The shift from real world to virtual and back again
The world of customer and user engagement shifted two decades ago with the birth of the World Wide Web. This accelerated as organizations developed “web” or “online” strategy to differentiate themselves from competitors.

This shift from engagement in the physical (real) world to the online (virtual) world was further emphasized with the emergence of mobile media and social technologies.

It was widely assumed that the accelerated, widespread growth in ownership of mobile devices, accessibility of Wi-Fi and mobile data would drive the user experience further away from the “offline world” towards online. Yet ironically, the proliferation of mobile and Wi-Fi have laid the foundation for a shift back to the offline world.

To be clear, online engagement strategy will continue to be a focal point for organizations—from retailers and shopping malls to museums and schools, hotels and hospitals. But now, with increasing mobile Internet usage, they have to pay more attention to mobile marketing and engagement.

As users walk around a venue, they are deeply connected to the online world, yet nestled in and very much aware of their physical and immediate reality: location. And so the “offline world” is once again trendy and relevant. Advertisers are calling the integration of both online and offline user engagement “Hyperlocal.”

Location reclaims its former spot as the new frontier for business innovation
Organizations today are focusing on the discipline of “digital innovation,” extending their interests to “social media” and “mobile innovation.” But the same market leaders must also start paying attention to a form of “location innovation.”

Simply put, prior to the late nineties, real-world customer experience and conversion was the main (if not the only) focus. Two decades on, the emphasis has gradually shifted to one that is predominantly focused on online or digital engagement—and that’s where businesses now slug it out for differentiation. And now, those two worlds are now about to collide. Competing brands and organizations have developed equally sophisticated digital capabilities, and the lower costs and greater range of tools have leveled the playing field. Differentiation has become more difficult, and in
the years ahead, business innovation or digital innovation will converge on the space that lies between the virtual world and real one.

The importance of understanding location data and creating useful location-based services or applications
The digital world is overwhelming, to say the least. Businesses compete intensely online—for attention, user engagement, and customer conversion—all of which directly and indirectly impact their bottom-line.

To complicate matters, they compete against a wide range of new, emerging businesses with disruptive business models, of which there are many: those that encourage peer sharing instead of buying (the “Sharing Economy”); auctions that promise greater value to the customer, but reduce profitability; and flash-sales or group-buying that puts control over pricing in the hands of consumers. This competition also rages on a global level. Just imagine a local retailer in Hong Kong going directly against Amazon, as a sophisticated shopper walks into a retail store, smartphone in hand.

In this new, dynamic environment, advertising and location-based services are crucial. With over 50% of our population living in urban cities, over 80% of our time spent indoors, and close to all business transactions taking place in buildings that have increasing access to Wi-Fi and mobile Internet, the ability to create a compelling mobile-engagement and on-site user experience is vital to any organization’s success.

Marketers have long excelled at brand building, lead generation, and demand generation—presumably leading to an increase in sales. But they’ve not had the chance to completely influence that one pivotal moment—when a customer is at his/her moment of decision—where he/she decides to buy or not, to take an action or not. That is, until now.

Researchers have not been able to thoroughly analyze the real-life behavior leading up to a customer’s purchase decision. There have been surveys and observation studies, but there has not been a way to map actual people movement in the “real-world environment” to their final decision-making patterns. The world as we know it, is about to change.

Are location-based applications (that offer services and advertising) the answer?
As businesses turn the spotlight on location technology and location services, marketers and start-ups in the last five years have been rolling out “LBS” (Location Based Services), mobile apps, and “SoLoMo” (a combination of Social-Local-Mobile) or “Hyperlocal” campaigns.

Are these the answer to deeper customer engagement and better user analytics?
Yes and no. In the last five years, visionary marketers and app developers have been defining the future of user engagement through mobile computing devices. They offer a glimpse into the future of user engagement and analytics.

There are two critical gaps that need to be addressed: accurate positioning and network control.

Why is accurate positioning important? In location-based customer engagement, a miss is as good as a mile.
If you’re in Starbucks, receiving advertising content for a store in the next building, it isn’t engagement. It’s spam.

This impacts user experience too. If you use Foursquare or Facebook Places to check-in on your social networks, a building with accurate positioning creates a more seamless user experience—simply click ‘check-in’ and you will automatically be checked in to the actual store you’re visiting. Contrast this with the current experience of clicking ‘check-in’ and then scrolling through a list of options to find the exact spot you want to check-in at.

The importance of Network Control
Without network control, businesses can only access the data of users who download an app—their app. With network control, businesses have a complete view of what’s happening in their venues. Who’s using their app? Who’s not? Where are they spending their time on premise?

