IEEE P802.11
Wireless LANs

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| Use Cases Analysis |
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# Use Cases

## #1 Printers

### # 1a: (3D Printer)

Entering a new hotel for the first time, you wish to find a WLAN that supports a 3D printer to quickly fabricate a new lock mechanism for a sales meeting.

The hotel has 6 WLANs, 5 of which either require payment or pre-arranged credentials. You notice that the 6th WLAN is advertised as being a free network belonging to the hotel, which you are unsure about.

You wish that your STA could determine which (if any) of the WLANs support the 3D printer (possibly with associated cost information), prior to paying or registering for credentials

**Specific device (3D Printer) discovery**

**Service cost**

**Location (relative to user)**

**Speed of Service**

**Service discovery**

**Scope: in scope**

### #1b: (Printer)

**Kate enters a conference room and requests the printing service through her mobile phone.**

**AP with a printer associating to it receives Kate’s request.**

**AP may inform Kate the information of the printing service (e.g. price, 3D or not) as well as the printer (e.g. channel, address).**

**AP may also inform the printer the information of Kate’s mobile phone (e.g. channel, MAC address).**

**A communication link will then be set up between Kate’s mobile phone and the printer.**

**Key Words:**

**Specific service discovery**

**Service providing device’s information discovery**

**Service provided by associated device**

## #2 (Sports Event)

Whilst travelling you want to catch up on some sports events.

You prefer to watch some free edited highlights or perhaps pay for a high quality match. Your current contract with the mobile operator “Gamma-plex” will not allow this service, so you need to discover another WLAN that can and what the offerings are. There are many WLANs around, but its not obvious what video services are available at each one.

**Specific service (video streaming) discovery**

**Service cost (free)**

**Location (relative to user)**

**Service discovery**

**Scope: mobile operator aspects not in scope**

## #3 (Software Update)

You own a slightly unusual software defined multi-mode radio (originally purchased in Zaire) that has a un-reliable Bluetooth module in it and you want to download some new software for it.

You really need this urgently, so cost is not important, just speed of delivery to fix the issue.

You are surrounded by 7 WLANs and quickly need to know which one can provide a VPN connection through to an SDR module provider for your specific multi-mode radio and be billed in Singapore dollars.

**Specific entity (Software Defined Radio Provider) discovery**

**Service cost (multi-currency) discovery**

**VPN discovery**

**Internet access discovery**

**Location (relative to user)**

**Speed of Service**

**Scope: in scope**

## #4 (Hotel case 1 - discovering, through an AP, the services that are directly provided by the AP)

You enter IEEE meeting hotel and want to find a printer

You notice that there are three WLANs in the hotel with “xxx Printer” SSID

1. The hotel printer (free for hotel guest and 24/7 availability)

2. The FedEx/Kinko’s Office printer (not free; but has richer features such as 3D; available 6am-10pm for pickup; can do FedEx)

3. The printer in the IEEE staff office (located in a secured environment, available 9am-5pm to non-IEEE-staff)

You are not an IEEE staff, and

A. It is 1pm. You are sensitive to IT security.

B. It is 9pm. You want a high-quality print-out and cost is not an issue.

C. It is 11pm. You are sensitive to costs.

**Specific device (printer) discovery**

**Service cost discovery**

**Location (relative to user)**

**Speed of Service (time of day)**

**Service discovery**

**Scope: in scope**

## #5 (Hotel case 2 - discovering, through an AP, the services that are provided by devices associated with the AP)

You enter IEEE meeting hotel and want to find a printer

You notice that there are two WLANs in the hotel

1. The hotel WLAN, with two printers associated with

The hotel printer (free for hotel guest and 24/7 availability)

The printer in IEEE staff office (located in a secured environment, available 9am-5pm to non-IEEE-staff)

2. The FedEx/Kinko’s Office WLAN with one printer associated with (not free; but has richer features such as 3D; available 6am-10pm for pickup; can do FedEx)

You are not an IEEE staff, and

A. It is 1pm. You are sensitive to the security.

B. It is 9pm. You want high-quality print-out and cost is not an issue.

C. It is 11pm. You are sensitive to costs.

**Local AP Services / Network Services (Architecture)**

**Specific device (printer) discovery**

**Service cost discovery**

**Location (relative to user)**

**Speed of Service (time of day)**

**Service discovery**

**Scope: in scope**

## #6 (Airport case)

You are at an airport terminal. You want to download a movie to watch it later on the flight.

