energy) tag is commonly used and attached to the asset. There are several BLE tags to choose from but typically these tags would have a battery lifespan of 2-4 years, lightweight and water resistant devices that can be attached to assets through:

- Badges
- Wristband
- Sticker
- Key Chain
- Lanyard
- Etc.



Some manufactures use motion detection and accelerometers to activate the tag when in use to extend the battery life as well as detecting direction of movement. Depending on the requirements some tags are also equipped with an SOS or Alarm function, meaning the user can simply squeeze the tag and an alarm message is sent to the receiver or Beacons. BLE tags can even be used to monitor people and is often used in health care centers.

However, if the desire is to assist individuals using smartphones with wayfinding and navigation indoors then you can use the smartphones Bluetooth and/or WiFi capabilities. The only concern here is with the level of positional accuracy needed, which leads to the next question.

What level of positional accuracy is needed?

There are basically three types of positional accuracy to consider when it comes to indoor mapping.
1. Relative
2. Proximity
3. Something Better

Each, including something better, is determined by the requirements of what you are monitoring and the technology deployed. There are numerus types of technology that supports some form of positioning from Magnetic to video. This chart illustrates the commonly used positional technologies and estimated accuracy.

Technology	Accuracy
VLC (Visual Light Communication)	1-3 cm
VCC (Visual Camera Communication)	10 cm
Bluetooth	1-3 m
WiFi	3-10 m

It is important to fully understand the level of positional accuracy required and the ability of the technology to support this accuracy prior to implementing any devices as it could be an expensive challenge to change out later.

How often is monitoring required?

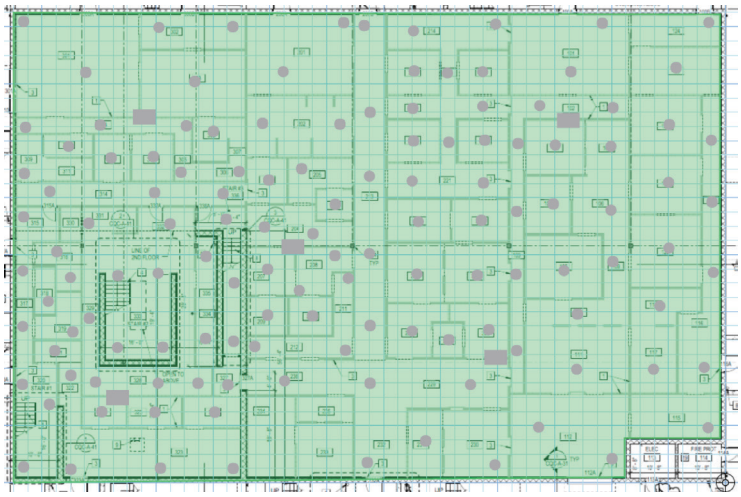
This question refers to the frequency at which a sensor is sending a signal to an access point or beacon. Sensors could range from BLE tags to Smartphones devices and could be near real-time to something less. It is hard to achieve real-time monitoring as there is always a delay between the time it takes a signal to travel from the sensor through the system to the calling application such as smartphone navigation tool. It is important to implement the right type of sensor technology to achieve the relative frequency desired.

Signal strength and frequency impacts battery life of the device. For example; a BLE tag sending a signal every second with an 8 hour a day usage can last up to 2 years before needing to change the battery. Smartphones on the other hand are hard to predict because you can't dictate what other applications and services are running on the device that could be depleting the battery life.

What can the facility support for indoor technology?

This refers to the building infrastructure needed to support the indoor technology. Beacons or Access Points typically require hardwired power to function efficiently for long periods of time. There are however options for battery operated devices. These typically have a life span of 2-4 months before the battery needs to be replaced depending on the manufacturer.

It is important to fully understand the layout of the facility needing to be mapped and monitored to the level of where Access Points would be placed to maximize coverage and gain the positional accuracy required as well as providing adequate power needs.