Immense, untapped opportunity for lack of sophisticated technology and strategy
In 2013, Forrester Research concluded that only 4 percent of U.S. online adults have used location-based apps, and only 1 percent uses them regularly. It’s clear that there is immense opportunity to increase usage through the design of excellent user experience and the provision of good incentives.
Businesses must navigate both a hurriedly developed and a constantly and rapidly changing sea of technologies, solutions, and strategies for engagement with users—both customers and employees—and they must understand their users’ behavior.

What location technologies have helped us to achieve in the past, where they fall short, and what technologies are available today to help us push the envelope

Today, the location industry has several mature technologies that naturally pave the way for Wi-Fi offerings. If we step back and consider the pace at which location technologies have emerged and become important everyday tools, it’s astonishing. GPS married with maps and navigation is the most prominent example of the ever-emerging location industry, but there are many other subtle and significant ways that location services are showing up.

**Cellular**

Because mobile phones use cellular wireless technology, it’s common for everyday users to assume that most location information comes from cell towers. Though the data connection itself (maps, search, navigation, etc.) can come from cellular data, the location piece is normally provided by GPS. Cell towers can provide some rough location estimates by using a handful of different techniques, but for the most part, these calculations are not terribly accurate. But even in a worst-case scenario, a “cell of origin” approach (i.e. what tower/AP is the user connected to?) has its uses—for instance, time zone detection by mobile phones. However, when we talk about value-rich location services, we need far better accuracy than can be provided by cellular options, so we look to other technologies.

**Global Positioning Systems (GPS)**

For outdoor location, GPS is the clear favorite today; this fact has been fortified by the inclusion of GPS in almost all smartphones—even mundane ones.

GPS receivers calculate location (latitude and longitude) via trilateration of signals from at least three satellites—with four or more, altitude can also be measured. The GPS unit (phone, car, handheld device, etc.) relies on a relatively unobstructed view of the sky, and can achieve accuracy in the range of 5-20 meters. With that level of accuracy, GPS can be used for a variety of mapping and navigation functions like detection of location (obviously), speed, bearing, tracking, time to destination, distance from destination, and much more.

But though GPS plays a central role for outdoor location, the line-of-sight limitation provides a fairly strong problem when GPS is brought indoors. For that reason, several other technologies have emerged for this purpose.

**Radio Frequency Identification (RFID)**

RFID is a contactless technology used to exchange small amounts of information carried by RF tags. The tags can be either battery-powered devices that actively transmit or passive devices that must be read by an RFID reader. The applications for active and passive tags are unique, but at the end of the day, they are both used to track or locate an asset.

Active tags can work at longer range and are applied to more expensive equipment, such as high-value stock in warehouses, automobiles on the assembly line, medical equipment, or possibly people. Conversely, passive tags are very inexpensive and are used in a more disposable way. They are activated and read only at short range at fixed chokepoints in a known workflow, such as the exit of a retail store (i.e. to prevent theft). RFID is used heavily in many industries like manufacturing, retail, healthcare, and even farming. For those applications, RFID works quite well; but, the main drawback with RFID is that it has very little extensibility beyond asset tracking.

**Location Services**

Many of the most valuable location services today are built on the GPS location engine; but, nobody gets excited about GPS anymore. The interest comes from the applications it can enable. While the services provided by RFID and cellular location engines are somewhat self-contained by the limitation of the technology itself, GPS is more like an empty canvas waiting for a creative solution. And many such solutions have already been built:

- **Maps** – Whether it’s for navigation, turn-by-turn, search, or any other use case, mapping is undoubtedly the number one service that comes from location technology. Solutions abound, and they are growing fast.
- **Social Media** – As traditional forms of communication, content sharing, and socialization are enhanced by online versions, adding location context to the social process can add value to friends and content consumers.
- **Geotagging** – Going hand-in-hand with social media, geotagging adds location information to photos, videos, messages, and sundry other media.
- **Social Updates** – In a connected world, many friends and families want to share their whereabouts at all times with important people in their lives.
- **Reminders** – In case you are absent-minded or a poor multi-tasker, location-based alerts and reminders can keep you on track when you arrive at or leave a specific place.
• **Safety** – Location can provide safety services in a number of ways. Emergency services with access to a mobile phone location can respond more expediently; parents can extend an extra layer of accountability to their children when they’re out of the house; family members can be located at large events, parks, or other venues; and there are plenty more.

• **Device Recovery** – In the event of a lost or stolen phone, location can be used for recovery.

