



# Hardware Free Guide

The Deep Location®  
Company

[www.pointr.tech](http://www.pointr.tech)

# Table of contents

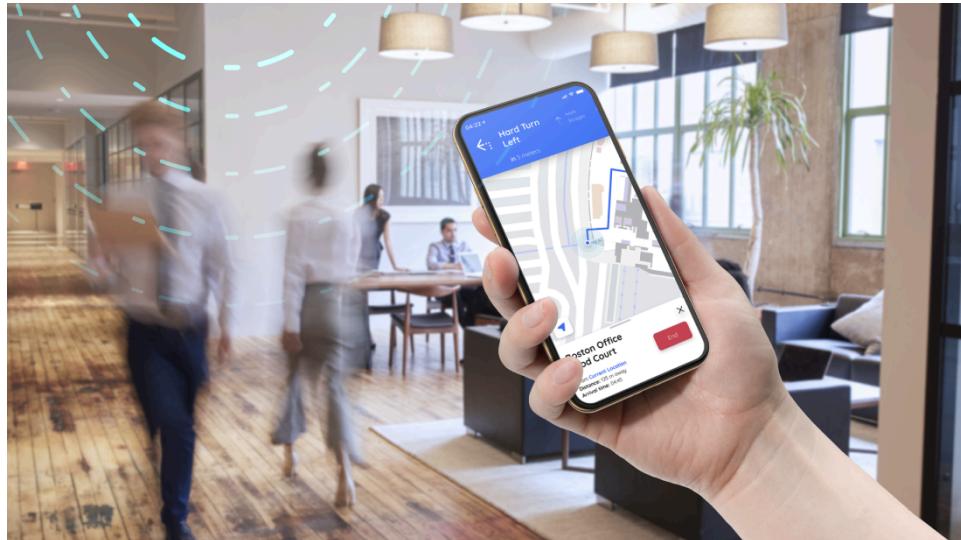
- Introduction
- How does a hardware-free indoor location system work?
- Promise versus reality - does hardware-free truly work?
- Hardware-free versus hardware-based systems
- Planning for hardware-free location - questions to ask
- Conclusions
- How can Pointr help?

# Introduction

The past twenty years have seen the widespread adoption of smartphones and other affordable devices that provide two key navigational features: rich, detailed digital maps; and GPS receivers that know a person's "blue dot" location on these maps. These twin technologies have given rise to an explosion of powerful new applications. Some of these — turn-by-turn driving directions — were obvious, but many were unforeseen and their value clear only in retrospect.

But GPS has one major drawback: it rarely works indoors. So what can companies do if they want to enable a similar set of applications and benefits for large indoor environments?

Alternative technologies that can accurately identify and track the real time location of a visitor — or more precisely, of that user's smartphone or similar device — have been developed and improved markedly in the last decade or more. The most effective of these systems rely upon hardware such as beacons which are affixed throughout a location and can then gauge a user's position using triangulation, the angle of arrival of signals, the user device's sensors, and other techniques.



Recently, some vendors have attempted to provide indoor location *without* any building hardware infrastructure. This is obviously an attractive proposition. But can hardware-free indoor locations really deliver the same accuracy and reliability? In this guide, we'll cover everything there is to know about the current state of hardware-free indoor location solutions, including the science behind them, their effectiveness compared to systems that

rely upon hardware, and ultimately whether you should consider a hardware-free solution for your indoor location system.

*“At Enlighted we evaluated numerous solutions for indoor positioning. Our initial exploration into fingerprinting solutions revealed that this technology required recalibration every 4-8 weeks, which undermines both efficiency and sustainability. Pointr’s solution eliminates the need for such fingerprinting and maintenance, providing an instant and highly accurate blue-dot experience. This advancement truly embodies the transformative potential of AI and IoT in smart building management” - Colm Nee, CTO, Enlighted, a Siemens company*

## How does a hardware-free indoor location system work?

First, it's important to understand that there are two different interpretations of the phrase “hardware-free:

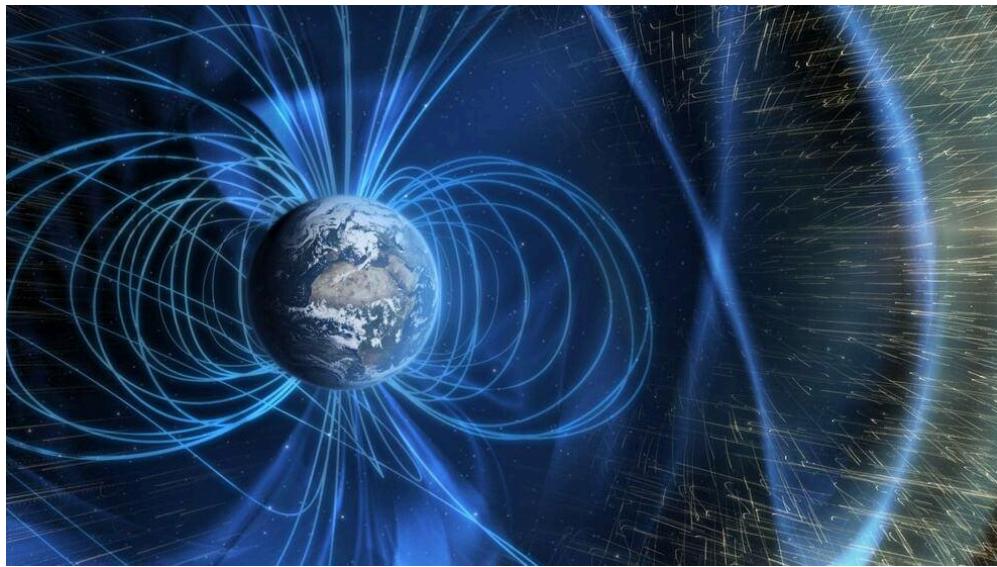
- **No-Hardware:** solutions that require no installed hardware whatsoever, instead relying upon naturally-occurring signals such as geomagnetic readings
- **Low-Hardware:** solutions that don't require any *additional* hardware to be installed within a building, but make use of hardware that's typically already there, such as WiFi access points. This is analogous to GPS: no new hardware (other than a receiver) is needed, but the existing network of GPS satellites is essentially. Low-hardware solutions are sometimes augmented with extra infrastructure, blurring the line between “low-hardware” and “hardware-based” solutions.

### No-Hardware solutions

The most common approach to no-hardware location exploits Earth's naturally-occurring geomagnetic field. This field varies subtly from place to place, creating the possibility that a “map” of these signal variations can be constructed by assembling a comprehensive set of signal readings throughout an indoor space. This process is called *fingerprinting*. Then a smartphone running software that has access to this map, and which has adequate geomagnetic signal sensors, can in theory pinpoint its own location.

In practice, the effectiveness of geomagnetic fingerprinting depends critically on two presumptions:

1. That the geomagnetic signal is very stable, so that the geo-signal map is reliable over time..
2. That geomagnetic signals vary with the required level of precision. For example, if we need accuracy to within one meter, geomagnetic signals must measurably vary over that distance to be a plausible solution.