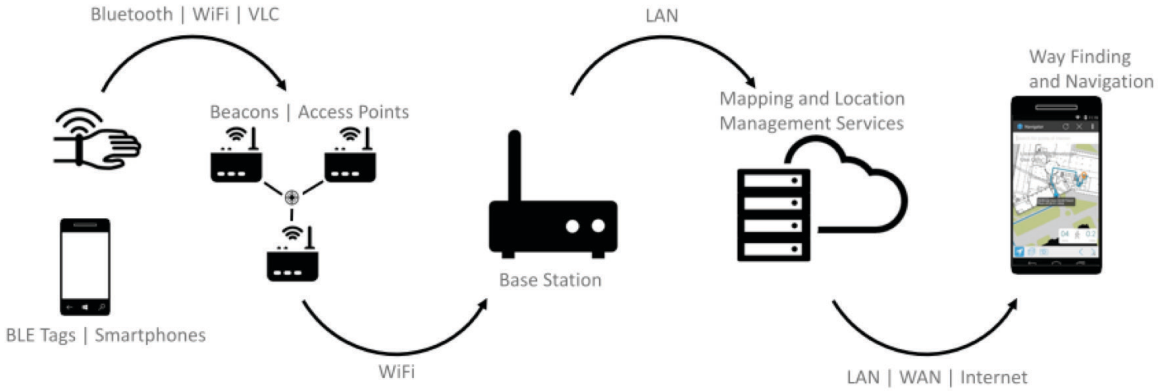
This graphic is an example of a 20,000-squarefoot facility. 130 access points/beacons where needed for adequate coverage.

Are there other business systems that need to be integrated with?

We've seen an increase in the need to integrate corporate business systems with indoor mapping technology. This is also referred to as the IoT or Internet of Things of indoor mapping. One example would be to tie into the security systems of a facility so as a user navigates through a building, key fobs or security check points can be integrated into the user's experience. Another example would be to provide geo-fencing that would monitor access to a conference room or other areas of concern for activity in that area.

3 Infrastructure

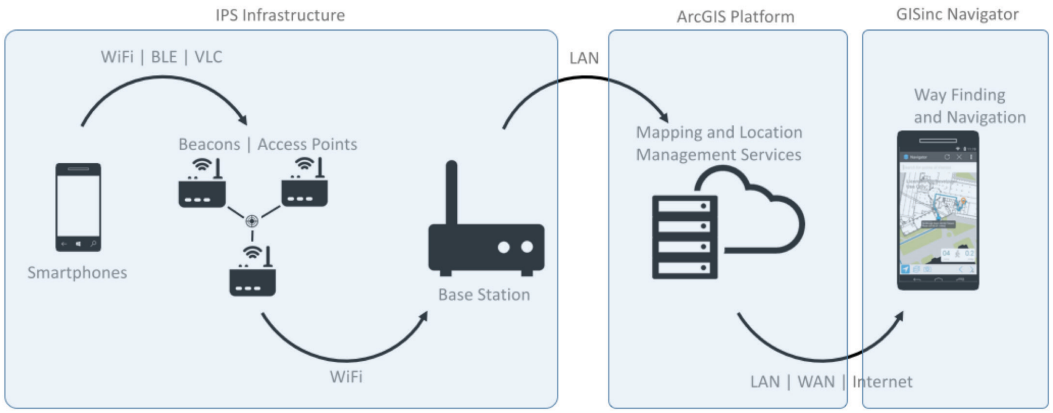
Below is a typical architecture design illustrating an indoor mapping solution.



Each component within the platform could have several options depending on the requirements discussed above. For the purposes of this document we will outline a typical deployment scenario.

Deployment Examples

- GISinc Navigator
  - - Provides indoor positioning, navigation and analytics
- ArcGIS Platform
  - - Provides a complete mapping and location management platform
- IPS Infrastructure
  - - Provides a complete infrastructure for capturing high frequency and accurate blue-dot locations



It is important to understand that not all facilities and indoor mapping requirements are the same and it is imperative to be flexible within the platform to support multiple types of scenarios.

4 Detailed Infrastructure Components and Communication

The key components behind indoor mapping and navigation are: positioning, navigation and mapping. This section will outline the options for these critical components. For the purposes of this document BlooLoc and Acuity's Atrius platforms will be referenced.

Positioning

Positioning, which is also known as trilateration, can take place at the local (on-premise) level through a base station or in the cloud (off-premise) through IPS platforms such as Acuity's Atrius and BlooLoc location based service offerings. Typically, when implementing BlooLoc infrastructure alongside GISinc Navigator, the positioning is handled by BlooLoc services. Then the coordinates in X, Y format are sent to Atrius Services to first, perform the projection needed to transform the X and Y coordinates into Latitude and Longitude coordinates and then stores the information in a data warehouse for analytical processing. Finally, the data is published as a "blue-dot" service and is accessible through an API or REST services.

