A Guide to Bluetooth Beacons

September 2014

A white paper by the GSMA

Executive Summary

An emerging mobile technology, Bluetooth Low Energy (BLE) beacons enable smartphones apps to pinpoint their exact location, indoor or outdoor, with a level of accuracy down to a few centimetres. The signal from a beacon can be used to trigger a specific app notification relevant to that location and time. Beacons are inexpensive, small and often battery-powered devices that can be discreetly placed in retail, entertainment, hospitality, transport, healthcare, outdoor media and private locations to enable a wide variety of use cases. Diagram 1 shows some examples of how beacons can be used in a retail context.

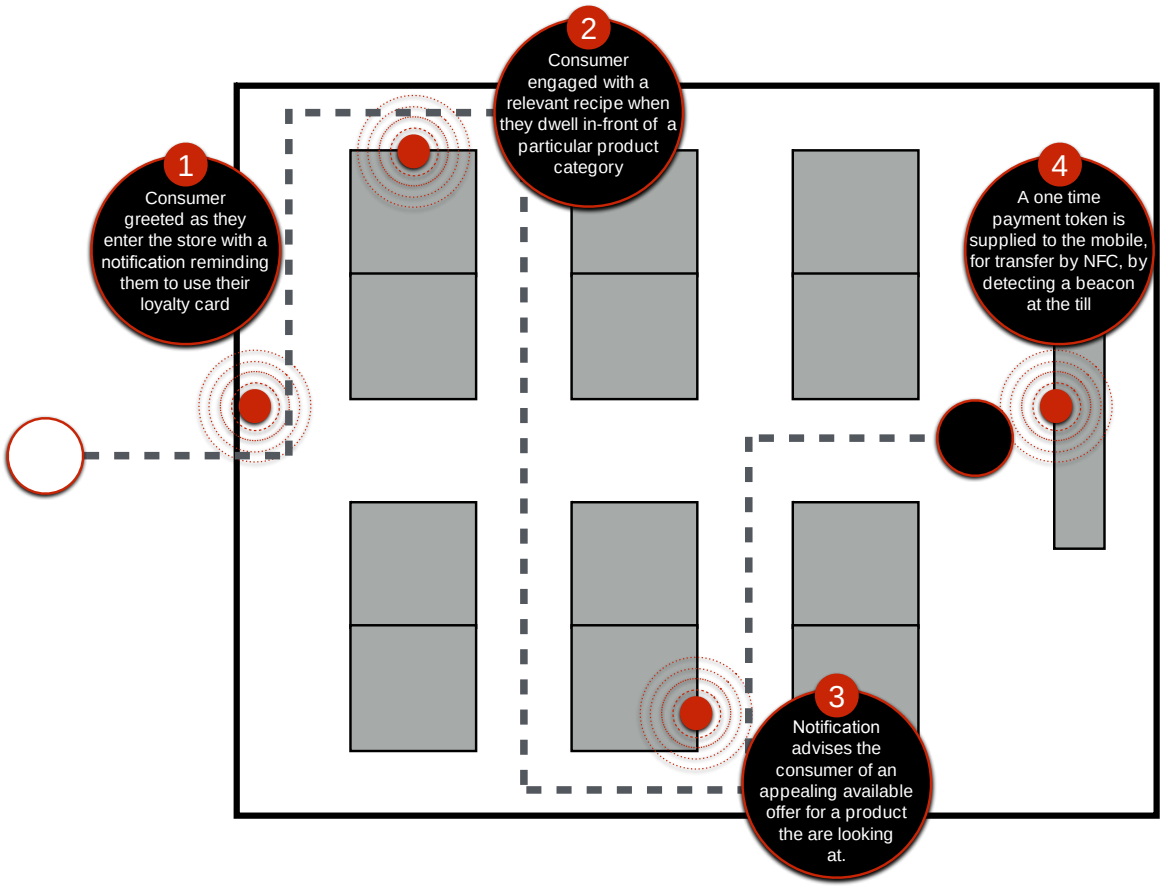


Diagram 1, source Appflare

Beacons help app developers to engage consumers at the right place and time, pushing out relevant information and content, rather than requiring the consumer to search for offers, payments details, tickets or loyalty cards. Note, in some cases an app may need to use a cellular or Wi-Fi connection to display the appropriate content, while in other cases, the relevant content may already be cached within the app. Beacons can also give app developers greater insight into consumers' behaviour, for example, by enabling them to track the typical path through a store or dwell time at a particular product.

Care should be taken to ensure that beacons do not over prompt apps to deliver notifications that are too frequent, intrusive or irrelevant. The risk is that consumers will disable notifications or Bluetooth, or even delete apps if they do not feel they are being given value. The table below shows the main strengths of Bluetooth beacons and some important considerations relating to their usage. There is also a barrier here to consumers just switching on Bluetooth and trusting that they are not being unknowingly (in the background) interrogated to obtain information or data that they are not willing to share with 3rd parties.

Strengths	Considerations
Beacons can be easy to install, as most don't need connectivity	Consumers' smartphones must have Bluetooth 4.0 or BLE to receive information from beacons
Beacons provide accurate proximity information, even indoors	The consumer smartphone operating system must support BLE
Beacon hardware is inexpensive	Bluetooth must often be enabled manually on the smartphone
Beacons can run on batteries for several months to several years, depending on the configuration	Apps must be beacon-enabled by the developer and security/set-up management
Beacons can be very small and discreet	Apps need to be designed to avoid excessive notifications
Some smartphones and tablets can be configured to act as beacons	If apps are badly coded, beacons could drain the handset battery

About this paper

The GSMA is evaluating the role of Bluetooth Low Energy (BLE) beacons – an emerging technology – in enabling digital commerce and the engagement of a consumer within a journey. This paper considers how BLE beacons can enable smartphone apps to derive micro-location data to:

- Present relevant offers
- Surface appropriate loyalty cards
- Facilitate transactions
- Deliver tickets
- Enable check-ins
- Deliver information

Aimed at mobile operators and their partners in adjacent industries, the paper is designed to be a guide to BLE beacons and their potential role in the retail, hospitality, transport, healthcare, entertainment and banking sectors. Mobile operators should consider whether beacons could play a valuable role within a broader mobile commerce solution designed to support retailers and other merchants

Methodology

Via a series of structured workshops and interviews, input to this white paper was provided by Appflare, Estimote, inBeacons, inMarket, Proxama, Swirl, Virgin Atlantic and Weve.

Introduction to Bluetooth Beacons

A relatively new concept, Bluetooth beacons can help apps running on mobile devices to determine their precise location. A beacon broadcasts a Bluetooth Low Energy (BLE) signal over a distance of up to 50 metres that can be detected by compatible devices. The signal is short and simple, and typically does not change. As a result, most beacons do not require any connectivity and are often very small and battery powered. The technology they are based upon is inexpensive to mass-produce, with the BLE chip costing less than a dollar.

In many cases, beacons can provide a smartphone with location information with greater precision than that offered by alternative technologies, such as GPS, Wi-Fi and cell tower triangulation. Importantly, beacons also work well indoors, enabling them to be used in a wide variety of applications, such as triggering information / offers upon entering a retail store, surfacing tickets at entry to a transit station and initiating a transaction at a retail point of sale. In some use cases, the app may need to use a cellular or Wi-Fi connection to display relevant content, while in other cases the app can simply pull up the content from a local cache. Appendix 1 provides more information on the technology used in BLE beacons.

Whilst the technology itself is quite simple and has been in existence since 1994, Bluetooth was not widely regarded as an enabler of location-based services until June 2013 when Apple introduced the iBeacon specification. Once Apple built a specification for beacon hardware and iBeacon functionality into iOS, running on iPhones and iPads, retailers, such as Carrefour, Universal Music, Macy's, Best Buy, JC Penney, Target, Crate & Barrel and others, began to deploy beacons in a variety of locations. Although a number of companies have developed BLE beacons, Apple's iBeacon is the only widely adopted specification for beacons to date.

Whereas Apple's iBeacon technology and most other beacon products are one way (they only transmit information from the beacon to compatible devices), PayPal has developed a two-way beacon (designed to support in-store transactions) that can also receive information. See Appendix 8 for more on this.

Other technologies

There are numerous technologies, such as Wi-Fi and NFC, in the market today that can perform some, all or more of the tasks that beacons can perform. They each have specific strengths and weaknesses. *Table 1* below gives a very high level overview of some of these technologies and how they compare with beacons.

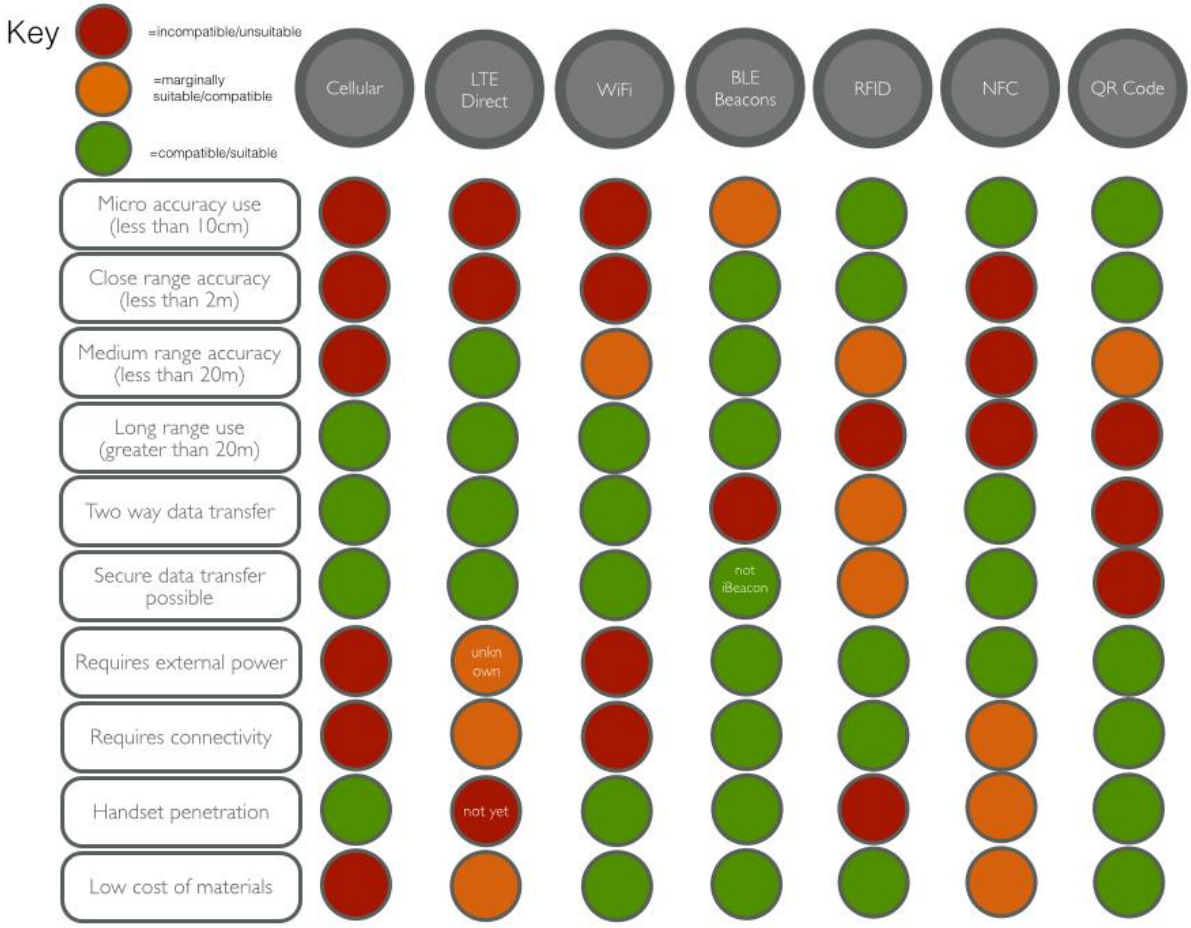


Table 1

Device compatibility

There are three main factors that determine whether a device is compatible with a BLE beacon:

1. Is the hardware compatible?
The vast majority of smartphones now being manufactured support BLE. We expect all smartphones shipped in 2015 to be equipped with BLE. However, an older generation of legacy handsets still in use today don't support BLE.

2. Does the device have the right operating system?
The vast majority of devices running Apple's iOS are enabled at a software level for beacons. However, only 12.1% of Android devices are running version 4.3 or above - the versions of Android that support BLE (as of March 2014, source Google). We expect this proportion to increase steadily with new device shipments and user upgrades (see diagram 2). Windows Phone version 8, which is used in more than 50% of Windows phones, supports BLE.

3. Is the device Bluetooth-enabled?
Apple's iOS operating system now enables Bluetooth by default and we estimate that more than 70% of iOS handsets have Bluetooth enabled. Among Android and Windows devices, we estimate this number ranges

from 22% to 33% depending on the market. However, as consumers see the value of BLE beacons and apps ask users to enable Bluetooth, we believe the majority of smartphone users will keep Bluetooth enabled within 24 months. As this factor is in the user domain, the service provider doesn't have control.

