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Wi-Fi Service Discovery over 802.11u Using Non-Native Generic Advertising Services (GAS-SD)

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Abstract

Wi-Fi Service Discovery over 802.11u Using Non-Native Generic Advertising Services (GAS-SD)

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Public and private Wi-Fi hotspot providers have a strong interest in serving targeted, localized network applications to their users. A variety of functions that currently require personal attention (such as ordering coffee, table availability notifications, store inventory searches, access to the local newspaper, and more) can be provided to mobile devices without requiring the customer to wait for someone to help them. Many of these services are available today on smartphones and web apps, if users work hard enough to find them. Providing tailored offerings to local clients without forcing them to find and download a custom application requires both a way to notify users who are in a venue and an agreed-upon format for service announcements.

While the IEEE's 802.11 Task Group U has broadly defined "Generic Advertising Services" (GAS) that an AP can use to inform clients of available resources, in practical terms this capability is not commonly used for anything except "Native GAS" advertisements of Internet connectivity providers. "Non-Native" service advertisements

use the same transport but have no agreed-upon, non-proprietary standard for sending information between devices and service providers. With a common service description format, “Non-native GAS” frames in IEEE 802.11u beacons enable Wi-Fi Access Points (APs) to advertise discoverable services to client devices, providing the underlying support needed to enable a wide variety of applications without a difficult discovery process for the user.

This report defines Generic Advertising Services-Service Discovery (GAS-SD) as a common, freely-available service description format to be used between device software, 802.11u capable APs, and backend services to enable service discovery. It demonstrates such a service in use, provides sample data and a Document Type Definition (DTD) that can be used to define additional services, and describes a number of use cases for GAS-SD in public hotspot locations.

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Introduction

In Steven Spielberg's 2002 movie *Minority Report*, Tom Cruise's character John Anderton comes into contact with a series of advertisements that are customized to reflect his shopping history and likely interests.[1] We hear the ads offer him beer, travel packages, and cars. A virtual agent asks him about "that three pack of tank tops" he purchased on his last visit. It's a noisy, pushy future that is being actively developed today.[2]

Businesses have tried many approaches to provide additional network information and services to users when those users are at a particular store or venue. Long before it was possible to deliver targeted ads and information to mobile devices, stores offered in-store circulars and coupons to meet this need, although methods to digitally deliver in-store circulars are currently being developed.[3] Operating system providers like Apple have geo-fencing APIs to create location-based services that send messages to trigger application events based on geographic proximity.[4] Portable game consoles have been designed with the ability to detect specific Wi-Fi networks and provide custom games when connected.[5] Bluetooth Low Energy iBeacons provide devices with precise location data to allow applications to interact with specific services[6]. Near Field Communications (NFC) systems are available for contactless payment systems at gas pumps and retail stores[7]. Captive portal advertisements and landing pages allow Wi-Fi providers with a way to present information to customers in exchange for Wi-Fi service[8].

All these technologies have limitations; NFC works best if the device is within 4 cm of the sensor, geo-fencing and iBeacons require the user to install an application on their computer or smartphone, specific SSID processing requires the user to join a network to transmit data. Even today's versions of *Minority Report*'s iris scanners are

limited to identification of eyes they have seen before[9]. None of the solutions has the capability to discover an unknown service and allow the user to select it from a list, as users currently do with unknown Wi-Fi networks offering Wi-Fi connections.

Wi-Fi networks, which already provide network discovery mechanisms, are well-suited to provide service discovery as well. Looking at a single provider, AT&T's Wi-Fi Services network saw 2.7 billion connections in 2012 at stadiums, coffee shops, restaurants, hotels, supermarkets, retail stores and other venues that could provide additional services to the users in those venues.[10]

The technology and the underlying protocols to provide such a high-level service-discovery system are available, but there is no agreed-upon standard for the actual data interchange between devices providing services and those seeking them. This paper will suggest a simple, extensible format for providing service information over Wi-Fi, and will detail a number of use cases that the format can enable.

Related Work

The group of technologies marketed as "Wi-Fi" are defined in the *IEEE Standard for Telecommunications and Information Exchange Between Local and Metropolitan Area Networks, part 11* (IEEE 802.11)[11]. The 802.11 standard is under active development and is in widespread use throughout the world. The Wireless Broadband Alliance expects that there will be nearly six million commercial hotspots deployed worldwide by 2015[12]. 802.11 amendments have provided a number of significant enhancements to improve speed, enhance security, and provide additional capabilities in Wi-Fi networks. Task Group U worked to extend 802.11 networking capabilities to allow better internetworking with external networks. While the bulk of this amendment is designed to allow seamless roaming between networks, the Wi-Fi beacon sent by 802.11u Access Points (APs) can be used to send information about "Generic Advertising Services" (GAS), which provide a mechanism to provide additional service information to 802.11 devices.[13]

Service discovery has been a valuable tool for network resource location for decades. Widely deployed implementations like AppleTalk Name Binding Protocol[14], Universal Plug-and-Play (UPnP)[15], and Domain Name Service-Service Discovery (DNS-SD)[16] have enabled many millions of computers to connect to remote resources by a simple selection process. Instead of having to know the network address of a printer, a user can, for instance, select "Third Floor Printer-By The Break Room". Under DNS-SD, the simple user interaction of selecting a printer by name is actually more complex in ways the user doesn't see. The device queries the local network segment for a service, in this example "printing services" and receives a response from every device on the local link providing that service (or a proxy for it). In DNS-SD, this would be a request for

"printer._tcp.local." and all devices providing "printing services" over TCP would respond with information required to use the service.[17] DNS-SD requires that devices discovering services be networked together, although there is no requirement that the network has connectivity beyond the local link. It uses DNS requests on port 53 as an underlying transport mechanism, because DNS has a well-established broadcast/response pattern.[18]

Location Based Services based on micro-transmitters like iBeacons are rapidly entering the market as device manufacturers provide APIs and hardware support for the Bluetooth Low Energy (BLE) standard. iBeacons are short-distance low-power radios that broadcast an identifier and nothing else. An iBeacon supporting mobile application must be pre-installed in order for the device to respond to the iBeacon. The application is launched when the iBeacon's signal is picked up, and the application acts on the information about the iBeacon it is near. The two key concepts of iBeacons, Micro-location and Interaction/Engagement/Context[19], are addressed in this paper using Wi-Fi as the transport. The two technologies have some overlap in use cases, but are complementary in many ways. The services described in this paper are provided for the most part by cloud or venue-based servers and do not necessarily require a specific client application on the device, while iBeacon requires an application. iBeacon works with a network of sensors providing individual data about location to the device. It does not provide network connectivity; instead it causes an application to launch on the device and provides an identifier to the application. Any further interaction is up to the app. One limitation of iBeacons is that if the correct app is not installed, the system cannot provide service to the user. A potential application of a GAS-SD supporting network is to advertise and allow a user to download an application for a venue's iBeacon. This is detailed in Use Case 2 below.