• **Recreational Uses** – Whether for fitness, golf, hiking, camping, or any other number of sports, location tools can have value.

• **Device Profiles** – Many mobile device users adapt their phone’s settings manually based on their context (e.g. silence the ringer, decrease the volume, etc.), but location can be used to automate this process.

Where technology provides a means, applications will follow. And because GPS enables development, it has done very well as a platform technology. But it remains considerably limited to outdoor applications. That gap left for indoors is filled in part by RFID, but the real contender for our attention is Wi-Fi. With the right implementation, Wi-Fi location engines can provide that same blank slate upon which businesses can build a myriad of solutions. And it is very clear that they will.

**Wi-Fi Location**

Location technologies are becoming a major focal point in the WLAN industry because of the desire to utilize better “spatial awareness” in indoor business solutions. Interest comes from just about every industry that uses Wi-Fi, but the applications are highly diverse.

Wi-Fi location has some history—mostly for manual location of rogue APs and clients—but the applications are quite limited, with slow and plodding uptake. Now that almost all users everywhere carry mobile devices with embedded Wi-Fi, the relevance of location is accelerating.

At a high level, the components of Wi-Fi location can be broken into three major groups:

• **Location Engine** – the algorithms that determine where a specific device is located

• **Analytics** – systems for generating reports from, and conducting analysis of, location data

• **Integration Tools** – APIs, SDKs, and other enablement tools that allow businesses to build solutions from the location platform (i.e. engine and analytics)

**Location Engines**

Wi-Fi can support a number of different location techniques today, but most implementations have historically focused on RSSI (received signal strength indicator). Several variations of RSSI techniques are available, and new techniques are also on the horizon.

**RSSI Approaches**

Signal strength localization techniques are the de facto standard for location engines today. RSSI-based localization is a way to measure a client’s position based on the signal strength received by multiple APs (at least three) around the client. Two techniques are most common, known as trilateration and RF fingerprinting.

A trilateration (or multilateration—more than three) approach utilizes RSSI measurements from multiple APs to determine a station’s location. In a highly accurate implementation of this, each AP will calculate a client’s distance based on a combination of signal characteristics including path loss figures and client transmit capabilities. Then, if at least three APs can determine a client’s distance from the AP itself, a circular plot can be created for each AP—on which the client should be located. The intersection of three distance measurements should be the client’s location, as shown in Figure 1.

![Figure 1: Ruckus SPoT™ (Smart Positioning Technology)](image-url)
is performed throughout the deployment environment to collect actual RSSI measurements from known locations. The calibration data is then imported to a location engine and used to perform pattern matching. Since measurements are collected in real-world conditions by the actual APs used in the deployment, accuracy is much better than lateration techniques alone.

RF Fingerprinting with Pattern Matching

Though RF fingerprinting has advantages for accuracy, the biggest hurdle is the manual process of calibration. Client location accuracy depends on the number and density of fingerprints collected during calibration. Also, for highly dynamic RF environments where the building environment is constantly changing (e.g. office rearrangement, ongoing construction, warehouse stock variability), a moment-in-time fingerprint may not provide the same level of ongoing accuracy as it would in a more static environment.

With RF fingerprinting, accuracy from 3-10 meters is today’s norm.

Cell of Origin options are also available in Wi-Fi and are slightly more useful than the same technique in macro cellular networks. Because Wi-Fi is generally a micro-cell solution, cell of origin can indicate user presence in a building, a subsection of a building, or a specific outdoor area. The potential location range of cellular cell of origin is too broad to have many applications.

Time-Based Approaches

Though RSSI measurements in Wi-Fi are somewhat capricious, time-based approaches in the future may be more predictable. A forthcoming method to measure Wi-Fi location depends on the constant traveling speed of RF waves at Wi-Fi frequencies. To that end, the round-trip time (RTT) of frame exchanges can be used to determine client distance from an AP.

Travelling at approximately the speed of light, it takes typical RF signals approximately 3.3 nanoseconds to move 1 meter. To accurately determine distance with RTT metrics, Wi-Fi chip clocks (the time measuring instrument) must be sufficiently fast as to minimize the physical distance an RF wave will travel between clock cycles. And when that level of granularity isn’t delivered, accuracy deteriorates.

With RTT distance measurements, multiple APs can utilize time difference of arrival (TDoA) calculations to determine the client’s location.