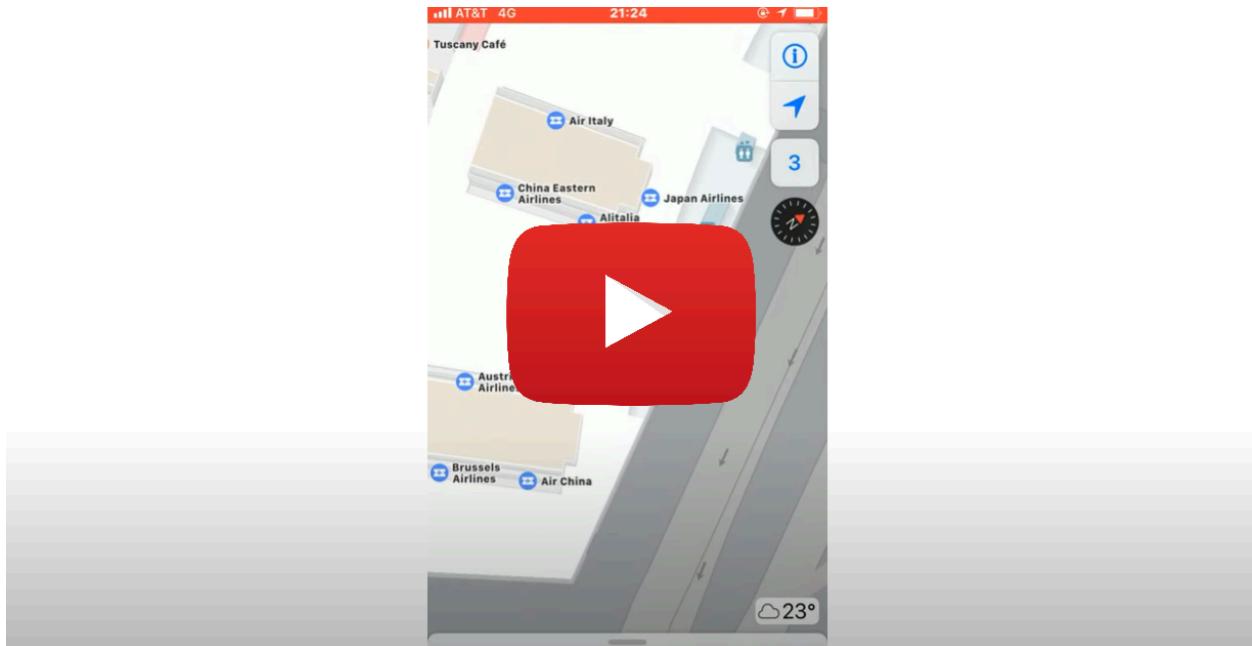


A very different no-hardware approach is called dead reckoning. For this method, a person starts from a known initial location — a store entrance, for example — and then uses a smartphone's sensors (accelerometer and gyroscope) to try to keep very careful track of the person's movements, both distance and direction, from there. Combined with information about walls, corridors and other map features, dead reckoning tries to continuously update location. But in practice, the sensors on a smartphone on their own aren't nearly precise enough to accurately measure distance and heading. Even small errors are rapidly compounded and multiplied. As a consequence, dead reckoning without the support of hardware sensors in the building is rarely used in practice.

## Low-Hardware solutions

Though often advertised by vendors as “hardware-free”, this approach actually does rely upon hardware. Their distinction is that it relies only on hardware that’s typically already in a building’s existing infrastructure. Most common are WiFi access points, but low-hardware solutions can also take advantage of smart LED lights (which often have useful built-in beacons, usually Bluetooth-based) if present.

Low-hardware approaches typically take one of two forms. The first is similar to the no-hardware solution outlined above, but in this case the fingerprinting map is based not on geomagnetism, but rather on signals from WiFi access points and other installed devices, each of which is unique.



*An illustration of a fingerprinting-based solution*

The second approach is more dynamic: the fixed position of each signal-emitting device is carefully measured. Then, as a visitor moves through a room, their smartphone “listens” to the relative strength (or notes of the absence) of every signal expected to be received. Using this information, software tries to triangulate position in real time.

*“We faced issues with accuracy and the stability of the blue dot in previous systems we tried - when it’s for accessibility, you need accuracy to ensure safety. The technology simply wasn’t good enough. Then we met Pointr, and our partnership enabled us to meet our objectives” - Sylvain Denoncin, Okeenea*

# Promise versus reality: Does hardware-free truly work?



As discussed above, no-hardware and low-hardware approaches to indoor location have considerable appeal. But how well do they work?

