# Wi-Fi Alliance Technical Committee
# P2P Task Group

# Wi-Fi Peer-to-Peer (P2P) Technical Specification

## Version 1.2

# 1 Document History

| Version | Date | Status | Comments |
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| 1.0.00 | 2009-12-09 | Approved for Internal Release | Peer-to-Peer Technical Specification v1.00 |
| 1.1 | 2010-10-04 | Final | Public release version |
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| 1.1.02 | 2011-12-13 | Draft | - Updated WSC Primary Device Type attribute table in Annex B.2 to incorporated new "tablet" sub category (WSC v2.0.1).<br>- Added Wi-Fi Display Service Protocol Type in Table 63 |
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# 1 Introduction

## 1.1 Overview

This document is the Technical Specification for WFA P2P, a solution for Wi-Fi® device-to-device connectivity. This Specification defines an architecture and set of protocols that facilitate WFA P2P operation and that are backward compatible with existing Wi-Fi CERTIFIED™ devices.

## 1.2 Scope

The scope of this Specification is limited to that outlined by the Wi-Fi P2P Specification Requirements Document (SRD) [8]. The content of this Specification is designed to address the seven system solution requirement areas identified in the SRD:

— Discovery (Device Discovery and Service Discovery),

— Pairing (including Group Formation and P2P Invitation),

— Connectivity,

— Power Management,

— Group Management,

— Coexistence, and

— Legacy.

This Specification is also intended to meet the user experience and additional requirements defined in the SRD [8].

## 1.3 References

[1] IEEE Std 802.11–2007 IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks-Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications.

[2] IEEE Std 802.11k–2008 IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 1: Radio Resource Measurement.

[3] IEEE Std 802.11y–2008 IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 3: 3650–3700 MHz Operation in USA.

1 [4]   IEEE P802.11u/D9.0 Draft Standard for Information Technology –
2       Telecommunications and information exchange between systems – Local and
3       metropolitan area networks – Specific requirements Part 11: Wireless LAN
4       Medium Access Control (MAC) and Physical Layer (PHY) specifications
5       Amendment 7: Interworking with External Networks.

6 [5]   IEEE P802.11v/10.0 Draft Standard for Information technology –
7       Telecommunications and information exchange between systems – Local and
8       metropolitan area networks – Specific requirements – Part 11: Wireless LAN
9       Medium Access Control (MAC) and Physical Layer (PHY) specifications
10      Amendment 8: Wireless Network Management.

11 [6]  Wi-Fi Protected Setup Specification – version 1.0, December 2006, Wi-Fi
12      Alliance, http://www.wi-fi.org/specifications.php

13 [7]  WMM™ (including WMM™ Power Save) Specification – version 1.1, Wi-Fi
14      Alliance, http://www.wi-fi.org/pdf/WMM_Specification_1-1.pdf

15 [8]  Wi-Fi P2P Specification Requirements Document (SRD) for Wi-Fi Peer-to-Peer
16      (P2P) Devices – version 1.0, March 2009, Wi-Fi Alliance

17 [9]  Bonjour, http://developer.apple.com/networking/bonjour/index.html

18 [10] Universal Plug and Play (UPnP), http://www.upnp.org

19 [11] Web Services Dynamic Discovery (WS-Discovery), April 2005,
20      BEA Systems/Canon/Intel/Microsoft/webMethods,
21      http://specs.xmlsoap.org/ws/2005/04/discovery/ws-discovery.pdf

22 [13] IEEE P802.11-REVmb/3.0 Draft Standard for Information technology –
23      Telecommunications and information exchange between systems – Local and
24      metropolitan area networks – Specific requirements – Part 11: Wireless LAN
25      Medium Access Control (MAC) and Physical Layer (PHY) specifications.

## 1.4   Definitions

27 The following definitions and terms are used in this document:

28 **Config Methods**: The Wi-Fi Simple Configuration methods supported, as
29 defined in the Wi-Fi Simple Configuration Specification [6].

30 **Client**: A P2P Client or a Legacy Client that is connected to a P2P Group
31 Owner.

32 **Credentials**: The information that is required to join a P2P Group as defined in
33 the Wi-Fi Simple Configuration Specification [6].

34 **Device Password ID**: The Wi-Fi Simple Configuration method currently in use,
35 as defined in the Wi-Fi Simple Configuration Specification [6].

36 **Find Phase**: A phase in P2P Discovery that is used to ensure that two
37 simultaneously searching P2P Devices arrive on a common channel to enable
38 communication.

1 **Legacy Client**: A STA that is Wi-Fi CERTIFIED™, but not P2P compliant.

2 **Listen Channel**: The channel chosen from the set of Social Channels, which is
3 used by a P2P Device to be discoverable.

4 **Listen State**: A state used in P2P Discovery in which a P2P Device dwells on a
5 Listen channel to be discoverable.

6 **Managed P2P Device**: A P2P Device that has the capability to be managed by
7 a WLAN infrastructure.

8 **Operating Channel**: The channel on which the P2P Group is operating.

9 **P2P Client**: A P2P Device that is connected to a P2P Group Owner.

10 **P2P Coexistence Parameters**: A combination of Primary P2P Coexistence
11 Parameters and Secondary P2P Coexistence Parameters.

12 **P2P Concurrent Device**: A P2P Device that can concurrently operate as a
13 WLAN STA in WLAN.

14 **P2P Device**: WFA P2P certified device that is capable of acting as both a P2P
15 Group Owner and a P2P Client.

16 **P2P Device Address**: An identifier used to uniquely reference a P2P Device.

17 **P2P Discovery**: A capability that provides a set of functions to allow a device to
18 easily and quickly identify and connect to a device and its services in its vicinity.

19 **P2P Group**: A set of devices consisting of one P2P Group Owner and zero or
20 more Clients.

21 **P2P Group ID**: An identifier used to indicate the presence of a specific P2P
22 Group.

23 **P2P Group Owner**: An "AP-like" entity that may provide and use connectivity
24 between Clients.

25 **P2P Interface Address**: The MAC address of the P2P interface, an address
26 used to identify a P2P Device within a P2P Group.

27 **Persistent P2P Group**: A P2P Group for which Credentials are stored and may
28 be made available for reuse after the initial use completes. Such a P2P Group
29 has a lifetime that may extend over a number of distinct sessions beyond the
30 initial use until the group is deliberately dissolved.

31 **P2P Wildcard SSID**: The SSID field "DIRECT-".

32 **Primary P2P Coexistence Parameters**: One or more Channel Usage
33 elements (see IEEE P802.11v [5]).

34 **Provisioning**: A phase of P2P Group Formation in which Credentials for the
35 P2P Group are exchanged based on the use of Wi-Fi Simple Configuration [6].

36 **Search State**: A state in the Find Phase in which a P2P Device sends Probe
37 Request frames on the Social Channels.

**Secondary P2P Coexistence Parameters**: Zero or one Country and Power Constraint element pairs where the Country element includes a Maximum Transmit Power Level field, and zero or one WMM Parameter Elements.

**Security Domain**: An environment comprised of a set of devices that use common security credentials and policies.

**Scan Phase**: The process in P2P Discovery to collect information about surrounding devices or networks by scanning all supported channels.

**Social Channel**: A subset of commonly available channels in the 2.4 GHz band (1, 6, and 11).

**Temporary P2P Group**: A P2P Group that is formed only when required and ceases to exist after the initial use completes. Such a P2P Group has a lifetime consisting of a single use.

**Topology**: The arrangement in which the nodes of a network are connected to each other and (in some cases) to other networks.

## 1.5    Abbreviations and acronyms

| | |
|---|---|
| **AP** | Access Point (IEEE Std 802.11-2007) |
| **AM** | Active Mode (IEEE Std 802.11-2007) |
| **ANQP** | Access Network Query Protocol (IEEE P802.11u) |
| **CTWindow** | Client Traffic Window |
| **EOSP** | End-of-Service-Period (WMM) |
| **GAS** | Generic Advertisement Service (IEEE P802.11u) |
| **GO** | P2P Group Owner |
| **L2** | OSI Layer 2, a Data Link Layer protocol |
| **L3** | OSI Layer 3, a Network Layer protocol |
| **NoA** | Notice of Absence |
| **OppPS** | Opportunistic Power Save |
| **P2P** | Peer-to-peer |
| **PS** | Power Save mode (IEEE Std 802.11-2007) |
| **P2P IE** | P2P Information Element |
| **P2P PS** | IEEE802.11 Power Save adapted for P2P operation |
| **P2P WMM-PS** | WMM-PS adapted for P2P operation |
| **QoS** | Quality of Service |
| **RA** | Receiver Address (IEEE Std 802.11–2007) |
| **SA** | Source Address (IEEE Std 802.11-2007) |

| | | |
|---|---|---|
| 1 | **SD** | Service Discovery |
| 2 | **STA** | Non-AP Station (IEEE Std 802.11–2007) |
| 3 | **TA** | Transmitter Address (IEEE Std 802.11–2007) |
| 4 | **TIM** | Traffic Information Map (IEEE Std 802.11-2007) |
| 5 | **TBTT** | Target Beacon Transmission Time (IEEE Std 802.11-2007) |
| 6 | **TLV** | Type-Length-Value |
| 7 | **TS** | Traffic Stream (WMM) |
| 8 | **TU** | Time Unit (IEEE Std 802.11–2007) |
| 9 | **UPnP** | Universal Plug and Play™ |
| 10 | **USP** | Unscheduled Service Period (WMM) |
| 11 | **WLAN** | Wireless Local Area Network |
| 12 | **WMM**® | Wi-Fi Multimedia™ |
| 13 | **WPA2**™ | Wi-Fi Protected Access® 2 |
| 14 | **WMM-PS** | Wireless Multimedia Power Save |
| 15 | **WSC** | Wi-Fi Simple Configuration |

# 2 Architectural overview

## 2.1 P2P components

The P2P architecture consists of components that interact to support device-to-device communication.

P2P Device:

— Supports both P2P Group Owner and P2P Client roles.

— Negotiates P2P Group Owner or P2P Client role.

— Supports WSC and P2P Discovery mechanism.

— May support WLAN and P2P concurrent operation.

P2P Group Owner role:

— "AP-like" entity that provides BSS functionality and services for associated Clients (P2P Clients or Legacy Clients).

— Provides WSC Internal Registrar functionality.

— May provide communication between associated Clients.

— May provide access to a simultaneous WLAN connection for its associated Clients.

P2P Client role:

— Implements non-AP STA functionality.

— Provides WSC Enrollee functionality.

## 2.2 P2P topology

The P2P Topology is 1:n where multiple Clients are connected to one Group Owner. Such a set of connected devices is called a P2P Group. Each Client in a P2P Group may be either a P2P Client or a Legacy Client, as shown in Figure 1.
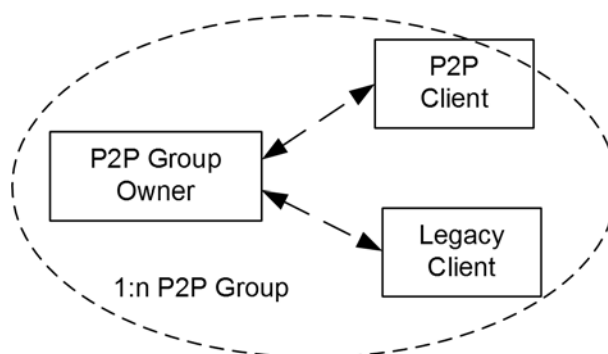


**Figure 1—P2P components and topology**

1      A P2P Group has a single SSID and provides one security domain.

2      Figure 2 illustrates a 1:1 topology, which is a subset of P2P 1:n topology (n=1).



3
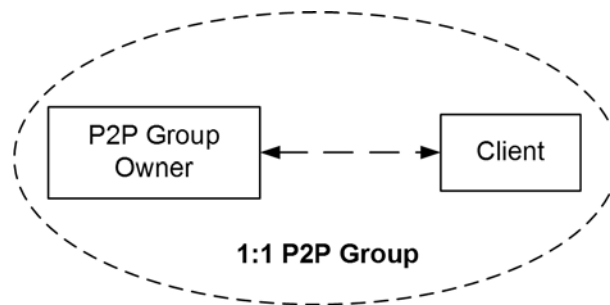
4      **Figure 2—A subset of P2P 1:n topology (n=1)**

## 5   **2.3**   **Concurrent operation**

6      A P2P Device can operate concurrently with a WLAN (infrastructure network).
7      Such a device is considered a P2P Concurrent Device. The concurrent
8      operation requires a device to support multiple MAC entities.



9
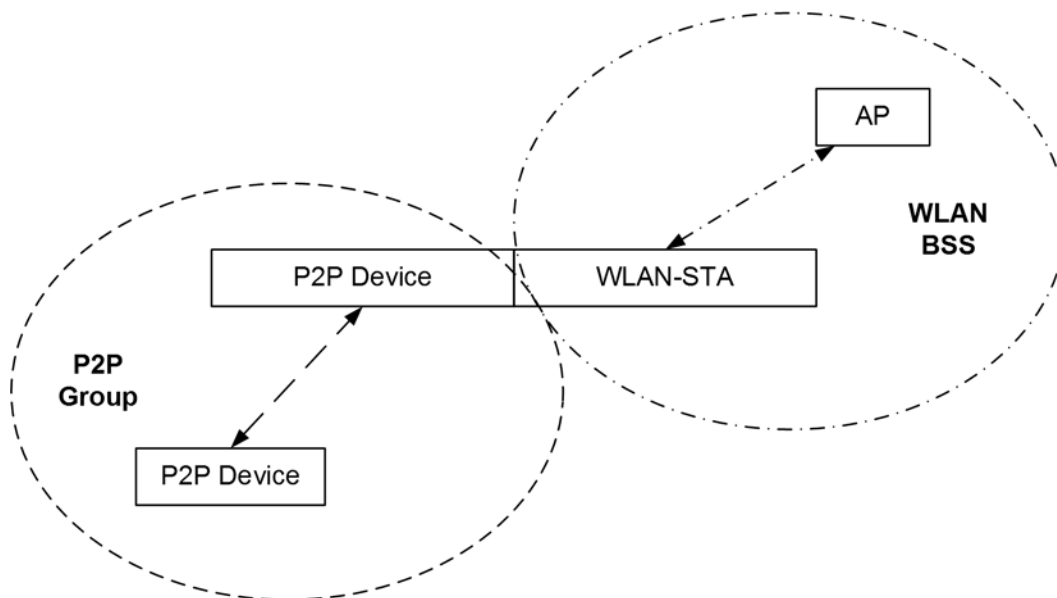
10      **Figure 3—P2P Concurrent device**

11      As an example, Figure 3 shows a P2P Concurrent Device that has one MAC
12      entity operating as a WLAN-STA and the second MAC entity operating as a
13      P2P Device. The dual MAC functionality can be provided via two separate
14      physical MAC entities each associated with its own PHY entity, two virtual MAC

1　entities over one PHY entity, or any other approach. Implementation of multiple
2　MAC functionality is out of scope of this specification.