Chip clock speed aside, one key drawback of this technique is that it requires client association to an access point. Without an association, Wi-Fi lacks a protocol-level technique by which to
force clients to immediately respond with a specific frame type—this is a necessity for measuring RTT. Thus, it enables certain business workflows and applications, but completely neglects others—unless time-based techniques are combined with RSSI-based techniques. Accuracy from current implementations of time-based options is similar to RSSI, approximately 3-8 meters.

Infrastructure-based Engines with AP Reporting
Location engines are commonly located on the infrastructure side of the network as an appliance, though it is also possible for them to exist on the client device. Most implementations will favor infrastructure-side engines, due to the ease of compatibility across all Wi-Fi client types. When the intelligence is integrated within the APs and control plane functions, it is much easier to track all Wi-Fi devices.

Due to the intensive nature of location data processing, location engines are typically abstracted from the APs and controllers into a dedicated appliance or cloud service. Of course, the data collection aspect of location solutions comes from the AP, and is reported to the location appliance or controller, as shown in Figure 3.

Client-based Engines
Client-based Wi-Fi location engines are still largely a thought exercise and not a widespread real-world product today. Several problems quickly show up when the client device is asked to do the heavy lifting.

First, using location engine techniques previously discussed, it’s far more difficult to load a mapping tool with all RF fingerprints onto a client device. Such a database would be required for every location where the device may be used, which could easily take up considerable memory and consume excess battery life for ongoing calculations.

Second, business drivers for client-side location engines would typically depend on user/customer-owned devices, which inevitably include multiple client-side operating systems (iOS, Android, Windows, etc). Unfortunately, Apple has a closed policy for Wi-Fi API usage, making this information out-of-reach for app developers. To that end, a mobile app-based client tool would be restricted to a subset (possibly even a minority at some venues) of mobile OSs, excluding Apple, which has thus far halted significant progress.
Of course, this doesn’t prevent companies like Apple or Google from building their own solutions, which may also happen. The presence of sensors—accelerometer, gyroscope, compass—in mobile phones could also enable new techniques.

What are some of the emerging solutions and how do they differ?
Today, there is massive confusion in the industry because when you mention “location based services,” “LBS,” “location based marketing,” or “location based technology”, a pile of different solutions turn up. And the problem is that there isn’t a clear way to distinguish between the different types of “location” applications, solutions, and other technologies. Until now.

6 Categories of Location Based Technology and Services

The following six categories highlight the differences in today’s many location-based technologies and services.

1. Social-focused
Social-focused services are focused on sharing your current location with your friends, and broadcasting your reviews and tips related to the given venue so that your social circle can benefit from it. Businesses increasingly have a presence on these apps to directly engage, advertise, or provide a service to users.

Examples include global location-based social platforms like Foursquare and Facebook.

2. Utility-focused
Utility-focused services are primarily concerned with way-finding—that is, helping you get from one point to another. The prime examples are Google Maps and Bing Maps.

3. Brand-focused
Brand-focused services provide location-based content, services and way-finding features for a particular brand or venue.

A good example would be a shopping mall app having social, way-finding, advertising, and promotion features that revolve around that particular mall.

4. Promotion-focused
Promotion-focused services use tactics like discounts to encourage “last meter” conversion, where an attractive offer is used to lure shoppers in a mall towards a particular shop.

Examples include shopper engagement apps like Shopkick.

5. Data-focused
Data-focused services place emphasis on data collection. A good example would be companies like Euclid and Nomi, using anonymous data from users’ smartphones to collect location data via a Wi-Fi infrastructure—with or without a phone app involved.

Market research companies can take it further by providing their panel of subjects with a mobile app, which can then be used to customize personal preferences or behavioral information.

6. Infrastructure-focused
Infrastructure-focused services provide accurate positioning to enable all the other service providers to increase the accuracy of their content-delivery, advertising, promotion, engagement and analytics.

This is where indoor positioning solutions like Ruckus Wireless’s SPoT™ Location Engine have a role to play in the global location technology ecosystem.

Two broad applications for Location Based Technology
To enable businesses to think clearly about location and to focus on creating an effective “location strategy,” it helps to start from the two main general applications for location technology—analytics and engagement.

Analytics
Analytics is the collection, processing, and analyzing of user data—both location data and other personal or behavior data. For instance, where exactly is User X in a shopping mall? That’s location data. And location data is the new competitive edge for businesses like retailers and mall owners, venue owners, and event organizers. It will transform the way organizations like hotels, hospitals, schools, and museums manage their staff.

Who is User X? What’s his/her name, gender, age, social graph, mobile number, shopping interest? That’s personal data. How does he respond to coupons offering promotions? How often does he visit? When was his last visit? How much time did he spend in the store? Was this movement consistent or not? That’s behavior.

