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Indoor tracking and maps: The hype died, but the show is not over

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Between 2013 and 2015 hype around indoor tracking built up. Yet today nobody seems to talk about indoor tracking or remember the apps. While the hype has died, work has continued in the shadows addressing both issues with tracking technology and indoor maps.

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Between 2013 and 2015 hype around indoor tracking built up. Big name retailers like Target and Macy's were rushing to get consumer apps out; apps like Syrup, Yap, or Shopkick were advertised heavily; retailers were actively experimenting with indoor tracking beacons to see how the technology would provide business impact. Yet today nobody seems to talk about indoor tracking or remember the apps. While the hype has died, work has continued in the shadows addressing both issues with tracking technology and indoor maps. Now the topic is getting relevant again; at the latest Mobile World Congress in Barcelona, players like Nokia presented some new solutions to the field[1].

In this article we cover the technology and business landscape of two distinct but interlinked fields – indoor tracking and indoor maps. Indoor tracking involves detecting the accurate location of a mobile device indoors. The challenge is having a technology that provides sufficient accuracy. Indoor maps, on the other hand, involves creating (interactive and datarich) maps of indoor locations for an array of different applications such as indoor navigation and marketing.

Several technologies for indoor tracking and maps, but real standards missing

Indoor tracking is a field with unique challenges. Outdoors, the Global Positioning System[2] (GPS) is generally used for tracking location information. The basic technology involves sending signals to four distinct satellites and calculating the distance and angle between them to derive the location on earth. However, GPS does not work indoors, due to attenuation caused by construction materials (satellite signals are blocked by building structures) or signals reflecting off a multitude of surfaces (even if signals reach inside a building, they bounce off too much from the walls and furniture, rendering them useless). Since people in average spend more than half of their time indoors[3], a real need exists for an accurate Indoor Positioning System (IPS). Accuracy matters. While outdoors a few meters is good enough, indoors every meter is significant, be it for navigation or targeted marketing. Tracking is not all – there is also a need for accurate indoor maps. While simple indoor maps can be made 2D, typically these are inherently 3D given most structures are multilayered and incorporate data for a large number of objects. Indoor maps for navigation, design and marketing are built to be interactive and data rich, and are typically used with associated software to provide full functionality. For example, using indoor maps for (real-time) guidance often involve 3D rendering and virtual reality capabilities. Developing, managing and maintaining indoor maps is a complex task, and here too special software is needed.

To address the technical challenges of the indoors, several technologies have been developed and tested over the years. One approach has been to try adapting GPS by making the tracking sensitivity higher, and by adding in other relevant information to assist in positioning. This is called A-GPS, or Assisted GPS[4]. However, the approach has not achieved sufficient accuracy, and is not generally used for indoor tracking. As Wi-Fi has expanded with wireless access points proliferating since the 2000s, the Wi-Fi Positioning System (WPS) has become a complementary technology for GPS[5]. Based on the strength of Wi-Fi signals reaching a mobile device, combined with the location of the Wi-Fi hotspot or wireless access point, position information can be obtained. However, this information is only accurate when the transmitter location is known, and even so, the range of error is large, often over 50 meters, which is not good enough. Bluetooth and beacon technology offered a breakthrough, and built up a lot of hype in 2013-2015. Technically speaking, Bluetooth and beacon technology are not positioning technologies, but rather relate to proximity. Yet, these technologies addressed the needs of retailers –alerting when a customer is in close proximity to a specific location or product. While previous indoor positioning technologies use a narrowing-down approach (increased accuracy of position), beacon technology provides a solution bottom-up (proximity to beacon device).Combined with other indoor positioning technologies like dead reckoning[6] or the aforementioned A-GPS and WPS, sufficient accuracy for indoor tracking has become feasible. The most recent technology for enhanced accuracy is magnetic positioning. A key issue for accurate indoor tracking is that building structures distort signals. Magnetic positioning technology uses the magnetic fingerprint of the building's steel structure (see figure 1). With data from a magnetic sensor found in most smartphones today, it is possible to accurately track the indoor location without additional hardware[7].

Figure 1. Principle of magnetic positioning technology[8]

The issue with all the technologies is the lack of a widely accepted standard. As there is no clear “winner” technology, many businesses push their own proprietary formula of mixing different technologies together to provide the most accurate indoor tracking possible. This can be confusing to end-customers. Setting a standard that provides required accuracy and applicability would help to speed up adaptation and reduce cost. Given the stage of technology evolution, a standard starts to seem reachable now.

For indoor maps, technological challenges include capturing indoor-specific data, applying that to different use cases, and using/managing it. Indoor maps can be used for simple navigation (like in malls or convention centers), but use cases are much more diverse, supporting tasks such as building maintenance, security, and renovation planning. Solution flexibility is key – the software must adapt to requirements big and small. While constructing or renovating buildings take months or even years, changing around furniture or setting up new partitions is done in minutes. For an indoor map to be updated to accurately represent the current information, flexibility in the components as well as the ability to update layouts easily is needed.

A particularly useful technology for adding depth to information is integration of architectural components. Similar to how outdoor traffic navigation systems integrate traffic information and related laws, indoor maps benefit by adding layers or architectural information and standards. For simple indoor navigation for visitors, this would involve information of lifts, exits and amenities like water fountains and restrooms. However the idea has wider applicability in building construction and maintenance, as well as lighting, piping, or security design. Indoor mapping technology could be used already in the early design and construction phase, continuing throughout the building’s lifecycle[9].