3　A P2P Group may operate in the same or different operating class and channel
4　as a concurrently operating WLAN BSS. For example, a WLAN BSS may
5　operate in channel 36 in the 5.2 GHz band, while the P2P Group may operate in
6　channel 6 in the 2.4 GHz band.

7　This specification does not preclude a P2P Device operating as a member of
8　more than one P2P Group simultaneously, however, such operation is out of
9　scope and therefore not described.

## 2.4　Functions and services

### 2.4.1　Basic functions and services

12　This specification assumes that all the STA functions and services to pass the
13　following WFA Certifications are implemented in P2P Devices:

14　— WFA certification for at least 802.11g, which includes WPA2
15　— Wi-Fi Protected Setup™ [6]
16　— Wi-Fi Multimedia [7]

17　Any required 'AP-like' functions and services required for P2P Group Owner
18　operation are described within this specification.

19　In order to promote efficient wireless medium use:

20　— P2P Devices shall not use 11b rates (1, 2, 5.5, 11 Mbps) for data and
21　management frames except:

22　　■　Probe Request frames sent to both P2P Devices and non-P2P Devices.
23　— P2P Devices shall not respond to Probe Request frames that indicate
24　support for 11b rates only.

25　Note 1 —This means that the P2P Group Owner transmits Beacon frames using
26　OFDM.

27　Note 2 — This means that the P2P Group Owner transmits Probe Response frames
28　using OFDM, including frames sent in response to Probe Requests received at 11b
29　rates from non 11b-only devices.

30　Note 3 — P2P Devices shall not include 11b rates in the list of supported rates in
31　Probe Request frame intended only for P2P Devices. 11b rates may be included in the
32　list of supported rates in Probe Request frames intended for both P2P Devices and
33　non-P2P Devices.

### 2.4.2　P2P specific functions and services

35　In addition to the assumed functions listed in §2.4.1, a P2P Device supports the
36　following P2P specific functions:

— **P2P Discovery** provides a set of functions to allow a device to easily and quickly identify and connect to another P2P Device and its services in its vicinity.

— **P2P Group Operation** resembles infrastructure BSS operation as defined in IEEE Std 802.11-2007 [1], and provides additions for a P2P Group operation.

— **P2P Power Management** provides a set of functions to reduce power consumption of P2P Devices.

— **Managed P2P Device Operation** (optional) describes the ability for P2P Devices to operate in an enterprise environment where P2P Devices may be managed by the Information Technology (IT) department of the enterprise.

Note — An informative diagram shown in Annex A illustrates P2P Device state transitions.

### 2.4.3   P2P Device addressing

A P2P Device shall have a P2P Device Address, conforming to the format as described in §7.1.3.3.1 of IEEE Std 802.11-2007 [1], which is used to uniquely reference that P2P Device. The P2P Device Address of a P2P Device shall be its globally administered MAC address, or its globally administered MAC address with the locally administered bit set. The P2P Device Address shall be used as the receiver address (RA) for all frames sent to a P2P Device during P2P Discovery, with the sole exception of using a broadcast receiver address in a Probe Request. The P2P Device Address shall be used as the transmitter address (TA) for all frames sent by a P2P Device during P2P Discovery.

A P2P Device will assume the role of P2P Group Owner or P2P Client when in a P2P Group. The P2P Device is a different logical entity from the P2P Client or P2P Group Owner so has its own addressing mechanism. The P2P Device shall assign a P2P Interface Address, corresponding to the format as described in §7.1.3.3.1 of IEEE Std 802.11-2007 [1], which is used to communicate with the P2P Group Owner or Clients within a P2P Group. A P2P Interface Address is not required to be globally unique and may be locally administered. A P2P Interface Address may be the same as the P2P Device Address provided the requirements for P2P Interface Address in this clause are satisfied. A P2P Device shall use its P2P Interface Address as the transmitter address (TA) for all frames sent within a P2P Group. A P2P Device shall use the P2P Interface Address of the intended recipient P2P Device as the receiver address (RA) for all unicast frames sent within a P2P Group.

A P2P Device shall only use a P2P Interface Address for communication within a P2P Group. All other communication between P2P Devices shall use the P2P Device Address.

A P2P Group has a session that starts and ends as described in §3.2 and subsections. A Persistent P2P Group may have multiple distinct sessions. The P2P Interface Address shall be assigned prior to starting a P2P Group session

1 and shall not change within a P2P Group session. The P2P Interface Address
2 expires at the end of a P2P Group session. A P2P Device may use a different
3 P2P Interface Address for distinct sessions of a P2P Group. A P2P Device shall
4 not attempt to communicate to a P2P Device using a P2P Interface Address
5 from a P2P Group session that has ended.

6 As described in §2.3 a P2P Device may support more than one interface for the
7 purpose of a concurrent WLAN connection. A P2P Device shall assign a P2P
8 Interface Address for the P2P Group that is distinct from the address used for
9 the concurrent WLAN connection.

10 As discussed in §2.3 a P2P Device may support more than one interface for the
11 purpose of membership of multiple P2P Groups. A P2P Device shall assign a
12 different P2P Interface Address for each P2P Group for which it is concurrently
13 a member.

14 The BSSID (Address 3 field value) to be used in frames sent by a P2P Device
15 during the Find Phase and during Group Operation is specified in §3.1.2.1.3
16 and §3.2.2. When communication is not within a P2P Group, e.g. during Service
17 Discovery, P2P Invitation, GO Negotiation and Device Discoverability, a P2P
18 Device shall use the P2P Device Address of the intended destination as the
19 BSSID in Request, or Confirmation frames and its own P2P Device Address as
20 the BSSID in Response frames.

# 3 Functional description and procedures

## 3.1 P2P discovery

### 3.1.1 Introduction

P2P Discovery enables P2P Devices to quickly find each other and form a connection.

P2P Discovery consists of the following major components:

— **Device Discovery** facilitates two P2P Devices arriving on a common channel and exchanging device information (e.g. device name and device type).
— **Service Discovery** is an optional feature that allows a P2P Device to discover available higher-layer services prior to forming a connection.
— **Group Formation** is used to determine which device will be the P2P Group Owner and form a new P2P Group.
— **P2P Invitation** is used to invoke a Persistent P2P Group or invite a P2P Device to join an existing P2P Group.

### 3.1.2 Device Discovery procedures

#### 3.1.2.1 Basic mechanisms of Device Discovery

The objective of P2P Device Discovery is to find P2P Devices and quickly determine the P2P Device to which a connection will be attempted. P2P Device Discovery consists of two major phases: Scan and Find, which are described in detail in the following sections.

Device Discovery uses Probe Request and Probe Response frames to exchange device information. The P2P Devices in a P2P Group are discovered via a Probe Response frame from the P2P Group Owner.

A P2P Device shall not respond to Probe Request frames unless it is:

— a P2P Group Owner or
— in the Listen State, or
— a P2P Device associated with an infrastructure AP on the channel on which the Probe Request was sent — in which case the P2P Device may respond provided it is not already a member of a P2P Group.

A P2P Device shall not transmit Beacon frames unless it is a P2P Group Owner.

Note — §2.4.1 contains additional rules that apply to frames sent during Device Discovery.

### 3.1.2.1.1 Listen State

A P2P Device that is not in a P2P Group may use the Listen State to become discoverable. In the Listen State a P2P Device dwells on a given channel, termed the Listen Channel. This is a channel chosen from the list of Social Channels. Channels 1, 6, and 11 in the 2.4 GHz band shall be used as the Social Channels. The Listen Channel shall be chosen at the beginning of the Device Discovery and shall remain the same until P2P Discovery completes.

A P2P Device in the Listen State shall only reply to Probe Request frames that contain the P2P IE, the P2P Wildcard SSID element, a Wildcard BSSID, and a Destination Address that is either the broadcast address or its P2P Device Address. If one or more Requested Device Type attributes are present in the WSC IE in the Probe Request frame, the P2P Device in the Listen State shall only respond with a Probe Response frame if it has a Primary Device Type or Secondary Device Type value identical to any of the Requested Device Type values. If a Device ID attribute is present in the P2P IE in the Probe Request frame, the P2P Device in the Listen State shall only respond with a Probe Response frame if its Device Address matches that in the Device Address field in the Device ID attribute.

One or more P2P IEs and the WSC IE shall be inserted after other information elements in the Probe Response frames transmitted by a P2P Device. The inclusion of the WSC IE in the Probe Response frame sent by a P2P Device allows it to advertise human-readable device-specific information. The WSC IE shall contain the required attributes for an AP/Registrar as described in §7.2.5 of [6]. Device Password ID shall be a required attribute if Credentials are available and ready for immediate use.

Note — Examples of Credentials being 'available and ready for immediate use' include active PBC mode (PBC method), PIN being displayed (Display method) and PIN entered (Keypad method).

A P2P Device in the Listen State shall set the Source Address (SA) and BSSID to its P2P Device Address, and shall set the SSID to the P2P Wildcard SSID in all Probe Response frames that it sends. The P2P Device shall set the ESS bit of the Capabilities field in the Probe Response frame to 0 and IBSS bit to 0.

The Find Phase, as described in §3.1.2.2 makes use of the Listen State. The P2P Device in the Find Phase shall stay in the Listen State for the time periods defined in the Find Phase and shall be constantly available within those time periods.

When not in Find Phase a P2P Device may stay in the Listen State for an extended period of time. Any interruption in availability, for example to scan or use power save mechanisms as defined in IEEE Std 802.11-2007 [1], may result in lengthened or unreliable discovery. A P2P Device should be available in the Listen State for at least a contiguous period of 500ms every 5s in order to enable other P2P Devices to discover it. A P2P Device may support reconnection of a Persistent P2P Group in which case it may need to modify this timing, as described in §3.2.5.

**3.1.2.1.2 Scan Phase**

The Scan Phase uses the scanning process defined in IEEE Std 802.11-2007
[1]. It may be used by a P2P Device to find P2P Devices or P2P Groups and to
locate the best potential Operating Channel to establish a P2P Group. In the
Scan Phase, devices collect information about surrounding devices or networks
by scanning all supported channels.

The P2P Device in the Scan Phase shall not reply to Probe Request frames.

A P2P Device may simultaneously scan for P2P Groups and legacy networks
(i.e. 802.11 infrastructure networks). The WSC IE shall be included in all Probe
Request frames, with Device Name, Primary Device Type and Device
Password ID as required attributes. A P2P Device that uses PushButton
configuration method shall indicate when it is in active PBC mode (i.e. during
the 120 second walk time after the user has pressed the push button) by setting
the Device Password ID value to PushButton. Secondary Device Type List shall
be an optional attribute. A P2P Device may send a Probe Request frame
containing the P2P IE and the Wildcard SSID to elicit Probe Response frames
from both legacy networks and P2P Group Owners. Inclusion of the P2P IE in
the Probe Request frame is required to enable the P2P Group Owner to include
the P2P Group Info attribute in the Probe Response frame. P2P Clients shall
not reply to Probe Request frames so they can only be discovered by the Probe
Response frame from the P2P Group Owner containing the P2P Group Info
attribute, as described in §3.2.4.

A P2P Device may limit its Scan to P2P Devices and Groups. A Probe Request
frame intended only for P2P Devices shall include the P2P IE and shall have
the SSID element set to the P2P Wildcard SSID.

Note — There is a very low probability of a legacy network that has the P2P Wildcard
SSID as its SSID; such a Probe Response frame may be identified by the lack of the
P2P IE.

A P2P Device may narrow its scan to either:

— a specific device type, or device types by including the WSC IE with one or
more Requested Device Type attribute in the Probe Request frame. The
Requested Device Type attribute has the same format as the Primary
Device Type attribute in the WSC specification [6].
— a specific P2P Device by including the P2P Device ID attribute in the P2P
IE in the Probe Request frame. This provides a mechanism to scan for a
specific P2P Device.

**3.1.2.1.3 Find Phase**

The Find Phase is used to ensure that two simultaneously searching P2P
Devices arrive on a common channel to enable communication. This is
achieved by cycling between states where the P2P Device waits on a fixed
channel for Probe Request frames (the Listen State) or sends Probe Request
frames on a fixed list of channels (the Search State). Convergence of two
devices on the same channel is assisted by randomizing the time spent in each

cycle of the Listen State. Time to converge is minimized by limiting the list of channels to a small set known as the Social Channels (Channels 1, 6, and 11 in the 2.4 GHz band). In the Find Phase, a P2P Device shall alternate between the Listen and Search states as specified below.

The duration of each Listen State within the Find Phase shall be a random integer of 100 TU Intervals. This random number shall be no greater than the maxDiscoverableInterval value and no less than the minDiscoverableInterval. Default values for maxDiscoverableInterval and minDiscoverableInterval values are 3 and 1 respectively. The randomness in the time spent in the Listen state is to avoid a case where two P2P Devices in the Find Phase are in lock-step and thus will never find each other. While in the Listen State within the Find Phase a P2P Device shall be constantly available on the Listen Channel.

P2P Devices in the Search State shall transmit one or more Probe Request frames on each of the Social Channels. All Probe Request frames transmitted by P2P Devices in the Search State shall:

- – Include the P2P IE.
- – Include the WSC IE, with Device Name, Primary Device Type, and Device Password ID as required attributes. Secondary Device Type List shall be an optional attribute.  A P2P Device that uses PushButton configuration method shall indicate when it is in active PBC mode (i.e. during the 120 second walk time after the user has pressed the push button) by setting the Device Password ID value to PushButton.
- – Have the SSID field set to the P2P Wildcard SSID.
- – Have the BSSID field set to the Wildcard BSSID.

Probe Request frames sent by P2P devices in the Search State may include either one of the following:

- – Requested Device Type attribute in the WSC IE. This attribute has the same format as the Primary Device Type attribute in the WSC specification.
- – P2P Device ID attribute in the P2P IE.

A P2P Device in the Search State shall not reply to Probe Request frames.