There are plenty WLANs around.

The free airport WLAN is too slow for you to download the movie before your boarding time.

Another WLAN, ran by a bar located at the terminal, charges a premium for Internet access, but offers descent throughput that allows you to download your movie in time.

Another WLAN, ran by a bookstore located at the terminal, offers movie download service and charges on a per-view base.

**Specific service (off-line video download) discovery**

**Service cost discovery**

**Speed of Service (duration & time of day)**

**Location (relative to user) [Is this movie service available at this location?]**

**Location routing**

**Internet access discovery**

**Scope: in scope**

## #7 (Access Network Discovery and Selection Function)

A user is roaming and does not want to get pricy data access over the cellular connection

The user enters a location where the user’s home operator can offer a decently priced deal to get data over a WLAN roaming agreement

The user’s device discovers the WLAN access that can provide the service and obtains a new operator’s policy where local WLANs are indicated as a preferred access for the data service

The device selects and connects to the indicated WLAN, and data services are now accessed through this WLAN

Note: The use case can also be applicable to WLAN-only devices.

**Only IEEE 802.11 consideration (scoping issue)**

**Service cost discovery**

**Location (relative to user)**

**Policy discovery**

**Interface to another discovery mechanism (e.g. ANDSF)**

**Internet access discovery**

## #8 (Jane in shopping mall)

Jane is doing some shopping in a mall. Instead of entering stores one by one on foot to find some good deals, she receives, on her mobile device, the mall directory information (such as stores’ names and locations) as well as the special offers associated with each store. The information is broadcasted by the AP deployed by the mall operator.

**Ignore the “broadcast by AP” point**

**Service discovery**

**Location (relative to user)**

#9 (Discovery services before association)

John enters a hotel and wants to find a WLAN that supports a 3D printer.

There are 5 WLANs in the hotel, but not obviously what services they provide and the parameters of their services, such as price, service time, admission control etc.

John sends out request of “printer” service, then APs of these WLAN response his request.

Finally, John chooses a WLAN to do his print task.

## #9 Identical to use case #1

## #10 (Public Transit Agency)

The client is interested in specific services rather than devices (like a printer) that are available from the network the AP is attached to. It may not be an external network- it may be a network wholly owned and operated by an agency.

For example, a public transit agency installs several APs in a joint subway/bus transfer station. They have installed a server on that network that accepts connection protection requests from travelers (a concept where a bus or train might be held a few minutes so if one is running late, connections won’t be missed). They also provide schedule information.

This use case is also in IEEE 802.11ai (since there will be a large number of travelers trying to associate at the same time), but there is no mechanism to let the travelers know that these services are available on the infrastructure.

In addition to connection protection, there are two additional applications in a grouping known as Integrated Dynamic Transit Operations (IDTO). The additional applications are dynamic dispatching whereby a transit company may serve stations at designated locations according to the user’s request (made from a smart phone or other mobile device) rather than by a fixed schedule, and dynamic ridesharing whereby travellers and drivers with smart phones, tablet computers or other portable mobile devices can dynamically identify and accept potential ridesharing opportunities along a given travel route. Implementation of any or all of these applications is expected to be at the discretion of the transit agencies or localities that will operate the services.

People traveling away from home will not know if these services are available at their destination.

One use case where there is a great need for discovering if these services are available is to use ISD on the WLAN when you arrive at an airport. This use case can be a part of a wider application of “Ground Transportation Services” for which public transport and ridesharing are some of the options.

One variation of this use case would be to install the server that processes requests for these services on the airport WLAN (layer 2). The AP could either broadcast the availability of the services, or the STA could query the AP.

The other variation is where the services are available, but the server that processes the request is on the Internet (layer 3). In this variation, information should be made available in pre-associated state. Information concerning charges or fees for Internet access is also advertised so traveler can decide if it is worth paying for the Internet access, or whether there is an alternative method for requesting the service.

These services are location based services, so knowledge of the location of the STA is important.

