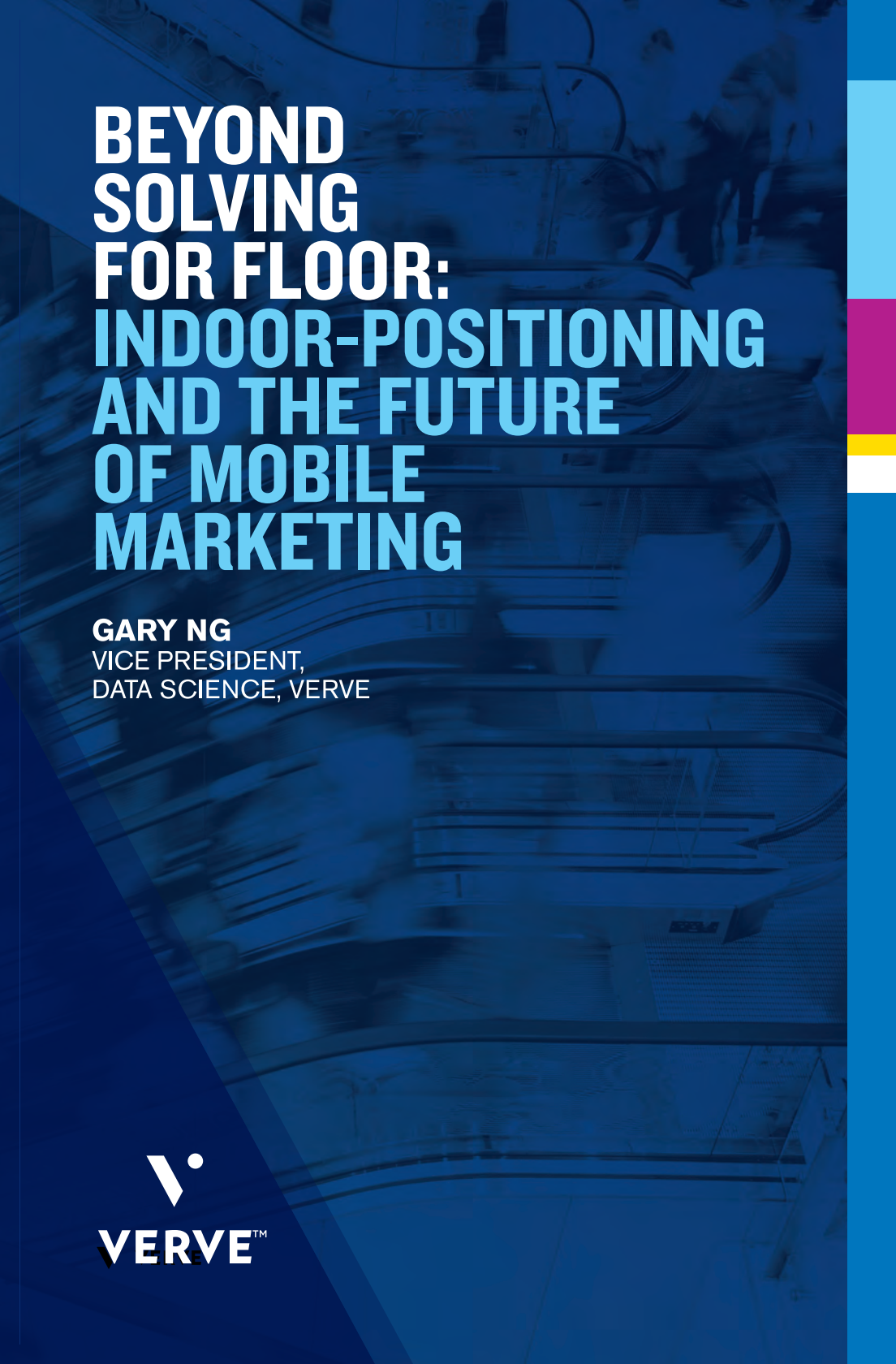

BEYOND SOLVING FOR FLOOR: INDOOR-POSITIONING AND THE FUTURE OF MOBILE MARKETING

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EXECUTIVE SUMMARY

Solving for vertical location – solving for floor – when it comes to identifying consumer movements and behaviors throughout interior locations presents complicated challenges around data sources and accuracy. There are currently significant hurdles, for example, between brands, marketers, and reliable systems for working with mobile-device altitude, ground-elevation data, and building floor-height.

