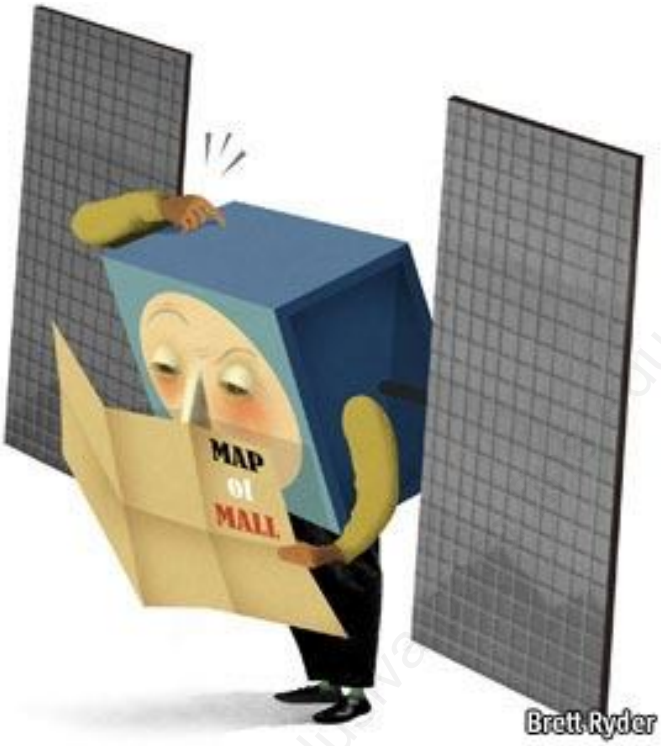
Finding the way inside

Navigation technology: Using satellites to determine your position only works outside. A new approach is needed indoors



Digital navigation surely ranks as one of life's high-tech bargains. Thanks to free Global Positioning System (GPS) signals broadcast by American satellites, and free online maps from companies like Google, Nokia and Apple, all you need is a smartphone with an internet connection to pinpoint your location on the Earth's surface and call up maps, directions and local information. Unless, that is, you are indoors. And even if you are outdoors in a built-up area, the lack of a clear view of the sky can prevent GPS working properly, because its satellite signals are easily blocked by roofs, nearby buildings or even trees. For positioning to work indoors, where people spend most of their time, new technologies are needed.

GPS satellites work by broadcasting ultra-accurate time and position data using on-board atomic clocks, allowing a receiver to calculate its location by comparing signals from four or more satellites. (This involves calculating the point of intersection between four spheres, each of which is centred on a satellite.) Some terrestrial positioning systems work in a similar way, but replace the orbiting metronomes used by GPS with fixed transmitter beacons installed at precisely known locations. By picking up and analysing the signals from these beacons, the receiver can determine its position. And because the beacons are much closer, their signals are strong enough to penetrate inside buildings.

Locata, an Australian company, recently unveiled a system of powerful transmitters whose signals can penetrate walls or cover large outdoor areas such as airfields. The beacons within the network are synchronised to within a billionth of a second, and can allow a receiver to determine its position to within less than a metre. One of its first customers is America's Department of Defence, which is increasingly worried about the ease with which its feeble GPS signals might be jammed by enemies. The US Air Force has installed Locata as a local backup to GPS at its White Sands Missile Range in New Mexico. Locata's transmitters are expensive, however, and its receivers are currently too bulky to find their way into mobile phones.

For the mass market, Nokia, a leading handset-maker, has been developing beacons using the latest version of Bluetooth wireless technology, which is a standard feature on the latest

smartphones. Each self-contained transmitter is powered by a small battery and can cover a modest indoor area of a few hundred square metres. Using directional radio sensing, phones can calculate their position, often to within a metre, from a single beacon.

A different approach that also works with existing phones is to install lighting based on light-emitting diodes (LEDs) that provide illumination but also flicker, invisibly fast, in a unique pattern. Smartphones with cameras can detect that pattern and look it up in an online database to determine their position. ByteLight, a start-up based near Boston, claims its technology can fix locations to within a metre in as little as a second. But ByteLights cost a little more than normal LED lights, and a lot more than fluorescent lights (though their lower energy consumption means running costs are much lower). And providing coverage using Bluetooth beacons or ByteLights means installing hundreds of devices in a large building, and then creating a map so that positioning signals can be turned into an accurate location. Battery-powered Bluetooth beacons can be installed quickly, but need to have their batteries replaced eventually.

“Indoor infighting means technology companies are duplicating their efforts at great expense.”Yet another proposal is to make use of the motion-sensitive accelerometers and gyroscopes found in virtually all modern smartphones. These are normally used to detect which way up users are holding a device or for gaming, but they can also track the distinctive motions of walking. Software can then guess the distance and direction travelled. In practice, however, the accuracy is poor, and someone standing still for a minute will appear to move slowly out of the building due to “drift” in the sensor. But research into this idea is continuing, because emergency-service and military users would like indoor-positioning systems that work even in buildings where power has been cut off.