**Service discovery**

**Location (relative to user)**

**Crowd sourcing capability discovery**

**Dynamic information (e.g. train times)**

**This is already covered by pre -association to open access walled garden**

## #11 (Local information service for Augmented Reality in Arboretum)

John is walking through a path in an arboretum and becomes curious about a tree in his sight.

He opens an AR browser on a smartphone for local information service and focuses on the tree.

On the screen of smartphone, he can read the name of the tree and where the tree originated from without getting close to the tree to see a sign or QR code tagged on the trunk.

He starts to surf internet from an URL given.

**Service discovery**

**Location (relative to user)**

**Device capabilities would form part of a query (camera etc.)**

## #12 (Local information service in a office for Augmented Reality)

John tags on the fridge in the office for his milk, but with a expiry date for cleaner by taking a picture in front of fridge.

Ann setups printer for his smartphone by AR browsing without pressing buttons on the printer or reading office manual and chooses it on AR to print.

Bob focuses his smartphone on TV to look a channel guide without turning on.

When Jane enters the office, she gets ideas what’s happening by receiving three local information tags, one for fridge, another for printer and the other for TV.

**Service discovery**

**Location (relative to user)**

**3rd party identifiers captured by the device would form part of a query (e.g. TV ID)**

## #13 (Network Selectin for Cloud Services - User of electronic consumer device starts to use application XYZ in his device)

The application-XYZ requires connectivity to cloud services.

Device has not yet associated to any network as it has not been used for a while.

Multiple different networks are available at that location.

Some networks are not accessible to the user.

Multiple networks are available which could be used for the connection to the cloud.

Each network may differ, as for example, in terms of:

Supported authentication mode, e.g. WEB based or USIM based;

Supported security;

Available latency and throughput ;

Network load or coverage/mobility support;

Network Operator preferences.

In the best case: The device is able to make a “clever” network selection, at once, so that application can operate seamlessly with high QoE without any manual intervention of the user.

In the unsuccessful case (which we should avoid): User realizes that application does not work properly and takes manual action to select network and provide authentication credentials.

**Service discovery**

**API required?**

**Scope: in scope**

## #14 (Local Service Discovery within a High Density Environment: A Railway Station Environment)

John enters the hall of a railway station and wants to find a coffee shop to wait for his friend. His smart phone sends requests for service discovery.

The Station AP replies with service content in it.

John’s smart phone displays the content on the screen and John finds the advertisements of coffees.

Then he selects a coffee shop for more information, such as coffee types and shop location etc.

The Station AP will provide him more information of the shop.

**Same as 1.8**

## #15 (Long Range Service Discovery within a Multiple AP Environment: An Enterprise Environment)

There are 2 types of WLANs in an hall of XX Company Base N. AP1 is open for display service and common information service. AP2 is security for printer service and scanner service, et al. Moreover, AP2 can reach the remote WLANs, which are AP3 and AP4.

AP3 is an security WLAN in Base N for project information, upload service etc al.，while AP 4 is a remote WLAN in Base S for data service of Base S, such as email service.

Dan and Emily enters the hall. Dan is an Employee of the company whose base is S. He is here for a project conference and now wants to check project information and meeting agenda in Base N, meanwhile check his email on the email server in Base S.

Emily is a graduate student, coming for an interview. She wants to find out the arrangement of her interview and room information.

Emily requests service discovery through her smart phone.

AP1 and AP2 provide their service contents.

 She finds that the common information may help, hence, sends further request with “common information” to AP1 for further information.

 AP1 replies with detailed descriptions of the “common information”, including map service and interview service, etc.

Then Emily may decide to associate to AP1 for further checking details of her interview arrangement.

**Service discovery**

**Location (relative to user)**

**Scope: in scope**

## #16 (Service Discovery based on Location Detection - Local Conference Service)

John enters a conference room and requests to finds the projector service.

The AP that has projector service, discovers John’s mobile device is within the Wi-Fi Direction connection area of the projector, then AP notifies his mobile device and the Projector to enable their WiFi-direct with some suggested information, such as suggested channel etc.

The Projector opens its WiFi-direct, perhaps listening on the suggested channel, ready to provide service.

John may also open WiFi-direct and set up a direct link on the suggested channel from AP.

