WHITE PAPER

STATE OF THE LOCATION INDUSTRY

PRESENTED BY mappedin

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INTRODUCTION

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With indoor positioning systems (IPS) constantly evolving, it can be challenging to know which solutions are the best for your business. IPS enabled platforms provide consumer insights like traffic patterns and dwell time, at a scale and accuracy never before achieved. These new insights enable businesses to provide additional benefits such as highly accurate navigation, targeted promotions, predictive search, and more.

While we don't have a stake in, nor are we trying to solve for indoor positioning, we do have a unique, front row seat to the rapid evolution of this market. We've written this piece to provide guidance on the IPS solutions available and how they each compare. We will dive into the leading IPS technologies, how they work, and evaluate their respective strengths and weaknesses. Ultimately we hope this information helps you determine which IPS solution is best for your business.

CURRENT LANDSCAPE

It's truly amazing to see the range of solutions being used to create the blue dot experience for indoor spaces. Below is a review of the current options and an explanation of how they work and differ:

POINT CLOUD

Stereo cameras enable users to capture three-dimensional images with the use of two or more images. Google initially used stereo cameras in Project Tango, allowing developers to use 3D mapping and augmented reality to calculate positioning by point-cloud geometry. Apple has since introduced the method of fingerprinting, creating a grid of a venue and using constant updates from your phone to update the accuracy overtime.

WI-FI

Existing Wi-Fi access point providers (APs) like Cisco and Aruba have added geo-fencing and proximity capabilities to their enterprise offering. Users on the network running an enabled application can determine their rough location indoors. Apple's IPS utilizes the radio frequency (RF) patterns of your Wi-Fi access points enabling an infrastructure free solution.

INERTIAL NAVIGATION

Many companies, including chipset manufacturers, have used onboard motion sensors built into every cell phone to perform what is called "inertial navigation" — guessing positions using physical motion sensing and last known position.

BEACONS

Apple and Google released Bluetooth Low Energy (BLE) specifications for iBeacons and Eddystone beacons, respectively. These offer similar proximity capabilities to Wi-Fi APs.

SMART LIGHTING

More novel approaches continue to crop up, such as Philips using smart lighting to transmit location IDs via high-frequency switching, or others using the Earth's EM field as a universal compass.

SENSOR FUSION

Sensor Fusion is an approach to Indoor Positioning that combines multiple of the above technologies to provide an even more accurate experience. We will cover more on Sensor Fusion later in this piece.

OUR EVALUATION

Rather than get lost in the technical details,
it is easier to simply evaluate performance.

✓ REAL ACCURACY (VS. THEORETICAL ACCURACY)

What is the realistic expectation under normal or sub-optimal conditions? For reference, accuracy of assisted GPS is approximately three meters outdoors.

✓ COST TO ACHIEVE DESIRED PERFORMANCE

How much will it cost to implement, own and maintain? For example, your implementation and ownership costs may be low, but the system requires a lot of maintenance at an additional cost.

✓ RESPONSE TIME

How long does it take for the system to respond? For example, on-device calculations are faster than server-side ones, because of the latency involved for the signal to travel there and back.

✓ RELIABILITY

How well will the solution function indoors? New systems sometimes get a pass when they start out buggy, but navigation is often mission critical.

TECHNOLOGY	ACCURACY	COST	RESPONSE TIME	RELIABILITY
POINT CLOUD	★★★	★★★★	★★★	★★★
WI-FI	★★★	★★★★	★★★	★★★
INERTIAL NAVIGATION	★★	★★★★	★★★★	★★★
BEACONS	★★★	★	★★	★
SMART LIGHTING	★★	★	★★	★★★★
SENSOR FUSION	★★★★	★★★★	★★★★	★★★★

Outstanding ★★★★ Good ★★★ Satisfactory ★★ Poor ★

** See Appendix on pages. 8-10 for measurement justification

OUR RECOMMENDATION

SENSOR FUSION WITH APPLE IPS

Combining multiple indoor positioning technologies, otherwise known as the method of Sensor Fusion, is going to give you the most accurate and reliable positioning, allowing you to choose technology that will work best in your specific space.

Mappedin has worked with a variety of IPS (Indoor Positioning Systems) and providers. Regardless of venues that use Bluetooth beacons, inertial nav, geomagnetic, Wi-Fi, or some combination of these, it's important to work with a vendor that understands the benefits to each and, ideally, someone who can work with a method of sensor fusion (a combination of as many of these as possible).

Sensor Fusion for indoor location is a relatively specialized capability and has only become readily available in the last 10 years. We're just starting to see real implementations of sensor fusion solutions — early trials always relied more on external geo-fences than internal sensors. Another reason is because smaller sensor fusion companies don't have the same marketing budgets as the big, proprietary infrastructure companies.

> You may be skeptical. Why have you heard so little about sensor fusion and so much about every other solution we've outlined?