Device Discovery procedures of a P2P Device are illustrated in Figure 4.
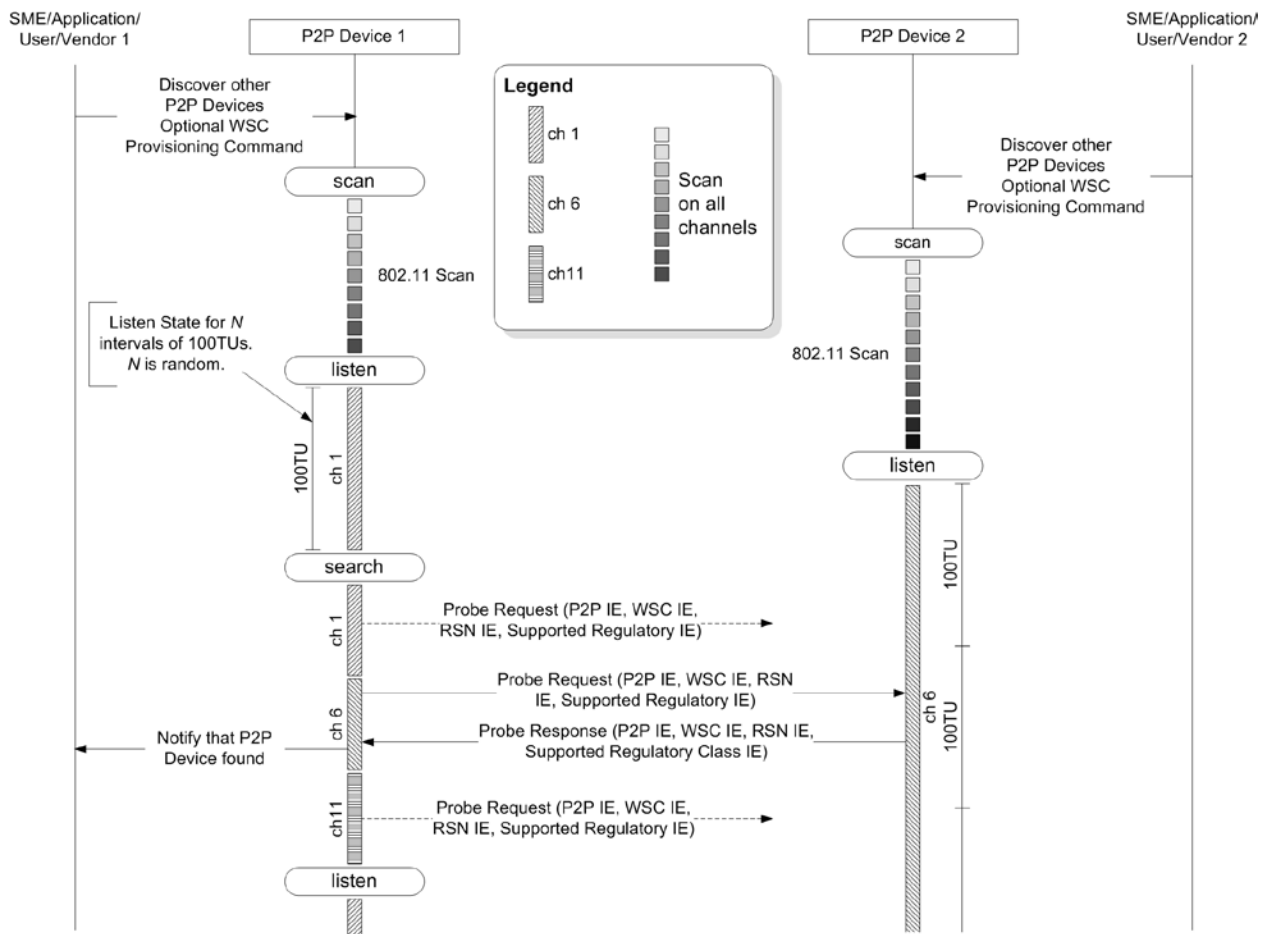
1
2
**Figure 4—Example Device Discovery procedures for a P2P Device**

3  **3.1.2.2  P2P Device discovering a P2P Device that is in a P2P Group**

4   A searching P2P Device discovers a P2P Group Owner in the Scan Phase
5   through received Beacon frames, or Probe Response frames. The searching
6   P2P Device will also discover other P2P Devices that are associated to that
7   P2P Group Owner from Group Information Advertisement (see §3.2.4).

8   A searching P2P Device should be aware that the P2P Group Owner may use
9   P2P power saving and this may impact discoverability of the P2P Group (see
10   §3.3.2).

11   A searching P2P Device should be aware that the target P2P Device may use
12   P2P power saving and this may impact communication with the P2P Device. If
13   the target P2P Device is a P2P Client in a P2P Group, a searching P2P Device
14   may send a Device Discoverability Request frame to the P2P Group Owner with
15   the P2P Device ID of the target P2P Device. The P2P Group Owner indicates to
16   the target P2P Device the request to be available for discovery and sends a
17   Device Discoverability Response, as described in §3.2.4. If the target P2P

Device is making use of power save mechanisms this response may take multiple beacon periods. On reception of a Device Discoverability Response frame that indicates success in the status code the searching P2P Device may attempt to perform Service Discovery or establish a P2P Group with the target P2P Device.

A P2P Client may indicate to the P2P Group Owner that it does not currently support P2P Discovery as described in §3.2.4.

Information in the P2P Capability attribute may be used to decide whether to attempt to join a P2P Group. If the P2P Group Limit field indicates that more connections are supported then the P2P Device may attempt to join the P2P Group to connect to the P2P Group Owner. If the Intra-BSS Distribution field indicates that communication between P2P Clients is supported then the searching P2P Device may join the P2P Group to communicate with any of the P2P Devices in the P2P Group.

If a P2P Device desires to join a P2P Group it may do one of the following:

— Use Wi-Fi Simple Configuration [6] to obtain Credentials. Wi-Fi Simple Configuration will take place on the Operating Channel of the P2P Group Owner.
— If the P2P Device is provisioned, connect to the P2P Group as described in §3.2.3.

If a searching P2P Device does not want to join the P2P Group that the discovered P2P Device is a member of, the searching P2P Device may do one of the following:

— Send a P2P Invitation Request frame to request that the target P2P Device joins a P2P Group of which the searching P2P Device is the P2P Group Owner or a P2P Client.
— Send a P2P Invitation Request frame to request that a previously established Persistent P2P Group, of which one of the P2P Devices is the P2P Group Owner, be invoked (see §3.1.5).
— Initiate Group Owner Negotiation to attempt to form a new P2P Group. The P2P Device Limit field bit in the Device Capability Bitmap field of the P2P Capability attribute indicates if the target P2P Device is able to establish an additional P2P connection.

### 3.1.2.3  Two P2P Devices in discovery

A P2P Device in the Scan Phase may discover a P2P Device in the Listen State. The Find Phase is used to ensure that two P2P Devices that are both in Device Discovery arrive on a common channel to exchange device information. If a P2P Device wishes to connect it may do one of the following:

— Initiate Group Owner Negotiation to attempt to form a new P2P Group.
— Send a P2P Invitation Request frame to request that a previously established Persistent P2P Group, of which one of the P2P Devices is the P2P Group Owner, be invoked (see §3.1.5).

1 — Send a P2P Invitation Request frame to request that the target P2P
2 Device joins a P2P Group of which the searching P2P Device is the P2P
3 Group Owner or a P2P Client.

#### 3.1.2.4  Device Discovery procedures for a P2P Group Owner

5 A P2P Device that is already operating as a P2P Group Owner stays on the
6 Operating Channel and waits for other devices to discover it. A P2P Group
7 Owner may search on other channels to find desired devices or services. If the
8 P2P Group Owner is unavailable on the Operating Channel it shall indicate this
9 using the Notice of Absence mechanism as defined in §3.3.3.2.

#### 3.1.2.5  P2P Group Owner enabling discovery for a Legacy Client

11 A Legacy Client uses the 802.11 scan process as defined in IEEE Std
12 802.11-2007 [1] to collect information about surrounding devices or networks. A
13 Legacy Client can only discover a P2P Group Owner. When a P2P Group
14 Owner receives a Probe Request frame from a Legacy Client in its Operating
15 Channel, the P2P Device shall transmit a Probe Response frame as defined in
16 IEEE Std 802.11-2007 [1] except as noted in §2.4.1. The Legacy Client may
17 use the collected information to initiate Wi-Fi Simple Configuration [6] in order to
18 connect to the P2P Device.

19 A Legacy Client that does not support Wi-Fi Simple Configuration [6] has to be
20 provisioned using methods outside the scope of this specification. The P2P
21 Group Owner shall generate the Credentials used for provisioning.

#### 3.1.2.6  P2P Device discovering a P2P Device associated with an infrastructure AP

23 A searching P2P Device may discover a P2P Device associated with an
24 infrastructure AP in the Scan Phase through Probe Response frames. A P2P
25 Device associated with an infrastructure AP receiving a Probe Request frame
26 with a P2P IE and either a wildcard SSID or a P2P wildcard SSID may respond
27 with a Probe Response frame with a P2P IE. A searching P2P Device should be
28 aware that the P2P Device may use power saving and this may impact its
29 discoverability. A P2P Device that is associated with an infrastructure AP shall
30 still need to be in the Listen State for Device Discovery as described in
31 §3.1.2.1.1 and §3.1.2.1.3.

32 Information in the P2P Capability attribute, or a Service Discovery exchange
33 may be used to decide whether to attempt to establish a P2P Group.

34 If a P2P Device desires to communicate with the discovered device it may do
35 one of the following on the channel of the discovered P2P Device:

36 — Send a P2P Invitation Request frame to request that the target P2P
37 Device joins a P2P Group of which the searching P2P Device is the P2P
38 Group Owner or a P2P Client.

39 — Send a P2P Invitation Request frame to request that a previously
40 established Persistent P2P Group, of which one of the P2P Devices is the
41 P2P Group Owner, be invoked (see §3.1.5).

1       — Initiate Group Owner Negotiation to attempt to form a new P2P Group.
2            The P2P Device Limit field bit in the Device Capability Bitmap field of the
3            P2P Capability attribute indicates if the target P2P Device is able to
4            establish an additional P2P connection.

### 3.1.3    Service Discovery procedures

6   The Service Discovery procedure is an optional frame exchange that may be
7   performed at any time to any discovered P2P Device, for example following a
8   successful Device Discovery procedure prior to group formation. This procedure
9   can be used to determine compatibility information on the services offered by a
10   P2P Device. This protocol is extensible and flexible so that it enables different
11   higher layer service advertisement protocol types such as Bonjour [9] and UPnP
12   [10].

13   The Service Discovery procedure leverages the Generic Advertisement Service
14   (GAS) protocol/frame exchange as defined in IEEE P802.11u [4]. The Service
15   Discovery procedure uses GAS with unicast standard public action frames with
16   a vendor specific body. It may be a single or multiple GAS Initial Request and
17   Response action frame exchange. The requesting P2P Device transmits one or
18   more GAS Initial Request frames. A target P2P Device that supports Service
19   Discovery responds with one or more GAS Initial Response frames. It is
20   assumed that service information is readily available within a P2P Device
21   supporting Service Discovery and the GAS Initial Response frame shall be
22   returned without delay after receiving a GAS Initial Request.

23   The Service Discovery procedure can be used to find:

24      — A list of all services offered by a P2P Device
25      — Information about a single service offered by a P2P Device
26      — Information about multiple services offered by a P2P Device
27      — If there has been a change in the services offered by a P2P Device

28   The requested information can be for a single service protocol type, for multiple
29   service protocol types, or for all service protocol types supported by a P2P
30   Device.

31   The decision to perform Service Discovery is implementation specific and
32   beyond the scope of this specification.

#### 3.1.3.1   Service Discovery Query

34   The Service Discovery Query frame uses the GAS Initial Request frame as
35   defined in IEEE P802.11u [4].

36   The Service Discovery Query frame shall support different query types, which
37   changes the content of the fields in the Vendor-Specific content field.

38   To request a list of all services of all higher layer (above Layer 2) service
39   protocol types, the Service Discovery Query frame shall include a single Service
40   Request TLV with the Service Protocol Type field equal to 0 and a Query Data

1  length of 0. A Service Transaction ID is included in all Service Request and
2  Response TLVs and is used to match the response to the query.

3  To request a list of all services of a specific higher layer service protocol type,
4  the Service Discovery Query frame shall include a single Service Request TLV
5  with the Service Protocol Type field set to one of the non-zero values defined in
6  Table 63 and a Query Data length of 0.

7  To request information about a specific service of a specific higher layer service
8  protocol type, the Service Discovery Query frame shall include a single Service
9  Request TLV with the Service Protocol Type field set to one of the non-zero
10  values defined in Table 63 and the Query Data. The Query Data field shall
11  include the service information type pertaining to the requested Service Protocol
12  Type. The service information type is out of scope of this specification since it is
13  defined by the service protocol being used.

14  To request information about multiple services of a single or multiple higher
15  layer service protocol types, the Service Discovery Query frame shall include
16  multiple Service Request TLVs. Each Service Request TLV shall contain the
17  Service Protocol Type field set to one of the non-zero values defined in Table
18  63 and the Query Data. The Query Data field shall include the service
19  information type pertaining to the requested Service Protocol Type.

20  The Service Update Indicator shall be included in all Service Discovery Query
21  frames. It shall be incremented every time a change occurs in the service
22  information of the P2P Device sending this Service Discovery Query. This
23  allows for a P2P Device to cache service information retrieved from another
24  P2P Device, together with the Service Update Indicator. Whenever a P2P
25  Device notices that the Service Update Indicator for another P2P Device has
26  incremented, it shall know to flush the cached service information for that P2P
27  Device.

28  ### 3.1.3.2  Service Discovery Response

29  The Service Discovery Response frame uses the GAS Initial Response frame
30  as defined in IEEE P802.11u [4].

31  Since the Service Discovery Response frame supports different query types,
32  the Vendor-specific content may contain different fields. A Service Transaction
33  ID is included in all Service Request and Response TLVs and is used to match
34  the response to the query.

35  If the Service Discovery Query frame is for all services and all higher layer
36  service protocol types, the Service Discovery Response frame may contain
37  multiple Service Response TLVs. Each Service Response TLV shall contain the
38  Service Protocol Type (for example, Bonjour, UPnP, etc.) field set to one of the
39  non-zero values defined in Table 63. The Service Transaction ID is set to the
40  value corresponding to the Service Transaction ID in the Service Request TLV.
41  The Status Code field of each returned Service TLV is set to Service available
42  (value 0 in Table 65). The available service information is contained in the
43  Response Data field. The Response Data field shall contain the service

information type and service data pertaining to the Service Protocol Type. If no services are available, a single Service Response TLV is returned with the Service Protocol Type field equal to 0, the Status Code field set to an appropriate error code, and a null value (zero length string) in the Response Data field.