LTE Direct (LTE-D) is an addition to the 3rd Generation Partnership Program's Long Term Evolution (3GPP LTE) standard proposed by Qualcomm Research. It will provide a decentralized peer-to-peer service discovery protocol similar to that envisioned for GAS-SD, but only for compatible LTE devices. LTE Direct is based on prior Qualcomm work on ad-hoc networks, such as AllJoyn and FlashLinQ.[20] LTE Direct defines a 128-bit "Public Expression" identifier, which is advertised to all devices within range, like a beacon. Devices are expected to filter Expressions to find those that are of interest to the user and connect together to provide a hyperlocal peer-to-peer decentralized service, which they describe as "Proximate Discovery."[21] As the name implies, LTE Direct provides direct device-to-device advertisements and communications, allowing user-to-user services that GAS-SD does not support. With LTE-Direct on two proximate devices, a user outside a sports stadium can advertise tickets to "today's game" and be found by a user looking for the expression that indicates "tickets."[22] However, LTE-Direct is restricted to devices that can communicate over a single cellular LTE network, and there must be a common central repository of known "Expressions" to map searches to suitable advertisements. GAS-SD trades off the advantages of fixed hierarchical expression categories for ease of development and deployment. The roadmap for 3GPP release 12 (due in December 2014) currently includes a study of part of LTE-D.[23] A future release, sometime after 2016, will be required to finalize LTE-D.

Non-native Generic Advertising Services are not standardized and there is no evidence that the Wi-Fi Alliance intends to work on them in the near future. Nevertheless, there is an existing implementation of 802.11u non-native GAS services: Cisco Networks' Mobile Services Advertising Protocol (MSAP), a licensed component

of Cisco Mobility Service Engine (MSE). Cisco publicly offers a demonstration license limited to 1,000 service advertisement clicks, and only for Cisco controller based Wi-Fi networks.[24] A significant advantage of using non-Native GAS advertisements (like GAS-SD and MSAP) is that the advertisement is part of the 802.11u management beacon and is transmitted to the client prior to association—a client receives information that allows services to be discovered without having to join the Wi-Fi access point's network. Mark Julier of Digital Air Wi-Fi Services says that "Depending on what as *[sic]* been configured in the Cisco MSE will depend on what is presented to the client. But this is typically links to a URL or application on an APP store.[25]" As described in this paper, GAS-SD is similar, but has options that allow users to send parameters with their queries. GAS-SD also is not limited to any particular AP family or mobile device, as long as 802.11u is fully supported.

Approach

In order to provide common, interoperable services that can be discovered by unassociated devices, an 802.11u Access Point (AP) needs to be configured to broadcast a GAS service advertisement and a Station (STA) needs to respond to and display a list of services. The format for the advertisement needs to be shared between the service provider and the receiver. This paper will define the beacon elements and the advertisement format the client will respond to. While the application developed to demonstrate this interaction was not integrated into the device's OS and Wi-Fi selector, the intent of this paper is to provide a format that can be implemented by any device manufacturer to provide service notifications to users as part of an integrated Wi-Fi system. It should be as easy to select an advertised service as it is to select an access network.

Because the service advertisement is broadcast over Wi-Fi beacons and Wi-Fi networks are typically designed to be available at a single customer location (a store or hotel, for instance), enterprise service providers have the capability to craft an advertisement specifically for a particular location. This can provide valuable services like venue maps, store inventory locators, local newspapers, restaurant reservations or any other content that might be specific to the needs of the customers who are at a particular Wi-Fi venue. The Use Case section below will detail a number of local services that can be advertised over GAS-SD. The interchange format will provide the capability for both the provider and the user to use parameters in a service URL in order to further customize the service.

802.11u Non-native Generic Advertising Services allows the pre-association advertisements to be carried in a new kind of 802.11 management frame called the Public

Action Frame (PAF).[26] When a station sends a GAS request, the AP returns the data in a series of these PAFs even if the device has not associated and is not addressable by the local network. If the beacon is not fetching actively updated content from the back-end service for each request, the service provider may not participate in the service discovery interaction until the device sends a service request to it. Because the Public Action Frames are only sent if the Station queries for them, this design allows richly defined services to be advertised without saturating the local airwaves with unnecessarily large beacons. Non-native GAS also allows the AP to proxy the request for a back-end server, which would be needed in more complex enterprise applications, especially those where a custom response might be constructed at run time. In the Implementation section below, the beacon will pass the advertisement directly to the client.

There are a number of viable formats for the advertisement. It could be implemented as a RESTful interface with pre-defined resources.[27] It could be implemented as a SOAP service.[28] It could be implemented as an XML document, or some combination of all of these options. This paper will use an XML format because XML advertisements are implementable with static service description files, minimizing the required server resources and also allowing a purely beacon based service definition.

This paper does not specify any particular approach that devices should use to provide service choices to users. Devices will be able to implement any appropriate selection mechanism to users. A simple extension of the Wi-Fi network selector dialogs common to all Wi-Fi devices would provide a minimal interface. A laptop might display more information than a mobile device, and a connected tablet might use a different selection mechanism. Advertising elements like an icon or a description might not be useful on a small screen device, but helpful on a larger screen. In addition, devices with voice interfaces or heads-up displays like Apple Siri or Google Glass might implement

these services in ways that take advantage of those platforms' unique designs. A local search option in Siri can respond to the query "Where are the light bulbs?" by telling the user "I see you are at Home Depot #0241, in Austin, Texas. Do you want me to search this store's inventory?" Siri could handle the back-end response and provide the user the aisle in the store with light bulbs and a map to reach them. Google Glass could function in essentially the same manner, or provide a visual indicator of which direction to go.

The beacon-probe-response interaction for 802.11u GAS advertisements keeps the size of the beacon from becoming a burden on overall network throughput by limiting detailed advertisements to specific requests, keeping the broadcast data to a minimum. Figure 1 shows an interaction diagram for a typical 802.11u service discovery setup. In this case the AP is a proxy for the service provider's advertisement. However, depending on the AP's configuration, it could cache the call to the Service Provider or be programmed to statically provide the advertisement without the initial call or the callback request. The beacon in 802.11u networking is very similar to prior 802.11 beacons, but has additional fields. The station sees the beacon (or probes and receives beacons in response) and identifies that it has 802.11u extended capabilities. It notices the tag for vendor-specific Advertising and makes a request for the advertisement. Figure 1 shows a case where the AP needs to request the advertisement from the service provider. It sends an initial response to the station to wait for a (short) period and then sends a GAS comeback request. Meanwhile, the AP sends a message to the service provider to request the advertisement. Until the AP receives the advertisement from the service provider, it continues to send GAS comeback requests to the station. After the advertisement is received, the AP responds to the next comeback request with the advertisement. The station processes the advertisement and offers the available services to the user. When the user chooses a service, a request is sent to the service provider and answered from it.