They have less to gain, too, since their value proposition is to save you infrastructure spend. However, Apple is leading the charge by making these systems free. Better products win, eventually. Indeed, we've heard from many customers recently that "beacons are dead." Everyone has tried them and are moving on. Some are working with vendors that have good track records and honest solutions. Yet others are being pitched new "silver bullets" that promise to do everything beacons were supposed to do, with none of the drawbacks. We personally remain skeptical of the latter.

MAKING THE RIGHT CHOICE

MAPPEDIN'S BLUEDOT EXPERIENCE

While we've concluded that Sensor Fusion is the best option today, we realize that it's important to continue to track the evolution of these technologies. Our goal with this piece is to provide you with the information required to make an informed decision on indoor positioning technology. As these technologies evolve and new ones get added, we will continue to offer our viewpoint on how they stack up against one another.

THE PLATFORM FOR SPACES

Headquartered in Waterloo, Ontario, Mappedin is the leading platform for indoor spatial data management, digitizing venues, and building best-in-class indoor mapping experiences. Built for scale, our flexible platform and enterprise grade tools enable us to work with leading operators and developers around the world.

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APPENDIX

POINT CLOUD

ACCURACY The initial “fingerprint” can be generated manually. After that, a critical mass of active users is required to contribute back data. Any discrepancies, such as a new poster on the wall, are integrated into the master fingerprint. With a reliably accurate fingerprint, positioning can be accurate to <1M.

COST Best of all, no additional infrastructure is required. Initial setup may require a contract from an approved vendor, but ongoing usage needs only your customers’ phones.

RESPONSE TIME The calculation will almost certainly still happen server-side, since the server needs to see all incoming data to perform updates.

RELIABILITY The edge-case for point-cloud will be in venues less travelled. With fewer users actively using the system and contributing back data, the fingerprint may erode over time and require manual resetting.

WI-FI

ACCURACY The Wi-Fi specification was designed for data transfer, not positioning. However, one can use the RSSI reading of signal strength from a known access point (AP) to guess position. It sounds straightforward enough until you take into account that electromagnetism isn’t linear, or really predictable at all. But with enough APs, it’s possible to get ~5m accuracy throughout a facility.

COST Now for the bad part. To get 5m accuracy, the APs needed are roughly ten times the number otherwise required for just data transfer. APs, especially the enterprise grade ones, are not cheap.

RESPONSE TIME Calculating position happens AP/server side, which adds some latency. Wi-Fi APs are broadcasting constantly however, so there is no delay in getting a signal on demand.

RESPONSE TIME Wi-Fi APs are built to be reliable. Enterprise grade ones are wired in, monitored 24/7, and built to operate for years. The only challenge is that when they do go down, others automatically crank up power levels, effectively skewing any positioning system fingerprinted to a certain configuration.

APPENDIX

INERTIAL NAVIGATION

ACCURACY Inertial motion sensors within phones are very accurate for the first three steps (starting from a known fixed location) and gradually less accurate after that. The challenge is integration "drift," small errors in measurement that compound quickly over time.

COST Like point-cloud, this method requires no outside infrastructure. It also doesn't require setup.

RESPONSE TIME The calculation is done device-side, using direct inputs from the motion sensor IC.

RELIABILITY Aside from the known degradation of accuracy over time, there are no complex systems that can break (other than the laws of physics).

BEACONS

ACCURACY Beacons work roughly the same way as Wi-Fi, physically speaking. Meaning that signal strength isn't always what you expect. Because beacons are cheaper than more Wi-Fi access points, you can place more of them in a facility and brute-force physical limitations of RF based positioning to get ~5M of accuracy.

COST Battery powered beacons cost around $15-$50 per unit. Wired ones cost roughly ten times that. It would take three hundred beacons to cover approximately 200,000 sq. ft. of space. If one opts for the cheaper, battery-powered setup, they have to factor in replacement costs over the next 12-18 months for every unit.

RESPONSE TIME Since beacons aren't used for data transfer, they typically do not broadcast all the time. Thus, there is an additional latency in getting the initial signal before server-side calculations.

RELIABILITY Beacons go down. Two year lifespan batteries sometimes die in six months. Their low price point and intended use as a proximity tool (versus positioning tool) means that QA isn't applied as rigorously.

APPENDIX

SMART LIGHTING

ACCURACY

A user may not always have their camera/phone oriented perfectly, so to compensate the light must be shone broadly. Problematically, light bounces. So a network of lights emitting different signals embedded in its switching frequency or spectrum will heavily overlap. A tough trade-off must be made: have a system that doesn't work unless users hold their phones exactly right or tolerate high amounts of errors.

COST

Similar to beacons, a smart lighting system must be deployed densely throughout a facility. Hundreds of lights per 100,000 sq. ft. at $50-$200/unit.

RESPONSE TIME

Calculating position happens server side. Additionally, the number of overlapping units means that any IDs will take longer to broadcast, receive, and distinguish.

RELIABILITY

Being plugged in, one doesn't have to worry about batteries running out. Also, new LED lights are rated to last a decade. If the trade-off mentioned in accuracy is made in favour of less overlap, reliability becomes a major issue (phone orientation).