Navigation

Navigation is made possible through a developed network dataset and routing solvers. Network datasets would consist of linear features representing preliminary and secondary pathways to and from points of interest, accessibility variables such as ADA compliant, physical limits such as pathway heights, one-way door access and finally security and safety considerations. Navigation is also a process that happens in real-time to give up-to-time accurate routes as the position changes.

Navigation is typically performed on the device requesting the route. This is the case for GISinc Navigator, all routing and navigation is processed locally on the smartphone or tablet.

Mapping

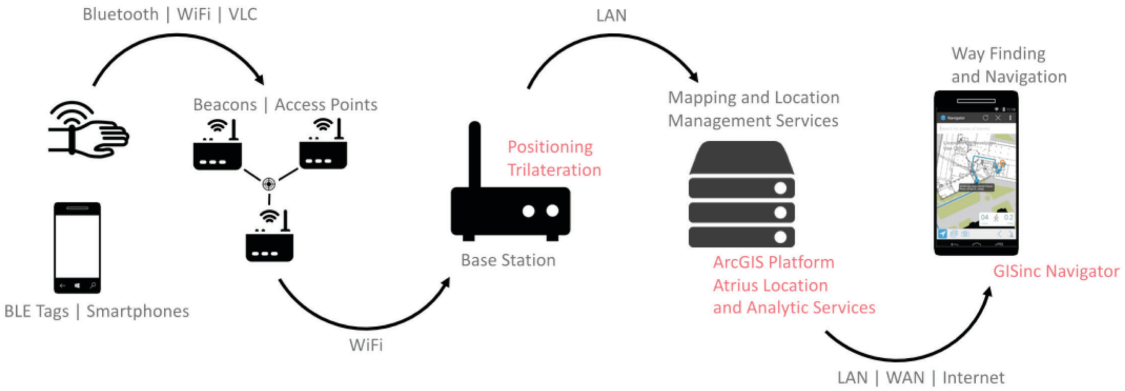
Mapping consists of floor plan base maps as well as detailed facility maps combined with blue-dot location and navigation routing with turn by turn directions. These mapping components can reside and are accessible from multiple locations and services. Esri's ArcGIS Platform is the choice for all mapping related functionality.

The ArcGIS Platform can be deployed internally to an organization as an on-premise solution or external to an organization as a cloud-based solution. Esri also offers an infrastructure, as a service, called ArcGIS Online; where Esri manages the complete ArcGIS Platform in the cloud for an organization.

Deployment Examples

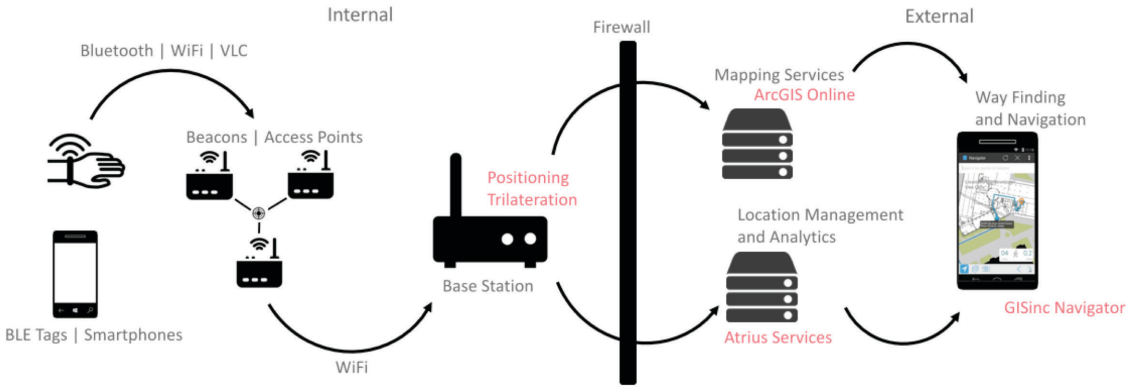
As illustrated above, the solution platform could be deployed entirely as an on-premise offering.

On-Premise Solution



At this point, each component can either be on-premise on in the cloud therefore multiple combinations of component architecture could take place.

Hybrid Solution



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