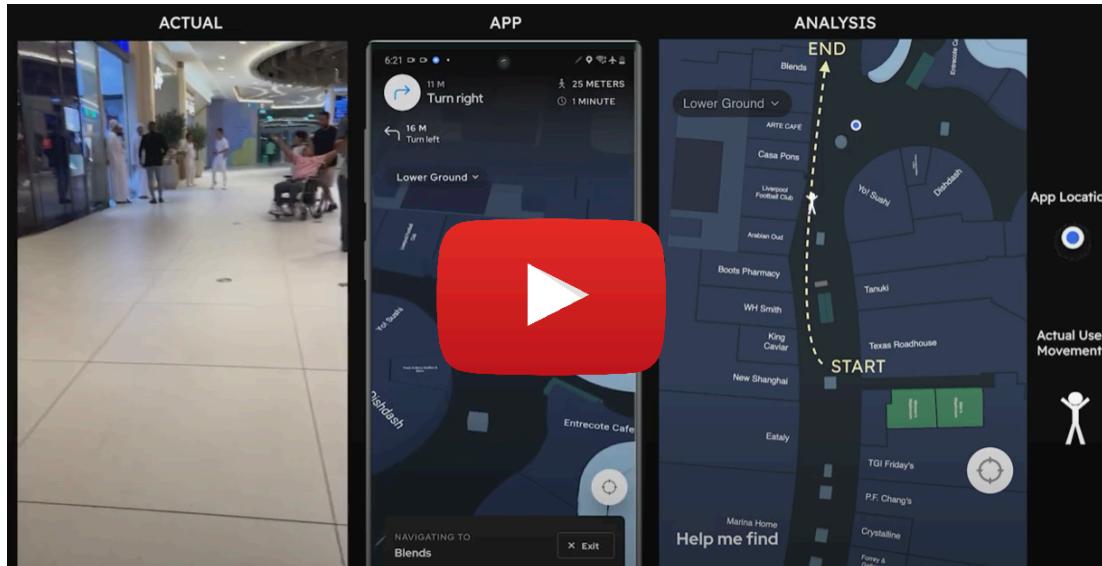
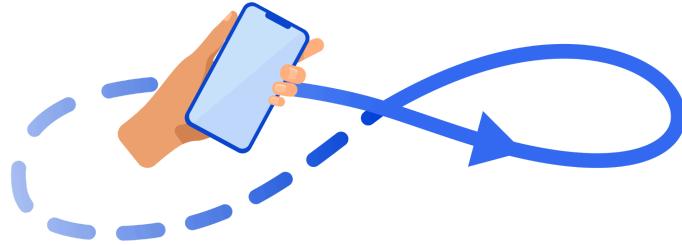
## No Hardware Solutions

### Advantages

- **No hardware cost** - Though location-assisting hardware is rapidly becoming cheaper, true no-hardware solutions offer the advantage of not requiring this investment.
- **No impact on the building** - In some cases, hardware installation might not be feasible, in which case a no-hardware solution makes sense.

### Disadvantages

- **Rapidly deteriorating accuracy** - Careful geomagnetic fingerprinting can yield a signal map that's useful and accurate when launched. But the earth's geomagnetic emanations aren't perfectly stable and the mapped environment often changes over time such that the map quickly becomes outdated, badly compromising accuracy. Moreover, the geomagnetic approach can get tripped up in multi-floor spaces or when trying to infer device orientation.
- **Costly, time consuming setup** - Counterintuitively, the time and money required to deploy a no-hardware solution is usually *more* than for a hardware-based approach, because the site survey and fingerprinting process are very painstaking and laborious.
- **Not scalable** - The combination of onerous setup and deteriorating accuracy — which demands that the setup process be repeated regularly — means that no-hardware solutions are inefficient and don't scale to large spaces or a portfolio of buildings.
- **User calibration required** - In many cases, end users are required to manually calibrate their device every time they want to use indoor positioning. This usually means waving their phone several times in a figure eight pattern.



*This video shows the reduced accuracy of a no-hardware solution after a period of time..*

*“One Pointr deployment we worked on was replacing a fingerprinted system. The system had worked to begin with, but had quickly degraded, and by the time we spoke with them the retail space were having their entire multi-million square foot area manually re-mapped every couple of months just to achieve basic results. With Pointr, they were able to achieve better accuracy, and needed none of the on-going maintenance” - Mustafa Duran, IPERA*

## Low Hardware Solutions

### Advantages

- **No new hardware costs** - Because low-hardware solutions depend only on what is already installed, no new hardware costs are incurred.
- **May be more stable and scalable than geomagnetic fingerprinting** - Low-hardware solutions that employ the fingerprinting approach are fundamentally subject to the same stability and scalability challenges of geomagnetic wayfinding. But those that use triangulation based on signal strength tend to be stable and therefore can scale well.