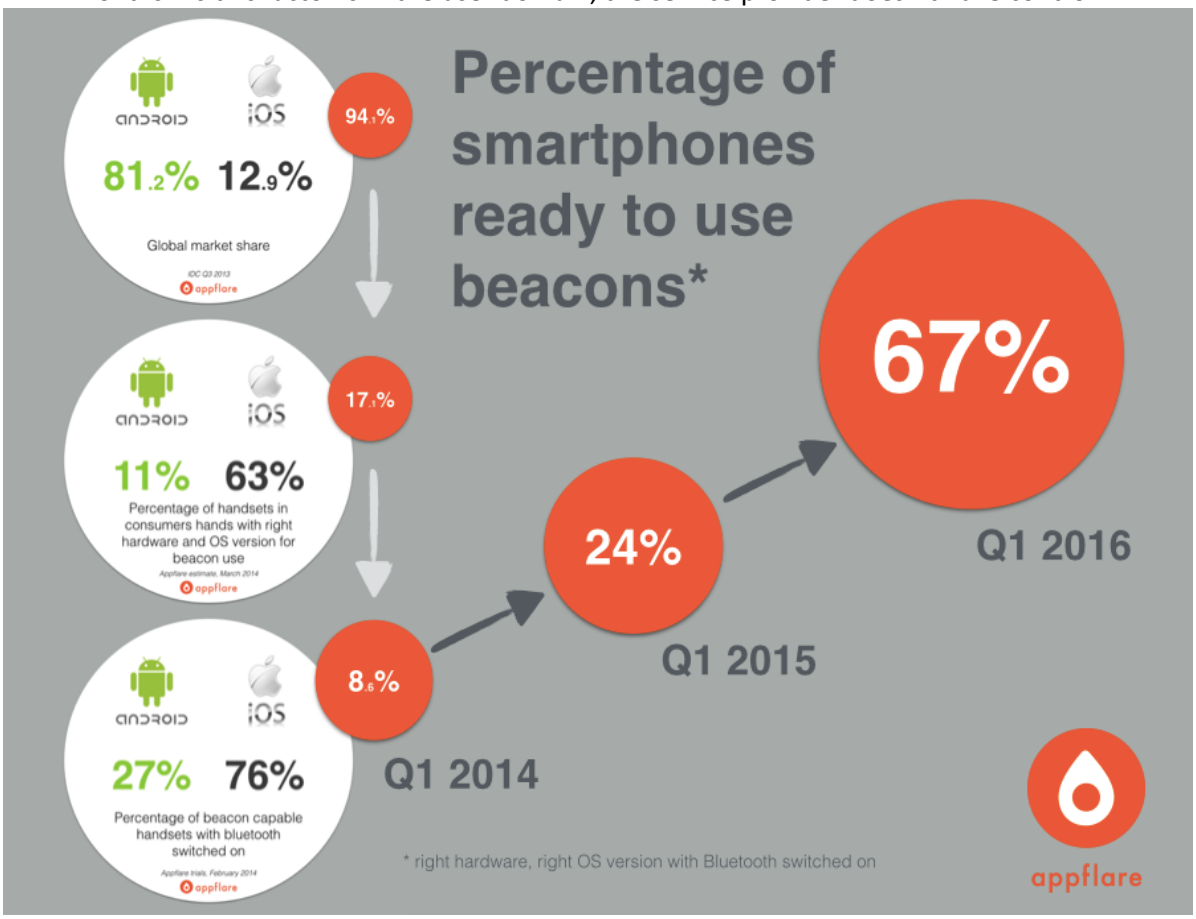


Diagram 2, Appflare global estimates, March 2014

Appendix 3 provides more information on the market requirements for BLE beacons.

The Opportunity

The advent of BLE beacons presents a wide range of opportunities for organisations to consider enhancing their smartphone apps and the shopping journey. By enabling apps to proactively present information to the consumer when that information is highly relevant to the consumer, beacons can be used to dramatically increase consumers' engagement with apps. However, care should be taken to ensure that apps do not overwhelm consumers with notifications, prompting them to switch off Bluetooth or delete the app (see Appendix 4 for more information on how to use beacons to engage consumers effectively and privacy issues).

Use cases broadly fall into two categories:

- Those designed to prompt a consumer to interact with an app.
- Those operating as a B2B service where consumers may be unaware of its use, not actively involved in its use or not part of the solution at all. Several of these use cases, which cover machine-to-machine solutions, are detailed in the Appendix 2 of this report.

Use Case Interactions

There are several different generic interactions that can be enabled by beacons working in conjunction with mobile apps. These are:

Deliver relevant content

A beacon may trigger an app to deliver information to an individual based upon their location. Typically content falls into one of the following categories:

- **An offer**: This may take the form of information or an actionable coupon (for example a barcode or NFC tap).
- **Loyalty**: Surfacing a loyalty card which may be used to collect points at the point of sale (PoS) or as the result of a visit.
- **Ticket**: A ticket for entrance to a transit station or some form of event/entertainment, typically rendered as a QR code or NFC tap.
- **Downloadable/streamable content**: Content such as video, audio, document or app.
- **Information/guidance**: Text or graphical guidance aimed at assisting an individual or informing them of something relevant to their time/location.

Facilitate payment

Beacons can play a role in either initiating a payment action, or forming part of the location verification. A beacon may alert an app that a consumer has entered a store where payment can be made using the app. The app may then take two possible actions (or both):

- Issue the consumer with a one-time or location-specific payment token to be used at the PoS[1].
- Inform the PoS that a particular customer is on the premises and can pay using their app (and issue the PoS with a token). This may or may not require the app to interact with the PoS.

Or the beacon may simply be used to inform the consumer that they can pay with a particular payment mechanism, with no location specific payment interaction.

[1] The GSMA's Enabling Technologies paper which will be published in September 2014 considers various different ways to validate the consumer's ID.

Enable check-in

A check-in is any action that an app performs as a result of being aware of beacon proximity, but does not necessarily require the consumer to directly interact or be informed. For example, a check-in may reward a consumer for visiting a particular location, without the individual having to interact with an app. A beacon could also trigger a social location check-in by an app, such as Foursquare (with the approval of the consumer).

Note, the app does not necessarily need to alert a consumer when they come into range of a beacon. A retailer's app might simply record when a customer enters a store, how often they visit, which stores they visit, how long they stay and even their path through the store. However, consumers should be made aware of any such tracking and gain an explicit benefit from sharing their location in this way. App developers and mobile operators should adhere to the GSMA's Mobile Privacy Principles. Appendix 4 of this paper also provides more information on how to engage with consumers.

Track an Item

Beacons are not always stationary items with a designated specific longitude and latitude. Beacons can also be attached to mobile items, where location is a measure of proximity to a 'tagged' item. For example, a suitcase may have a beacon attached, enabling the luggage owner to know when they are in range of their suitcase, or importantly, when their luggage goes out of range.

The role of beacons in retail

More than two thirds of American consumers[2] say that a timely, relevant notification that offers value will influence their shopping decision there and then. Beacons can help deliver these notifications, prompting spontaneous purchasing decisions, while facilitating engagement through mobile loyalty programs. Removing the need to carry a plastic loyalty card, retailers' mobile apps can also enhance the shopping experience with gamification, and surprise and delight techniques. Beacons can perform the simple job of reminding the consumer to use the retail app at the right point in time. *Diagram 3* shows typical retail user experiences.

[2] Source: A survey of 1,000 consumers in the U.S. by ResearchNow

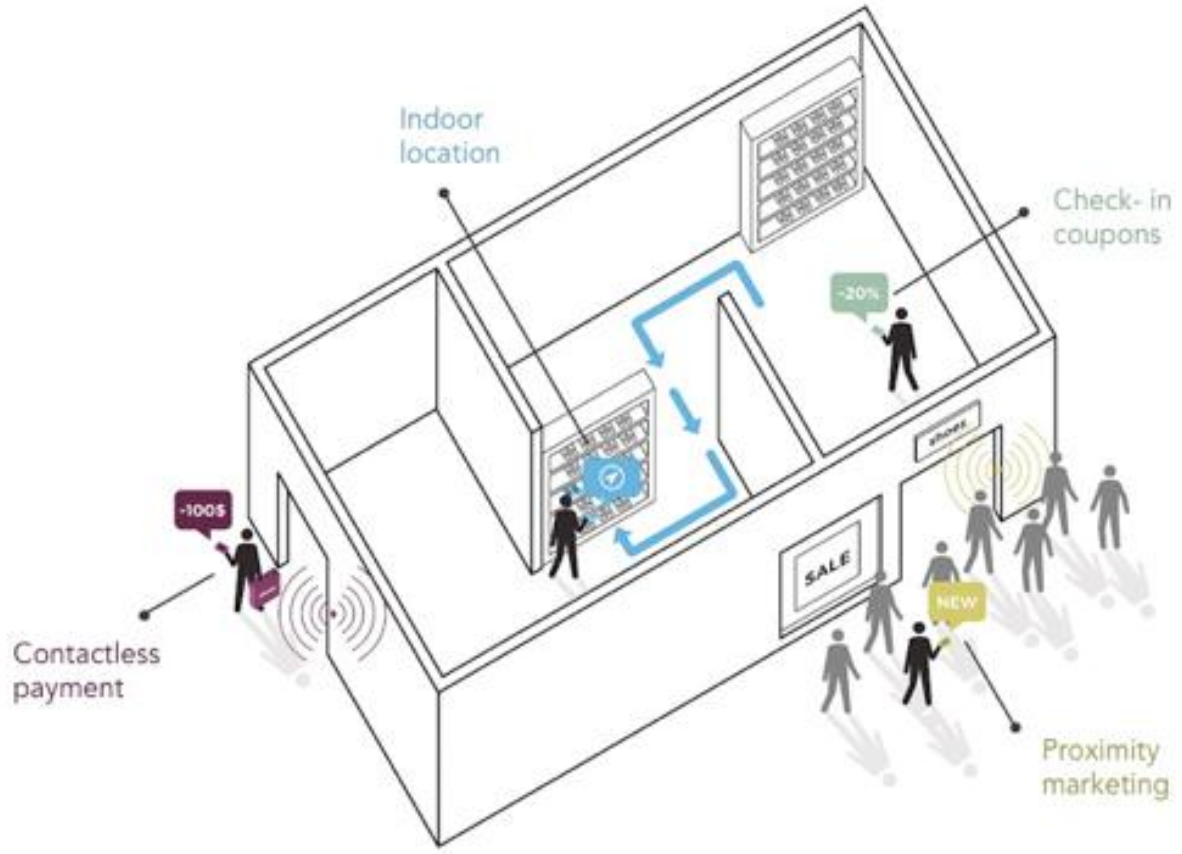


Diagram 3, source Estimote

In-store use cases

Retailers, such as Anthropologie, American Eagle Outfitters, Banana Republic, Best Buy, Burberry, Carrefour, Hamleys, Hugo Boss, Longchamp and Macy's are already beginning to deploy beacons. Here are some examples of retail use cases:

Surfacing offers/content/loyalty/check-in upon store entry

Potential examples include:

- Reminding a consumer to use a loyalty card as they walk in store
- Telling a consumer about an event in store that day
- Posting to friends news of a sale that day
- Giving a consumer a 10% offer via the retailer's app as they walk in store

As Paul walks into a store, the retailer's app on his phone detects a beacon above the door. Paul's phone vibrates and he pulls out his phone to see a notification on the lock screen:

"Welcome back Paul, there is a 2 for 1 offer on your favourite orange juice today"

The notification has been personalised based upon the app's knowledge of Paul's preferences and previous purchasing behaviour.

Surfacing offers/content upon store zone entry:

- Displaying photos of models wearing a new fashion range in the store
- Giving an offer on clothing that matches clothing purchased during a previous visit
- Telling a consumer about the 20% sale in the menswear department

As Alice enters the formal clothing area in a department store, the retailer's app on her phone notifies her:

"Hi Alice, why not buy a blouse to go with the suit your bought last week? Buy one today and we will give you a 10% discount"

The beacon in that department triggered the app notification with a personalised message based upon Alice's previous purchasing history.

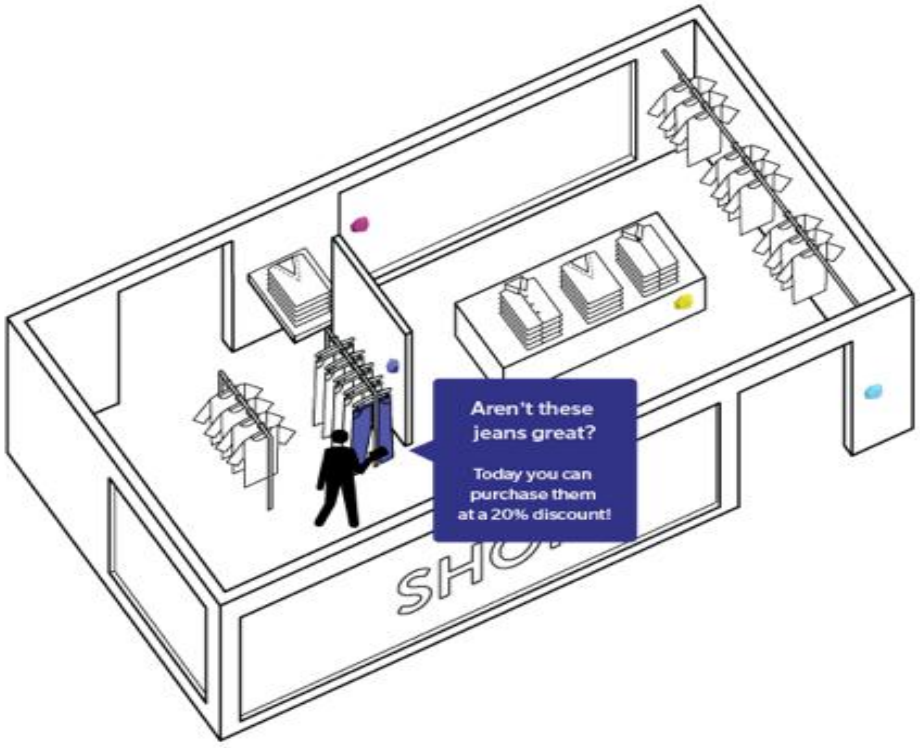


Diagram 4, an example of an in-zone notification. Source Estimote

Surfacing offers/content at a product level:

- Displaying photos showing how the product can be used
- Recipes for a particular ingredient

- Specifications for a product
- A specific offer

While walking around an electronics store, Anthony sees a digital radio he has been interested in for some time. Anthony spends a few minutes looking at the radio, at which point his phone notifies him:

"Hello Anthony, you have collected 1,800 points on your loyalty card: Enough for £50 off a digital radio today"

The app has used dwell time in front of the product category (by collecting data from local beacons) combined with his loyalty balance to deliver Anthony a very personalised message

.

Surfacing content upon store exit:

- Thanking a customer for a visit
- Offering a customer an incentive to visit again

After Sarah purchases some wine glasses and leaves the homeware store, the retailer's app on his phone notifies him:

"Thanks for shopping with us today Sarah. As a special thank you, if you return in the next week we will give you 40% off cutlery to match your glassware"

Sarah received an offer based upon live purchasing data.

Initiating a payment:

- Opening the relevant app for a remote (card not present) transaction
- Surfacing a mobilised store card for payment when approaching the point of sale

As Gale enters a fashion store, the retailer's app on her phone gives her a notification:

"Hi Gale, great to see you again. As you have shopped here before, we can make the experience easier. If you make a purchase today simply give your name at the till and we will automatically debit your card ending 3456"

Gale buys a new pair of jeans, and as she reaches the till to pay, she simply gives her name. The retailer's point of sale already knows Gale is in the store (thanks to the retailer's app on her phone pulling in location data from the store's beacons), and has been issued with a one-time payment token. When Gale identifies herself, the sales assistant is able to process the transaction without needing to take Gale's payment card or cash.