In the example advertisement.xml in Figure 2, the two services are on different endpoints and may be usable without network association at all in cases where the station has another path to the Internet.

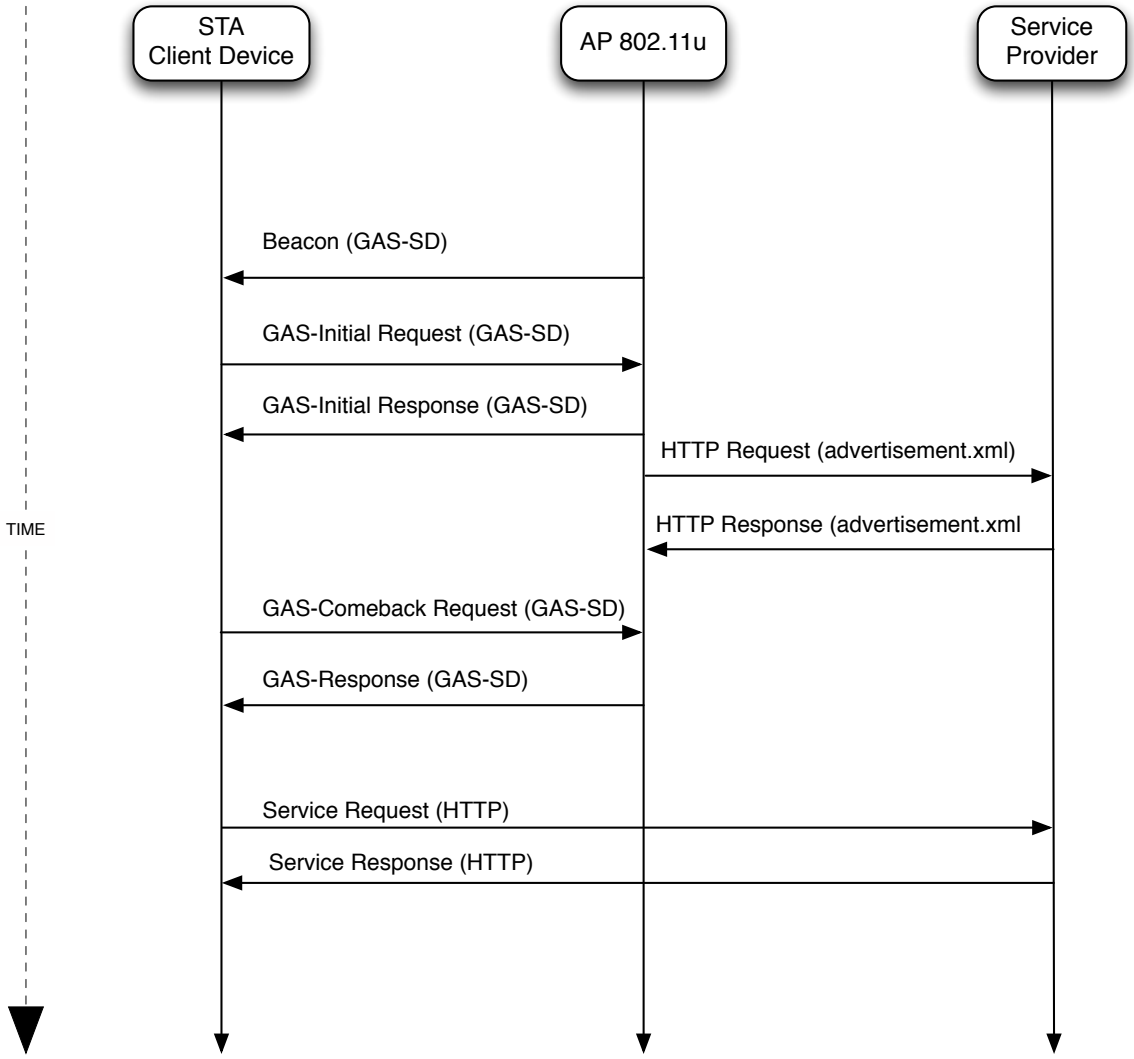

Figure 1. Interaction Diagram

Use Cases

Almost any conceivable localized service can be advertised between 802.11u APs and compliant Wi-Fi devices. Services that require native client-side code can boot-strap the process by advertising an app that can then provide the service. The use cases here are a sub-set of cases common to public providers of commercial Wi-Fi. A different set of services could be created for home network or corporate network Wi-Fi deployments. This paper focuses on commercial Wi-Fi on the assumption that public Wi-Fi needs will drive the adoption of a common data format for service advertisements.

Creating and popularizing a format like this is a chicken-and-egg problem. In order to make it worthwhile for vendors to build the capability to respond to advertisements into devices, there need to be services to consume. In order to make it worthwhile for service providers to provide services, there need to be devices to take advantage of them. GAS-SD will be viable if a Wi-Fi provider or other organization can convince both service providers and device manufacturers to implement it simultaneously. While this will be a challenge, it is worthwhile to provide the underpinnings of a wide variety of valuable applications.

BASE USE CASES

Receive and Display Service Advertisement

Use Case ID:	GAS-SD UC-1
Use Case Name:	Receive Service Advertisement and Display to User

Actor:	• Wi-Fi Device • Access Point (AP) • User
Description:	All Use Cases below include UC-1, which describes the standard preconditions, postconditions and assumptions involved in receiving an 802.11u beacon, decoding the advertisement, and displaying the available service to the user.
Preconditions:	Wi-Fi Device receives 802.11u style beacon from AP
Postconditions:	Wi-Fi Device disassociates from AP
Normal Course of Events:	1: Wi-Fi Device receives a beacon advertising service and fetches GAS-SD advertisement from the AP. 2: Wi-Fi Device displays an indicator that it has services to the User. 3: User takes action to display the service selector.
Alternative Courses:	3A: User declines to select a service and closes the service selector.
Exceptions:	Devices that are not associated with the AP and also have no other internet access do not display internet-only services.
Includes:	
Extensions:	
Assumptions:	• User has 802.11u compatible device capable of using the GAS-SD service described in this paper. • Wi-Fi Device is in range of the AP for the duration of the transaction. • Wi-Fi Device has a browser or other application capable of handling URLs to display and process the service results.
Notes and Issues:	