**Service discovery**

**Probe/Response mechanism**

**Location (relative to user)**

**Scope: Wi-Fi Direct aspects are out of scope for IEEE 802.11**

## #17 (Self-growing for energy-aware end-to-end delay optimization)

Sensor nodes are deployed in a given environment partially covered by a second type of network, e.g. IEEE 802.11 WLAN.

The sensor nodes are equipped with a reconfigurable radio unit; they share the communication band (e.g. 2.4 GHz band) with the WLAN but use a sensor network specific MAC protocol optimized for low energy consumption in order to achieve a long lifetime of the sensor network. They use multi-hop communication, causing long delays, to forward sensor readings.

During their lifetime of the sensor network, a change in its purpose occurs: in addition to existing functionality, sensor nodes have to report on delay sensitive data to a data sink.

Instead of reconfiguring the sensor network, nodes discover WLAN APs in their vicinity and discover if they either offer “self-growing services” or at least “data offloading capabilities”.

**Network access discovery**

**Scope: parts of it.**

## #18 (Purpose-driven network reconfiguration during an emergency situation)

Sensor nodes forming an ad-hoc network are deployed in a given environment partially covered by a second type of network providing centralized, single-hop backbone access, e.g. IEEE 802.11 WLAN.

Under normal operation, the sensor network provides sensing information (e.g. temperature in various locations of a building) at low duty cycles; the network is optimized for long network lifetime accepting higher delays in the acquisition of sensing information#.

An incident situation and the existing sensor node infrastructure is partially disrupted.

Additionally, the cognitive decision engine controlling the network reconfiguration and self-growing process of the sensor and WLAN network might detect that sensor nodes are located in an area where WLAN coverage is (no longer) given.

As a result, sensor nodes are reconfigured to permanently use the 802.11 MAC in order to act as a meshed network re-establishing 802.11-based coverage. Mobile devices of users within the incident area have to quickly discover those newly available “mesh APs” and their services to establish a link with them.

**Network access discovery**

**Scope: parts of it.**

## #19 (Cognitive Coexistence and self-growing for white space operation)

This use cases focuses on a locally deployed access point operating in white spaces in order to form a WLAN providing access to a small (company) network.

Over the lifetime of the deployments, the purpose of the deployed network elements grows from only supporting nomadic mobility to additionally supporting seamless mobility for mobile users.

Achieved in various ways:

cognitive decision engine achieves separation in (used) spectrum

the engine learns about the requirements of each device and intelligently considers a dynamic adaptation of assigned spectrum per node/network

each network adapts its purpose according to users’ needs (e.g. adding low latency low bandwidth communication for surveillance purposes to existing high bandwidth but long delay services).

For the integration of 802.11-based networks in this self-growing process, devices have quickly to query for cognitive, self-growing capabilities via application layer services.

**Network access discovery**

**Scope: none of it.**

## #20 (Shop Owner, without internet access, with Specials and Freebies)

Bogdan Cafe is a small restaurant just off the main square in a suburban town in southern Poland. The owner, Bogdan, has a desktop computer in the restaurant for business use: email, inventory, recipes, orders, menus, accounting and payroll. He also has an AP and a laptop, but since his internet service provider charges him by the hour for internet access, he rarely connects his AP to the internet. He has rigged a crude browser based interface to his computer which uses WiFi from his AP to display today’s menu, prices and specials. Since it is well known that Bogdan has the largest music collection in his town, his computer constantly streams top hit music to the speakers in his restaurant. Anyone in the restaurant can download today’s music selections with the daily password which Bogdan prints on each customer receipt. His AP broadcasts advertisements of the menu and today’s free music selections to all passing WiFi equipped smart phones. He also has a primitive bulletin board application which he shares with his password-enabled customers. “BogdansList” is a great local site for buying/selling/trading textbooks, music instruments, and any other garage-sale items for the locals in his town. He has found he can double his business when he advertises free music downloads and free community adverts at Bogdan Cafe.

**Service discovery**

**Proximity**

**Identical to 1.8**

## #21 Max needs a Cab

Max is a day trader in mid-town Manhattan. He is a can-do/can’t-wait kind of guy, always on the move. His smartphone has a new app to locate and call a cab for him in real time. The smart cabbies in NYC have the new WiFi Taxi-2-U app for their smartphones which constantly broadcast their location and service availability using WiFi Taxi-2-U advertisements to any WiFi device within radio range. When Max hits the street for lunch, he checks his Taxi-2-U app which displays all available taxis within radio range on a street map. He selects the closest cab based on the one-way streets and presses “NEED CAB NOW”. His WiFi smartphone connects to the selected cabby’s phone and provides Max’s location and cell phone number to the cabbie. His taxi arrives in 30 seconds, which is 10 seconds too long for Max.