Loyalty collection redemption:

- Reward a customer for visiting a store area
- Reward a customer as they enter the pickup point to collect an item in a retail store

As Jake enters a mobile phone store, the retailer's app on his phone delivers a notification:

"Hi Jake, welcome back! You can try the iPhone 5S today, and because you are a loyal customer we are adding five more points to your account, which means you qualify for a free phone upgrade"

Jake has been rewarded for visiting the store, enticing him to make a purchase that day.

Triggering feedback/questionnaire:

- Ask a customer what they are looking for during that visit
- Ask for feedback after a transaction

Upon entering his local newsagent, David gets a notification from the retailer's app on his phone:

"Hi there, to help us understand how we can serve you better, would you answer three quick questions today? In return we will give you a €3 voucher to spend"

In-store navigation:

- Direct the user to a location corresponding to an offer they have just been given
- Direct a user to a specific part of the store

Paul spends some time in the wine section of his favourite grocery story, which triggers the retailer's app on his phone to deliver a notification:

"Hi Paul, we see you are interested in red wine today. How about a Scottish fillet steak to accompany the wine for dinner? We have an offer on Angus steak in aisle 4 today – press here and we will show you where"

When he touches the notification, Paul's phone displays a simple map showing how to find the steak.

Initiating in-store Wi-Fi connectivity:

- Opening the store app to connect the user to the retailer's Wi-Fi for general use
- Connecting to the store Wi-Fi for a specific content download

Michelle spends some time in the jazz section of an independent record shop, triggering a notification:

"You can listen to the greatest jazz tracks from the sixties free of charge on your phone today. Swipe here and we will connect you to our free Wi-Fi and take you back in time"

After she touches the notification, Michelle's phone is automatically connected to the store Wi-Fi and taken to a mobile-enabled site where she can listen to samples of the top 10 tracks.

In-mall use cases

Many of the in-store use cases for beacons can also be applied at the level of a shopping mall, as well at store level. Here are some examples.

In-mall navigation:

- Giving a consumer graphical instructions how to reach a specific retail store
- Telling a consumer where the nearest ATM is

Surfacing offers/content/loyalty/check-in upon mall entry:

- Triggering an offer that can be used at participating mall retail stores
- Notifying a consumer of new store openings since their last visit

Surfacing offers/content/loyalty/check-in upon mall zone entry:

- Giving information about lunch options as a consumer enters the restaurant area
- Giving information about bank opening hours

Surfacing content upon mall exit:

- Giving information about transport links/delays from the mall
- Offering a parking discount as an incentive to visit again within a defined period of time

Triggering feedback/questionnaire:

- Delivering a questionnaire to understand the purpose of the visit
- Requesting a rating on parking at the mall that day

Initiating mall Wi-Fi connectivity:

- Opening a mall app to connect a consumer to mall-wide Wi-Fi
- Opening a third party app to connect a consumer to mall-wide Wi-Fi for specific content

Entertainment and Transport

Bluetooth beacons could be used to improve the consumer experience of any service that makes use of tickets, such as public transit and entertainment events. Existing electronic ticketing solutions can slow throughput at the gate/entrance as consumers unlock handsets, search for the right app and then present a ticket. Beacons enable the consumer to be prompted with a notification at the right time and place, with a single swipe to then present a ticket, thus reducing delays at the actual gate.

Beyond simple admittance, there is an opportunity to use beacons to increase sales of value added products, such as popcorn at a cinema, merchandise at an event or refreshments at a stadium. Beacons can activate timely messages to increase service efficiency and reduce queuing time, encouraging consumers to spend. In large venues, the ability to locate, or pre-order, refreshments can dramatically increase spending.

Travellers may be willing to pay for services that make their transport easier to plan and less stressful, turning a customer satisfaction opportunity into an actual revenue opportunity. For example, a consumer may buy a beacon to place in their luggage, which enables them to track their luggage through a compatible app. The transport operator can also use the app to provide the consumer with other services and promotional massages.

In Appendix 2 of this paper, we have outlined some of the potential use cases in entertainment and transport.

Public Service

Location-oriented alerts can help local councils, tourist boards and public services surface content at the right time and place, such as historic facts on a city tour or information on nearby attractions or facilities.

Healthcare

Beacons, combined with apps, can be used to check patients into hospital departments or surgeries and provide internal directions or relevant information. Beacons can also be used by healthcare insurers and associated partners, such as a network of gyms. For example, a health insurer could encourage customers to stay fit by rewarding them for gym visits.

In Appendix 2 of this paper, we have outlined some of the potential use cases in healthcare.

Financial services

Banks can use beacons to engage consumers when they are making purchases. For example, triggered by a beacon, a banking app could remind a consumer that they can use their bank card in a particular retail setting, and perhaps offer them an incentive. Banks could also offer consumers (who have opted in) specific financial services in third party locations. For example, if a banking app detects that a consumer has spent a long time in a jewelers, it is perhaps time to offer them home contents insurance, or at least remind them to add the item they just bought to their existing policy.

Banks could also use beacons on their own premises to improve customer service and to engage customers in a wider set of products and services.

Outdoor Media

Brokers of outdoor advertising could use cloud platforms and content management systems to offer an advertiser short term access to beacons at outdoor media sites to coincide with advertising campaigns. If a consumer has downloaded an app that monitors for an advertising broker's beacons, they could receive a notification enabling them to buy the product or service on the advertising hoarding they are looking at.

The role of mobile operators

Widespread deployment of beacons could lead to greater usage of mobile and cellular networks by consumers' devices, as apps retrieve relevant content and relay information back to developers. Beyond generating more traffic, the advent of beacons represents an opportunity for mobile operators in a number of ways:

- *Develop and integrate a consistent, interoperable set of standard technical capabilities to deliver beacon capability which merchants can easily incorporate with other technical capabilities within the shopper journey.*

- *Use beacons in their own retail outlets:* As retailers themselves, mobile operators can present consumers with intelligent interactions of a highly-personalised nature in their stores.
- *Include beacons in a broad mobile commerce offering:* Mobile operators developing a broad mobile commerce proposition aimed at engaging merchants, customers, and brands should consider adding BLE beacons to the suite of technology enablers (along with NFC, cellular connectivity, SMS/MMS and Wi-Fi) in that proposition.

Use beacons in operators' own retail stores

In many markets, mobile operators have their own retail stores and have an opportunity to take a thought leadership role in retail, both in terms of giving consumers a leading edge experience and showing other merchants the possibilities. Mobile operators can pre-load beacon-enabled apps on to handsets. This immediately gives a mobile operator the ability to engage and potentially reward consumers for visiting their stores. Mobile operators can increase the frequency of visits to a store by using beacons to do the following:

- Offer a free content download
- Deliver an incremental increase in minutes, data or texts
- Accumulation of check-in points
- Acceleration of rewards based on certain times/days/regularity

There is an opportunity for mobile operators to deploy beacons into retail locations. In order to make this network of beacons useful to the retailers, third party brands and the operators themselves, operators need to build a consistent technical platform both in the cloud and on the handset that can be integrated into operator wallets and third party apps. A single 'beacon network' and platform joining them all together will allow the market to accelerate and increase the speed of adoption. As a result this will create a commercial opportunity for all the ecosystem players involved and in turn benefit the consumer with a consistent user experience.

Include beacons in a broad mobile commerce offering

Mobile operators developing a broad digital commerce proposition could offer merchants and brands a selection of technology/connectivity enablers as part of a B2B relationship. Acting as a consultant and systems integrator, the mobile operator could work with the merchant or brand to determine the optimum mix of connectivity technologies to meet the business objectives. These enablers could include BLE beacons, as well as NFC, cellular and Wi-Fi connectivity for digital engagement in store, supported by a cloud-based engagement platform. Mobile operators could also advise and support merchants and app developers on how to deploy and configure beacons, how to engage effectively with consumers and how to integrate beacons into existing apps (see the appendices of this paper).

Mobile operators can could provide connectivity infrastructure, including BLE beacons, to individual stores, shopping malls and town centres or local authorities, as either a paid or free service, and derive the following benefits:

- Mobile operator apps, such as a wallet, can use location information to initiate an engagement on behalf of third parties, enabling consumers to manage coupons and loyalty programmes from multiple merchants and brands. See the GSMA white paper *Mobile Commerce in Retail: Loyalty and Couponing* for more information on this.
- A mobile operator could run a network of beacons that the apps of participating merchants and brands could use to determine a consumer's location. (Note, the merchant or brand should have the consumer's explicit permission to track their location.)

Mobile operators could collect additional information on consumer behaviour, developing a wide-ranging view of the consumer's location patterns, sometimes down to product level. They could aggregate this data

and provide market intelligence services to companies in other sectors of the economy. If they obtain permission from individual consumers, they could also provide this data to merchants and brands so that they can make highly targeted offers (see GSMA's privacy guidelines).

Appendix 1: Technology background

Basic Principles

Beacons use Bluetooth as the radio technology to carry the beacon broadcast. More specifically beacons use Bluetooth Low Energy, also known as Bluetooth Smart, Bluetooth LE or BLE. This is a technology designed and marketed by the Bluetooth Specialist Interest Group (www.bluetooth.org).

The technology itself is very simple. The lighthouse analogy is an accurate way to describe how they work. Just as a lighthouse emits light that anybody can see, a beacon emits a signal that compatible apps can see. It is effectively a one way broadcast; beacons transmit and apps receive. Quite simply an app can detect a beacon and use the signal to determine the location of the mobile device.

In the case of Apple's iOS operating system, enabling this process is very simple for the app developer - they simply ask iOS to watch for certain beacons and wake the app when the device receives a relevant signal.

Radio

Beacons typically use Bluetooth operating in the unlicensed 2.4GHz ISM (industrial, scientific and medical) band. This means beacons are using the same spectrum as Wi-Fi, automatic garage doors, cordless phones and microwaves. However, Bluetooth Low Energy has been allocated dedicated channels that help beacons avoid interference with nearby Wi-Fi routers.

Broadcast signals

Beacons use the GATT profile to broadcast their information (known as an advertisement). The broadcast itself contains purely static information, and does not itself contain any kind of message, offer or information for the user. The broadcast contains four simple pieces of information:

- ***Beacon Identifier****:* tells your operating system/app that this is a beacon
- ***Universally Unique Identifier (UUID):*** used to identify the owner/deployer of a group of beacons (for example, the brand of a chain of stores)
- ***Major****:* a number often used to identify a location (for example a specific store)
- ***Minor****:* a number often used to identify a micro-location (for example a door, floor/level, department, aisle or product)
- ***Power and calibration data:*** information to tell the app the power output and the expected power at a pre-defined range

The role of apps

A compatible app on a mobile device effectively sits and listens to Bluetooth, watching for beacons. When it sees a beacon it checks to see if the UUID is one that it recognises. If so, the app can make decisions regarding how to engage a user based on the information in the major and minor. In some cases, it may well be the operating system (for example with iOS) on the smartphone that is watching for beacons and the UUID, and the app is only 'woken up' when your UUID is seen.

iBeacon™

iBeacon is an Apple trademark. It describes the Apple technical and branding guidelines. Given iBeacon's dominant position (as of March 2014), much of this paper refers to methods of using iBeacon compatible beacons specifically. However many of the general principles apply to other proprietary beacon technology. It should also be noted that iBeacon 'broadcasts' can be seen just as well by non-Apple operating systems

and hardware, such as smartphones using the Android operating system. Currently, all information relating to iBeacon from Apple is protected by a Non-Disclosure Agreement, available only to organisations

Beacon Battery Life

Ideally, beacons, which use battery power, should have a life of at least one year if being deployed into a permanent location. However, the optimum battery life will depend on the application or relevant use case.

The protocol used has a large impact on the battery life of a beacon. Many beacons are capable of a battery life of close to ten years, and up to three years using just a coin cell battery. However, this tends to be when proprietary beacon protocols are used and the number of broadcasts per second can be varied depending on time of day, frequency of engagement or just long intervals to preserve battery.

Apple's specification for iBeacon states that the broadcast must be repeated ten times per second. This places a high demand on the battery of the beacon. A beacon in proprietary mode that has a battery life of 2 years may only have a battery life of 3 months in iBeacon mode. This is an important consideration when deciding which protocol to use.

However, there are many different factors that influence the choice beacon specification, beyond just battery consumption, such as compatibility with apps, operating systems and smartphones.

Devices supporting BLE

Table 2 shows examples of smartphones and tablets that support BLE include:

Manufacturer	Product Name
Apple	iPad (Air, Mini, 3rd & 4th gen)
Apple	iPhone (5s, 5c, 5 & 4s)
Google	Nexus 5, Nexus 4
Google	Nexus 7, Nexus 10
BlackBerry	Q10
BlackBerry	Z10
HTC	One, One Max
Microsoft	Surface
Motorola	Droid RAZR, Ultra, Maxx, Mini
Motorola	Moto G, X
Samsung	Galaxy Series
Sony	Xperia Series

Appendix 2: More use cases

Examples of entertainment and hospitality use cases

Events

Surfacing tickets/content upon event entry.

- surfacing the event ticket as the attendee reaches the event entrance to speed up the entrance process
- alert the attendee to the start time and location of next act

Surfacing offers/content/loyalty/check-in upon event zone entry.

- alerting an attendee to refreshment options as they leave a stage area
- surfacing an offer as an attendee comes close to promotional staff, where the beacon is attached to mobile staff

Surfacing content upon event exit.

- surfacing offers for content purchase relating to the event in question
- giving the attendee travel guidance

Event navigation.

- giving directions to the nearest first aid point
- directing a attendee to a 'friend' connected to by app, or directions to both parties for the nearest meeting point

Ordering of goods/services to seat.

- ordering of food or beverages directly to the attendee's seat
- ordering of food or beverages with location context, allowing the app to guide the attendee to the closest collection point

Triggering event rating.