If the Service Discovery Query frame is for all services of a specific higher layer service protocol type, the Service Discovery Response frame may contain multiple Service Response TLVs. Each Service Response TLV shall contain the Service Protocol Type field set to the requested service protocol type. The Service Transaction ID is set to the value corresponding to the Service Transaction ID in the Service Request TLV. The Status Code field of each returned Service TLV is set to Service available (value 0 in Table 65). The Response Data field shall contain the service information type and service data of the available service. If no services are available, a single Service Response TLV is returned with the Service Protocol Type field equal to the requested protocol, the Status Code field set to an appropriate error code, and a null value (zero length string) in the Response Data field.

If the Service Discovery Query frame is for a single service of a specific higher layer protocol type, the Service Discovery Response frame shall contain a single Service Response TLV. The Service Response TLV shall contain the Service Protocol Type field set to the requested service protocol type. The Service Transaction ID is set to the value corresponding to the Service Transaction ID in the Service Request TLV. If the service is available the Status Code field is set to Service available (value 0 in Table 65) and the Response Data field contains the corresponding service information type and service data. If the service is not available the Status Code field is set to the appropriate error status value in Table 65 and the Response Data field is a null value (zero length string)..

If the Service Discovery Query frame contains multiple Service Request TLVs for multiple higher layer services and for one or more service protocol types, the Service Discovery Response frame shall contain multiple Service Response TLVs. At least one Service Response TLV will be returned for each corresponding Service Request TLV identified by the Service Transaction ID. Each Service Response TLV shall contain the Service Protocol Type field set to one of the non-zero values defined in Table 63 corresponding to the requested Service Protocol Type. The Service Transaction ID is set to the value corresponding to the Service Transaction ID in the Service Request TLV. If the service is available the Status Code field is set to Service Available (value 0 in Table 65) and the Response Data field contains the corresponding requested service information type and service data. If the service is not available the Status Code field is set to the appropriate error status value in Table 65 and the Response Data field is a null value (zero length string).

The Service Update Indicator shall be included in all Service Discovery Response frames. It shall be incremented every time a change occurs in the Service Information of the P2P Device sending this Service Discovery

1　　Response. This allows for a P2P Device to cache service information retrieved
2　　from another P2P Device, together with the Service Update Indicator.
3　　Whenever a P2P Device notices that the Service Update Indicator for another
4　　P2P Device has incremented, it shall know to flush the cached service
5　　information for that P2P Device.

6　　If the Service Discovery Response frame, with multiple Service Response TLVs,
7　　exceeds the GAS Initial Response packet size, then the rules for GAS
8　　Fragmentation using GAS Comeback Request and Response shall be used as
9　　defined in IEEE P802.11u [4]. Annex C.3 provides information on the GAS
10　Fragmentation frames and procedure.

11　Figure 5 illustrates an example of the exchange of Service Discovery Query and
12　Response frames for Service Discovery.

**Figure 5—Example of Service Discovery procedure**
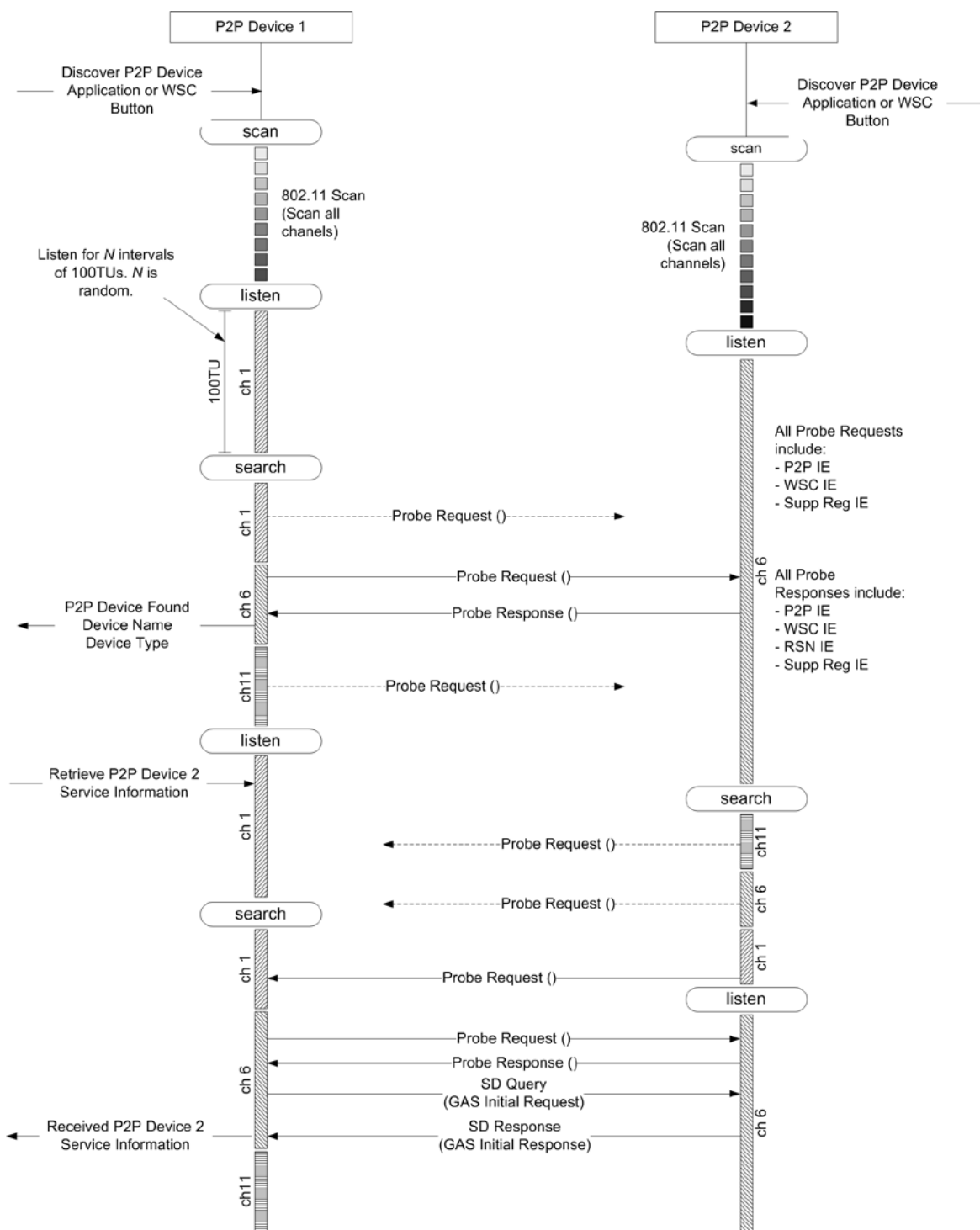
## 1  3.1.4  Group Formation procedure

### 2  3.1.4.1  General procedures

3  A P2P Device may autonomously start a P2P Group by becoming a P2P Group
4  Owner as described in §3.2.2. A P2P Device may use the Group Formation
5  Procedure to form a new P2P Group. Group Formation is used to determine
6  which device shall be the P2P Group Owner, exchange Credentials for the P2P
7  Group and determine its characteristics e.g. whether it shall be a Persistent P2P
8  Group or a Temporary P2P Group. Group Formation Procedure consists of
9  Group Owner Negotiation and Provisioning, as described in the following
10  sections.

11  Device Discovery (and optional Service Discovery) is intended to determine
12  which P2P Devices may attempt to connect. Device selection may be based on
13  non-unique information, e.g. Device Name, which potentially introduces
14  ambiguity in this process. P2P Device manufacturers should attempt to create
15  unique Device Names and user interfaces that maximize the probability of
16  selecting the correct device, but there will be cases where device selection is
17  non-deterministic. Group Formation uses the authentication provided by Wi-Fi
18  Simple Configuration [6] to determine that the correct devices are connected.
19  Group Formation may need to be executed more than once with different P2P
20  devices to resolve the case of multiple devices with the same Device Name.

21  Group Formation has a phase called Provisioning that uses Wi-Fi Simple
22  Configuration [6] with constraints as described in §3.1.4.3. Wi-Fi Simple
23  Configuration may take up to two minutes to complete, due to waiting for user
24  input. Since Group Formation may need to execute multiple times, such a delay
25  is unacceptable. A P2P Device shall obtain any information required to execute
26  Provisioning in advance of Group Formation, which includes information such
27  as a PIN that is obtained from a user. A P2P Device shall take no more than
28  fifteen seconds to complete Group Formation.

29  The P2P Device may use the information supplied in the WSC Config Methods
30  attribute, received in a Probe Response, to determine the appropriate
31  information to retrieve from the user e.g. PIN from a display, etc. A P2P Device
32  may send a Provision Discovery Request with a single method set in the Config
33  Methods attribute with the purpose of triggering some required action at the
34  receiving P2P Device e.g. on reception of this frame a display device may
35  display the required PIN. The Provision Discovery Request frame shall have a
36  single method set in the Config Methods attribute to indicate which of the
37  receiving P2P Device's methods the sending P2P Device intends to use. For
38  example, it shall set the 'Display' method if it intends to use a PIN the receiver
39  shall display. A P2P Device shall respond to a received Provision Discovery
40  Request frame with a Provision Discovery Response frame. The Config
41  Methods attribute in the Provision Discovery Response frame may have the
42  same single method set as in the received Provision Discovery Request frame
43  to indicate success or shall be null to indicate failure.

1    Table 1 summarizes the valid WSC Config Methods attribute settings in the
2    Provision Discovery exchange and the 'matching' WSC Device Password ID
3    attribute values to be used in Provisioning.

4    The P2P Group Owner is always the WSC Registrar and the selected PIN (from
5    the display of either the P2P Client or P2P Group Owner) is indicated using
6    Device Password ID attribute in the WSC M1/M2 messages as shown in Table
7    1.

8    Note —In contrast, it is common in non-P2P WSC use that the AP PIN is used with
9    reversed Registrar/Enrollee roles, i.e., a STA connecting to the AP acts as a Registrar
10   and uses the AP PIN (which is the Enrollee Device Password in this reversed-role
11   case).

12   **Table 1—Summary of WSC Config Methods and Device Password ID usage**

| Requestor | Provision Discovery Request | Provision Discovery Response | GO Negotiation Request | GO Negotiation Response | Requestor becomes Client (Enrollee) | Requestor becomes GO (Registrar) |
|---|---|---|---|---|---|---|
| | Config Methods | | Device Password ID | | Device Password ID in M1/M2 | Device Password ID in M1/M2 |
| Displays PIN | Keypad | Keypad | Registrar-specified | User-specified | Default (PIN) | Registrar Specified |
| Enters PIN | Display | Display | User-specified | Registrar-specified | Registrar Specified | Default (PIN) |
| Uses PBC | PushButton | PushButton | PushButton | PushButton | PushButton | PushButton |

13   When a P2P Device discovers another P2P Device with which it intends to
14   connect, it may start the Group Formation Procedure. A P2P Device shall
15   conduct the Group Formation Procedure with one other P2P Device. The Group
16   Formation Procedure shall complete prior to entering the Group Formation
17   Procedure with any other P2P Device. A P2P Device that is already in Group
18   Formation, and receives a GO Negotiation Request frame from a device with
19   which it is not in Group Formation, shall respond with a GO Negotiation
20   Response frame indicating failure (see §3.1.4.2.2).

21   Prior to beginning the Group Formation Procedure the P2P Device shall arrive
22   on a common channel with the target P2P Device. The Find Phase may be
23   used for this purpose. In this case, the P2P Device only needs to scan the
24   Listen Channel of the target P2P Device, as opposed to all of the Social
25   Channels. This use of the Find Phase is to recover from the case where the two
26   P2P Devices may simultaneously move to the Listen Channel of the other
27   device and thus miss each others Probe Requests. A P2P Device may start
28   Group Owner Negotiation by sending a GO Negotiation Request frame when
29   receiving a Probe Request frame from the target P2P Device.

1　　　　When the P2P Devices arrive on a common channel and begin Group Owner
2　　　　Negotiation, they shall stay on that channel until Group Owner Negotiation
3　　　　completes. Group Formation begins with the Group Owner Negotiation and
4　　　　completes with Provisioning as described in §3.1.4.3.

5　**3.1.4.2　Group Owner Negotiation**

6　　　　Group Owner Negotiation is a three way frame exchange used to agree which
7　　　　P2P Device shall become P2P Group Owner and to agree on characteristics of
8　　　　the P2P Group, as illustrated in Figure 6. The details of those three frames are
9　　　　described in the following sections.
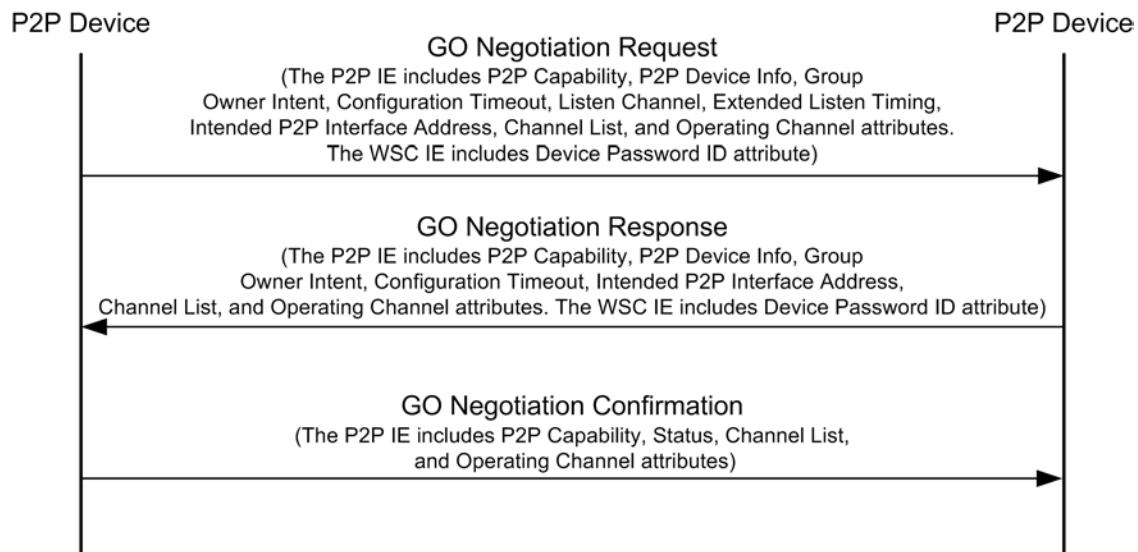


10
11　　　　　　　　　**Figure 6—Group Owner Negotiation message exchange**

12　　　　A P2P Device may choose not to respond to a Group Owner Negotiation frame
13　　　　due to reasons beyond the scope of this specification. The P2P Device that sent
14　　　　the Group Owner Negotiation frame shall assume that Group Owner
15　　　　Negotiation failed and is complete if it does not receive the next frame in the
16　　　　exchange within 100 milliseconds of receiving an acknowledgment frame. Either
17　　　　P2P Device may initiate Group Formation between these same P2P Devices
18　　　　again at a later time.