While progress is underway –i.e. developing technology that can further enable brands and marketers to overcome these obstacles – a more immediate solution to the vertical-location equation is to bring together extant technology for an indoor-positioning solution.

The approaches already available in this effort include 360-video, 3-D scene reconstruction tools, landmark and positional-device tech, and evolving capabilities around automated site-surveying and fingerprinting. Marketing, advertisers, and their technology partners are on the cusp of leaving behind the hazy picture of indoor spaces and realizing an indoor-positioning system model that can distinguish a consumer's location within the horizontal and vertical planes of a building.

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INTRODUCTION: THE QUEST FOR VERTICAL LOCATION

In recent months, marketers, advertisers, and organizations have turned their attention to the challenge of moving beyond *horizontal location* alone, seeking to accurately locate mobile users within multiple-level buildings.[1] At the heart of this quest for insights is the longstanding goal of adding *vertical location* to the horizontal dimension – achieving a complete view onto mobile shoppers' *indoor positioning*. In this way, marketers are reaching for a fully three-dimensional understanding of consumers' interior movements and behaviors, highlighting and learning from their choices and decisions within business and home addresses.

The applications of indoor-positioning as a technology, or system, according to experts promoting the development of the technology, include mobile couponing, in-store assistance, advertisements for new products, floor

1. Partyka, Janice. "New testbed for verifying location technologies," GPS World (July 11, 2016). Source: http://gpsworld.com/new-testbed-for-verifying-location-technologies/

planning analytics, theft control, and consumer way-finding (in which the old models of directional signage and mall kiosks are replaced by a fully mobile in-venue assistant). According to the InLocation Alliance, a group of industry leaders that promotes indoor-positioning innovation, once "early market services are in place more advanced services will be rolled out."[2] The potential of these services includes navigation, geocaching, and social-networking. Venue owners will also reap benefits: improved customer analytics will allow them to optimize not only customer experience but also the venue's internal processes and logistics."

To achieve indoor positioning, mobile marketing and technology partners must first graduate from thinking about vertical location as an isolated challenge. The industry must expand its mission to opening a full-spectrum view, one that is measured by sensors and permission-based data as it streams from consumers' mobile devices in both the vertical and horizontal dimensions. Building an indoor-positioning system that is both effective and efficient – plus sustainable – will require innovative use of technology, some of it already at hand. The tools to which we can turn include 360-video; 3D scene-reconstruction; mobile site-surveys; deploying and using landmark-creating positional devices; and technology that can streamline and automate the implementation and maintenance that indoor-positioning demands.

Developers and marketing-technology vanguards that hit these marks early-on will command a leading role in the marketplace. That is why it is worth pursuing indoor-positioning, and why it's worth doing so in the near term.

In the sections that follow, this white paper turns to what the industry can do – now and next – in its quest for indoor positioning, highlighting how the knowledge and instruments at marketing's disposal today can help build a powerful lens onto the mobile shopper in three dimensions for the future.

2. "The Opportunity for Indoor Positioning," InLocation Alliance (2017). Source: http://inlocationalliance.org/about/the-opportunity-for-indoor-positioning/

THE STORY SO FAR: DATA CHALLENGES HAVE SLOWED THE QUEST FOR VERTICAL LOCATION

Technology and marketing have historically attempted to *solve for floor* in an isolated way. The challenges have been significant, especially around acquiring the needed data to accurately understand a consumer's vertical location within a multi-floor interior. The following bullets highlight those dynamics.

- **Mobile-Device Altitude:** Smartphones have been marketing's primary tools for unlocking consumer altitude data. Even as device capabilities improve, however, essential differences in data continue to complicate the approach. Apple's iOS, for example, offers a vertical-accuracy metric similar to the horizontal data that it provides, but Android smartphones do not at this time. Overall, the root of the needed technology is in place, but the system is still a tangle of differing data types.

- **Ground Elevation:** Accurate floor-location also depends on trustworthy data regarding the elevation of the ground on which a building sits. Commercially

available elevation-map data help organizations gather this information, as do elevation maps from government sources. The actual elevation of a building, however, does not always match the map. Similar to cases in which latitude and longitude data aren't always correctly mapped to a particular location, elevation is just as challenging. Even small differences between the physical world and a map's given value can affect the accuracy of floor-location assessments.