**Service discovery**

**Location (relative to user)**

**Scope: minimal**

## #22 Operator or Internet Access



**Operator deploy different type of WLAN network, for example:**

WLAN network #1:

Provide Internet access service

WLAN network #2:

Provide Internet access service

Provide access service to operator’s core network

Do not provide seamless handover between WLAN and cellular network

WLAN network #3:

Provide Internet access service

Provide access service to operator’s core network

Provide seamless handover between WLAN and cellular network

The user may want to know the service type before associate to the WLAN network

**Network access discovery**

**Scope: IEEE 802.11-2012 (IEEE 802.11u)**

## #23 Gaming

* Tina is waiting flight in the airline lounge.
* She notifies AP that she has a game on her pad and she wants to find another player or join anybody else who’s playing the game.
* Cindy walks into the lounge later, and notifies AP the same information as Tina.
* AP then notifies Tina (or Cindy) the information of Cindy (or Tina), or both.
* Tina and Cindy connect to each other directly.

	+ **Key words:**
	+ Specific service discovery
	+ Service providing device’s information discovery
	+ Service provided by associated device
	+ Service report procedure for the devices that wish AP to answer service queries for them.

## #24 Traffic/Road Information Service

* Smart phones are often used on cars as temporary multi-function OBU – the “Nomadic device” feature.
* John puts his smart phone on the dash board of a car as its Personal Navigation Device (PND).
* John is driving and passing through an intersection where multiple hotspots co-exist and are run by different operators.
* John would like to quickly update its route with the latest traffic/road information via hotspots that provides the service of disseminating real-time traffic and road information including emergent events.
* John needs to know which hotspots provide such a service before he is out of the signal coverage (leaving the intersection).
* **Keywords:**
	+ Service Discovery (finding a specific application among multiple WLANs)
	+ Instant Service (required fast service discovery and fast link association)
	+ Proximity and time-related (Traffic/road information changes over time and the information dissemination should be location-based. Downloading the bulky traffic/road information of the whole US is time-consuming and BW-wasting.)

## #25 Indoor Parking Service Discovery

* Smart phones are often used on cars as temporary multi-function OBU – the “Nomadic device” feature.
* John puts his smart phone on the dash board of a car as its Personal Navigation Device (PND).
* John is driving into a parking tower where multiple WLANs would reside for different purposes.
	+ Internet Access
	+ Empty Parking lots navigation
* John would like to quickly know which WLAN provides indoor parking lot guidance service so that he does not need to spend much time in finding at which floor in which corner an empty lot is.
* **Keywords:**
	+ Service Discovery (finding a specific application among multiple WLANs)
	+ Proximity and time-related (Availability of lots changes over time and different towers have their own lot-availability map.)