ANY VENUE

Opt-In Consent

Use Case ID:	GAS-SD UC-2
Use Case Name:	Request User Consent to Track Usage

Actor:	• Wi-Fi Device • Access Point (AP) • User • Tracking Service
Description:	In order to measure Wi-Fi performance in a venue to improve service quality, a vendor chooses to ask the User's permission to track their use during the current visit. The customer may decline or accept the request. If the customer accepts, the Tracking Service records the acceptance and initiates tracking. If the customer declines, the Tracking Service does not track the User's activity. The Tracking Service may optionally offer some benefit to the User in exchange for permission, such as a free app, downloaded song, or discount coupon.
Normal Course of Events:	1: User chooses "Offer from Venue" item from Service List. 2: Wi-Fi Device requests offer from the Tracking Service and displays it to the User. 3: User Accepts terms of the offer. 4: Wi-Fi Device transmits acceptance to the Tracking Service. 5: Advertising Service tracks user information.
Alternative Courses:	3A: User declines terms of the offer. 4A: Wi-Fi Device transmits refusal to the Tracking Service.
Exceptions:	
Includes:	UC-1 Device Receives Service Advertisement
Extensions:	The service can provide a benefit in exchange for permission to track. In that case the Tracking Service must fulfill the offer.
Assumptions:	
Notes and Issues:	While permission can be requested and granted prior to association, actual tracking requires authentication and access to be granted to the Wi-Fi Device to use the network. Exact tracking methodologies and benefits from various forms of user tracking are beyond the scope of this paper, but a variety of sales data intelligence can be gathered from user in-store behavior.

Offer Application to User

Use Case ID:	GAS-SD UC-3
Use Case Name:	Offer User Venue-Specific Application

Actor:	• Wi-Fi Device • Access Point (AP) • User • Application Source
Description:	In order to provide a richer customer experience, a venue offers a custom application. The remote server sends a link to an Application in an appropriate App Store to the device. The user's Application Store application opens and allows the user to download the venue's application.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses the "Download Our App" from Service Selector. 2: Wi-Fi Device requests app from the Application Source and displays the download page to the User. 3: User downloads the application.
Alternative Courses:	3A: User closes service list without downloading app.
Exceptions:	Devices that are not associated with the AP and also have no other internet access do not display this internet-only service.
Includes:	UC-1 Device Receives Service Advertisement
Extensions:	
Assumptions:	
Notes and Issues:	Applications can be advertised and downloaded prior to association, if the device has a different internet interface (such as cellular service). A venue is using Bluetooth Low Power proximity sensors (such as Apple iBeacon compatible sensors) can provide the user with the necessary application with minimal effort, which is a key to high user acceptance.

Upgrade Bandwidth

Use Case ID:	GAS-SD UC-4
Use Case Name:	Upgrade User Bandwidth

Actor:	• Wi-Fi Device • Access Point (AP) • User • Network Management Service
Description:	A venue offering tiered bandwidth can provide users with a way to upgrade to a higher tier. Depending on the business model of the venue, this could be paying with a credit card, billing to a hotel room, entering a code from a receipt, logging in with a loyalty card ID, viewing an advertisement, or any method devised by the venue.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses "Upgrade Your Bandwidth" from Service Selector. 2: Wi-Fi Device requests service from the Network Management Service and returns information to the User. 3: The User completes the transaction and enjoys higher bandwidth.
Alternative Courses:	1A: User closes service list without upgrading bandwidth.
Exceptions:	
Includes:	UC-1 Device Receive Service Advertisement
Extensions:	The choice to advertise this service may, in an active enterprise network, be targeted at Users who are using enough bandwidth to make it worthwhile, or may be limited to periods in which there is excess bandwidth. Those conditions would be known to the Network Management Service providing system, which could tailor the service offering.
Assumptions:	
Notes and Issues:	Bandwidth has a necessary prerequisite of authorization and upgrading bandwidth may include authorization if the device has not yet done so.

Event Services

Use Case ID:	GAS-SD UC-5
Use Case Name:	Stadium Event Services

Actor:	• Wi-Fi Device • Access Point (AP) • User • Stadium Event Service
Description:	Large event venues have specific, frequently-changing content they wish to provide during an event or game, such as upcoming schedules, video replay or highlights, closed captions, box scores and other event-specific services that help fans have a better experience while visiting the venue. Information that can be delivered as a web application can be made available as an advertised service or the venue can advertise a site-specific application for the user to download (UC2).
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses the "Digital Dugout" item. 2: Wi-Fi Device transmits request to the Stadium Event Service. 3: Stadium Event Service handles the request on the back and returns a URL to the device to open the event's page. 4: Wi-Fi Device displays Event page in system browser and user interacts with it.
Alternative Courses:	1A: User closes service list without choosing the "Digital Dugout" item.
Exceptions:	
Includes:	UC-1 Device Receives Service Advertisement
Extensions:	
Assumptions:	
Notes and Issues:	This service can be used without associating with the AP, providing the Wi-Fi Device has another method of connecting to the internet. This or any other event service offering would be tailored to the needs and policies of the specific venue. The above use case is typical of the event specific services offered by the San Francisco Giants with their "Digital Dugout" product.[29]

Map/Food Finder/Nearest Bathroom

Use Case ID:	GAS-SD UC-6
Use Case Name:	Venue Information Services

Actor:	• Wi-Fi Device • Access Point (AP) • User • Venue Information Service
Description:	Any large venue, such as airports, stadiums, outdoor music festivals, and renaissance fairs, may wish to offer information about the site to users, such as a map, a food finder, a bathroom locator, parking or first aid locations. Allowing users to find venue data without waiting in line at an information counter improves user experience.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses the "Venue Map and Information" item. 2: Wi-Fi Device transmits request to the Venue Information Service. 3: Venue Information Service handles the request on the back and returns a URL to the device to open the venue's page. 4: Wi-Fi Device displays venue page in system browser and user interacts with it.
Alternative Courses:	1A: User closes service list without selecting the "Venue Map and Information" item.
Exceptions:	
Includes:	UC-1 Device Receives Service Advertisement
Extensions:	
Assumptions:	
Notes and Issues:	This service can be used without associating with the AP, providing the Wi-Fi Device has another method of connecting to the internet. This or any other venue service offering would be tailored to the needs and policies of the specific venue.