- socially share a rating for the event or specific act

Initiating Wi-Fi connectivity

- opening an app to connect the user to event Wi-Fi

Theatre/Cinema

- ***Surfacing tickets/content upon entry.***
  - surfacing the customer's ticket as they enter the cinema
  - telling the customer about offers of value add services that day (for example, popcorn)

- ***Surfacing offers/content/loyalty/check-in upon zone entry.***
  - offering movie trailer content when a customer dwells in front of movie promotional material
  - offering the ability to pre-order interval refreshments when entering the bar

- ***Surfacing content upon exit.***
    - offering video clips of that evenings performance
    - giving the opportunity to register for updates regarding a sequel or linked movie

- ***Navigation to seat.***
    - giving graphical instructions to guide a customer to their seat

- ***Ordering of goods/services to seat.***
    - ordering of refreshments for delivery to a customer's seat

- ***Triggering rating.***
    - rate and socially share a movie upon exit

- ***Initiating Wi-Fi connectivity.***
    - opening an app to connect the customer to cinema Wi-Fi to download a trailer

Stadia

- ***Surfacing tickets/content upon entry.***
    - surfacing the spectator's ticket as they enter the stadium
    - giving information about a football team selection for that match

- ***Surfacing offers/content/loyalty/check-in upon zone entry.***
    - check-in to a refreshment area, triggering an offer
    - merchandising offers when in range of an in-stadium shop

- ***Surfacing content upon exit.***
    - giving a spectator the option to purchase a season ticket
    - giving offers relating to nearby food/drink facilities

- ***Navigation.***
    - giving graphical guidance to reach a seat
    - giving graphical guidance to reach a location where sports bets can be placed

- ***Ordering of goods/services to seat.***
    - ordering of refreshments for delivery to a spectator's seat
    - ordering of refreshments from a spectator's seat, with resulting guidance to reach the closest collection point

- ***Triggering rating.***
    - spectator able to rate the performance of athletes
    - ability to vote for acts or sports people during sporting intervals

- ***Initiating Wi-Fi connectivity.***
    - opening an app to initiate connection to stadium Wi-Fi

Hotels

- ***Surfacing offers/content/loyalty/check-in upon hotel entry.***
    - bring up booking details/reference

- entice the guest to upgrade before check-in

- ***Surfacing offers/content upon hotel zone entry.***
  - open a tab at the bar
  - make a spa booking

- ***Surfacing content upon hotel exit.***
  - rate the stay on Tripadvisor

- ***Initiating a payment using zone or PoS proximity.***
  - with the app able to verify which room the guest is in, the guest can settle the bill from their room

- ***Loyalty collection redemption upon room/zone/PoS proximity.***
  - reward visits to a restaurant, spa or gym with offers

- ***Ordering of goods/services to room/hotel zone.***
  - using an app to order room service, or service to a particular area of the hotel

- ***Triggering feedback/questionnaire.***
  - collect feedback relevant to where the guest is at the time during the stay

- ***Hotel navigation.***
  - how to find the gym or breakfast

- ***Initiating Wi-Fi connectivity.***
  - open an app to offer Wi-Fi access, free or charged

Restaurants

- ***Surfacing offers/content/loyalty/check-in upon entry.***
  - offers to increase spend
  - reminding a diner to use their loyalty card

- ***Surfacing content upon exit.***
  - recommend the venue socially
  - make a future booking

- ***Initiating a payment using table or PoS proximity.***
  - using an app to ask for or even deliver the bill
  - pay a bill using an online payment app

- ***Loyalty collection redemption upon table/PoS proximity.***
  - gain points once seated at the table - just because the diner isn't the one paying it doesn't mean they are not a loyal customer

- ***Ordering of goods/services to table.***
  - ordering food or drinks via the app when the app knows which table the diner is at

- ***Triggering feedback/questionnaire.***
  - ask what dishes were good or which were missing from the menu

- feedback on staff and facilities

- ***Initiating Wi-Fi connectivity.***
  - opening a restaurant or third party app to give Wi-Fi connectivity

Bars

- ***Surfacing offers/content/loyalty/check-in upon entry.***
  - offers to increase spend
  - check-in socially shared to drive footfall

- ***Surfacing content upon exit.***
  - recommend the venue socially

- ***Initiating a payment using table or PoS proximity.***
  - using an app to ask for or even deliver the bill
  - pay a bill using an online payment app

- ***Loyalty collection redemption upon table/PoS proximity.***
  - gain points once seated at the table - just because the consumer isn't the one paying it doesn't mean they are not a loyal customer

- ***Ordering of goods/services to table.***
  - ordering food or drinks via the app when the app knows which table you are at

- ***Triggering feedback/questionnaire.***
  - feedback on staff and facilities

- ***Initiating Wi-Fi connectivity.***
  - opening a bar or third party app to give Wi-Fi connectivity

Examples of transport use cases

Road transport

- ***Surfacing offers/content/loyalty/check-in upon car park entry.***
  - give offers for nearby associated business relevant to time of day
  - car park loyalty points collection
  - advice regarding car park opening hours and charging

- ***Surfacing offers/content/loyalty/check-in upon petrol station entry.***
  - reminder to use loyalty card
  - setup a payment via mobile app for fuel
  - offer for products sold within the retail area

- ***Navigation to vehicle location.***
  - an app that remembers where the car was parked based on closest beacon

Trains

- ***Surfacing offers/content/loyalty/check-in station entry.***
    - directions to the ticket office
    - offers for retail and hospitality merchants inside the station

- ***Surfacing tickets upon platform entry.***
    - surfacing ticket

- ***Setting up billing upon entering ticket hall.***
    - buying a ticket through the app, or even collecting an ticket into the app

- ***Navigation to train/seat.***
    - directions to the relevant platform when ready
    - finding your seat on the train

- ***Initiating Wi-Fi connectivity.***
    - opening an app to provide free or paid Wi-Fi access

Airports

- ***Surfacing offers/content/loyalty/check-in upon entry.***
    - notifying the airline you have arrived at the airport
    - surfacing ticket
    - enticing passengers to upgrade

- ***Surfacing offers/content/loyalty/check-in upon zone entry.***
    - retailer specific promotions
    - reminders for travel money and offers

- ***Surfacing tickets upon airport/check-in desk/security/gate/lounge proximity.***
    - surfacing tickets for speed

- ***Airport navigation.***
    - finding the correct check-in desk
    - finding the lounge
    - getting to the gate on time
    - notifying the airline of your presence at any time

- ***Initiating Wi-Fi connectivity.***
    - opening an app to get free or paid Wi-Fi access

- ***Luggage tracking.***
    - passengers able to track and find their luggage
    - airline able to track luggage

Examples of healthcare use cases

Doctors' surgeries

- ***Surfacing content/check-in upon entry.***
    - notifying the surgery staff you have arrived
    - surfacing content regarding seasonal illness advice

- ***Surfacing content upon exit.***
    - reminder to book next check-up

- ***Triggering feedback/questionnaire.***
    - feedback of quality of care

Hospital

- ***Surfacing content/check-in upon entry.***
    - promotion of in-hospital retail and hospitality merchants
    - booking transport services for after an appointment
    - giving appointment number and waiting time advice

- ***Surfacing content upon exit.***
    - reminders to book next appointments

- ***Triggering feedback/questionnaire.***
    - quality of facilities

- ***Hospital navigation.***
    - find a department
    - find facilities

- ***Initiating Wi-Fi connectivity.***
    - open an app to connect to hospital Wi-Fi

Pharmacy

- ***Surfacing offers/content/loyalty/check-in upon store entry.***
    - advice regarding seasonal illness
    - reminder to use loyalty card

- ***Surfacing offers/content/check-in upon zone entry.***
    - telling pharmacy staff you have arrived to collect a prescription
    - offering waiting time advice
    - booking of a particular service

- ***Surfacing offers/content at a product level.***
    - advice on specific products or groups of products

- ***Initiating a payment using store/product or PoS proximity***

- ***Loyalty collection redemption upon store/zone/PoS proximity.***
    - surfacing loyalty card when in range of the PoS

- ***Triggering feedback/questionnaire***

- ***In-store navigation.***
    - finding a specific product

Examples of outdoor media use cases

- ***Surfacing offers/content/loyalty/check-in upon dwell/zone entry.***
    - trigger a game linked to the advertising campaign
    - deliver the offer detailed in the advertising

- ***Surfacing offers/content for nearby locations.***
    - used by third parties to surface and offer relevant to a nearby location, where that location may be a competitor
    - used by third parties for navigation

- ***Triggering feedback/questionnaire.***
    - find out what consumers think of the advertising or brand
    - feedback can be reflected, live, on digital advertising boards

B2B Use Cases

In this section, we consider, potential use cases for business-to-business (B2B) projects, which tend to be less visible than business-to-consumer use cases.

Note, that beacon or BLE technology is not necessarily the single best technology solution across all the use cases listed. Bluetooth beacons do, however, have the ability to provide a solution across all use cases with a great deal of flexibility.

In the automotive industry, for example, using beacons attached to cars during manufacture may not be the best way to track them, as alternative technologies, such as RFID, have an edge in terms of location accuracy, power, size and cost. However, a beacon attached to a vehicle can be useful throughout the vehicle's lifecycle, from manufacture to shipping to storage to sale to use and finally to servicing. All the individuals/organisations involved in this lifecycle will only need a smartphone and an app to access the vehicles.

Vehicle navigation

Beacons can be used to track people, devices or items in public areas. A good example of this can be vehicles in an urban environment. By placing inexpensive beacons on street furniture throughout a municipality, a driver's smartphone can feed back live location information with greater accuracy than standard location services or GPS. Again this may not be the best solution from a pure technology point of view, but add the ability to use standard smartphones and the low cost of the beacons it is a compelling use case.

In Transit

Tracking items in transit is the most common use case. Beacons can be extremely small and inexpensive especially when manufactured for a limited lifespan. For example, Qualcomm markets a beacon device with a month-long lifespan for US $5 for a single unit, less in volume.

An excellent example of tracking items in transit is luggage and airlines. Over 21 million bags are misdirected per annum (SITA 2014 baggage report). Adding a beacon to luggage is a simple low cost solution as allows it to be tracked by M2M specialist receivers throughout the airport baggage report). For example, Qualcomm markets a beacon device staff using a smartphone app.

As an added bonus, passengers can potentially also track their own luggage using an enabled app - getting an estimate on how far way their luggage is, or confirmation that it is in the vicinity.

In Storage

With the relatively long range of beacons and their ability to give ranging information, they can be an ideal technology for finding stored items. With a 50 metre range, an app enabled smartphone can verify whether a package is stored within a facility and use the package beacons, combined with permanently installed facility beacons to narrow down its position to around 1 metre.

In-home use cases

The use of beacons within the home is very much in its infancy, with examples only just starting to appear in the weeks leading to the publication of this document. We expect the combined creativity of app developers and consumers will lead to the emergence of many potential use cases and fully expect beacons to be in widespread use in the home by 2016.

Pairing

A household beacon within the home is very much in its infancy, with examples only just starting to appear in the weeks leading to the publication of this document. We expect the combined creativity of app developers and consumers will lead to n.

Action Triggering

Beacons within the home can trigger actions when entering range, leaving range or coming with a certain distance (see Diagram 5). One opportunity for mobile operators may be to trigger a connection to home broadband whenever in range of the access point (by embedding beacons in Wi-Fi access points), but also allow visitors to attach to Wi-Fi networks (using beacon location to automatically lookup credentials if they are authorised).

Applications such as IFTTT (a service that enables users to connect different web applications, such as Facebook, Evernote, Weather, Dropbox, together through simple conditional statements) and Zapier are good examples of how this kind of interaction can be customised by consumers within their own home. Offering beacons as one of a wide range of triggers that can be used for completely customisable actions using a large range of other apps:

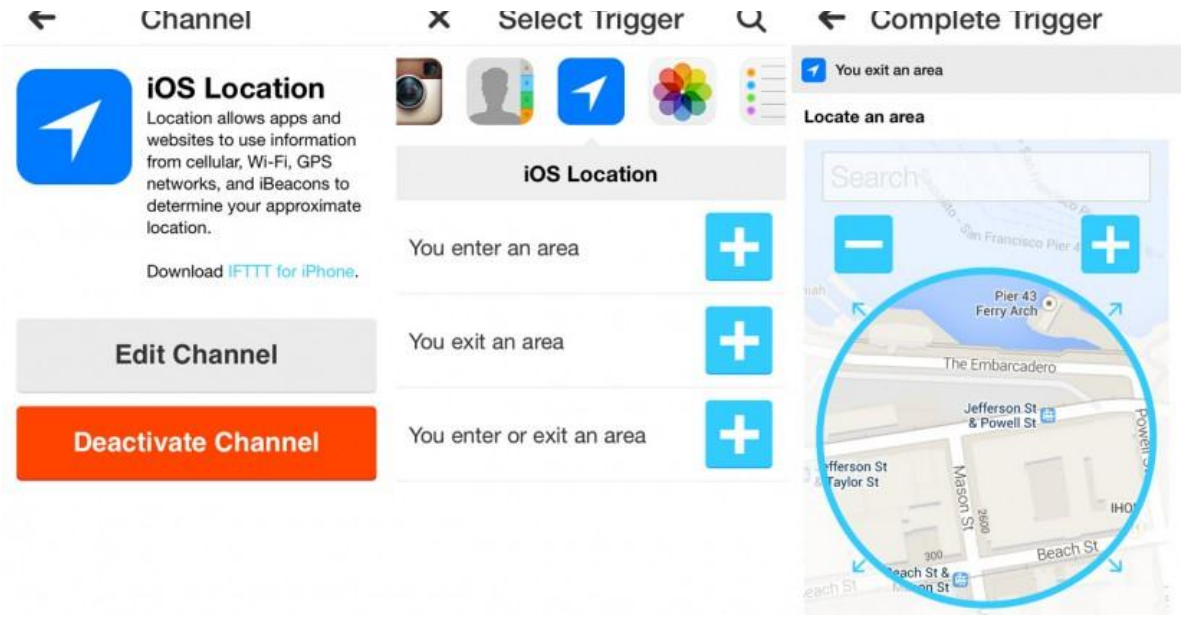


Diagram 5

A few applications are now becoming available to consumers that are purely iBeacon focused, which allows a consumer to specify an iBeacon and the resulting action, such as launching an app, web page or a timer ..