19　　　　A primary purpose of Group Owner Negotiation is to exchange the Group
20　　　　Owner Intent attribute to communicate a measure of desire to be P2P Group
21　　　　Owner. If the P2P Device must be the P2P Group Owner, the Intent field in the
22　　　　Group Owner Intent attribute shall be set to 15. The Group Owner Intent
23　　　　attribute should only be set to 15 when a configuration or service will only
24　　　　operate correctly at a P2P Group Owner; for instance, a P2P Device that is
25　　　　offering cross connection shall set its Intent value to 15.

The Tie breaker bit in a first GO Negotiation Request frame (for instance after power up) shall be set to 0 or 1 randomly, such that both values occur equally on average. On subsequent GO Negotiation Request frames except retransmissions, the Tie breaker bit shall be toggled. The Tie breaker bit in a GO Negotiation Response frame shall be toggled from the corresponding GO Negotiation Request frame.

If the Intent values in the GO Negotiation Request and Response frames are equal and less than 15, then the device sending the Tie breaker bit equal to 1 becomes the GO.

Group Owner determination is depicted in Figure 7.

x1 = Group Owner Intent Value of P2P Device 1
x2 = Group Owner Intent Value of P2P Device 2
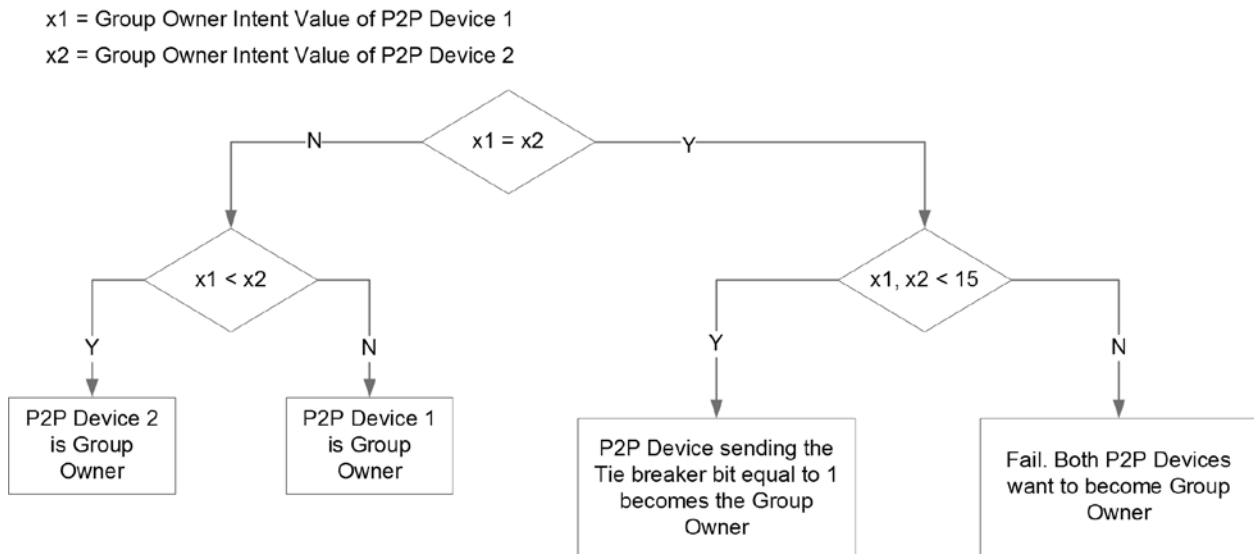


**Figure 7—Group Owner determination flowchart**

### 3.1.4.2.1 GO Negotiation Request

A P2P Device shall initiate Group Owner Negotiation by sending the GO Negotiation Request frame. The GO Negotiation Request frame shall include a P2P IE with the P2P Capability, P2P Device Info, Channel List, Listen Channel, Operating Channel, Group Owner Intent, Configuration Timeout and Intended P2P Interface Address attributes and a WSC IE with the Device Password ID attribute.

The Group Capability Bitmap field in the P2P Capability attribute indicates the characteristics of the P2P Group to be formed if the P2P Device sending the GO Negotiation request becomes Group Owner.

The Channel List attribute shall indicate the channels that the P2P Device can support as Operating Channel of the P2P Group if it becomes P2P Group Owner. The Operating Channel attribute includes a preferred Operating Channel. See §3.4.2 for additional rules on channel selection.

The Configuration Timeout attribute contains the maximum time that the P2P Device needs after completion of Group Owner Negotiation to be available to start Provisioning. The Intended P2P Interface Address attribute contains the P2P Interface Address that the P2P Device shall use during Provisioning if Group Owner Negotiation succeeds.

The Device Password ID attribute shall indicate the source of the Provisioning information that the P2P Device shall use in the WSC procedure. If the Provisioning information is a PIN from a display of the sending device the value shall be 'Registrar-specified'. If the Provisioning information is a PIN that was entered by a user of the sending device, the value shall be 'User-specified'. If the sending P2P Device is using the PBC method the value shall be 'PushButton'.

### 3.1.4.2.2 GO Negotiation Response

The P2P Device receiving a GO Negotiation Request frame shall examine the received information and respond with a GO Negotiation Response frame.

The P2P Device shall indicate its intent to enter Group Formation by sending a GO Negotiation Response frame that indicates a Status of Success. The GO Negotiation Response frame shall include a P2P IE with the P2P Capability, Status, P2P Device Info, Channel List, Operating Channel, Group Owner Intent, Configuration Timeout and Intended P2P Interface Address attributes and a WSC IE with the Device Password ID attribute.

A P2P Device may decline Group Owner Negotiation for any reason and shall send a GO Negotiation Response frame with the Status Code set to one of the "fail" codes in the Status attribute, as defined in Table 8.

A P2P Device that does not have the Provisioning information shall respond with a GO Negotiation Response frame that includes the Status attribute with the Status Code field set to "Fail; information is currently unavailable". If Provisioning information becomes available as a result of user input (Pushbutton, or Keypad Config Methods) within 120 seconds, the P2P Device shall restart Group Formation by sending a GO Negotiation Request frame to the requesting P2P Device. If the user input within this time window is to explicitly reject the Group Formation request, the P2P Device shall take no further action. A requesting P2P Device can assume that there will be no attempt to restart Group Formation if it does not receive a GO Negotiation Request frame within 120 seconds of receiving the GO Negotiation Response with Status Code "Fail: information is currently unavailable".

A P2P Device that is already in Group Formation that receives a GO Negotiation Request frame from a P2P Device with which it is not in Group Formation, shall respond with a GO Negotiation Response frame that includes the Status attribute with the Status Code field set to "Fail; unable to accommodate request".

If a P2P Device that must be P2P Group Owner (i.e. that P2P Device would indicate an Intent value of 15) receives GO Negotiation Request frame that also

1  contains an Intent value of 15, the P2P Device shall respond with a GO
2  Response frame containing a Status attribute with the Status Code field set to
3  "Fail: both P2P Devices indicated an Intent of 15 in Group Owner Negotiation".

4  Group Formation ends on transmission or reception of a GO Negotiation
5  Response frame with the Status Code set to a value other than Success. A P2P
6  Device may either subsequently enter, or continue Group Formation with other
7  P2P Devices. Either P2P Device may initiate Group Formation between these
8  same P2P Devices again at a later time.

9  Two P2P Devices that have discovered each other may send a GO Negotiation
10 Request frame to the other. In this case only the P2P Device with the highest
11 P2P Device Address shall send a GO Negotiation Response frame. If both P2P
12 Devices have indicated an Intent value of 15, the P2P Device with the highest
13 P2P Device Address shall send the GO Negotiation Response frame indicating
14 failure as above.

15 If the Status is Success the Group Owner Intent attribute included in the GO
16 Negotiation Response frame shall indicate its Intent value to be a Group Owner.
17 The interpretation of P2P IE fields in the GO Negotiation Response frame
18 depends on whether the P2P Device will become P2P Group Owner on
19 successful completion of Group Formation.

20 A P2P Device that will become the P2P Group Owner constructs the GO
21 Negotiation Response frame corresponding to the following rules. The Channel
22 List attribute shall indicate the channels that the P2P Device may use as
23 Operating Channel of the P2P Group. The channels indicated in the Channel
24 List shall only include channels from the Channel List attribute in the GO
25 Negotiation Request frame. The Operating Channel attribute shall indicate the
26 intended Operating Channel of the P2P Group. The channel indicated in the
27 Operating Channel attribute shall be one of the channels in the Channel List
28 attribute in the GO Negotiation Response frame. The P2P Group ID attribute
29 shall contain the intended SSID of the P2P Group. The Group Capability Bitmap
30 field in the P2P Capability attribute shall indicate the characteristics of the P2P
31 Group to be formed. The Persistent P2P Group, Intra-BSS Distribution, Cross
32 Connection and Persistent Reconnect bits in the Group Capability Bitmap field
33 in the P2P Capability attribute in Beacon and Probe Response frames
34 transmitted by the P2P Group Owner of the P2P Group formed, shall be the
35 same as within the Group Capability Bitmap field in the P2P Capability attribute
36 in the GO Negotiation Response frame.

37 A P2P Device that will become a P2P Client constructs the GO Negotiation
38 Response frame corresponding to the following rules. The Channel List attribute
39 shall indicate the channels that the P2P Device can support as Operating
40 Channel of the P2P Group. The channels indicated in the Channel List may be
41 determined independently from the channels in the Channel List attribute in the
42 GO Negotiation Request frame. The Operating Channel attribute may indicate a
43 preferred Operating Channel of the P2P Group, or may be omitted. Any channel
44 indicated in the Operating Channel attribute shall be one of the channels in the

Channel List attribute in the GO Negotiation Response frame. All bits in the Group Capability Bitmap field of the P2P Capability attribute shall be reserved. A P2P Device may decline Group Owner Negotiation if the characteristics of the P2P Group indicated in the Group Capability Bitmap field of the P2P Capability attribute in the GO Negotiation Request frame are not acceptable e.g. this will be a Persistent P2P Group and it cannot support a Persistent P2P Group, as defined in 3.2.5. In this case, the P2P Device shall send a GO Negotiation Response frame with the Status Code set to "Fail; incompatible parameters".

The Configuration Timeout attribute contains the maximum time that the P2P Device needs after completion of Group Owner Negotiation to be available to start Provisioning. The Intended P2P Interface Address attribute contains the P2P Interface Address that the P2P Device shall use during Provisioning if Group Owner Negotiation succeeds.

The Device Password ID attribute included in the WSC IE shall indicate the source of the Provisioning information that the P2P Device shall use. If the Provisioning information is a PIN from a display of the sending device the value shall be 'Registrar-specified'. If the Provisioning information is a PIN that was entered by a user of the sending device the value shall be 'User-specified'. If the sending P2P Device is using the PBC method the value shall be 'PushButton'.

A P2P Device may decline Group Owner Negotiation if the Device Password ID in the GO Negotiation Request is incompatible with the information it shall use to execute Provisioning. In this case, the P2P Device shall send a GO Negotiation Response frame with the Status Code set to "Fail; incompatible provisioning method".

### 3.1.4.2.3 GO Negotiation Confirmation

Upon receipt of the GO Negotiation Response frame with a Status Code indicating Success, the P2P Device shall examine the received information, and respond with a GO Negotiation Confirmation frame. The Status attribute included in the GO Negotiation Confirmation frame shall indicate whether the GO Negotiation succeeds or fails. It may fail for any reason; typical reasons may be lack of commonly available channel, incompatible parameters related to settings in the Group Capability Bitmap field of the P2P Capability attribute, etc.

If the Status is Success the interpretation of fields in the GO Negotiation Confirmation frame depends on whether the P2P Device that sent the frame will become P2P Group Owner on successful completion of Group Formation.

A P2P Device that will become the P2P Group Owner constructs the GO Negotiation Confirmation frame corresponding to the following rules. The Channel List attribute shall indicate the channels that the P2P Device may use as Operating Channel of the P2P Group. The channels indicated in the Channel List shall only include channels from the Channel List attribute in the GO Negotiation Response frame. The Operating Channel attribute shall indicate the intended Operating Channel of the P2P Group. The channel indicated in the

Operating Channel attribute shall be one of the channels in the Channel List attribute in the GO Negotiation Confirmation frame. The P2P Group ID attribute shall contain the intended SSID of the P2P Group. The Group Capability Bitmap field in the P2P Capability attribute shall be the same as in the GO Negotiation Request frame. The Persistent P2P Group, Intra-BSS Distribution, Cross Connection and Persistent Reconnect bits in the Group Capability Bitmap field in the P2P Capability attribute in the beacon of the group formed shall be the same as within the Group Capability Bitmap field in the P2P Capability attribute in the GO Negotiation Confirmation frame.

A P2P Device that will become a P2P Client constructs the GO Negotiation Confirmation frame corresponding to the following rules. The Channel List attribute shall indicate the channels that the P2P Device can support as Operating Channel of the P2P Group. The channels indicated in the Channel List shall only include channels from the Channel List attribute in the GO Negotiation Response frame and shall include the channel indicated in the Operating Channel attribute in the GO Negotiation Response frame. The Operating Channel attribute in the GO Negotiation Confirmation frame shall be the Operating Channel attribute from the GO Negotiation Response frame. All bits in the Group Capability Bitmap field of the P2P Capability attribute shall be reserved. A P2P Device may decline Group Owner Negotiation if the characteristics of the P2P Group indicated in the Group Capability Bitmap field of the P2P Capability attribute in the GO Negotiation Response frame are not acceptable e.g. this will be a Persistent P2P Group and it cannot support a Persistent P2P Group, as defined in 3.2.5. In this case, the P2P Device shall send a GO Negotiation Confirmation frame with the Status Code set to "Fail; incompatible parameters".

A P2P Device may decline Group Owner Negotiation if the Device Password ID in the GO Negotiation Response is incompatible with the Provisioning information it shall use to execute Provisioning. In this case, the P2P Device shall send a GO Negotiation Confirmation frame with the Status Code set to "Fail; incompatible provisioning method".

### 3.1.4.3  Provisioning

To allow for P2P Device configuration, P2P Devices may delay starting the Provisioning phase until the expiration of the maximum of the P2P Group Owners GO Configuration Time and the P2P Clients Client Configuration Time from the respective Configuration Timeout attributes exchanged during Group Owner Negotiation.