Buy Tickets, Goods, and Services

Use Case ID:	GAS-SD UC-7
Use Case Name:	Venue Sales Services

Actor:	• Wi-Fi Device • Access Point (AP) • User • Venue Sales Service
Description:	Any venue, such as airports, stadiums, outdoor music festivals, and renaissance fairs, may wish to sell items to the User, such as live concert recordings, tickets to future events, t-shirts, or food and beverages delivered to the User's seat. This can be integrated with electronic payment systems, credit card processing, or other payment methods to simplify the transaction for the user.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses the "Upcoming Shows" or "Beer Delivery" item. 2: Wi-Fi Device transmits request to the Venue Sales Service. 3: Venue Sales Service handles the request on the back and returns a URL to the device to open the venue's secure purchase page. 4: Wi-Fi Device displays secure venue sales page in system browser and user interacts with it.
Alternative Courses:	1A: User closes service list without selecting the "Upcoming Shows" or "Beer Delivery" item.
Exceptions:	
Includes:	UC-1 Device Receives Service Advertisement
Extensions:	
Assumptions:	
Notes and Issues:	This service can be used without associating with the AP, providing the Wi-Fi Device has another method of connecting to the internet. This or any other venue service offering would be tailored to the needs and policies of the specific venue.

RETAIL

Find in store/Price Check

Use Case ID:	GAS-SD UC-8
Use Case Name:	Search Store

Actor:	• Wi-Fi Device • Access Point (AP) • User • Store Inventory Service
Description:	A venue providing Wi-Fi at a retail store can provide a way to provide information about items offered at the User's location, such as the price of an item, the location of the item in the store, the item's stock status, and other details.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses the "Search This Venue" item. 2: Wi-Fi Device requests specifics of the search from the User (e.g. "what item are you searching for?"). 3: Wi-Fi Devices sends query to the Store Inventory Service and returns information to the User.
Alternative Courses:	1A: User closes service list without searching. 3A: Store Inventory Service fails to find information and returns a negative response.
Exceptions:	
Includes:	UC-1 Device Receives Service Advertisement
Extensions:	
Assumptions:	
Notes and Issues:	Search Inventory does not require association, as long as the Wi-Fi device has another way to reach the internet. Many retailers already have this search service available on their web sites. Adapting it to a localized search of a particular store would allow Users to fulfill many of their own store assistance requests.

Provide Customer Assistance

Use Case ID:	GAS-SD UC-9
Use Case Name:	Provide Customer Assistance

Actor:	• Wi-Fi Device • Access Point (AP) • User • Service Dispatch Service
Description:	A venue can provide on-line or in-person customer assistance for issues that cannot be resolved with an automated response. This can take the form of a VOIP call to a help desk, a virtual agent, or a request for an associate or manager to go to the customer's location.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses the "Get Help At This Store" item. 2: Wi-Fi Device requests service from the Service Dispatch Service and returns a web form to the User. 3: The User completes the form and returns it to the Service Dispatch Service. 4: The Service Dispatch Service determines the kind of support the User needs and provides it.
Alternative Courses:	1A: User closes service list without getting help.
Exceptions:	
Includes:	UC-1 Device Receives Service Advertisement
Extensions:	
Assumptions:	
Notes and Issues:	This service can be used without associating with the AP, providing the Wi-Fi Device has another method of connecting to the internet. Details of the service will depend on the needs of the retail venue; some may immediately connect a call to a call center, some may summon an associate or manager; some may have a more complex decision tree to determine the User's needs.

In-Store Circular/Coupons/Loyalty Programs

Use Case ID:	GAS-SD UC-10
Use Case Name:	Present Loyalty Card

Actor:	• Wi-Fi Device • Access Point (AP) • User • Loyalty Card Service
Description:	A store implements a typical retail Loyalty card, except the user's Wi-Fi device acts as the card. The user can check in at the current location, apply the loyalty card to a purchase, check balances, see coupons, and view any sales circulars that are currently available.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses the "Use your Venue Loyalty Program Card" item. 2: Wi-Fi Device requests service from the Loyalty Card Service and returns information to the User. 3: If the User has not already joined the program, they are offered the opportunity to join. 4: The Wi-Fi Device displays a code that the Cashier can enter to apply the loyalty card to the purchase.
Alternative Courses:	1A: User closes service list without using the loyalty card program.
Exceptions:	
Includes:	UC-1 Device Receives Service Advertisement
Extensions:	The same process and services can be used to provide in-store circulars and coupons, potentially in concert with other Use Cases, such as UC1.
Assumptions:	
Notes and Issues:	This service can be used without associating with the AP, providing the Wi-Fi Device has another method of connecting to the Internet.

Shopping List

Use Case ID:	GAS-SD UC-11
Use Case Name:	Manage Shopping List

Actor:	• Wi-Fi Device • Access Point (AP) • User • Store Inventory Service
Description:	A retailer whose customers regularly shop for items like groceries can use a web app or device app to store and manage a shopping list for the User. The User at can fill this in at home based on supply levels or recipes, and the app can provide the user with a store map showing where the items are located, check stock, recommend alternatives, offer coupons, or any other action the venue wishes to take to help the user shop.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses the "Grocery List" item. 2: Wi-Fi Device requests service from the Store Inventory Service and returns information to the User.
Alternative Courses:	1A: User closes service list without using the shopping list.
Exceptions:	
Includes:	
Extensions:	The same process and services can be used to provide in-store coupons, potentially in concert with other Use Cases, such as UC1.
Assumptions:	
Notes and Issues:	This service can be used without associating with the AP, providing the Wi-Fi Device has another method of connecting to the internet. Venues can use this information the way they would use any shopping information they gather: they can project future inventory needs, they can recommend related items for out of stock items, they can offer coupons for store-brand equivalents, or any other kind of data analysis this level of detail permits.

Price Match

Use Case ID:	GAS-SD UC-12
Use Case Name:	Match Sales Price

Actor:	• Wi-Fi Device • Access Point (AP) • User • Store Inventory Service
Description:	A retailer may wish to address "showrooming", a common retail concern about shoppers using retail stores as showrooms and purchasing products from on-line competitors by offering a price-match guarantee. If the user finds the identical item advertised on-line for less, the details can be transmitted to management, who can approve a price match on the item.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses the "Price Match" item. 2: Wi-Fi Device requests product information, advertised price, and URL of competitor for comparison. 3: Wi-Fi Device transmits request and product information to the Store Inventory Service, which handles the request on the back end. 4: Service transmits a decision and coupon code to the Wi-Fi Device. 5: Wi-Fi Device presents information to User.
Alternative Courses:	1A: User closes service list without selecting a price match.
Exceptions:	
Includes:	UC-1 Device Receives Service Advertisement
Extensions:	
Assumptions:	
Notes and Issues:	This service can be used without associating with the AP, providing the Wi-Fi Device has another method of connecting to the internet. This or any other customer service offering would be tailored to the needs and policies of the specific retailer. The above use case is typical of one approach to price matching and is similar to the policy of retailer Best Buy.[30]