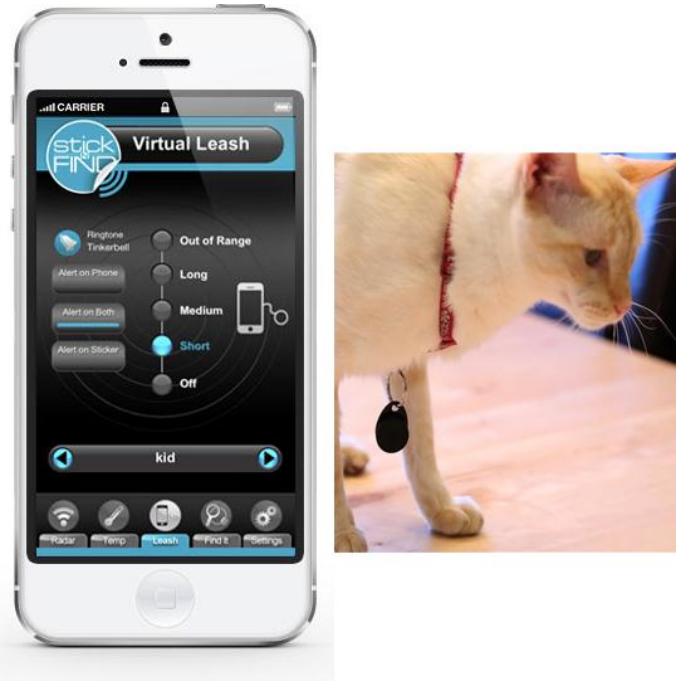
Tracking

Beacons can be used to track valuable items, children, the elderly or pets. There are two scenarios in which this can work:

- Placing beacons around a property and the smartphone of the individual being tracked sets off an alarm/location trigger, if they leave this geo-fenced area.
- Attaching beacons to items or pets which then triggers an alarm when they are out of range

This can be achieved using beacons, or using generic BLE connectivity with similar hardware (see Diagram 6)

Diagram 6, source StickNFind



Note, organisations developing applications that detect beacons to deliver location-based and personalised content, should follow the Mobile Privacy Principles established by the GSMA.

Personalisation

It is possible to personalise the in-home environment using beacons. With beacons placed in the home, or individual rooms, white/brown goods or environmental controls can be configured to suit the person that has entered the zone. Examples of smart white/brown goods or environmental controls that are controlled via mobile include Nest or Belkin WeMo.

There have been a number of apps and BLE hardware providers enter the in-home security market in the past 12 months. We believe some of these use cases will transfer to beacons, for example, allowing apps to trigger entry to a premises based upon user proximity and an authorised app.

Peer-to-Peer

The use of beacon protocols is not limited to transmissions from dedicated hardware to an app. Some apps are just starting to use beacon protocols to turn the handset into a beacon, allowing for peer-to-peer (or app to app/handset to handset) proximity detection and ranging. This can be especially useful when creating a social app that, for example, could detect other app users in the same location.

Appendix 3: Market Requirements

The following market requirements have been captured from interviews with organisations currently using or trialing beacons and also from organisations considering using the technology and currently assessing the market.

Hardware

There is some confusion in the market today regarding the capabilities of the beacon hardware on offer from manufacturers. Manufacturers should consider giving basic guidance in their product sheets for the information shown in Diagram 8:

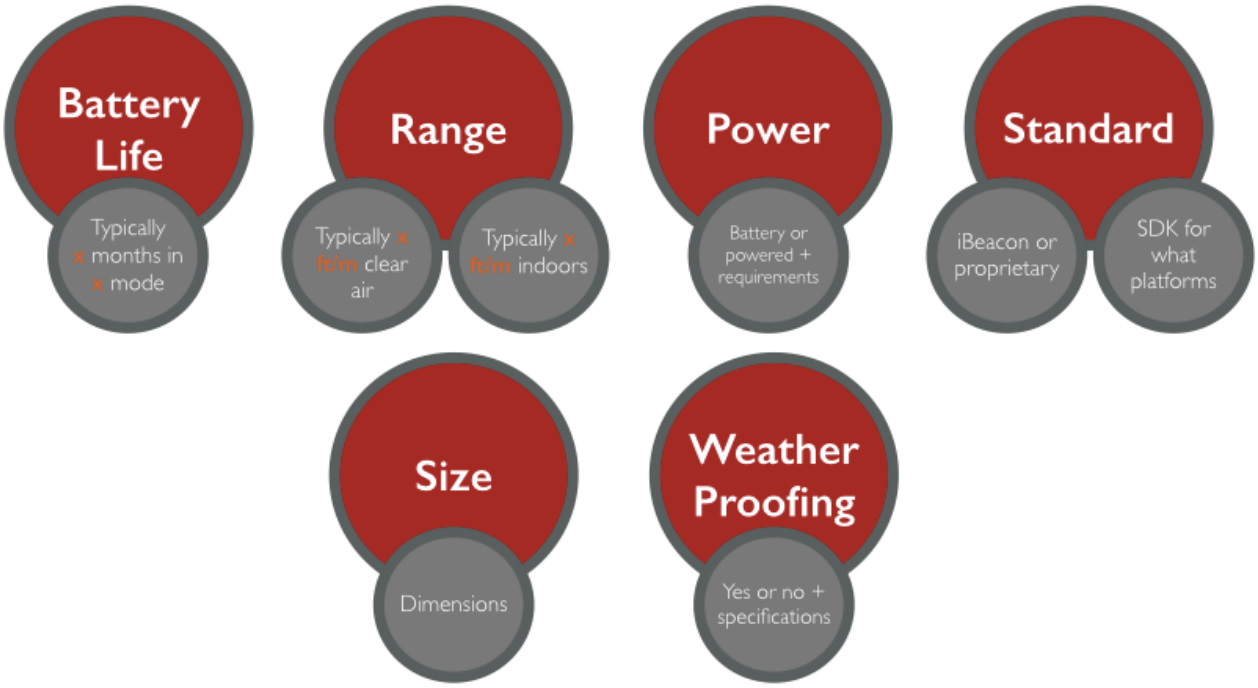


Diagram 7

Battery Life

The battery life of a beacon will vary from one manufacturer to another and, in particular, depending on what specification is in use. Proprietary beacons range from 20 transmissions per second to once every 2 seconds.

For example, iBeacons transmit 10 times per second, and as a result tend to have shorter battery lives than beacons using other specifications. Compared to proprietary beacon protocols the difference can be as much as a factor of three.

Generally speaking the more frequent the transmission, the more likely an app is to see the beacon and the more accurate the ranging data (the app's estimation of how far from a beacon it is).

It is possible to configure beacons to operate to iBeacon guidelines in every way except advertising frequency. Reducing the advertising frequency can increase the battery life. However, this could have implications on user experience and raise compatibility issues with apps that are expecting standard iBeacon behaviour.

Generally speaking, if a beacon is going to be put in a permanent position as a location reference it is good practice to ensure the device has a battery life of at least one year, ideally two years. Anything shorter, particularly for large beacon estates, creates a high burden in terms of replacing beacons.

When a beacon is replaced, the replacement either needs the same configuration or apps/cloud platforms need to be updated of the new beacon configuration. This introduces the potential for mistakes. Therefore, it is important to reduce the frequency of beacon changes as much as possible.

However, the requirements for battery life vary depending on the application and use case. In some instances the required battery life may be only a few days. For shorter term requirements, the battery life is far more flexible, and it is often advantageous to have a shorter battery life. For example for a beacon to 'expire' after a short period of time without it having to be manually removed.

One, often over-looked, factor is transmission power. Most beacons can be configured to transmit at different powers. Increasing the power will reduce the battery life of a beacon. It is suggested that manufacturers state transmission power used to arrive at a stated battery life to give beacon buyers some guidance. Otherwise buyers may find beacons running out of power far earlier than expected.

Naturally, some installations will allow for a reduced transmission power, therefore extending the battery life of a beacon. It is worth noting, especially if you have a large beacon estate, that your beacons may well all run out of power at different times creating something of a management headache.

Range

General feedback from current users is that beacons should be configured, and tested after installation, to provide a range of 20 metres, effectively covering a sphere with a diameter of between 30 metres and 40 metres. Many software development kits configure apps to scan for beacons every 20 seconds in background mode. Humans tend to walk at a pace of 1.4 metres per second, meaning they cover 28 metres in a 20 second period. Therefore a beacon range set to 20 metres with a realistic coverage zone of 30 metres should ensure most apps get a chance to see a beacon even when in background mode.

This works well in an entrance area. However beacons placed and designed to capture people who are lingering can utilise a far smaller range.

iBeacon and iOS creates a framework for ranging, with three states when in range of a beacon; far, near and immediate. Many contributors to this paper feel that due to the inconsistent nature of radio/environments these distance measurement states are very hard to use reliably. Typically triggering an engagement when near or intermediate seems to be the most effective approach. The greater the range the more chance of being seen by an app, but the greater the range the less accurate the location data, making for a potentially less relevant engagement.

Size/Format

The appropriate size and format of beacons comes down to their use case. To minimize tampering and theft, beacons should remain discreet unless they are designed for user to physically interact with them. Therefore beacons, should be as small as physically possible for their capability and discreet in terms of colour and design to allow them to go unnoticed.

Managed Service

As with any other technology being deployed widely into the field, beacons are a specialist infrastructure product. Many organisations' IT departments or media/advertising agencies require a specialist company to deploy and manage estates of beacons.

Deployment

Deploying beacons requires the following:

- Physical beacon installation to ensure correct, concealed placement
- Testing of the radio environment to ensure correct operation on a location by location basis
- Testing of a relevant app or use case to ensure a beacon 'triggers' an app at the right time/distance
- Accurate cataloguing of beacons - which beacon is where.

On-going support

Due to their simplicity, beacons are often an 'install and forget' technology, especially as they require no connectivity and often no external power. However, units do fail, get lost/stolen or the batteries run out. There is a requirement for companies to provide a managed service to address these issues, with service level agreements.

However, as beacons have no connectivity, maintenance can be difficult. Many organisations are looking to employ passive monitoring that involves apps difficult. When a central platform notices a beacon stops being reported, field engineers can be deployed to fix/replace the beacon.

For more mission critical applications there is a requirement for active monitoring, involving a connected device that actively watches the beacon and reports its status to a central platform. One way to achieve this is to provide staff in a location with an app that monitors beacons in background.

Location Data

Beacons can be used is a wide variety of locations to provide triggers or data. The range of a beacon can be vice that actively watches the beacon and metres.

Store Level

This is the most common requirement in the retail sector, in particular, enabling an app to know when it enters a specific premises.

Door/Floor Level

Placing beacons on specific entrances/exits or stairwells enables an app to know broadly where a user is within a location. This approach, for example, can be used in a hotel or department store.

Department Level

Beacons can be deployed to cover an entire department or area. For example, a furnishings department or a platform in a train station.

Aisle Level

Aisle level beacon use has often been cited in grocery store use cases, with the beacon range tuned down so an app can see when a user enters a very specific area of a store, allowing contextually relevant notifications to be served or for indoor mapping to show a very precise location.

Product Level

In some cases it is possible to tune the range of a beacon down to less than 1 metre, in order to know when a consumer is in the proximity of a specific product. This can be used very effectively in combination with dwell time (when a consumer spends a specific amount of time in looking at product), potentially flagging a need for additional information or assistance. This level of accuracy can be used in a range of scenarios, such as changing rooms in fashion retailers, to incentivise consumers to make a purchase after long dwell time.

Care should be taken in all cases not to ‘over-engage’ consumers with multiple notifications within a location, as this may cause users to disable apps, locations, notifications or Bluetooth.

Analytics

A great deal of information can be derived from beacon use. For example, store visit frequency, path through store, dwell time or product level engagement. There is strong demand, in particular from merchant, brands and outdoor media, to understand and use this data effectively.

Many beacon suppliers have created analytic dashboards for beacons owners to get access to this data. There is also a strong requirement, if the data can be linked to a known individual, for data to be exportable (or custom reports to be made) for use in external systems. For example, to be mixed with existing CRM data.

Note, organisations developing applications that detect beacons to deliver location-based and personalised content, should follow the Mobile Privacy Principles established by the GSMA.

Appendix 4: Consumer Engagement

Beacons offer app developers the opportunity to deliver messages to consumers at the right time, right place and with the right context. This should mean beacons act as a filter on the user's behalf, giving them a compelling experience across all their apps, where they are only engaged in the right context.

However, as with any new technology, there may be the temptation for developers to e right time, right place and with the right context. This should mean beacons act as a filter on the user's behalf, giving them a compelling the app, disabling notifications for all apps or even disabling Bluetooth completely.

The survey results[3] in Diagrams 8 and 9 shows that consumers are receptive to receiving relevant notifications in a retail context, for example. Diagram 10 also shows the various factors that prompt consumers to turn off these push notifications.