The P2P Device selected as P2P Group Owner during Group Owner Negotiation shall start a P2P Group session as described in §3.2.2 using the Credentials it intends to use for that group. The P2P Group Owner shall use the Operating Channel indicated during Group Owner Negotiation, if available. The P2P Client shall connect to the P2P Group Owner to obtain Credentials. If the Operating Channel is not available the P2P Group Owner shall use another channel from the Channel List attribute sent in the GO Negotiation Confirmation

frame. The P2P Client may have to scan to find the P2P Group Owner if the intended Operating Channel is not available. The Group Formation bit in the P2P Group Capability Bitmap of the P2P Capability attribute shall be set to 1 until Provisioning succeeds.

Provisioning shall be executed as described in Wi-Fi Simple Configuration [6] with the following modifications:

— The P2P Group Owner shall serve the role as the AP with Internal Registrar. It shall only allow association by the P2P Device that it is currently in Group Formation with. Since the user has entered the WSC PIN or triggered the WSC PushButton functionality on both devices, the Registrar shall send M2 in response to M1 and shall not send M2D.

— The P2P Client shall serve the role as the STA Enrollee. It shall associate to the P2P Device that it is currently in Group Formation with.

P2P Devices that have either a keypad or display shall support WSC PIN and PBC. P2P Devices that have neither keypad nor display shall support WSC PBC. P2P Devices shall not use WSC Label Configuration Method with other P2P Devices.

If Provisioning fails then Group Formation ends and the P2P Group Owner shall end the P2P Group session as described in §3.2.9. If Provisioning fails the P2P Device may retry Group Formation or return to Device Discovery.

On successful completion of Provisioning the P2P Group Owner shall set the Group Formation bit in the P2P Group Capability Bitmap of the P2P Capability attribute to 0. At this point the P2P Client may join the P2P Group using the Credentials supplied during Provisioning.

### 3.1.5  P2P Invitation procedure

The P2P Invitation Procedure is an optional procedure used for the following:

1. A P2P Group Owner inviting a P2P Device to become a P2P Client in its P2P Group.
2. A P2P Client inviting another P2P Device to join the P2P Group of which the P2P Client is a member because it wishes to use some service of the P2P Device.
3. Requesting to invoke a Persistent P2P Group for which both P2P Devices have previously been provisioned and one of the Devices is P2P Group Owner for the Persistent P2P Group.

A P2P Device that is invited to join an operational P2P Group through successful completion of the P2P Invitation Procedure, i.e. (1) or (2) above, may:

— Use Wi-Fi Simple Configuration [6] to obtain Credentials. Provision Discovery and Wi-Fi Simple Configuration will take place on the Operating Channel of the P2P Group Owner.

1 — If the P2P Device is provisioned, connect to the P2P Group as described
2      in §3.2.3.

### 3.1.5.1 P2P Invitation Request

4 A P2P Invitation Request frame may be transmitted by:

5 — A P2P Device that is a member of a P2P Group (i.e. P2P Group Owner or
6      P2P Client) to another P2P Device that supports P2P Invitation Procedure
7      signaling and is currently not a member of the P2P Group to invite that
8      P2P Device to join the P2P Group. When used for this purpose, the
9      Invitation Type in the Invitation Flags attribute included in the P2P
10      Invitation Request frame shall be set to 0.

11 — A P2P Device that is a member of a Persistent P2P Group to another
12      member of that P2P Group and one of the Devices is the P2P Group
13      Owner, to request that the P2P Group be invoked. When used for this
14      purpose, the Invitation Type in the Invitation Flags attribute included in the
15      P2P Invitation Request frame shall be set to 1.

16 The contents of the P2P Invitation Request frame depend on the role of the
17 sending device in the P2P Group (in the case of requesting to invoke a
18 Persistent P2P Group, the role of the device in that Persistent P2P Group).

19 A P2P Invitation Request frame transmitted by a P2P Group Owner shall
20 include the P2P Group ID, P2P Group BSSID, Channel List, Operating Channel,
21 and Configuration Timeout attributes in the P2P IE. The Channel List attribute
22 shall indicate the channels that the P2P Device can support as Operating
23 Channel of the P2P Group. The Operating Channel and Configuration Timeout
24 attributes shall be set as follows:

25 — If the P2P Invitation Request frame is transmitted by a P2P Group Owner
26      inviting a P2P Device to become a P2P Client in its P2P Group, the
27      Operating Channel attribute indicates the Operating Channel of the P2P
28      Group. The GO Configuration Timeout field in the Configuration Timeout
29      attribute shall be set to 0.

30 — If the P2P Invitation Request frame is transmitted by a P2P Device
31      requesting to invoke a Persistent P2P Group of which it is P2P Group
32      Owner, the Operating Channel attribute indicates the intended Operating
33      Channel of the P2P Group. The Configuration Timeout attribute shall
34      indicate the configuration time required for the P2P Group Owner to start
35      the P2P Group session after a P2P Invitation Response that indicates
36      success.

37 A P2P Invitation Request frame transmitted by a P2P Client shall include the
38 P2P Group ID, Channel List and Configuration Timeout attributes. The Channel
39 List attribute shall indicate the channels that the inviting P2P Device can
40 support as Operating Channel of the P2P Group. An Operating Channel
41 attribute may also be included: rules for inclusion of the Operating Channel
42 attribute and setting of the Configuration Timeout attribute are as follows:

— If the P2P Invitation Request frame is transmitted by a P2P Client inviting a P2P Device to join the P2P Group of which it is a member, P2P Group BSSID and Operating Channel attributes shall also be present, indicating the BSSID and Operating Channel of the P2P Group, respectively. The Client Configuration Timeout field in the Configuration Timeout attribute shall be set to 0.

— If the P2P Invitation Request frame is transmitted by a P2P Device requesting to invoke a Persistent P2P Group in which it is a P2P Client, an Operating Channel attribute may be present to indicate a preferred Operating Channel. The Configuration Timeout attribute shall indicate the configuration time required to the point that the P2P Client is ready to join the P2P Group after a P2P Invitation Response that indicates success. The P2P Device that sent the P2P Invitation Request frame shall assume that process failed if it does not receive a P2P Invitation Response frame within 100 milliseconds of issuing the P2P Invitation Request frame.

### 3.1.5.2 P2P Invitation Response

A P2P Device that receives a P2P Invitation Request frame and supports the P2P Invitation Procedure signaling shall return a P2P Invitation Response frame. If the P2P Device accepts the invitation it shall set the Status attribute in the response to success. If the P2P Device does not accept the invitation it shall set the Status attribute to the appropriate failure code. The decision to accept or deny the P2P Invitation Request frame is left to P2P Device's implementation policy.

A P2P Invitation Response frame (with the Status attribute set to Success) transmitted by the P2P Group Owner of a Persistent P2P Group in response to a request to invoke that P2P Group, shall include the P2P Group BSSID, Channel List, Operating Channel and Configuration Timeout attributes to indicate the Group BSSID, potential Operating Channels, intended Operating Channel and any GO Configuration Time. The channels in the Channel List shall only include channels from the Channel List attribute in the P2P Invitation Request frame. The channel indicated in the Operating Channel attribute shall be one of the channels in the Channel List attribute. In the case where there are no channels commonly supported by the P2P Devices the P2P Invitation Response frame shall include a Status attribute with the Status Code field set to "Fail; no common channels".

A P2P Invitation Response frame (with the Status attribute set to Success) transmitted by an invited P2P Client or the P2P Device that is a P2P Client in a Persistent P2P Group, shall include the Channel List and Configuration Timeout attributes. The Channel List indicates the Operating Channels the P2P Client can support. The channels in the Channel List shall only include channels from the Channel List attribute in the P2P Invitation Request frame. The Configuration Timeout attribute shall indicate the configuration time required to the point that the P2P Client is ready to join the P2P Group after a P2P Invitation Response that indicates success. In the case where there are no

channels commonly supported by the P2P Devices, or the current operating channel is not supported by the responding P2P Client, the P2P Invitation Response frame shall include a Status attribute with the Status Code field set to "Fail; no common channels".

The invited P2P Device may also pass the invitation request to a higher layer. In this case it shall respond with a P2P Invitation Response frame with a Status attribute with the Status Code field set to "Fail: information is currently unavailable". The invited P2P Device shall not wait for any action from a higher layer to send the P2P Invitation Response frame. The P2P attributes returned in the P2P Invitation Response frame shall be as previously described for 'Success', with the exception that inclusion of the Operating Channel attribute is optional when the P2P Invitation Response frame is sent by the P2P Group Owner of a Persistent P2P Group in response to a request to invoke that P2P Group. The Configuration Timeout attribute returned in the P2P Invitation Response frame shall be ignored by the inviting P2P Device.

A P2P Device that receives an Invitation Request frame with an Invitation Type in the Invitation Flags attribute set to 1, indicating a request to re-invoke a Persistent Group, and an unknown P2P Group ID, shall respond with an Invitation Response frame with a Status attribute with the Status Code field set to "Fail: unknown P2P Group".

### 3.1.5.3  Use of the Invitation Procedure to invoke a Persistent P2P Group.

A P2P Group Owner may invoke a Persistent P2P Group at any time by starting a P2P Group session as described in §3.2.2. Optionally, it may choose to only start the P2P Group session after a successful P2P Invitation Request and Response frames exchange with a member of that P2P Group. In such a case, the P2P Group can only be invoked by P2P Devices that support the P2P Invitation Procedure signaling. Thus all P2P Devices that are capable of supporting Persistent P2P Groups shall support the P2P Invitation Procedure signaling.

A P2P Client that desires to invoke a Persistent P2P Group shall first discover the P2P Device that is the P2P Group Owner for this Persistent P2P Group and then successfully complete a P2P Invitation exchange with that device. The Invitation Type in the Invitation Flags attribute included in the Invitation Request frame in this exchange shall be set to 1.

A P2P Device that receives an Invitation Request frame to re-invoke a Persistent Group shall ignore the Config Methods field in the P2P Device Info attribute.

A P2P Device that receives an Invitation Request frame to re-invoke a Persistent Group  and responds with a P2P Invitation Response frame with a Status attribute with the Status Code field set to "Fail: information is currently unavailable" shall behave as follows:

— If a response is received from higher layers within 120 seconds (e.g. as a result of user input) authorizing the request, the invited P2P Device shall

restart the Invitation procedure by sending an Invitation Request frame to the requesting P2P Device.

— If the higher-layer response within this time window is to explicitly reject the Group Formation request, the invited P2P Device shall take no further action.

The requesting P2P Device can assume that there will be no attempt to restart the Invitation Procedure if it does not receive an Invitation Request frame within 120 seconds of receiving the Invitation Response with Status Code "Fail: information is currently unavailable".

To allow for P2P Device configuration, P2P Devices that are reinvoking a P2P Group may delay starting the P2P Group session until the expiration of the maximum of the P2P Group Owners GO Configuration Time and the P2P Clients Client Configuration Time from the respective Configuration Timeout attributes exchanged during P2P Invitation.

If the P2P Client does not detect the presence of the P2P Group Owner on the intended Operating Channel it shall scan the channels in the Channel List in the P2P Invitation Response frame. The P2P Group Owner may be operating on a different channel, for example if the intended Operating Channel is not available when the P2P Group is invoked.

## 3.2    P2P Group operation

P2P Group operation closely resembles infrastructure BSS operation as defined in IEEE Std 802.11-2007 [1] with the P2P Group Owner assuming the role of the AP and the P2P Client assuming the role of the STA. The similarities and differences between infrastructure BSS and P2P Group operation are described in this section.

### 3.2.1    P2P Group ID

The P2P Group Owner shall assign a globally unique P2P Group ID for each P2P Group when the P2P Group is formed and this shall remain the same for the lifetime of that P2P Group. The format of the P2P Group ID attribute is defined in §4.1.17.

The P2P Group ID contains the globally unique P2P Device Address of the P2P Group Owner which assures that different P2P Devices create P2P Groups differentiated from each other. A P2P Group Owner shall determine the Credentials that are required to join a P2P Group. The Credentials shall be fresh for each P2P Group formed. The Credentials for a P2P Group issued to a P2P Device shall:

— Use WPA2-PSK as Authentication Type.

— Use AES as Encryption Type.

— Use a Network Key Type of 64 Hex characters.

⎯ Use a different SSID for each group to assure that all P2P Groups are unique.

A P2P Group Owner shall maintain a WPA2-PSK pass-phrase for delivery to Legacy Clients. This may be delivered using WSC, or in the case of a Legacy Client that does not support WSC, by means outside the scope of this specification. The PSK is derived from the pass-phrase and SSID. The WPA2-PSK pass-phrase shall contain at least eight ASCII characters randomly selected with a unified distribution from the following character set: upper case letters, lower case letters and numbers.

Each SSID shall begin with the ASCII characters "DIRECT-". This SSID requirement may enable users of Legacy Clients to differentiate between a P2P Group and an infrastructure network. Following "DIRECT-" the SSID shall contain two ASCII characters "xy", randomly selected with a unified distribution from the following character set: upper case letters, lower case letters and numbers. This SSID requirement makes the probability low that a Legacy Client encounters two P2P Groups with the same SSID and mistakenly attempt to roam between them. Any byte values allowed for an SSID according to IEEE802.11-2007 [1] may be included after the string "DIRECT-xy" (including none).

### 3.2.2  Starting and maintaining a P2P Group session

The P2P Group Owner may be determined through the Group Formation Procedure described in §3.1.4. The P2P Group Owner may be set by configuration, for example when connecting to a Legacy Client or when cross connection is provided etc. The P2P Group Owner shall assign a P2P Interface Address that it shall use as its MAC address and BSSID for the duration of the P2P Group session. The P2P Group Owner shall select an Operating Channel, following any procedures required for operation in a certain frequency band in a particular regulatory domain. On that Operating Channel, the P2P Group Owner shall transmit probe responses in response to probe requests, and shall transmit beacons advertising the TSF (for timing synchronization), required operational parameters, supported capabilities, membership, and services available within the P2P Group.

A P2P Group Owner shall respond to Probe Request frames following the rules in IEEE Std 802.11-2007 [1], with the following modifications:

⎯ The P2P Wildcard SSID shall be treated the same as the Wildcard SSID for the purposes of deciding to transmit a response (i.e. in IEEE Std 802.11-2007 [1], Clause §11.1.3.2.1, change "The SSID in the probe request is the wildcard SSID or the specific SSID of the STA" to "The SSID in the probe request is the wildcard SSID, the P2P wildcard SSID, or the specific SSID of the STA,")

⎯ When a P2P Group Owner responds to a Probe Request frame containing the P2P IE it shall include the P2P Group Info attribute in the P2P IE in the Probe Response frame. The P2P IE shall include the P2P Group Info

attribute unless there are zero connected P2P Clients. A P2P Group Owner shall not include a P2P IE in the Probe Response frame if the received Probe Request frame does not contain a P2P IE.