Where's the money - the diverse business side of indoor tracking and maps

The hype in 2013-2015 started out with Apple’s introduction of their proprietary iBeacon protocol. This meant that proximity tracking was now available as a feature in all Apple mobile devices. This represented a new technology standard that created activity across the entire value chain, with big expectations for broad based adoption of indoor tracking. Hardware companies focused on building beacon devices with the iBeacon protocol appeared; a myriad of software application companies competed with each other to become the dominant platform; app developers raced towards brick-and-mortar based businesses where indoor tracking would be used the most. An overview of value chain at the height of this frenzy is shown in figure 2. Hardware standardized (and commoditized) quickly, while software technology quickly (over-) saturated and diverged (without standardization). This may be counterintuitive, but stemmed from hardware and software companies having different business imperatives. Hardware had to be cheap, compatible and platform-agnostic, whereas software platforms sought to create a lock-in effect on customers, driving them to adopt a singular dominant solution rather than providing compatibility across platforms from different vendors. Similar to what happened to the personal computer industry in the 1970s[10], the hardware became a standard low-cost commodity with production moving to countries like China or south-east Asia. Software would be the money-maker for the player that was able to become the dominant solution in the market.



Figure 2. Beacon B2B value chain during hype of 2013-2015

However, unlike in PCs, this process halted when end-users did not see the value of the indoor tracking technology. Retailers and brick-and-mortar stores had a clear incentive to apply the technology, so that they could identify customers nearby. However, from the end-user point of view, enabling iBeacon notifications simply meant that there was another channel for (often unwanted) advertisements through their mobile devices. Many of the biggest deployment efforts were led by large brand name retailers (such as major supermarket chains[11]), but customers rarely downloaded the app and actually used it. Due to low adoption rate by end-users, the hype withered. A simple Google search for “iBeacon” gives top results for 2014 with a few articles in 2015, but virtually nothing after that. Another lesson that a clear value to the end-user is needed for technology to be adopted.

However, indoor tracking and mapping is not a lost case. Currently indoor Location-Based Service (LBS) companies are gearing up to provide a wider range of services, backed by new technology that provides richer data on indoor locations. Magnetic positioning is one of the technologies that is gaining momentum now, with potential for more widespread adoption since necessary sensors are already built into existing mobile devices. Also a more sensitive and accurate tracking technology has recently been announced by Nokia, using ultra-wideband radio[12]. With the sensitivity of indoor tracking improving, better functionality and features are possible.

The key challenge of the indoors location business continues to be an unclear revenue model. As we saw, the model of simply pushing proximity advertisements was unsuccessful. The next generation of indoor tracking technology will differ by providing equal benefits to end-users and service providers through improved accuracy and richer information. If adoption grows enough, the advertisement revenue model could be sufficient. However, there are further possibilities; for example, indoor tracking could be integrated with mobile payment, eliminating the need to stand in line at an amusement venue (a well-known problem in places like Lotte World in Seoul) or exhibition, or waiting in line to place an order for a drink or snack[13]. As stronger revenue models emerge, more players are likely to join in.

Integration with rich data is broadening the application space. Beyond B2C applications, industry-specific B2B tools are being developed. Architectural design and construction, warehouse management, and factory management are just a few of many growing B2B application areas. For example, Locatible[14] is a company that provides indoor mapping and tracking solutions specialized for hospitals. It helps visitors navigate within the building, and also tracks staff, patients and assets. It even alerts the staff if a patient falls out of bed and provides analysis on patient flow. Another company providing B2B indoor tracking and mapping solutions is Virtual Builders[15], which provides an array of solutions for construction, maintenance, and building servicing. Included are tools that incorporate indoor tracking and mapping technologies already in the modeling stage of a building, and provide a platform for designing and managing security, CCTVs, lighting, egress, and pipelines.

The hype died, but there is a robust trend of development underneath

Currently the biggest applications of indoor tracking are found in retail venues, such as large scale malls and department stores. The technology is still mostly used for pushing promotions and providing indoor navigation for finding a specific product among aisles and sections. This traditional application area will continue to develop. As accuracy and cost-efficiency improves further, adaptation will pick-up. Expect integration with mobile payment technology, making services such as self-checkout at supermarkets with your mobile phone possible.

B2B applications can also be expected to continue growing. There are many promising areas, such as filling in the last mile gap for asset tracking and logistics, enhanced productivity in design, planning and constructing buildings, and managing maintenance of lighting, security, piping, or complying with safety standards.

In the future, indoor tracking technology will be integrated with further technologies, creating a seamless IoT environment. A simple example is connecting indoor tracking with outdoor GPS, so that the navigation system can predict the time of arrival, including walking through the building to reach the car, or even start the car when the user is leaving the building. Integration with a smart home/office environment can also be expected, allowing for example dynamic temperature management of indoor spaces based on where people are present.

Indoor tracking is one of the key technologies in advancing Virtual Reality (VR) and Augmented Reality (AR) (see our previous article). Currently, VR technology is tethered to a computer, which limits mobility. Tracking the users' surroundings needs further development, to avoid the user bumping into walls or furniture while immersed in an alternative reality. Accurate indoor tracking, combined with data transmission technology will allow the un-tethered user to walk around safely.

Although the initial hype has died out, indoor tracking and mapping continues to see solid improvements in technology, and has several promising application areas. The technology is worthwhile to keep an eye on over the coming years.

Further reading and references:

This blog is based on a broad range of articles and reports. Some of the more interesting ones are listed below.

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