- **Building Floor Height:** The height of a building's floors is also a critical factor in determining vertical location. Building codes and standards help to create a baseline in this effort, but, as the Council on Tall Buildings and Urban Habitat notes, floor height can differ from structure to structure based on location, purpose, materials, form, profile, and other factors.[3] The challenge intensifies as one considers the availability of floor-height data: while details can be found in the records of architects, civil-engineering firms, and government departments, widespread distribution of floor-height information is not the norm.

Challenges like the above-listed examples require new approaches to combining the advantages of finding a consumer's horizontal and vertical location. Knowing the floor, however, still misses the mark when it comes to delivering information of value to marketers and venue owners. For example, within which tenant's space on a floor is the consumer's device positioned? This is a data point that adds context to shoppers' behavioral patterns, needs, and activities. In turn, this information leads to the need for floorplans and tenancy details from commercial real-estate services and other sources.

If solving for floor creates a maze of data-needs – not all of them immediately solvable – then indoor-positioning stands as a key strategy for navigating these challenges. With innovation on the industry's side, pinpointing the indoor customer in the multi-floor space across a wider spectrum of data and tactics is a project we can undertake today.

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3. "Height Calculator," Council on Tall Buildings and Urban Habitat (2016). Source: http://www.ctbuh.org/TallBuildings/HeightStatistics/HeightCalculator/tabid/1007/language/en-US/Default.aspx

NEXT STEPS: EVOLVING FROM VERTICAL LOCATION TO INDOOR-POSITIONING

There are several key resources to consider when solving for indoor-positioning. The following examples are given with two assumptions: **(1.)** as technology improves, accuracy will not be problematic; **(2.)** consumer data permissions will be earned as brands and marketers develop increasingly relevant and highly contextual mobile experiences.

- **Indoor-Positioning Data:** Approaches to indoor-positioning include gathering or simulating data around on-site indoor radio-signal strengths (such as Wi-Fi and Bluetooth-powered beacons); non-radio data (i.e. magnetic fields, light waves, and visible-light communication technology); and sound waves (ultrasound technology, for example).

- **Mapping Landmarks and Finding Fingerprints:** Indoor-positioning also requires pre-defined positional maps of known *landmarks* respective to the floor plan of a given multi-floor space. When we talk about landmarks, these can range from an individual retailer's entrance all the way to a specific aisle within a store. To landmarks, we then add an overlay of signal strengths – or *fingerprints* – which allow us to see and account for as many unique signals and empty spots between landmarks as possible. The objective is to eliminate dead zones, mapping all the unique areas in the retailer's space.

INDOOR-POSITIONING AND PRIVACY

In recent years, in their quest to develop advanced indoor mobile and data-driven shopping experiences, retailers have walked fine lines when it comes to acquiring consumer-behavior insights while respecting and protecting consumer privacy.[4] The key to striking the right balance, as recent research tells us, is to emphasize relevance over all else. Especially among Millennial and Gen Z consumers – Mobile Prodigies is the term for this grouping, according to a recent Verve report – given the right attention to context, incentives, and rewards, device owners tell us they will give marketers access to their data (and even reverse withdrawn data permissions when the context is focused and feels right).[5]

4. Cohan, Peter. "How Nordstrom Uses WiFi To Spy On Shoppers," Forbes (May 9, 2013). Source: https://www.forbes.com/sites/petercohan/2013/05/09/how-nordstrom-and-home-depot-use-wifi-to-spy-on-shoppers/#6f7126e43629

5. "The Rise of Mobile Prodigies: Millennials, Gen Z, and the Future of Mobile Marketing," Verve (2016). Source: http://www.vervemobile.com/prodigies/

- **Compare and Estimate:** The next step is to compare the real-time reception of relevant signals by a shopper's mobile device to the known fingerprints logged on the positional maps. The real-time fingerprint could be a single signal or it could be a collection of signal strengths. It could be a constellation of Wi-Fi access points and beacons or it could be a characterization of received magnetic fields, wave forms, and embedded codes. In all cases, the comparison of real-time signals to the known fingerprints allows the marketer to accurately estimate the mobile user's location over time within a building.

Each of the above approaches require installation of hardware at a retail site, calibration of installed devices, and also, initially, on-site labor in the form of digitally mapping the indoor location and obtaining signal fingerprints. At present, there is no industrywide instruction manual for these steps, no established best practices to ensure that this mapping and surveying will both yield the best results and also be repeatable across numerous venues in cost-effective ways.