— If one or more Requested Device Type attributes are present in the Probe Request frame, a P2P Group Owner shall only respond with a Probe Response frame if it has one or more Primary or Secondary Device Type values identical to any of the Requested Device Type values, or if it has a connected P2P Client with one or more Primary or Secondary Device Type values identical to any of the Requested Device Type values. The P2P Group Owner may filter the P2P Group Information returned in the Probe Response frame to include only devices with matching Primary or Secondary Device Type values.

— If a Device ID attribute is present in the P2P IE in a Probe Request frame, a P2P Group Owner shall only respond with a Probe Response frame if its Device Address, or the Device Address of a connected P2P Client matches that in the Device Address field in the Device ID attribute.

In all Probe Responses that it sends, a P2P Group Owner shall set the SSID to the SSID of the group, and shall set the SA and BSSID to its P2P Interface Address.

A P2P Group Owner shall set the ESS subfield to 1 and the IBSS subfield to 0 in the Capability Information field of Beacon and Probe Response frames that it sends.

A P2P Device shall indicate that it is a P2P Group Owner by setting the Group Owner field of the P2P Capability attribute to 1 in transmitted Beacon and Probe Response frames. The P2P Group Limit field in the P2P Capability attribute shall be set to 0 to indicate that additional P2P connections are supported in this P2P Group, and set to 1 if no further P2P connections are supported. A P2P Group Owner shall be able to support a minimum of one Client.

A P2P Device shall include the WSC IE in all transmitted Beacon, Probe Request and Response frames. Both the Device Name and Primary Device Type are required attributes in the WSC IE. The Secondary Device Type List is an optional attribute in the WSC IE. The inclusion of the WSC IE in the Probe Response frame sent by a P2P Device allows it to advertise human-readable device-specific information. It should be noted that this information is openly advertised.

A Client acquires the Group Credentials through static configuration or through Wi-Fi Simple Configuration [6]. When using Wi-Fi Simple Configuration [6], the P2P Group Owner shall serve as the WSC Registrar and the Client shall serve as the WSC Enrollee.

A P2P Group Owner shall conform to the relevant sections of IEEE Std 802.11-2007 [1] when operating at 5GHz. A P2P Group Owner that desires to change the Operating Channel during a P2P Group session shall use the

1  Extended Channel Switch Announcement as defined in IEEE Std 802.11y [3] to
2  inform P2P Clients.

### 3.2.3 Connecting to a P2P Group

4  A P2P Device discovers a P2P Group or another P2P Device using the Device
5  Discovery procedure described in 3.1.2.

6  Prior to connecting to the P2P Group the P2P Device shall assign a P2P
7  Interface Address that it shall use as the MAC address of the P2P Client for the
8  duration of the P2P Group session. When a P2P Device joins an existing P2P
9  Group that it has not stored a credential for, it shall send a Provision Discovery
10 Request frame with a single method set in the Config Methods attribute to
11 indicate the desire to enroll in the network. The Provision Discovery Request
12 frame shall be sent to the P2P Device Address of the P2P Group Owner and on
13 the operating channel of the P2P Group. The P2P Group Owner may use this
14 frame as a trigger that a device wants to enroll (maybe an indication can be
15 shown to the user). A P2P Group Owner shall respond to a received Provision
16 Discovery Request frame with a Provision Discovery Response frame. The
17 Config Methods attribute in the Provision Discovery Response frame may have
18 the same method set as in the received Provision Discovery Request frame to
19 indicate success or shall be null to indicate failure. The P2P Client that sent the
20 Provision Discovery Request frame shall assume that process failed if it does
21 not receive a Provision Discovery Response frame within 100 milliseconds of
22 issuing the Provision Discovery Request frame. A P2P Client may proceed
23 regardless of the status of the Provision Discovery Response status.

24 The P2P Client acquires the Group Credentials through static configuration or
25 through Wi-Fi Simple Configuration [6]. When using Wi-Fi Simple Configuration
26 [6], the P2P Group Owner shall serve as the WSC Registrar and the P2P Client
27 shall serve as the WSC Enrollee. In order to connect to a P2P Group, the P2P
28 Client, using the Credentials, shall engage in the authentication procedure in
29 §11.3.1.1 of IEEE Std 802.11-2007 [1] and the association procedure in
30 §11.3.2.1 of IEEE Std 802.11-2007 [1] with the P2P Group Owner.

31 A P2P Client shall not attempt to connect to a P2P Group that has the Group
32 Formation bit in the P2P Group Capability Bitmap of the P2P Capability attribute
33 set to 1 unless it is in Group Formation with that P2P Device, as described in
34 3.1.4.

35 When a P2P Client associates with a P2P Group Owner, it provides its Device
36 Name, Primary Device Type, and optionally Secondary Device Type List
37 information to the P2P Group Owner by including the P2P Device Info attribute
38 (see §4.1.15) and the P2P Capability attribute (see §4.1.4) in the P2P IE in the
39 Association Request frame. This information shall be used by the P2P Group
40 Owner for Group Information Advertisement.

41 When using PIN based WSC, the selected PIN (from the display of either the
42 P2P Client or P2P Group Owner) is indicated using Device Password ID

1      attribute in the WSC M1/M2 messages as shown in Table 1 (when connecting
2      to a P2P Group, the requestor always becomes P2P Client).

### 3.2.4   P2P Group Owner services for P2P Client discovery

4      Group Information Advertisement provides a mechanism to discover a P2P
5      Device that is a P2P Client in an existing P2P Group. A P2P Group Owner shall
6      advertise the device information of the P2P Clients currently connected to the
7      P2P Group by including the P2P Group Info attribute in Probe Response frames
8      according to the rules above. The P2P Group Owner shall include a P2P Client
9      Info Descriptor in the P2P Group Info attribute for each P2P Client that is
10      connected to the P2P Group. Once the P2P Group Owner determines that a
11      P2P Client has left the P2P Group, the P2P Client Info Descriptor for that Client
12      shall be removed from the P2P Group Info attribute. The P2P Group Owner
13      shall not include a P2P Group Info attribute if it has zero connected P2P Clients.

14      A searching P2P Device may send a Device Discoverability Request frame to a
15      P2P Group Owner to request a P2P Client that supports P2P Client
16      Discoverability to become available for exchange of discovery information, or
17      initiation of Group Formation. On reception of a Device Discoverability Request
18      frame with a P2P Device ID attribute that contains the P2P Device Address of a
19      P2P Client in the P2P Group, a P2P Group Owner shall send a GO
20      Discoverability Request frame to the P2P Client. Delivery of the GO
21      Discoverability Request frame may be delayed due to the P2P Client using
22      Power save mechanisms. A P2P Client should stay constantly available for at
23      least a 100 TU after receiving a GO Discoverability Request frame or until
24      communication with the searching P2P Device completes. On successful
25      delivery of the GO Discoverability Request frame the P2P Group Owner shall
26      send the searching P2P Device a Device Discoverability Response frame
27      indicating success in the status code. If the P2P Group Owner cannot deliver a
28      GO Discoverability Request frame to the target P2P Device it shall send the
29      searching P2P Device a Device Discoverability Response frame with the Status
30      attribute indicating fail in the Status Code, as defined in Table 8.

31      A P2P Client that connects to a P2P Group Owner indicates support for P2P
32      Client Discovery using the P2P Client Discovery bit in the P2P Capability
33      attribute in the Association Request frame. If the P2P Client supports P2P
34      Client Discovery, the P2P Client shall set the P2P Client Discovery bit to 1,
35      otherwise it shall be set to 0. The P2P Client may indicate changed support for
36      P2P Client Discovery in a subsequent (Re)association Request frame.

37      A searching P2P Device can determine that a P2P Client does not support P2P
38      Client Discovery since the P2P Group Owner includes the P2P Capability
39      attribute of each P2P Client within the P2P Group Info attribute. The following
40      rules apply where a P2P Client has indicated it does not support P2P Client
41      Discovery:

- — A searching P2P Device shall not send a Device Discoverability Request frame to a P2P Group Owner containing the P2P Device ID of that P2P Client
- — A searching P2P Device shall not send any frame to the P2P Device that is that P2P Client
- — The P2P Group Owner shall not send a GO Discoverability Request frame to that P2P Client

A P2P Device that is a P2P Client within a P2P Group should support P2P Client Discoverability unless device or application restrictions prevent it from doing so. A P2P Device that has ended a session as P2P Group Owner of a Persistent P2P Group that has the Persistent Reconnect bit in the P2P Capability attribute set to 1 shall support P2P Client Discovery when it is a P2P Client in a P2P Group. Such a P2P Device should also select appropriate power save timing to minimize the delay in delivery of a GO Discoverability Request frame, e.g. by being available at each TBTT.

A P2P Group Owner that has one or more connected P2P Clients that have indicated support for P2P Client Discovery should take this into account in setting its own discoverability according to the recommendations in §3.3.2.

### 3.2.5  Persistent Group operation

A P2P Device that successfully obtains Credentials for a Persistent P2P Group shall store the P2P Group ID and Credentials for that P2P Group. This enables the P2P Device that is P2P Group Owner to recreate the P2P Group for additional sessions after initial formation. P2P Clients can also request that the P2P Group be restarted and use the stored Credentials to join. The P2P Group Owner of the Persistent P2P Group may also store a list of P2P Device Addresses of P2P Clients that have joined the Persistent P2P Group.

The P2P Group ID and Credentials for a Persistent P2P Group do not change for each session of that P2P Group, however, the P2P Interface Address (and therefore BSSID) and operating channel of the P2P Group may not be the same for each session. The P2P Interface Address used by P2P Clients within a Persistent P2P Group may also change for each session. The Persistent P2P Group bit in the Group Capability Bitmap field in the P2P Capability attribute shall be set in the Beacon and Probe Response frames transmitted by the P2P Group Owner. The Persistent P2P Group, Intra-BSS Distribution and Persistent Reconnect bits in the Group Capability Bitmap field in the P2P Capability attribute in Beacon and Probe Response frames shall be the same for each session.

The P2P Group Owner of a Persistent P2P Group is determined when the P2P Group is formed and is the same P2P Device in subsequent P2P Group sessions. The P2P Group Owner of a Persistent P2P Group shall operate as a P2P Group Owner as described in §3.2. The P2P Group Owner may end a P2P Group session as described in §3.2.9.

The P2P Device that ended the P2P Group session may:

— Enter the Listen State, see §3.1.2.1.1. The P2P Device may be discovered as described in §3.1.2.3.

— Join another P2P Group, in which case it may be discovered as described in §3.1.2.2.

— Enter the Find Phase, see §3.1.2.1.3.

A P2P Group Owner may advertise that it supports P2P Client reconnection without user intervention for a Persistent P2P Group by setting the Persistent Reconnect bit to 1 in the Group Capabilities Bitmap field that it sends describing the P2P Group capabilities. A P2P Device that advertises this for a Persistent P2P Group may use the Listen State to remain discoverable as described in §3.1.2.1. The P2P Device may adopt different availability timing within the Listen State to that generally recommended for discoverability in §3.1.2.1. The P2P Device may advertise its Listen State availability timing by including the Extended Listen Timing attribute in Probe Request, Probe Response, GO Negotiation Request and (Re)association Response frames as described in §4.1.10. Two parameters define P2P Device timing in Listen State: a period of continuous availability and an interval between the start of successive periods. The period of availability should be at least 10 milliseconds. The interval between availability determines the typical time it shall take to discover the P2P Device and should be chosen to meet the needs of target applications for that P2P Device. A P2P Device may communicate the availability timing that it desires of a Persistent P2P Group Owner by including the Extended Listen Timing attribute in (Re)association Request frames.

Note — Although a P2P Device requesting availability timing should include the Extended Listen Timing attribute in all (Re)association Request frames, the attribute shall only have meaning in the (Re)association Request frame sent when connecting to the P2P Group, i.e. it is ignored when associating as part of Provisioning/WSC.

A P2P Device that is the P2P Group Owner of a Persistent P2P Group shall restart the Persistent P2P Group state on completion of a successful P2P Invitation exchange requesting that the Persistent P2P Group be invoked. A P2P Device may also restart a Persistent P2P Group of which it is P2P Group Owner in response to a request from a higher-layer.

A P2P Device may decide to no longer use a Persistent P2P Group in which case it may delete the Credentials of that P2P Group. A Persistent P2P Group ends when the P2P Group Owner deletes the Credentials.

### 3.2.6 Communication in a P2P Group

Communication within a P2P Group shall employ WPA2-Personal security with AES-CCMP as the encryption cipher. Immediately after a successful association, the P2P Group Owner and the newly connected P2P Client shall execute the 4-way handshake, as specified in §8.5.3 of IEEE Std 802.11-2007 [1], in which the P2P Group Owner shall act as the authenticator and the P2P Client shall act as the supplicant. The resulting temporal encryption keys shall

be installed and used to encrypt unicast and broadcast/multicast frames exchanged between the P2P Group Owner and the Client as described in IEEE Std 802.11-2007 [1].

Higher-layer data services may use IP. The P2P Group Owner shall act as a DHCP server to provide IP addresses to the connected P2P Clients that use IP. The DHCP Server shall at a minimum support Internet Protocol version 4 (IPv4) and assignment of an IP address, subnet mask and default gateway. A P2P Client that uses IP shall be capable of acting as a DHCP Client.

Note — While a P2P Device can select distinct IP subnets for each P2P Group for which it is P2P Group Owner, it is possible that a P2P Device connected to more than one P2P Group may end up with colliding subnets. Use of a random component in the selection of IP subnet may reduce the probability of (but not eliminate) this situation occurring.

Data is exchanged between the P2P Group Owner and each connected Client. Both the Group Owner and the Client may employ power savings techniques, so each shall use the appropriate data delivery mechanisms as described in §3.3.

The P2P Group Owner may provide a data distribution service between all connected Clients in the P2P Group. A P2P Group Owner that provides such a service shall set the Intra-BSS Distribution bit to 1 in the Group Capability Bitmap field that it sends describing its own capabilities.

A P2P Group Owner may cross connect between a WLAN and a P2P Group using any mechanisms above layer 2. Mechanisms for cross connection are outside the scope of this specification. A P2P Group Owner that provides cross connection shall set the Cross Connection bit to 1 in the Group Capability Bitmap field that it sends describing its own capabilities. A P2P Group Owner shall not cross connect between the WLAN and P2P Group using layer 2 mechanisms. A P2P Group Owner shall not enable cross connection while associated to a WLAN AP that advertises a P2P Manageability attribute with Cross Connection Permitted set to 0.