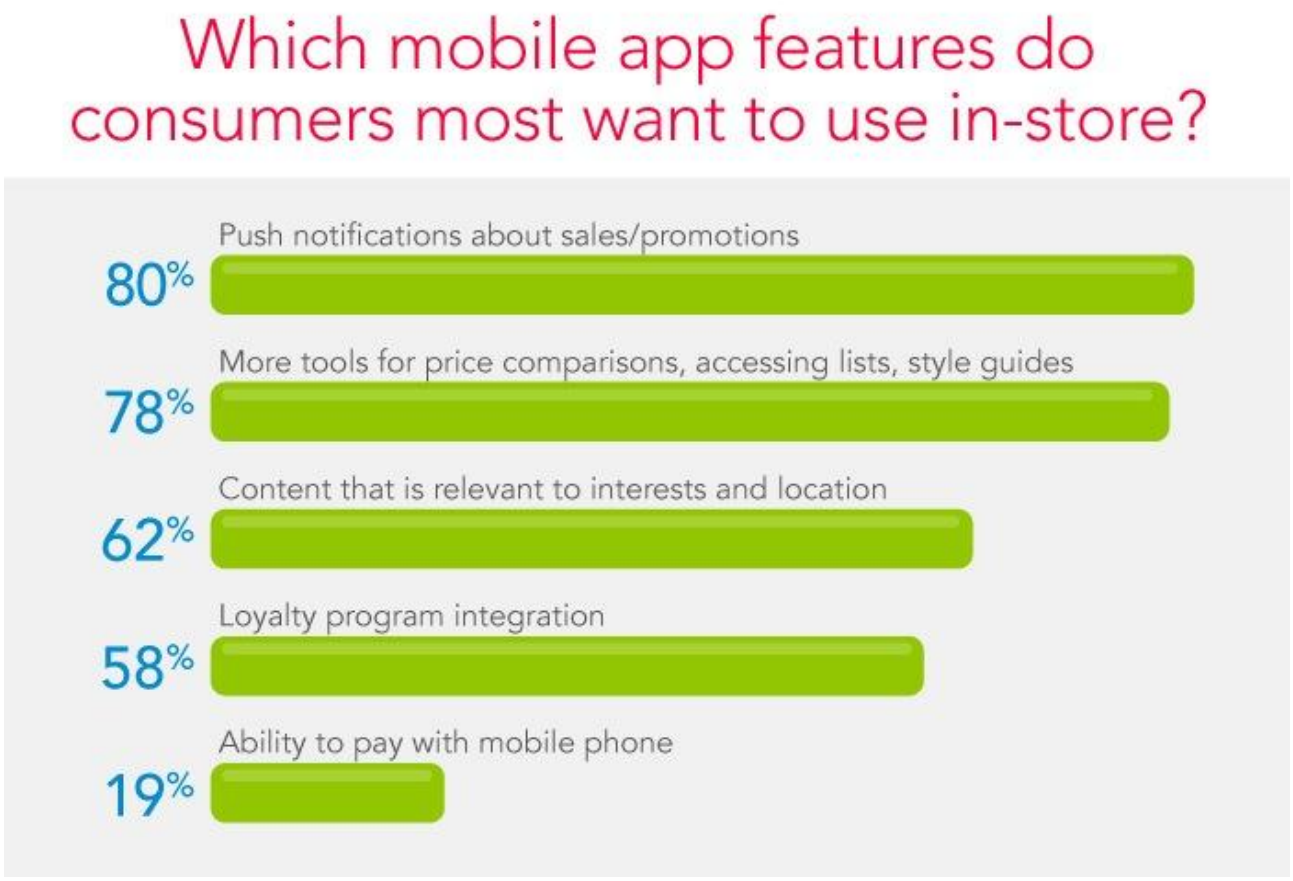


Diagram 8, Swirl, February 2014

[3] Source: A survey of 1,000 consumers in the U.S. by ResearchNow

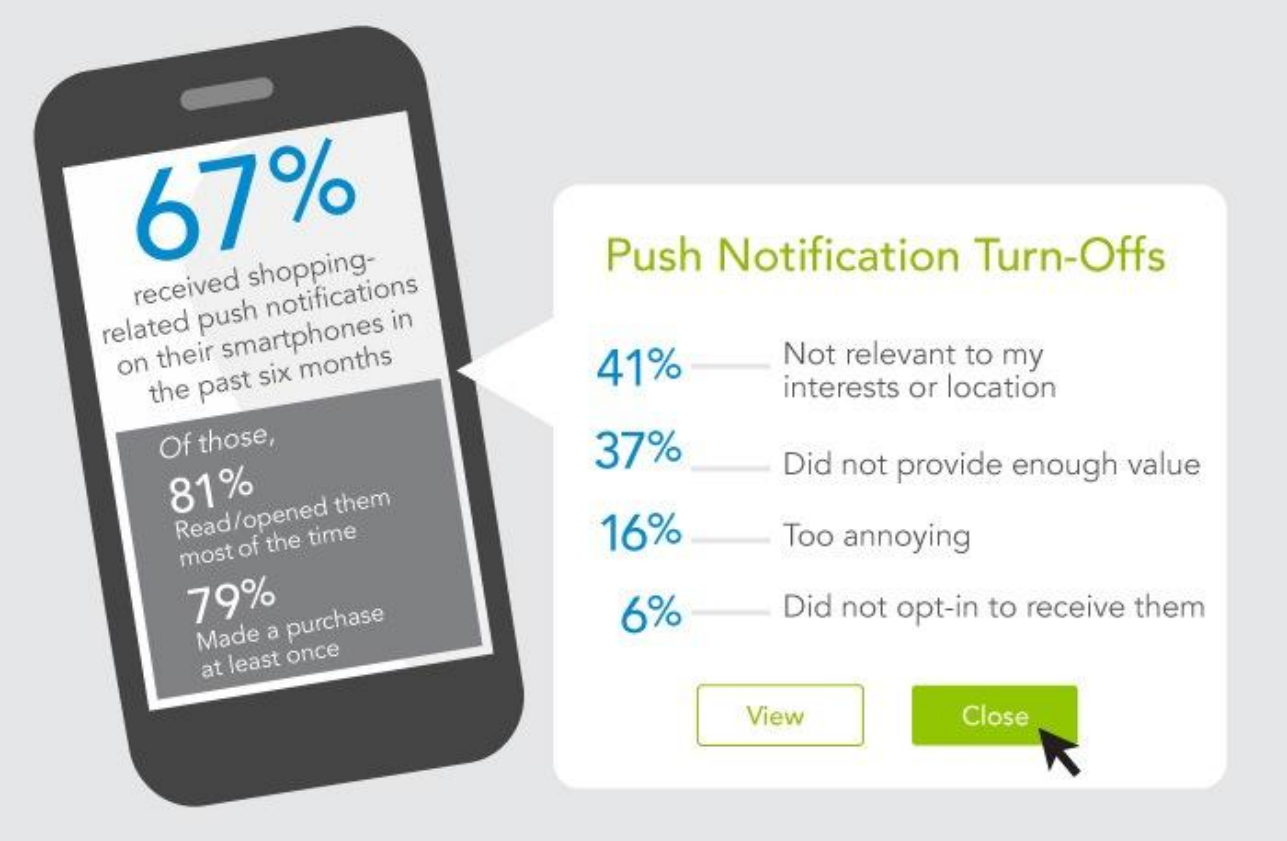


Diagram 9, Swirl, February 2014

It is therefore essential that app developers carefully consider the frequency with which they engage users. An engagement is typically classified as an out-of-app push notification:

These include (but not limited to):
iOS

- Lock screen notification
- Out-of-app dialogue box
- Notification centre item

Android

- Lock screen notification
- Top tray icon and item

There are four primary factors that app developers should consider when thinking about how often they should engage users:

- Engagement per entity: the total number of engagements over a period of time from a single organisation or app.
- Total engagements*:* the total number of engagements a user is likely to receive on their smartphone from all organisations or apps.
- Content re-use: the number of times a user sees notifications about the same content.
- Location re-visits*:* how often or when to re-engage a user when they re-visit the same location, or another location in the same engage users: is typically classified as

It is difficult to recommend any hard and fast numbers against these four criteria, as they depend a great deal on the use case. For example, automatically surfacing a travel ticket each time you enter a transit location is useful, even if you visit 10 times a day. However it would not be appropriate to engage a user 10 times a day for a 10% off voucher for an unqualified item they did not engage with. As shown in Diagram 11, there are two types of engagement:

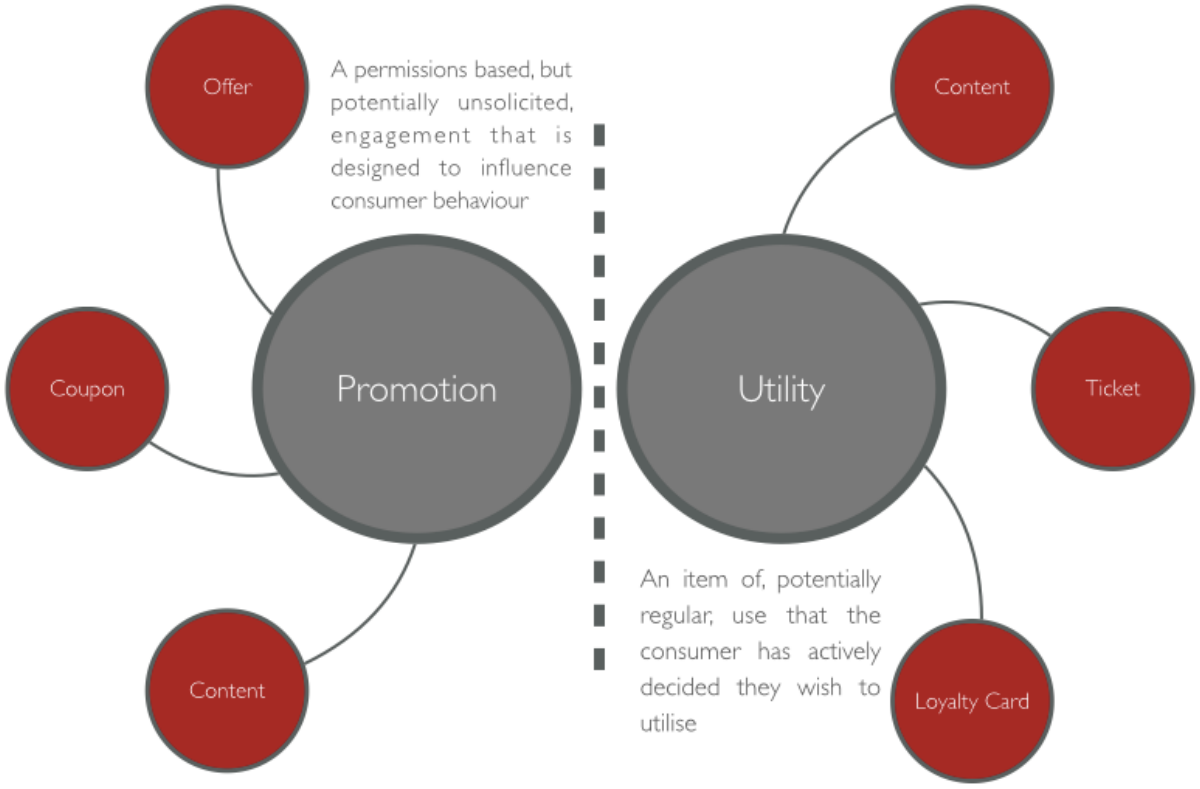


Diagram 10

Promotion engagements are those that are intended to positively influence user behaviour. An example of this would be advertising or a discount offer.

Utility engagements are those that a user has decided to utilise in a pre-meditated fashion and represent something that assists a user. These would typically be building passes, tickets or loyalty cards.

Best practice for the two different types of engagement are quite different. Guidance for utility engagements is easier to quantify: Continue to show a utility engagement for as long as the consumer is engaging with it, as long as it is presented in context.

The guidance is softer for promotion engagements, and very much depends on the circumstance and use case. Broadly speaking, if a consumer responds positively continue to engage them, but stop when they stop responding. This basic guidance can apply to both the re-use of content and location re-visits.

Whilst the technology and engagement is in its infancy it is advised that any single organisation or app should try and keep the total number of engagements per day relatively low and slowly increase to try and find the point at which users are no longer happy to be engaged (i.e. they disable notifications):

Multiple App Engagement

It is possible to engage users using multiple apps, sometimes simultaneously with the same messages. Many apps may make use of the same beacon, and may be under the control of a single organisation, or many organisations.

Where all the apps are attempting to deliver the same message from the same organisation, measures should be taken to ensure the user only receives the message once, from one app at a time. This will help to ensure the user does not become over-loaded.

Organisations providing content management platforms, supporting apps, should look to offer a prioritisation methodology.

Relevancy of Message

Clearly, the success, or otherwise, of user engagements will depend on relevancy. If the message is not relevant the user will either ignore or disable future engagements, no matter what other guidance is followed.

Not only should an engagement capture the attention of a user at the right time and place, the message should be as directly relevant to the users as possible.

Basic guidance, such as triggering an offer for men's waistcoats in the menswear department to a consumer that has previously purchased a suit, can require sophisticated platforms and intelligence systems.

However, it is relatively trivial to ensure an app does not engage a consumer outside of a store's opening hours.

In many instances, the use of an external CRM (customer relationship management) or campaign platform can create more complex sets of rules for engagement, which can be changed on a regular basis, may be appropriate. Broadly speaking the more intelligent the engagement, the greater the chance of the consumer reacting positively.

Transparency

Consumers should be made well aware of the location-tracking capabilities of an app to ensure beacon-enabled apps do not become perceived as 'spy-ware' in the future. The use of location data should be tied to a clear value exchange: What is the user getting in return for giving up their location data? Timely offers, a better experience, better communication, an easier journey, social interaction? The user should also be able to disable this function easily. The same approach should also be taken for notifications and any data that may be transferred or stored about the user.

For further guidance on this issue, please see the Mobile Privacy Principles established by the GSMA.

Push versus Immersive Experiences

There is a temptation to use beacons as a way to 'push' advertising or messages onto a consumer. Instead, beacons should be used to design helpful, immersive experiences. Rather than simply pushing out promotional messages, app developers should take the opportunity to help the consumer and make their experience easier and enriched.

Appendix 5: App Integration

Beacon Detection

Apple iOS deals with iBeacon detection in the location services framework, so it will not be covered in this document. However for more information developers can reference the 2013 WWDC materials from Apple.

Strategies for scanning

App developers can use many different strategies to scan for beacons. Software development kits (SDK) provide for specific strategies (some are listed below). Alternatively, a developer can create their own code and find the right route for their app.

There is a trade-off between continual scanning and reducing the smartphones battery life, versus scanning infrequently, but potentially missing the beacon. There are many tactics a developer may wish to consider. For example:

- Only scanning during the opening hours of the stores the app relates to
- Only scanning when the consumer is not stationary
- Only scanning when within a larger geo-fence containing the beacon location

The effectiveness of an app and its associated impact on battery life will be a product of the scanning strategy. Many developers have found the following method to be effective:

- Sleep for 20 seconds
- Scan for 1 second, if no beacon is seen go back to sleep for 20 seconds
- If a beacon is seen then continue to scan

Generally speaking, developers that use this strategy tend to see their apps having no more than a 2% battery life impact on the smartphone (that equates to the overall app footprint, not just the beacon scanning element). Consuming more than 2.5% of the smartphone battery is bad practice and may lead to the consumer uninstalling the app or switching off Bluetooth. Our interviewees told us that apps that use more than 5% result in the majority of consumers disabling the entire app within a few weeks.

It is worth noting that battery drain will vary from handset model to handset model, so should be tested across multiple models/manufacturers.

Some handsets have been seen to consume up to twenty times as much battery power undertaking the same scan, compared with the same app on an alternative handset running the same OS. This difference relates to the Bluetooth chipset in use and the manufacturer undertaking the same.

Available SDKs

Here are some examples of organisations that provide beacon SDKs for iOS or Android:

- Appflare (www.appflare.com)
- BlueCats (www.bluecats.com)
- Estimote (www.estimote.com)
- Radius Networks (www.radiusnetworks.com)
- Roximity (www.roximity.com)
- Sonic Notify (www.sonicnotify.com)
- StickNFind (www.sticknfind.com)

- Swirl (www.swirl.com)
- Twocanoes (www.bleu.io)
- Qualcomm (www.gimbal.com)

Cloud Platform Integration

Cloud platforms are discussed at length in Appendix 9 and in Appendix 10. There are numerous reasons to use a cloud platform:

- Enable basic protection for beacons
- Collect beacon location data for analytics
- Passively monitor beacons
- Grant access to many apps, potentially for defined durations
- Provide engagement capping.