### Disadvantages

- **Limited accuracy** - Low-hardware solutions rely chiefly on WiFi because these access points are omnipresent in modern buildings. But because they aren't designed to help a receiving device infer its location, WiFi tends to have poor accuracy.
- **Insufficient density** - On a related note, WiFi access points and other devices that low-hardware solutions rely on are installed at places and in numbers that make sense for their intended purpose. But this is usually insufficient for use as an indoor location infrastructure.

# Hardware-free versus hardware-based systems

No approach to indoor navigation is ideal in every respect. The most appropriate solution depends on your needs and your environment. Here's a summary of how the approaches we've discussed stack up:

	No hardware (geomagnetic)	Low hardware (WiFi)	Hardware (BLE beacons)
<b>Blue dot accuracy</b>	+/-5m (assuming very recent fingerprinting)	+/-10m	1-3m
<b>Maintenance schedule</b>	Location resurvey at least every year, ideally more regularly as results degrade	Regular check-ins due to likelihood of access points being moved	Check in after 2 years - beacon battery life expected to last 4-5 years
<b>Setup overhead</b>	Fingerprinting survey (~10 days for 1 person surveying average mall)	Initial configuration of access points	Beacon installation
<b>Setup cost</b>	\$\$\$	\$	\$\$
<b>Core benefits</b>	<ul style="list-style-type: none"> <li>Truly hardware-free</li> </ul>	<ul style="list-style-type: none"> <li>No additional hardware installation</li> </ul>	<ul style="list-style-type: none"> <li>Highest accuracy</li> <li>After initial setup, lowest maintenance</li> <li>Most scalable solution</li> </ul>
<b>Core disadvantages</b>	<ul style="list-style-type: none"> <li>Rapidly degrading results necessitate regular refreshes of fingerprinting map</li> <li>Secondary signals (such as compass readings) are unreliable, meaning orientation accuracy is poor</li> </ul>	<ul style="list-style-type: none"> <li>Entirely dependent on amount of hardware already installed</li> <li>Not truly hardware-free</li> <li>Limitations on iOS devices due to Apple restrictions</li> </ul>	<ul style="list-style-type: none"> <li>Hardware must be installed (can be used in addition to existing hardware)</li> </ul>

# Planning for hardware-free location - questions to ask

Because indoor location technology is developing rapidly, selecting the right solution and vendor can be daunting. Here are some questions you should ask before committing time and money to a deployment or even a pilot program:

- **Is the proposed solution really ‘hardware-free’?**
  - Some so-called “hardware free” solutions are in fact hardware based, but rely on existing infrastructure rather than installation of hardware. This sounds good, but as explained doesn’t meet many customer’s precision requirements. Moreover, some vendors market hardware free solutions but ultimately need to deploy new hardware because of insufficient accuracy.
- **How often does the system need to be recalibrated?**
  - All fingerprinting solutions, whether based on geomagnetism or other electromagnetic signal patterns, share the disadvantage that the signal map degrades over time because these signals are inherently unstable. So it’s important to know what to expect about the cost and frequency of recalibration, and the accuracy you can expect between these efforts.
- **What’s the proof?**
  - It’s easy to make accuracy claims, but reputable vendors back up these claims with field-tested data from real world deployments.
- **Is a trial an option?**
  - Pilot programs are standard practice in the indoor location market, and any vendor confident in their solution should be willing to offer this before you make a long-term commitment.
- **How long does deployment take?**
  - Fingerprinting in general, and geomagnetic-based systems in particular, can be costly and time consuming to set up because of the complexity of site surveys. This issue is always important — especially because of the need to recalibrate regularly — but especially so for customers with many sites.
- **Does the vendor offer a broader portfolio of products and services?**
  - Indoor location is essentially useless without complementary offerings. The most obvious is digital maps, but there are also other important capabilities: content management systems, integration SDKs, APIs for interfacing with third-party systems, customer service, and more. Make sure your vendor has the full solution you will need, today and in the future.



# About Pointr

Pointr has over a decade of leadership in indoor navigation solutions. We've built the industry's most robust mapping and navigation solution, underpinned by our AI-based [Deep Location](#) technology and our [MapScale®](#) tool. We've built and manage some of the world's largest deployments for world-class customers in retail, workplaces, hospitals, airports, resorts, and events.

If you're considering your options for an indoor location solution, [get in touch](#) for expert advice and to learn more about how Pointr can help you meet your business goals.

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