# 2. Requirements

1. (From use case #7)
2. ANDSF is an important ISD protocol which enables discovery and usage of “mobility services,” which is arguably the main IP-network service offered by cellular networks.
3. Known gaps exist when ANDSF is used with existing 802.11-based systems (i.e. WiFi systems)
4. The SG should examine the issues highlighted in detail to understand whether these are in scope for 802.11. If so, the scope of the proposed amendment produced by SG should include closing these gaps.
5. (From use case #8)
6. AP indicates, in the beacon, that it is an information provider and advertises the categories of information that it provides and the corresponding broadcasting schedule.
7. AP further broadcasts details of one or more different categories of information at a time, based on the broadcasting schedule.
8. A STA can selectively receive a particular category of information that it wishes to received, maybe based on the inputs from the end user.
9. Need to specify a list of service/information categories and related attributes.
10. Need to extend the Beacon frame to advertise service information.
11. (From use case #9)
12. STA indicates, in the probe request, the information or service that it is looking for, maybe with the inputs of the end user via an application
13. AP receives this scanning and check local services information, and if having such information or supporting such service, sends probe response with information of the service or information that it has or supports.
14. STA receives information of existing WLANs and based on user’s preference (e.g. time, charge, quality etc.) choose one to associate with.
15. Need to specify a list of service/information categories and related attributes.
16. Need to extend the Probe Req/Rep frames to carry service information.
17. (From use case #10)
18. The AP indicates in the beacon which (ground transportation) services are available (at airport or transit station) from server on LAN or;
19. A STA can submit a probe request for specific services (may be initiated by an app); AP sends probe response indicating if service is supported.
20. If the services are not available locally (server is not on WLAN) but is available on an external network reachable from the WLAN, the STA should be able to get the necessary information in a pre-associated state (service discovery protocol may be existing IETF protocol-SG will examine).
21. AP responses should indicate if there are charges or fees for the service.
22. Location of the STAs is required for the application.
23. (From use case #11)
24. STA providing information prepares image feature fits in a beacon frame with a tag of an object.
25. STA submits information to AP in a probe request or by post-association method.
26. AP accepts local information from information provider.
27. AP broadcasts local information with images in beacon fames in schedule.
28. STA recognizes local information in beacon frames and keep them in memory.
29. (From use case #12)
30. Beacon frames or pre-association frames need to be specified to contain local information.
31. Local information includes object/service types and related attributes.
32. memo just for general object.
33. printer setup attributes for printer.
34. Locality lessens security concerns but simple security model for protecting AP from digital graffiti is required.
35. AP needs to be extended to use a dedicated message server.
36. In a busy area, stopping of local information service and broadcasting bare beacon frames is required for traffic control.
37. (From use case #13)
38. User connectivity without manual intervention - Connection to cloud is most of the time the service that user desires.
39. Devices needs to make “clever” decisions - ISD work could provide additional information and new means for this “clever” decision making process.
40. Some of this work has been potentially done in 802.11u and WiFi-alliance already - Review of prior work is needed.
41. (From use case #14)
42. Service devices should publish their service capability to the associated AP.
43. The requesting devices should be able to request for service discovery, including discovering further information of a preferred service.
44. The AP should be able to provide service content and detailed service information according to requesting devices’ request.
45. (From use case #15)
46. AP should be able to be configured whether it can provide services to other APs.
47. AP should be able to provide requesting devices its local services, as well as services information provided by its reachable APs.
48. Service devices should publish their service capability to the associated AP.
49. The requesting devices should be able to request for service discovery, including discovering further information of a preferred service.
50. (From use case #16)
51. The requesting devices should be able to request for service discovery, including discovering further information of a preferred service.
52. The AP should be able to know device capability of requesting and requested STAs, such as support Wi-Fi Direct.
53. The service devices and requesting device should be able to enable/disable their Wi-Fi direct to save power consumption.
54. The AP should be able to detect positions of devices.
55. The AP should be able to notify devices to enable their Wi-Fi direct with a suggested channel etc. to set up a direct link.
56. (From use case #17, #18, #19)
57. Transparent “tunnelling” of service discovery protocols before actual 802.11 link set-up.
58. Announcement of “available services” via beacon, or probe response, or other means (provisioning of unsolicited announcements).
59. (From use case #20)
60. An AP which is not connected to the internet can provide discovery services to nearby STAs.
61. Provisions for ANQP-like services hosted by local STA or AP can enhance service discovery in rural and undeveloped areas.
62. A STA connected to the power grid (no power save issues) can host discovery advertisements from other power-constrained STAs.
63. (From use case #21)
64. STA’s (connected or disconnected from internet) can advertise services to other STAs in radio range.
65. Location aware STAs can provide their location in service discovery advertisements.
66. Location-aware STAs can use their location to negotiate services and interactions with other location-aware STAs.
67. Service discovery advertisements for power constrained STAs (battery operated) shall minimize power used for Service Discovery functions.
68. Service discovery advertisements can be updated by advertising STA in near real time, i.e. cab transitions from “available” to “in use”.
69. (From use case #24, 25)
70. An AP is allowed to advertise pre-association-phase messages containing the information service advertisements in the WLAN that it dominates.
71. An AP allows pre-association users to send service probe messages to it for inquiring the services provided in the WLAN. In this mode, AP is responsible for transmitting a service probe response message to the user for providing service access details in the WLAN. The service probe response messages should be transmitted within a time constraint for high-mobility users (e.g., users on vehicles).