There are also disadvantages to using cloud platforms:

- Handsets require data connectivity to use them
- Increase in the battery requirement per beacon 'sighting'.

Offline Mode

In many markets, retail stores have cellular connectivity black spots, meaning many smartphones will not have a data connection when indoors. If a cloud platform is being used, the SDK should support an offline mode. This can enable an app to cache beacon information (perhaps the 100 nearest beacons), allowing interaction to take place even if data connectivity is not present.

Appendix 6: Beacon Deployment

Radio Environment

In the same way that Wi-Fi performance suffers when there are multiple access points using the same channel in 2.4GHz, so does Bluetooth and beacons. As a result beacons do not always perform as well as expected, with typical symptoms such as:

- Apps not seeing beacons despite being in range
- Limited range
- Highly inaccurate ranging information
- Corruption of broadcast beacon data

The same sort of processes and precautions should be taken when deploying beacons as are used when deploying a public Wi-Fi network.

If the beacon is mission-critical it is good practice to perform a radio site survey before installation to check how congested the radio environment is. If 2.4GHz is particularly congested, more than one beacon may be needed to cover a particular area.

Physical Placement

As discussed in the earlier section on size/format in market requirements, beacons should be discreet and if possible out of sight/reach.

A discussed in the earlier section on size/format in market requirements, beacons should be discreet and if possible out of sight/reach. Floors, ceilings and walls can all bounce the signal further. However, people tend to obscure the radio, stopping it dead in its tracks.

Position the beacon in a place that gives the clearest line of sight. Given smartphones are often kept at waist level, the most efficient place to position a beacon is often on the ceiling.

In awkward locations, walls and ceilings can be used to bounce the radio signal towards the user. But be aware that ranging is a function of the distance the radio travels to reach its destination. If the signal is being bounced off a ceiling first this distance will increase (despite the actual physical distance being shorter).

As discussed in the radio environment section, always ensure beacon placements are tested after installation, and if possible, test with the intended app. Often the results are not as expected and a beacon may need to be:

- Repositioned
- Reconfigured for additional power (this will reduce the battery life)
- Supported by additional beacons with the same configuration to cover radio blind spots

As discussed earlier, using a lower power will extend the battery life of the beacon, saving time and money. A smaller beacon range also increases its location accuracy (by virtue of its signal covering a small area), therefore, in some use cases increasing the relevancy of the message.

As beacons use the same frequency as Wi-Fi, it is good practice not to place beacons too close to Wi-Fi access points. As a minimum try and ensure at least 100cm between them, ideally more.

Care should also be taken to ensure the physical security of the beacon, to stop tampering or theft.

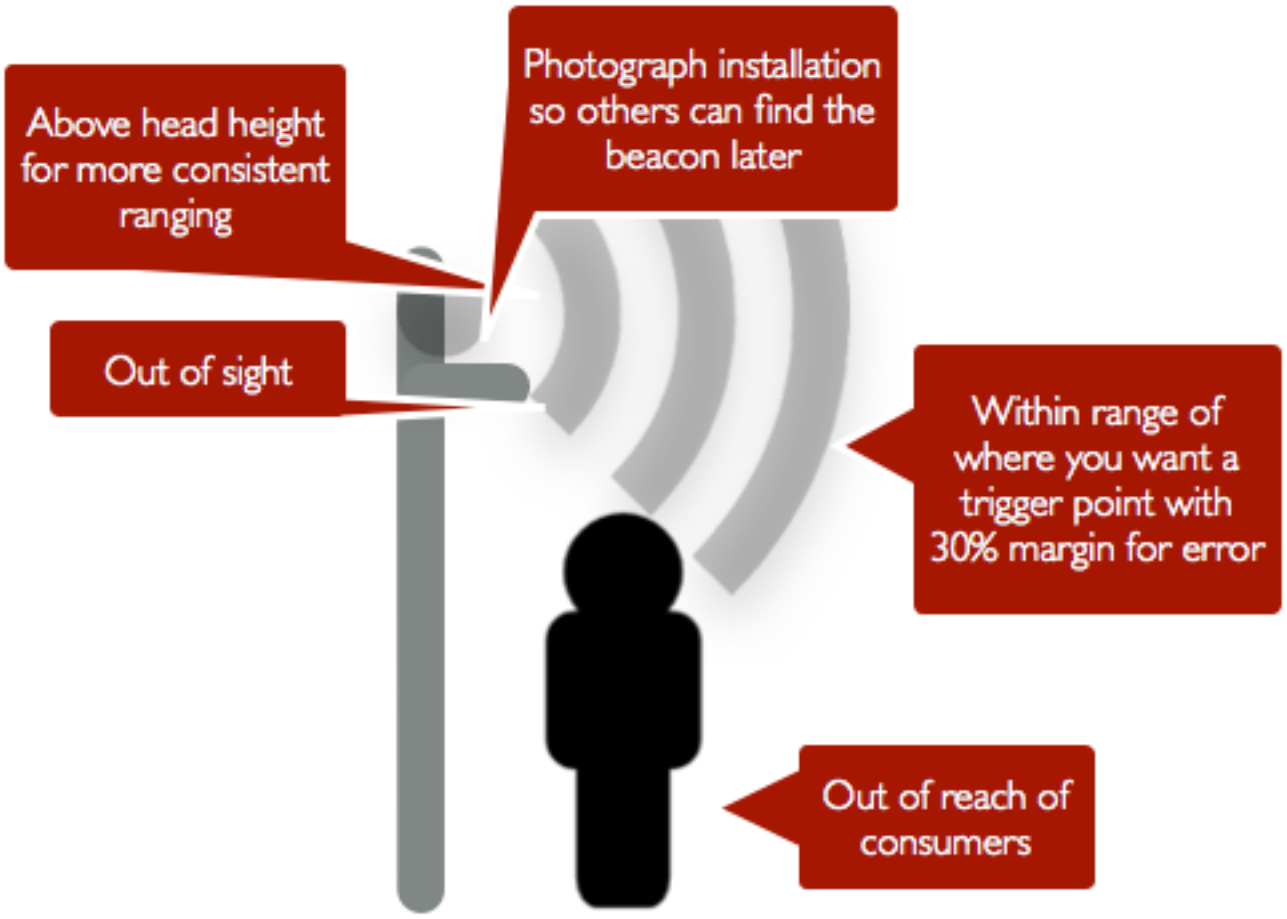


Diagram 11

Appendix 7: Beacon Schemas

With most beacon systems, app developers have the flexibility to adopt a range of schemas and logic. This section provides some explanations of how different elements of beacon transmissions work and some suggested schemas.

The only de facto 'standard' to date is Apple's iBeacon. Therefore this section has been tailored around the iBeacon specification. However, the full technical specification of iBeacon is currently protected by Non-Disclosure Agreements of those licensed to use iBeacon technology. Therefore, the information used in this document has been derived from freely-available sources on the internet.

Before using beacons, an app developer should check the full specification to establish whether they use iBeacon licensed technology and if not, whether they support UUID, major and minor transmission.

The UUID

UUID stands for Universally Unique Identifier. The objective of the UUID is to uniquely identify distributed systems without the need for any (or very little) centralised infrastructure.

A UUID is a 16-bit octet (or 128-bit number). As used with iBeacon it is represented as 36 alphanumeric characters (32 alphanumeric characters and 4 hyphens). For example: 3974240-1c6f-4625-a892-b1bd8a717771

There are 340,282,366,920,938,463,463,374,607,431,768,211,456 possible UUID combinations.

Despite the enormous number of UUID combinations that are possible, relatively few are in use by beacons. The primary reason for this is default manufacturer settings. Many manufacturers sell beacons using a single, common UUID. This results in large volumes of beacons being deployed with a common UUID.

This can cause short-term problems with the app from one organisation being awoken by another organisation's beacon. As a minimum this could cause handset battery life concerns. In the long term, if this becomes common, it may be possible to come across not just a duplicate UUID, but also a duplicate major and minor configuration (especially where majors and minors of single digits are in use) resulting in falsely triggered engagements.

Whilst these appear to be rare cases in 2014, if beacons are deployed widely it could become a more significant problem. It is strongly advised that manufacturers of beacons do at least one of the following:

- Randomise the UUID in every beacon manufactured
- Generate a unique UUID in every beacon manufactured
- Include guidance in the beacon packaging to inform the purchaser about the benefits of choosing their own UUID
- Direct purchasers to online resources where they can generate their own UUID

To head off the long-term problem, it is an open question as to whether there should be a website centrally issuing UUIDs, ensuring that each and every UUID issued is unique.

As discussed in the Appendix 9, using an UUID that spans multiple organisations' beacon deployments can be preferable in some instances.

Major & Minor identifiers

Major and minor identifies are part of the iBeacon specification, but they have also been used extensively in other proprietary implementations. They form part of the overall beacon hierarchy:
The generally adopted use of major and minor is as follows:

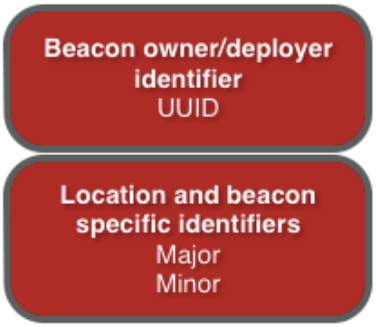


Diagram 12

- **Major:** Identifies the location. For example the store address/number. This can be a group of beacons.
- **Minor:** Identifies a micro-location within a location. For example, a door, department, floor or aisle. This would be a single beacon.

However, it is up to the app developer to decide how to use these two identifiers, and entirely proprietary schemas can be adopted. For example, in some cases the major and minor are joined to make a single, unique, beacon identifier. As such the major and minor have no intrinsic value, only what is decided by the app developer.

The major and minor both have the same structure; a 2-byte integers. In practice each is a number from 0 - 65535.

It is possible to derive a large number of unique locations from just one of the major or minor numbers, leaving the other for an alternative use (for example some form of authentication/ checksum/ verification).

As discussed in the Appendix 9, using a schema that can be decoded by third parties is not always preferable. However, should a logical schema be required, here are some examples.

Diagram 14 and *Table 3* show an example contributed by Proxama, while *Table 4* from Appflare, shows how the major may be used to identify the location, but a series of minors may be used to identify micro-location.

Wildcards may also be used in a major/minor schema with an interpretive algorithm contained in the app.

The major and minor can often be seen expressed not as integers, but in hexadecimal code. For example the number 19876 would be expressed as 4da4.

The 2-byte **Minor** field data structure is split between store and area. The number of bits to allocate to either is configured within the trigger data as an integer between 0 and 16. For example, the 16 bit Minor field for a 250 store chain could be configured as follows:

<<9 bits Store Id><7 bits area Id>> which gives 512 stores and 128 areas within each store, the 'split_location' data field would be set to 9.

A large 3,000 store chain could be configured as follows:
<<12 bits Store Id><4 bits location Id>> which gives 4096 stores and 16 areas within each store, the 'split_location' data field would be set to 12.

Thus the configurations available for the Minor field, to split between store and area are as follows:

Diagram 13, source Proxama

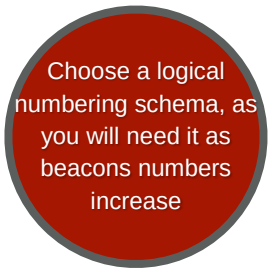
Split Position	Stores	Areas
0	ALL	65536
1	2	32768
2	4	16834
3	8	8192
4	16	4096
5	32	2048
6	64	1024
7	128	512
8	256	256
9	512	128
10	1024	64
11	2048	32
12	4096	16

13	8192	8
14	16384	4
15	32768	2
16	65536	**ALL**

Table 3, Proxama

Micro-Location Type	Identifier digits (#can often be seen expressed not as integers, but in hexadecimal c	Remaining digits unique number/beacon
Product	1###x	1
Aisle	2##xx	2
Point of Sale	3##xx	2
Door	4##xx	2
Department	5##xx	2
Floor	6##xx	2

Table 4, Appflare



Appendix 8: Beacons Enabling Payments

From a technology perspective, BLE beacons can be used in two different ways as part of the payment journey:

- Giving a payment app location context or triggering a payment action
- Actually performing the transfer of payment details (using a two-way beacon)

In March 2014, EMVCo announced the development of the Payment Tokenization Framework which is designed to allow tokenised payments using a variety of different technologies, including BLE. This would enable BLE to be used as a payment token transport for open-loop payments such as Visa and MasterCard. The first version of this specification is scheduled to be completed in 2014.

Triggering Payments

In this instance a beacon is being used to inform an app that it is in a particular store (or at a specific PoS) and asks a cloud-based payment platform to create a store/visit specific payment token as a result. See diagram 15.