Individually, location data and personal data are powerful tools for generating insights into customer/user behavior. But today, with the right location technology, we can merge those two powerful sets of data into one powerful source of knowledge.
Engagement

Engagement is the ability to interact by sending content and receiving a response from users. When we discuss ‘location-based’ engagement, a mobile app or browser makes this possible.

Assume that someone with a smartphone and a location-enabled shopping app is standing in front of a store in a large mall. It is now possible for an advertiser to know that this person is actually standing in front of that particular store and to actually act on that knowledge by sending the customer an advertisement or promotional content that’s relevant and that triggers a positive response—a purchase, for instance.

How do we do that?

At a high-level, any piece (or combination of pieces) of analytical or behavioral data can be combined to trigger actions. A simple example is user entrance to a specific zone of the store; user dwell time near a storefront, return visits within a certain period of time, and of course there are many more. Advertisers use analytical data to determine how they could improve business and then create custom engagement plans to accomplish it. Using zone-based (i.e. geo-fencing) triggers as an example, advertisers can pre-define the promotional content they’d like to push to users in a specific area of a venue. And when that happens, the pre-determined ad or interaction is immediately sent to the user’s smartphone via the advertiser’s app.

Why is geo-fencing and accurate positioning so important?

Simply put, when a user is outside a geo-fence, he doesn’t receive any advertising or other content. And when he/she is, the piece of content can be sent directly to him/her. To create engagement that is relevant, timely (and not perceived as spam), and effective for the venue owner, the location engine itself must be accurate.

What makes us unique, and how we excel

In response to growing market needs, in 2013 Ruckus Wireless acquired an indoor positioning company—YFind Technologies—with an impressive patent portfolio and a high-accuracy indoor positioning technology. Today, that technology is at the core of Ruckus SPoT™ (SmartPositioning Technology).

SPoT™ is a network-based, Wi-Fi positioning technology that puts full control of location data in the hands of service providers, venue owners, and businesses.

It is also the world’s first comprehensive cloud-based location suite:

- A positioning engine
- A location analytics Dashboard
- Location API to enable app developers to build an ecosystem of location-based business and consumer apps

On top of this, Ruckus is building SPoT™ Location Ecosystem—an ecosystem of business and consumer application developers who can enable businesses and governments to better exploit the SPoT™ positioning engine and location data.

Because it is cloud-based, venues are easily set-up with an online map creation and management tool, as well as a mobile calibration app, which makes deployment easy and scalable.

And all of this sits on the high performance Wi-Fi hardware solutions that Ruckus is well known for.

What keeps retailers up at night, is also what keeps customers up at night...in a rather different way.

While retailers and other businesses are increasingly excited about the opportunity to collect and analyze huge stores of data on customer movement, the very same thought scares many individuals.

Like every other discussion surrounding privacy, the topic of location tracking and personal location data is a sensitive one.

This is true in the emerging field of location analytics, and especially so as more consumers use smartphones that potentially give a lot more information away than they are actually aware of. And while online behavior tracking is very common today, consumers have a much greater sense of intrusion when user analytics and tracking are done on a physical basis.

User privacy is a broad topic that’s clearly not confined to location data, and it should not be discussed only in the context of location data. However, businesses and venues, app developers, marketers, and researchers would be wise to understand that privacy is a major concern for many consumers. They can, and should, address these concerns proactively with clear terms and conditions that explain how the data is being used, and maintain a focus on providing user/customer value – i.e. better experience, better content. The solution is clear communication and complete transparency.
No efforts to understand and engage users as well as to market to customers can be truly sustainable if privacy risks or concerns outweigh the benefits of the value proposition by the brand or venue. Businesses should focus first on creating and offering value to users. And when they do, customers will be more willing to volunteer more of their personal information (in this case, location data) for that better user experience.

**Conclusion**

**Where will Location bring us all?**

We’re at the start of a long cycle of innovation—where accurate user positioning and location data will dramatically change the way businesses and governments engage with customers, citizens, and other stakeholders via their smartphones and other mobile devices, deriving transformative insights.

All this disruptive innovation will only be possible when a robust positioning engine is built into the infrastructure of buildings and cities. That level of integration drives our vision for “location-intelligent buildings and cities.”

But that’s only the beginning. The real business value of “location” is found in the invention and use of business and consumer applications that make a real difference to both customers and business decision makers. That happens when technology providers, app developers, data scientists, and digital marketers all come together to form that very critical ecosystem of location innovators.