Progress and development is underway. Deployments of Wi-Fi access points and beacons are increasing in scale within the US and elsewhere. The UK's second busiest airport recently added thousands of beacons, for example, hoping to streamline passenger flow.[6] Consortiums such as InLocation Alliance are also focusing on how to accelerate the development of solutions.[7] Google recently announced an indoor-positioning project of its own.[8]

Meanwhile, as the following list shows, there *are* available technologies that can empower marketers to leverage relatively inexpensive and simplified site-surveying.

- **360-Video:** In pursuit of indoor-positioning, commercially available 360-video – not virtual reality, but a video environment in which the viewer can fully rotate their on-screen view[9]– allows marketing and technology partners to do for multi-floor building interiors what Google has done for street maps and street-view features. With solutions such as Google Backpack already advancing, the technology needed to visually map interior spaces is not a vision for tomorrow – it's a reality, today.

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6. Lomas, Natasha. "Gatwick Airport now has 2,000 beacons for indoor navigation," TechCrunch (May 25, 2017). Source: https://techcrunch.com/2017/05/25/gatwick-airport-now-has-2000-beacons-for-indoor-navigation/

7. "The Opportunity for Indoor Positioning," InLocation Alliance. Source: http://inlocationalliance.org/about/the-opportunity-for-indoor-positioning/

8. Lomas, Natasha. "Google has an indoor positioning tech in the works, called VPS," TechCrunch (May 17, 2017). Source: https://techcrunch.com/2017/05/17/google-has-an-indoor-positioning-tech-in-the-works-called-vps/

9. Adams, Eric. "Most Virtual Reality Is Not Virtual Reality. Here's Why," Gear Patrol (July 18, 2016). Source: https://gearpatrol.com/2016/07/18/virtual-reality-vs-360-video/

- **3D Scene Reconstruction:** By taking multiple 2D images of an environment and then estimating a 3D visual based on the resulting collection of shots, we can now create stereo-vision models from mono cameras.[10] This technology is already in play, particularly in the realm of augmented-reality experiences such as Microsoft's HoloLens. Combined with 360-video, marketers and technology partners can more easily create three-dimensional models of landmarked environments.

- **Other Landmark-/Positional-Device Installation and Identification:** Further augmenting the ability to create the positional maps and signal-strength models that indoor-positioning requires, technology such as sticky labels with Quick Response codes or infrared receptors further allows surveyors to pinpoint key and critical spots within buildings.

- **Automated Site-Surveying and Fingerprinting:** A significant approach to streamlining the indoor-positioning process involves automation. Robots are already capable of roaming buildings and creating maps using ultra-sound, for example, and drones can now maneuver in unified and coordinated ways. These tools can augment – even replace – time-consuming human-conducted site-mapping. Furthermore, automated fingerprint readings can be linked to 360-video, 3D scene reconstruction, and positional-label tactics to decrease the cost and time of indoor-positioning solutions. This approach can also include self-calibration – automatic tests to see where signal strengths need adjusting, where more positional devices are required in an area, and to re-map after merchandise has been moved. Crowdsourcing is also a helpful approach – collecting and mapping data via the hundreds or potentially thousands of shoppers walking through each space every day; their mobile devices' sensors can help chart the environment and spot-check potential store-configuration changes.

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10. Ignat, Oana. "3D Scene reconstruction," OpenStreetMap@Telenav (March 10, 2017). Source: http://blog.improve-osm.org/en/2017/03/3d-scene-reconstruction/

With maps, models, and landmarks in place, marketing is on the cusp of leaving behind its hazy picture of indoor spaces and realizing an indoor-positioning system model that can distinguish a consumer's location with the horizontal and vertical planes of a building.

Rather than solving for floor as an isolated problem, mobile marketers and their technology partners should be putting resources into solving for general indoor-positioning. In other words, floor identification is less relevant if you already have accurate readings that define all the known spaces within a multi-level building; floor becomes one more element in that holistic picture.

Pursuing a single solution in this way, one that accounts for both horizontal and vertical position within a consumer's indoor location, will allow marketing to not only solve for floor, but also achieve efficiencies and improve outcomes aisle by aisle, product by product, as the interior of a shopping environment expands, changes, and evolves over time.

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