HOSPITALITY/HEALTHCARE

Check In/View Bill/Check Out

Use Case ID:	GAS-SD UC-13
Use Case Name:	Hotel Front Desk Service

Actor:	• Wi-Fi Device • Access Point (AP) • User • Front Desk Service
Description:	Many functions where a hotel guest currently needs assistance from the front desk of the hotel can be more conveniently and economically handled by a Front Desk Service, which can also call the Front Desk if the automated options are not sufficient to meet guest needs. Basic functionality like checking in, viewing the bill, checking out, setting a wake-up call, or extending the guests' stay are typical of the types of service that can be automated.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses the "Front Desk" item. 2: Wi-Fi Device transmits request to the Front Desk Service, which handles the request on the back and transmits a decision and coupon code to the user.
Alternative Courses:	1A: User closes service list without selecting the "Front Desk" item.
Exceptions:	
Includes:	
Extensions:	With appropriate privacy and user security safeguards, this use case could be tied to an electronic keyless entry system using Bluetooth or NFC radios. A keycard delivery system can also be used, with code transmitted to the Wi-Fi Device that allows the Desk Clerk to provide the correct keycard for the User.
Assumptions:	
Notes and Issues:	This service can be used without associating with the AP, providing the Wi-Fi Device has another method of connecting to the internet. This or any other customer service offering would be tailored to the needs and policies of the specific hotelier.

Today's Newspaper

Use Case ID:	GAS-SD UC-14
Use Case Name:	Provide Local Amenities

Actor:	• Wi-Fi Device • Access Point (AP) • User • Amenity Service
Description:	An hotelier may wish to offer, as a complementary or add-on amenity, a local or national newspaper delivered electronically. With an appropriate arrangement with a news provider, this may even be a customized edition providing information and advertisements aimed selectively at travellers.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses the "Complimentary Local Newspaper" item. 2: Wi-Fi Device transmits request to the Amenity Service, which handles the request on the back and URL to the Wi-Fi Device. 3: The Wi-Fi Device opens the URL in the browser, providing access to the newspaper
Alternative Courses:	1A: User closes service list without selecting the "Complimentary Local Newspaper" item.
Exceptions:	
Includes:	UC-1 Device Receives Service Advertisement
Extensions:	If the hotel wishes to charge the User for the newspaper, the selection process can be enhanced to provide a payment option.
Assumptions:	
Notes and Issues:	This service can be used without associating with the AP, providing the Wi-Fi Device has another method of connecting to the internet.

Room Service Interactive Menu

Use Case ID:	GAS-SD UC-15
Use Case Name:	Room Service

Actor:	• Wi-Fi Device • Access Point (AP) • User • Room Service Service • Kitchen
Description:	An hotelier may wish to provide on-line room service or other deliverable services to their guests.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses the “Room Service” item. 2: Wi-Fi Device transmits request to the Room Service Service, which handles the request on the back and transmits a menu to the user. 3: User selects items to order to room. 4: Service confirms order and delivery time and sends order to Kitchen. 5: Kitchen prepares and delivers order.
Alternative Courses:	1A: User closes service list without selecting room service.
Exceptions:	
Includes:	UC-1 Device Receives Service Advertisement
Extensions:	Variants on this use case for laundry service, special housekeeping requests, and other hotel-provided services would use similar workflow.
Assumptions:	
Notes and Issues:	This service can be used without associating with the AP, providing the Wi-Fi Device has another method of connecting to the internet.

Local Search/Concierge Services

Use Case ID:	GAS-SD UC-16
Use Case Name:	Concierge Service

Actor:	• Wi-Fi Device • Access Point (AP) • User • Concierge Service
Description:	An hotelier may wish to provide concierge services to their guests. This can provide items like local ticket search, restaurant recommendations, a list of restaurants that deliver to the hotel, a geographic-aware search engine (like YP.com), directions, taxi and airport shuttle requests, and other services provided by the concierge desk. In addition, the User can be connected directly to the hotel's concierge desk if the service cannot provide their needs.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses the "Concierge" item. 2: Wi-Fi Device transmits request to the Concierge Service, 3: Concierge Service handles the request on the back end and provides a list of services. 4: The Wi-Fi Device displays the options to the User. 5: User interacts with the Concierge Service directly, selecting any options that make sense for the user's needs.
Alternative Courses:	1A: User closes service list without selecting the "Concierge" item.
Exceptions:	
Includes:	UC-1 Device Receives Service Advertisement
Extensions:	
Assumptions:	
Notes and Issues:	This service can be used without associating with the AP, providing the Wi-Fi Device has another method of connecting to the internet.

TV Guide/Web Based Remote Control

Use Case ID:	GAS-SD UC-17
Use Case Name:	Television Service

Actor:	• Wi-Fi Device • Access Point (AP) • User • Internet-enabled in-room television set (TV) • Video On Demand Service (VOD)
Description:	An hotelier may wish to provide television and video-on-demand control and schedule information to guests. Television functions like ordering movies, ordering video games, choosing a channel, or setting a sleep timer can be provided via a Video-On-Demand Service to the room. In addition, video services can be provided to guest Wi-Fi Devices, allowing multiple guests to watch separate channels in the same room, including premium movies.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses the "Video Options" item. 2: Wi-Fi Device transmits request to the VOD Service. 3: VOD Service handles the request and provides a list of available movies and Televisions/Video devices they can be watched on. 4: The Wi-Fi Device displays the options to the User. 5: User interacts with the VOD Service directly, selecting any options that make sense for the user's needs. 6: VOD Service turns on TV and starts purchased movie.
Alternative Courses:	1A: User closes service list without selecting a video.
Exceptions:	
Includes:	UC-1 Device Receives Service Advertisement
Extensions:	
Assumptions:	
Notes and Issues:	This service can be used without associating with the AP, providing the Wi-Fi Device has another method of connecting to the internet. It is likely that venue policy would prevent such use, in order to better assure that the guest ordering the movie has rights to do so. Integration with an existing VOD partner would simplify design and construction of this use case.