No added ingredients

The ideal indoor-location technology, then, would be one that required no additional hardware to be installed in buildings or added to mobile phones. Fortunately, the modern world is suffused with electromagnetic radiation that can be exploited for positioning purposes. Modern steel-and-concrete buildings, for instance, have internal magnetic fields that vary subtly throughout their structure. Mobile phones may be able to determine their positions indoors using their internal digital compasses. IndoorAtlas, a start-up based in Finland, claims it can provide indoor accuracy of less than two metres using this method, once a venue has been surveyed.

Most ambient radiation, however, is deliberately generated. TruePosition, a firm based in Berwyn, Pennsylvania, wants to use digital television signals as the basis of its positioning technology. It plans to install monitoring devices on TV broadcasting towers to measure tiny deviations in their specified frequencies and frame rates. The receiver picks up these distinctive signals from multiple towers and communicates with TruePosition’s servers to determine its position to within around 50 metres. The firm hopes to reduce that to 10 metres with an additional beacon or two per city block, or with mobile beacons that can be deployed quickly in an emergency.

A more promising approach may be to use signals from mobile-phone networks and Wi-Fi hotspots. Smartphones already have the necessary radio receivers to pick up these signals, which have the added benefit of being most common precisely in places where pedestrians get lost: in airports, malls and city centres. Unlike GPS, though, these signals do not contain positional information. As a result, a labour-intensive survey is required to take a digital fingerprint of the relative strengths of the wireless signals present at multiple points within each venue. Software on a smartphone then consults this online database to calculate the phone’s location to within five or ten metres. This is the approach used by many companies including Skyhook, based in Boston, and by Wifarer, based in San Jose.

“In many ways, Wi-Fi is a terrible location technology,” says Cedric Dupont, a product manager in the Geo team at Google, an internet giant. “The trick is making it work in most places, most of the time, for most people.” That will probably mean combining positioning

information from multiple sensors in a smartphone: Wi-Fi and mobile-phone signals, GPS readings, data from accelerometers and gyroscopes, and images of the surroundings from the phone's camera. CSR, a British chipmaker, has developed a chip called SiRFstarV that combines multiple signals from a smartphone's various radios with its own movement and pressure sensors, using clever software to take into account the strengths and weaknesses of each. It can achieve an accuracy of about three metres.

Improving indoor positioning will mean navigating commercial obstacles as well as technological ones, as large technology firms try to maintain their grip on the potentially lucrative consumer insights that the technology will provide. Apple prevents apps on its iPhones and iPads from accessing raw Wi-Fi data, forcing them to use its own location services instead. The same is true of BlackBerry hand-helds and Windows phones. Skyhook claims that when two handset-makers, Samsung and Motorola, tried to build smartphones using Google's Android operating system, but replacing Google's positioning services with its own, Google withdrew the Android licences for the handsets in question. Google says it did so for compatibility reasons. The matter will come to court in February. "This is all-out war," says Ted Morgan, Skyhook's boss.

Google has already surveyed over 10,000 venues, mostly in America, while Nokia, which supplies indoor maps to Microsoft, has visited more than 5,100 venues in 40 countries. Apple is almost certainly carrying out similar inspections, as are a dozen or so smaller companies. It is no small undertaking, because regular return visits are needed to check for changes. Nokia's field team alone is over 1,000 strong. Google is also experimenting with crowdsourcing indoor maps. It allows business owners to upload a floor plan of their property then map local Wi-Fi signals themselves using an app for Android smartphones. But few have yet done so. Owners of shopping malls and other venues are worried that Google might sell location-based advertising without sharing revenue with them, or point shoppers towards cheaper products online.

"If Google is providing a solution for your venue, they are collecting an awful lot of information about your customers," says Liam Quirke, a location-services analyst with IHS, a market-research firm. It could, for example, provide information about what people are buying. The result of all this indoor infighting is that technology companies are duplicating their efforts at great expense, venues are suspicious of multiple incompatible systems and consumers are denied a choice of services. "Without some convergence, you're not going to see a platform where nine out of ten buildings you walk into are well mapped," says Mr Morgan of Skyhook.

There is some light at the end of the shopping mall, however. A draft now working its way through the Internet Engineering Task Force, a body that develops online standards, proposes a standard set of location-related measurements and data-rights disclosures. This would provide a common format for wireless-signal surveys and give venue owners a voice in how their indoor maps could be used.

There has also been headway in cutting through the tangle of competing standards that has discouraged investment in infrastructure. In August a group of 22 technology companies including Nokia, Samsung and CSR formed the In-Location Alliance. This trade organisation is dedicated to building indoor-location systems around two technologies, Bluetooth beacons and Wi-Fi signal mapping. It may finally give the indoor positioning industry something it currently lacks: a sense of direction.

Fonte: The Economist, London, v. 405, n. 8813, p. 18-19, 1 a 7 Dec. 2012.