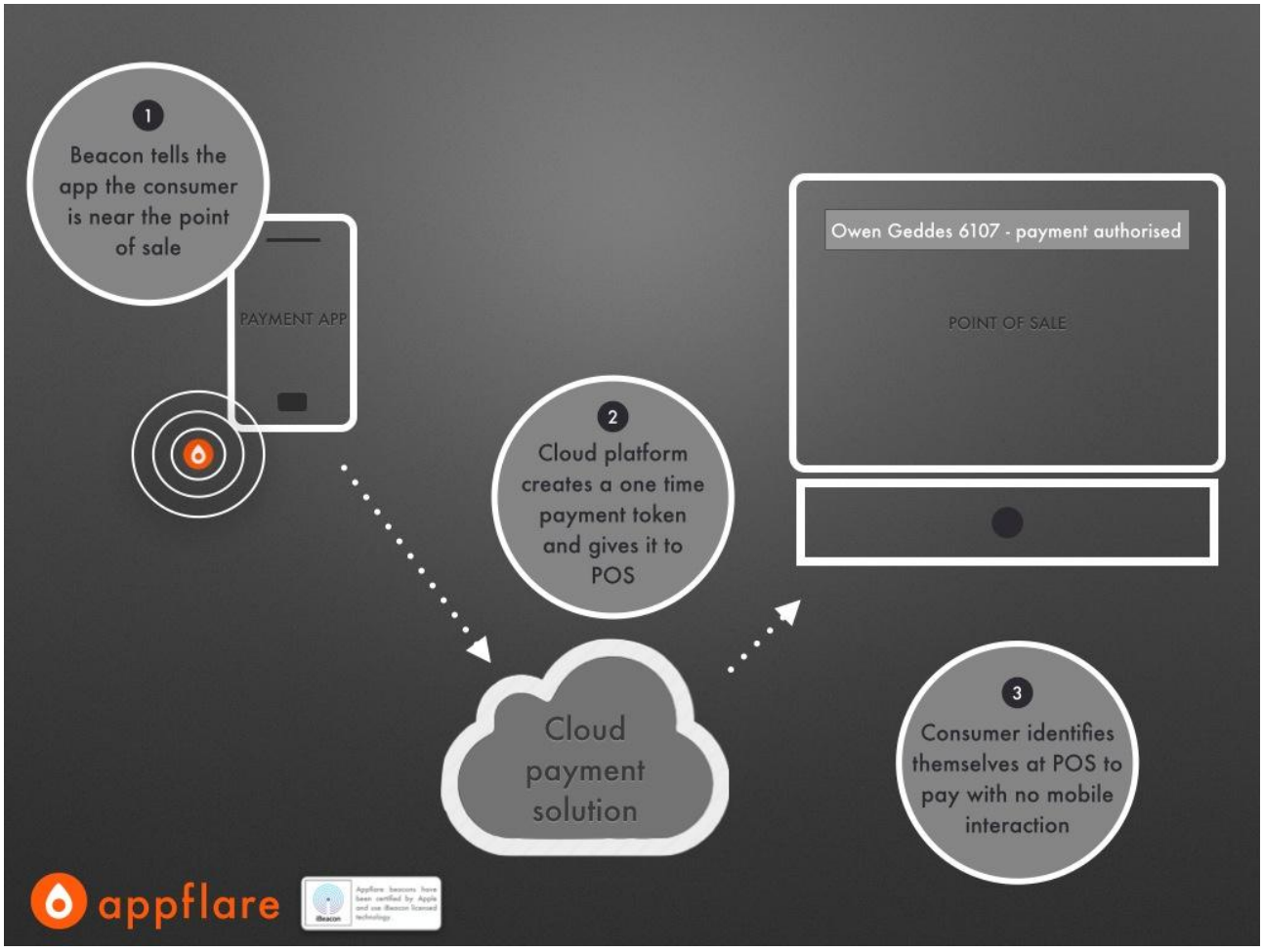


Diagram 14, Appflare

Completing Payments

In this example, beacons are being used to trigger the creation of a payment token. See Diagram 16. A two-way beacon, such as that developed by PayPal, can be used to transfer this token to the POS.

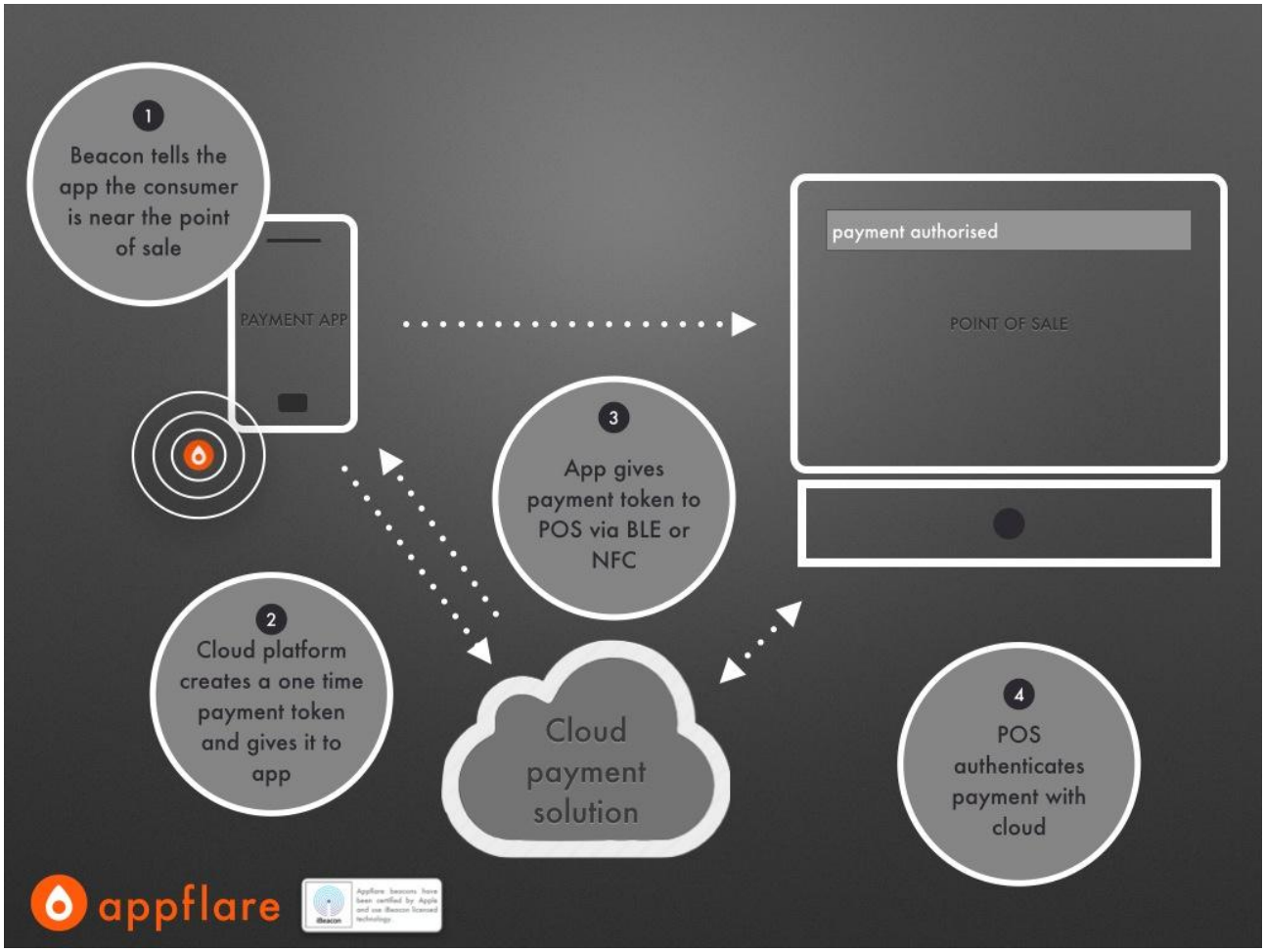


Diagram 15, Appflare

PayPal Beacon

PayPal launched a service in 2013 that uses a two-way beacon to support an in-store payment process. It works like this:

- A retailer has a PayPal Beacon plugged into their PoS terminal
- A consumer has the PayPal app on their phone and checks-in upon entering the store
- The PayPal app sees the PayPal Beacon
- The PayPal Beacon requests a payment token and verifies with the PayPal app
- The payment token is given to the PoS and attributed to an individual
- At the PoS the consumer identifies themselves and the till operator compares the given name with a list of people in-store at that time via the PoS. A photo ID is displayed on the PoS screen to verify the individual
- The payment is then completed using the token the PoS has stored for that consumer, with no further consumer interaction required (no phone or card interaction).

Appendix 9: Protection

Consumer Protection

Because consumers need to download and install a specific app in order to interact with a beacon, the technology is effectively permissions-based, assuming the app developer is transparent with the consumer. The consumer should always have the option to disable location services and notifications for a beacon-enabled app. Consumers are also able to uninstall any app or disable Bluetooth at any time to stop any undesired interaction with beacons.

Care should be taken when using beacons to identify a consumer's location in four regards:

- Always offer the consumer value in return for knowing their location
- Ensure consumers fully understand how their location data will be used and recorded
- Take appropriate steps to protect any live or historical data stored both within an app and on any centralised platforms
- Do not share any user location or engagement data with third parties unless clear authority has been given by the individual to do so

Organisations developing applications that detect beacons to deliver location-based and personalised content, should follow the Mobile Privacy Principles established by the GSMA.

Deployer Protection

Organisations deploying beacons need to ensure their infrastructure cannot be used by unauthorised third parties, such as competitors or rogue apps. Proprietary beacon protocols, such as those offered by Appflare, StickNFind and Qualcomm, offer encryption and authentication to prevent unauthorised use of beacons.

However, the iBeacon specification in its standard form does not provide this kind of protection. In the example below two retailers deploy iBeacons, using their own UUID and major and minor schema. It is entirely possible for retailer B to discover the retailer A UUID (using an Android app such as iBeacon Detector), then use that UUID in their own app to know one of their customers entered retailer A's premises, or even trigger an offer.

Whilst such activity is unlikely to take place between rival retailers, third party apps could certainly take this approach. It is also possible for a third party to attempt to 'decode' any structured major and minor schema, allowing them to understand a consumer has not just entered a premises, but which premises and location within the premises.

There are a variety of approaches to solve this problem using iBeacon. No individual approach fully solves the problem, but multiple approaches can be combined to achieve the desired outcome:

- Use a non-deployer-unique UUID
    - Advantages:
        - Using a consistent UUID means apps in iOS still know which UUID to look out for
        - A UUID used by other locations means the UUID cannot be used to identify your premises using UUID alone
        - This approach remains compatible with all known existing beacon enabled apps (such as Apple's Passbook)
    - Disadvantages:
        - Your app will be woken up each time it sees the UUID, and this may not always be your location. There may be increased battery drain from the app if the UUID is very widely used
        - Major and minor identifiers need to be managed with anybody else also using the same UUID to ensure two locations don't use the same combination therefore confusing the app as to its real location
        - A third party can still visit every location and make a list of each major and minor combination, although for large numbers of locations this may prove impractical for the third party
- Ensure the major and minor schema is not decodable by third parties (using random major and minor identifiers)
    - Advantages:
        - Third parties cannot use the major and minor to easily identify location
        - This approach remains compatible with all known existing beacon enabled apps (such as Passbook)
    - Disadvantages:
        - Your app will need to hold a database of all the beacons used in your locations, or a cloud-based platform will need to hold the details and the app asks for the information based upon the major and minor
        - Cloud based platforms require data connectivity unless the SDK contains an offline cached mode
- Change the major and minor frequently (for example, once per minute)
    - Advantages:
        - Third parties cannot use the major and minor to identify location
    - Disadvantages:
        - Your app will need to reference an online platform to get the location data or hold an algorithm to decode the major and minor based upon time/location and any other referencing data
        - Cloud based platforms require data connectivity, unless the SDK contains an offline cached mode

A combination of two or more approaches can give a 'reasonable' level of protection in non-mission critical or insecure use cases. Where increased protection is required a proprietary beacon protocol can be used. However, it should be noted that proprietary protocols will not function with standard iOS location services and apps, such as Apple's Passbook app.

Moreover, deployers should ensure that any beacons in the field should be configured with a secure, private password, to ensure third parties cannot hijack the beacon, changing its configuration.

Appendix 10: Cloud Platforms

Cloud-based platforms can be used effectively, in combination with approaches discussed in Appendix 9, to ensure only authorised apps can use beacon infrastructure. They can also be used to grant apps access to beacons for a short defined period of time. Importantly, they can collect data and be used for passive monitoring.

Architecture Models

There are three basic modes of operation for apps and beacons:

- Standard: the app holds all the beacon estate data locally
- Cloud: an app queries a cloud based platform with the UUID, major and minor to get the detailed location data returned
- Cloud secure: the beacon data is fully encrypted and can only be decrypted by the cloud platform, which returns to the app detailed location data

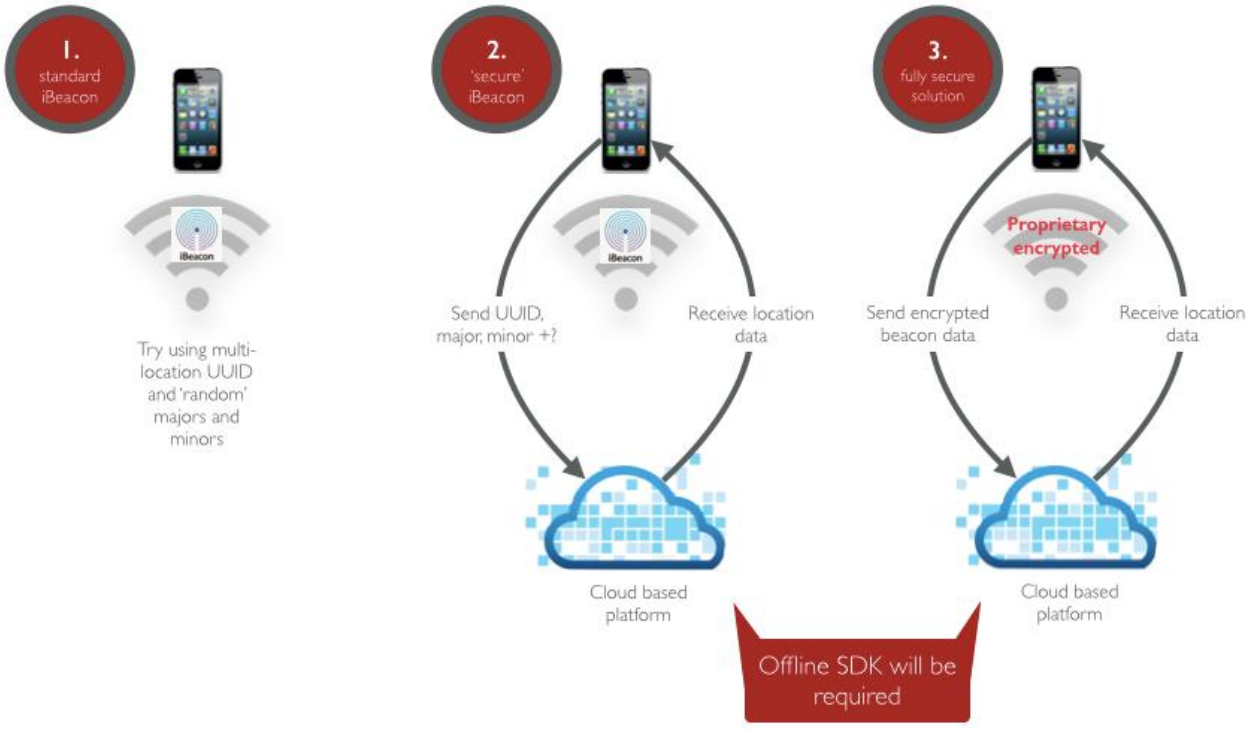


Diagram 16

The author

Owen Geddes of Appflare authored this paper on behalf of the GSMA. Appflare offers a mobile engagement advisory service to brands, retailers and mobile operators. Appflare also operates a network of beacons in public locations along with an authentication and content platform for apps.