RESTAURANTS

Your Table Is Ready

Use Case ID:	GAS-SD UC-18
Use Case Name:	Hostess Service

Actor:	• Wi-Fi Device • Access Point (AP) • User • Hostess Service
Description:	A full-service restaurant may wish to provide guests with hostess services via mobile devices. Guests could use this service to check in, check wait times, and receive "table ready" notifications without needing to wait for an available host/hostess to help them.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses the "Request Seating" item. 2: Wi-Fi Device transmits request to the Hostess Service. 3: Hostess Service handles the request on and asks for the guest name, party size, and restaurant-specific options (e.g. "inside or outside?") 4: The Wi-Fi Device transmits the data to the Hostess Service. 5: The Hostess Service returns an approximate wait time and the information required to register for a system notification. 6: The Wi-Fi Device displays the wait time and sets up the notification. 7: When the table is ready, the Hostess Service sends a notification to the device. 8: The Wi-Fi Device notifies the user to go to the hostess stand for seating.
Alternative Courses:	1A: User closes service list without selecting the "Hostess Service" item. 7: The User takes the device out of Wi-Fi range and the seating request is handled like any other abandoned request.
Exceptions:	
Includes:	UC-1 Device Receives Service Advertisement
Extensions:	
Assumptions:	
Notes and Issues:	This service can be used without associating with the AP, providing the Wi-Fi Device has another method of connecting to the internet.

Place Order

Use Case ID:	GAS-SD UC-19
Use Case Name:	Order Service

Actor:	• Wi-Fi Device • Access Point (AP) • User • Order Service • Kitchen and Wait Staff
Description:	A full-service or quick-service restaurant may provide the opportunity to order directly from an on-line menu. The menu can include pictures and videos of the food and drinks, as well as requests for drink refills and other requests.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User selects "Order from your Phone" item. 2: Wi-Fi Device transmits request to the Order Service, 3: Order Service receives the request and returns a unique URL for the online menu. 4: The Wi-Fi Device displays the menu to the User. 5: User interacts with the Order Service directly, selecting any options that make sense for the user's needs. 6: Orders are sent to the Kitchen. 7: The Wait Staff deliver food and drink as ordered.
Alternative Courses:	1A: User closes service list without selecting the "Order from your Phone" item.
Exceptions:	
Includes:	UC-1 Device Receives Service Advertisement
Extensions:	This service ties naturally with UC-21: Pay on-line. A table game module, similar to UC-17, can also be created.
Assumptions:	
Notes and Issues:	This service can be used without associating, providing the Wi-Fi Device has a method of connecting to the internet. This is similar to UC-14 and also to existing tablet ordering system such as the service built by Ziosk for Chili's restaurants.[31] Ziosk also provides payment services and sells video games through their tabletop tablet, as a way to entertain children while the party is waiting for food.

Now Playing/Song of the Day

Use Case ID:	GAS-SD UC-20
Use Case Name:	Music Service

Actor:	• Wi-Fi Device • Access Point (AP) • User • Music Service
Description:	A venue providing music can provide information about it to their users, including "now playing", playlists, requests, and links to purchase the music directly from a favored music service.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses the "Now Playing In This Store" item. 2: Wi-Fi Device transmits request to the Music Service, 3: Music Service receives the request and information about the currently playing music, including links to purchase it. 4: The Wi-Fi Device displays the data to the User. 5: User interacts with the Music Service directly, selecting any options that make sense for the user's needs.
Alternative Courses:	1A: User closes service list without selecting the "Now Playing In This Store" item.
Exceptions:	
Includes:	
Extensions:	This service ties naturally with UC-19: Menu Service, and could be presented as a page linked from that service.
Assumptions:	
Notes and Issues:	This service can be used without associating with the AP, providing the Wi-Fi Device has another method of connecting to the internet.

Pay on-line

Use Case ID:	GAS-SD UC-21
Use Case Name:	Bill Pay Service

Actor:	• Wi-Fi Device • Access Point (AP) • User • Order Service • Kitchen • Wait staff
Description:	A venue can provide a service to allow a user to check or pay a tab without needing to wait for the wait staff to bring the bill, take payment and return. This speeds up the departure for the user and provides the venue with the table space more quickly.
Preconditions:	
Postconditions:	
Normal Course of Events:	1: User chooses the "Pay from your Phone" item. 2: Wi-Fi Device transmits request to the Payment Service, 3: Payment Service receives the request and returns a unique URL for the table's bill. 4: The Wi-Fi Device displays the bill to the User. 5: User interacts with the Payment Service directly, selecting any options that make sense for the user's needs (e.g. multiple cards, tip). 6: Payment is processed through the restaurants payment processing system. 7: The guests leave.
Alternative Courses:	1A: User closes service list without selecting the "Pay from your Phone" item.
Exceptions:	
Includes:	UC-1 Device Receives Service Advertisement
Extensions:	This service ties naturally with UC-19: Place Orders.
Assumptions:	
Notes and Issues:	This service can be used without associating with the AP, providing the Wi-Fi Device has another method of connecting to the internet. The system built by Ziosk for Chili's restaurants also has this feature. Ziosk reports that approximately 50% of customers use it to pay, because they do not wish to wait to pay.[32]

Implementation

Implementation consisted of creating a small 802.11 network consisting of one Station (STA) and one Access Point (AP) broadcasting an 802.11u beacon. The Access Point used was a Ruckus R300 controller-based Wireless Access Point and a Ruckus Zone Director 1100 controller using firmware 9.7. The Ruckus firmware is designed to comply with the Wi-Fi Alliance's Passpoint/Hotspot 2.0 specification[33], which includes full 802.11u compliance. The station was a MacBook Pro with built-in AirPort Wi-Fi. Wireshark[34] was used to validate that the beacon contained the advertisement and that the appropriate management frames would transfer advertisement.xml (see figure 2) to the station.

The DTD for 802.11u GAS-SD

The implemented application, which is a stand-in for a built-in Wi-Fi client, is a simple XML parser and web page display app. If a service requires user-defined parameters, it pops up a request for those parameters, constructs the URL, and submits it.

The advertisement contains a DTD declaration at the top level, followed by the actual contents. In the experiments executed below the DTD was inline, but upon actual implementation the DTD will be published to allow common use of it by any vendor.

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE GAS-SD [
<!ELEMENT GAS-SD_VERSION (#PCDATA)>
<!ELEMENT SERVICES (SERVICE+)>
<!ELEMENT SERVICE (DESCRIPTION?,URL,ICONURL?,ICON?,PARAMETERS?)>
<!ELEMENT DESCRIPTION (#PCDATA)>
<!ELEMENT URL (#PCDATA)>
<!ELEMENT ICONURL (#PCDATA)>
<!ELEMENT ICON (#PCDATA)>
<!ELEMENT PARAMETERS (PARAMETER*)>
<!ELEMENT PARAMETER (FIELD_LABEL,FIELD_NAME, FIELD_DATA?)>
<!ELEMENT FIELD_LABEL (#PCDATA)>
<!ELEMENT FIELD_NAME (#PCDATA)>
<!ELEMENT FIELD_DATA (#PCDATA)>

<!ATTLIST SERVICE NAME CDATA #REQUIRED>
<!ATTLIST SERVICE AUTH_REQUIRED (YES|NO) "YES" >
<!ATTLIST PARAMETER USER-SUPPLIED (YES|NO) "YES">

]>
```
Figure 2: GAS-SD XML DTD

The first child of the GAS-SD doctype is a version element, which provides a future path for improvements to the format. The second child is a container named "Services", which must contain one or more service. The service element requires a mandatory Name Attribute and has an optional "Auth-Required" attribute. The service element consists of the following elements: a mandatory URL, an optional Description, IconURL, ICON, and one or more parameters. Parameters have elements for field name, field_label, and optionally field_data. There is an optional attribute to indicate user-supplied fields. Under normal operation, a URL has strings that match the field_name in each parameter and the client application is responsible for building the correct URL from user input. There is nothing in the data format to protect the application from a poorly written parameter (i.e., one that does not substitute cleanly or is missing from the URL). Implementers are advised to check for this when creating and testing services.

Sample Advertisement.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE GAS-SD>
<GAS-SD>
  <GAS-SD_VERSION>1.0</GAS-SD_VERSION>
  <SERVICES>
    <SERVICE NAME="Test Service" AUTH_REQUIRED="NO">
      <DESCRIPTION>This is sample service #1</DESCRIPTION>

<URL>http://www.whiterose.org/index.html?mode=[[MODE]]&amp;uuid=[[SESSI
ON_ID]]&amp;user=[[USER]]</URL>
      <ICONURL>https://www.whiterose.org/images/whiterose-
glass.gif</ICONURL>
      <PARAMETERS>
        <PARAMETER USER-SUPPLIED="NO">
          <FIELD_LABEL>Mode:</FIELD_LABEL>
          <FIELD_NAME>[[MODE]]</FIELD_NAME>
          <FIELD_DATA>Active-Active</FIELD_DATA>
        </PARAMETER>
        <PARAMETER USER-SUPPLIED="NO">
          <FIELD_LABEL>Session ID:</FIELD_LABEL>
          <FIELD_NAME>[[SESSION_ID]]</FIELD_NAME>
          <FIELD_DATA>F9781EBA-D19B-4A78-BAF9-B2D78EE30968</FIELD_DATA>
        </PARAMETER>
        <PARAMETER USER-SUPPLIED="YES">
          <FIELD_LABEL>User Name:</FIELD_LABEL>
          <FIELD_NAME>[[USER]]</FIELD_NAME>
        </PARAMETER>
      </PARAMETERS>
    </SERVICE>
    <SERVICE NAME="Staples Inventory Service" AUTH_REQUIRED="NO">
      <DESCRIPTION>This is sample service #2</DESCRIPTION>
<URL>http://checkinventory.site44.com?site=S&amp;sku=397061&amp;loc=787
41</URL>
      <ICONURL>https://www.whiterose.org/images/whiterose-
sm.png</ICONURL>
      <!-- This one has no parameters... -->
    </SERVICE>
  </SERVICES>
</GAS-SD>
```

Figure 3: Advertisement.xml

The XML Document in Figure 3 contains two services, “Test Service” and “Staples Inventory Service.” The former is not a working service; it will return the same web page regardless of the parameters passed. The Test Service has three parameters: two pre-defined and one user-defined. The Session ID parameter would be generated for

each initial request to prevent accidental double submissions or malicious replay attempts.

Once the client software has retrieved the advertisement from the 802.11u beacon, the XML is parsed to generate a list of items to display, as in Figure 4. On user selection of a service, the client software detects all user parameters, prompts for them using the field_label, replaces the field name with the input value, calls the service, and displays the resulting web page.

```
NSXMLNode *docNode = [[document rootElement] childAtIndex:0];
if (![[docNode description]  isEqual: @"SERVICES"])  }
   docNode = [docNode nextSibling];
}
docNode = [docNode childAtIndex:0];
do {
   int j, elemCount = [docNode childCount];

   for (j=0; j < elemCount; j++) {
      elemName = [[docNode childAtIndex:j] name];
      elemVal  = [[[docNode childAtIndex:j] childAtIndex:0] XMLString];

      if (elemName) { // only services will have this field
        NSLog(@"%@ : %@", elemName, elemVal);
        [Displaylist addElementByName:elemName withValue: elemVal)];
      }
   }
} while ( (docNode = [docNode nextSibling]) );
```

Figure 4: Parsing advertisement.xml

The responding service should be capable of handling improper input in the response from the client, including bad or missing parameters, failure to provide user parameters, and malicious calls. Security should be appropriate for the kind of service provided. Informational pages that do not require input may be sent using http transport, while transactions involving payments require more secure processes. They should be secure, passwords should not be transmitted or stored in easily-crackable formats, and user-identifiable information should not be retained unnecessarily.

Results

Configuring an 802.11u beacon was straightforward, although it required the latest firmware from the vendor. In order to configure the non-native advertisement in the 802.11u beacon, the Ruckus AP required a native GAS Association Query Network Protocol (AQNP) provider to be configured. For enterprise and commercial Wi-Fi providers, this may not be a hurdle to successful implementation of GAS-SD.

Implementing the code in Objective-C was a mixed success. The xml handling and list-based selection options were implemented using standard libraries. Getting the beacon was more difficult. Apple's CoreWLanManager Framework in MacOSX 10.9.2 does not provide full access to the beacon, so the test application scans for an xml advertisement at a specified URL in lieu of pulling the data from the AP. A device OS manufacturer would have full access to the beacon to follow the 802.11u GAS-Request protocol and would therefore be able to overcome this limitation.

Once the data was published and acquired, transforming, displaying, selecting and processing it were possible using standard design patterns. A list of services was displayed, and upon selection, a browser was launched to call each service's URL as described in the data format. In order to provide the ability to meet the formatting needs of all the use cases, the parameter section was added to provide more flexibility between clients and service providers.

Each Use Case listed above was compared to the DTD in the Implementation section above to assure that it could be discovered and used with the proposed format. No additional requirements were discovered.

Conclusion

The flexibility to retrieve an arbitrary XML advertisement, which may be created on demand, allows GAS-SD to provide a viable solution for all the use cases listed in this paper as well as many not considered.

Businesses could create useful and profitable new services for users by extending existing location-based offerings. With improvements that are not technically challenging, Wi-Fi can provide a way to create new types of services that are easily used in many types of venues. 802.11u non-native GAS advertisements are designed to provide exactly the kind of data that a service discovery protocol needs to provide a bridge between Wi-Fi Devices and service providers.

The data format described in this paper is a viable alternative to the many location-based services available to providers today, and enables new and innovative services that make mobile devices more valuable to their users and Wi-Fi services more valuable to venues.

Further work in this area with device manufacturers and service providers is required to fully implement a common standard for information exchange in 802.11u beacons, but the building blocks to do so are readily available and can be used immediately.

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