A P2P Client shall not cross connect between a WLAN and a P2P Group using mechanisms at any layer.

If a WLAN Infrastructure determines that a P2P Device is a P2P Concurrent Device and is operating with the P2P Infrastructure Managed bit in the Device Capability Bitmap field of the P2P Capability attribute (see Table 12 in §4.1.4) set to 0, the AP may deauthenticate or disassociate the STA. The Deauthenticate or Disassociate frame shall include the P2P IE with the Minor Reason Code field set to 2 in the Minor Reason Code attribute (see §4.1.3).

Note — It is advisable that a P2P Device deauthenticated or disassociated with this Minor Reason Code not attempt to (re)associate to the WLAN AP either:

— with the P2P Infrastructure Managed bit in the Device Capability Bitmap field of the P2P Capability attribute set to 0 until the P2P Device expects that the WLAN AP permissions could have changed, or

1        — until P2P Device capability is disabled.

2     Note — Disabling P2P Device capability includes omitting the P2P IE from all
3     Management frames, leaving all P2P Groups and not responding to Invitation Requests.

### 3.2.7   Disconnecting from a P2P Group

5     A P2P Client shall, when possible, indicate intent to disconnect from a P2P
6     Group by using either:

7     — the deauthentication procedure in §11.3.1.3 of IEEE Std 802.11-2007 [1]
8         to send a Deauthentication frame to the P2P Group Owner, or

9     — the STA disassociation procedure in §11.3.2.5 of IEEE Std 802.11-2007
10         [1] to send a Disassociation frame to the P2P Group Owner.

11     A P2P Group Owner shall not depend on receiving either indication and may
12     determine that a Client has departed for a variety of reasons.

### 3.2.8   Disconnecting a P2P Client

14     A P2P Group Owner may disconnect a Client from a P2P Group. In order to
15     disconnect a Client, a P2P Group Owner shall use either:

16     — the deauthentication procedure in §11.3.1.3 of IEEE Std 802.11-2007 [1]
17         to send a Deauthentication frame to the Client, or

18     — the AP disassociation procedure in §11.3.2.7 of IEEE Std 802.11-2007 [1]
19         to send a Disassociation frame to the Client.

20     The P2P Group Owner shall be the AP in these procedures and the Client shall
21     be the STA.

22     A P2P Group Owner may reject authentication, or deny association of a P2P
23     Device that has previously been deauthenticated, or disassociated due to
24     protocol error, or disruptive behavior.

25     If authentication is rejected, the status code returned in the Authentication frame
26     with Authentication transaction sequence 2 shall be set to 37 (The request has
27     been declined). See §7.3.1.9 and §8.2.2.2 of IEEE Std 802.11-2007 [1].

28     If association is denied, a P2P Information Element shall be included in the
29     Association Response frame containing a P2P Status attribute with the status
30     code value 6 (Fail: denied due to previous protocol error, or disruptive behavior).

### 3.2.9   Ending a P2P Group session

32     If an orderly shutdown is possible, a P2P Group Owner shall indicate to the
33     connected Clients its intention to end a P2P Group session. Unexpected
34     departure of a P2P Group Owner shall terminate the P2P Group session.

35     A P2P Group Owner indicating intent to terminate a P2P Group session shall
36     use the deauthentication procedure in §11.3.1.3 of IEEE Std 802.11-2007 [1] to
37     send a Deauthentication frame to the broadcast address, or to all connected

Clients. The reason code in the deauthentication frame shall take the value 3 (Deauthenticated because sending STA is leaving (or has left) IBSS, or ESS).

If there are no connected P2P Clients the P2P Group Owner may end the P2P Group session.

## 3.3 P2P Power Management

### 3.3.1 Introduction

P2P power management supports power save mechanisms for P2P Group Owners and P2P Clients. The approach is based on existing PS and WMM-PS power management delivery mechanisms with two new procedures that allow the P2P Group Owner to be absent for defined periods; Opportunistic Power Save and Notice of Absence. Small adaptations to PS and WMM-PS protocols at the P2P Client are necessary to allow for P2P Group Owner absence periods. The adapted protocols are termed P2P PS and P2P WMM-PS to differentiate them from the existing schemes on which they are based. These mechanisms are available in a P2P Group in which only P2P Devices are associated.

Legacy Clients do not understand the P2P protocol and consider the P2P Group Owner to be an AP. Legacy Clients expect an AP to be available all of the time and any mechanism that alters availability may result in undesirable consequences, e.g. needless consumption of spectrum due to multiple retries, or disassociation by the Legacy Client.

11n-capable P2P Devices may use SM Power Save in communication with other 11n capable P2P Devices, or 11n-capable Legacy Clients. An 11n-capable P2P Device must comply with requested 11n SM Power Save settings when transmitting to another 11n-capable P2P Device, or 11n-capable Legacy Client.

### 3.3.2 Power Management and discovery

P2P Power Management reduces P2P Device availability and therefore impacts the discoverability of that P2P Device. For this reason, the P2P Power Management protocol defines an availability period, called the CTWindow, to assist in maintaining P2P Device discoverability. The CTWindow is a period during which a P2P Group Owner is present.

The P2P Group Owner is responsible for selecting an appropriate value for CTWindow. The CTWindow shall be an integral number of TU and shall always be less than the beacon interval. For a P2P Group Owner that desires to be discoverable, the CTWindow should be at least 10 TU. A CTWindow shall start at each TBTT and extend for the chosen duration. During this time window the P2P Group Owner shall be in the active state subject to the P2P Group Owner power save state precedence rules in §3.3.3.2. A P2P Group Owner shall complete any active frame exchange sequence prior to ending the CTWindow.

1     Note — The priority of Beacon frame transmission in the power save state precedence
2     rules means that use of passive scanning can be helpful in discovering a P2P Group
3     Owner that is using Power Management.

4     CTWindow is also used for P2P Group Owner Opportunistic Power Save as
5     described in §3.3.3.1. It should be noted that it may take a number of DTIM
6     intervals to successfully communicate new, updated or cancelled CTWindow
7     timing to all P2P Clients in a P2P Group.

8 ### 3.3.3   Power Management at a P2P Group Owner

9     PS and WMM-PS power save schemes are based on the assumption that the
10    AP is awake to receive changes in power management state information, and in
11    the case of WMM-PS, trigger frames from the STA.

12    Power management for the P2P Group Owner consists of delivery mechanisms
13    based on those defined for PS and WMM-PS, together with two methods that
14    allow the P2P Group Owner to be absent for defined periods. These schemes
15    are termed Opportunistic Power Save and Notice of Absence.

16 #### 3.3.3.1  P2P Group Owner Opportunistic Power Save procedure

17    P2P Group Owner Opportunistic Power Save is a power management scheme
18    that allows a P2P Group Owner to gain additional power savings on an
19    opportunistic basis.

20    Opportunistic Power Save uses the CTWindow described in §3.3.2. The P2P
21    Group Owner shall indicate that Opportunistic Power Save is enabled by setting
22    the OppPS bit to 1 in the CTWindow and OppPS Parameters field of the Notice
23    of Absence attribute. The CTWindow field shall be set to a non-zero value if the
24    OppPS bit is set to 1.

25    At any time after the end of each CTWindow, if all of the connected P2P Clients
26    are determined to be in Doze state by the P2P Group Owner, the P2P Group
27    Owner may enter Doze state from that time until the next TBTT. After a DTIM,
28    the P2P Group Owner shall complete delivery of all queued broadcast/multicast
29    frames prior to entering Doze state, even if the total time taken to send these
30    frames exceeds the CTWindow. Delivery of queued broadcast/multicast frames
31    that is interrupted by a NoA absence period, shall continue after the absence
32    period has ended.

33    As long as any Client is determined to be in Awake state, the P2P Group Owner
34    shall remain in Awake state subject to any advertised Notice of Absence
35    schedule. A P2P Group Owner shall determine that a P2P Client is in the
36    Awake state if it is in the Active mode or if it is in the Power Save mode and has
37    a WMM Unscheduled Service Period (USP) in progress or an unanswered PS-
38    Poll. Figure 8 illustrates an example of P2P Group Owner Opportunistic Power
39    Save with two connected P2P Clients, both using P2P PS.

40    This scheme creates opportunities for P2P Group Owner power save at the
41    expense of increased latency in P2P Client transmissions, including transitions

1        from Doze state to Awake state. This increased latency means that there is
2        comparable latency for upstream and downstream traffic when a P2P Group
3        Owner uses this mechanism.

4        Opportunistic Power Save may be used by the P2P Group Owner when
5        connected P2P Clients are using the P2P PS procedures defined in §3.3.4.2, or
6        the P2P WMM-PS procedures defined in §3.3.4.3. A P2P Group Owner shall
7        cancel any Opportunistic Power Save if it accepts a P2P Presence Request
8        from a connected P2P Client (see §3.3.4.4). The P2P Group Owner shall not
9        use Opportunistic Power Save while it has active P2P Presence Requests from
10       one, or more connected P2P Clients.



11
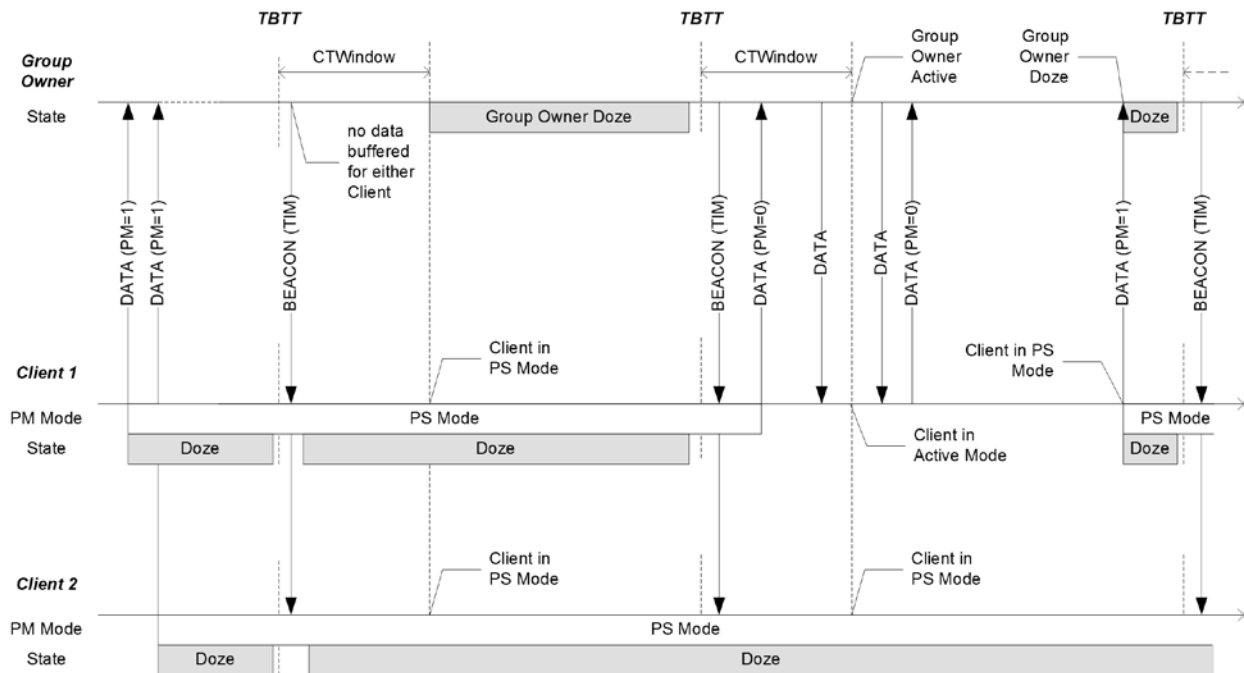
12       **Figure 8—Example of P2P Group Owner Opportunistic Power Save**

13   **3.3.3.2   P2P Group Owner Notice of Absence procedure**

14        A P2P Group Owner establishing a Notice of Absence schedule shall include a
15       P2P Notice of Absence attribute describing the planned absence timing within
16       transmitted Beacon and Probe Response frames.

17        A P2P Group Owner may indicate Notice of Absence timing directly to a P2P
18       Client using a Notice of Absence Action frame.

19        There shall be no more than one Notice of Absence attribute in a Beacon,
20       Probe Response, or Notice of Absence Action frame.

21        Notice of Absence timing is specified by the values of the combination of Start
22       Time, Interval, Duration and Count fields in the Notice of Absence attribute —
23       see Table 26. The Start Time field shall indicate the start time of the timing

schedule. The Interval field shall indicate the absence interval. The Duration field shall indicate the length of each absence. The Count field shall indicate the number of absences.

The lower order 4 octets of the TSF timer cover a span of around 71 min. Due to TSF timer wrap-over and due to the possibility of receiving a frame containing a Notice of Absence attribute after the indicated Start Time, ambiguity may occur. To resolve this ambiguity:

— The P2P Group Owner shall update the Start Time field in the Notice of Absence attribute for an active schedule every $2^{31}$μs. The Count field in the Notice of Absence attribute shall also be updated at this time to reflect the number of pending absence periods after the new Start Time.

— To determine Start Time, a P2P Client shall use the nearest absolute TSF timer value in past or future where the lower order 4 octets match the Start Time field in the Notice of Absence attribute.

These measures ensure that new P2P Clients that join during an established Notice of Absence schedule are able to compute absence interval timing.

The Index field within the Notice of Absence information attribute shall contain a number that identifies the instance of Notice of Absence timing. The initial value for the Index field shall be arbitrarily chosen by the P2P Group Owner. The P2P Group Owner shall increment the Index value each time a new Notice of Absence schedule is announced, or whenever any field within the Notice of Absence attribute is changed. A new or revised Notice of Absence schedule shall commence at the time specified in the Start Time field of the Notice of Absence descriptor.

To cancel a Notice of Absence schedule, the P2P Group Owner shall omit the Notice of Absence Descriptor that defines the schedule from the Notice of Absence attribute from the P2P IE in transmitted Beacon and Probe Response frames. If there is neither a Notice of Absence schedule nor a CTWindow after deletion of a Notice of Absence schedule, the Notice of Absence attribute may be omitted from the P2P IE. A Notice of Absence schedule with a Count value indicating a specific number of absences may be cancelled prior to the terminal count. If the Count value is equal to 255, the cycle shall repeat until cancelled.

Note — Cancellation applies immediately that a Beacon frame is transmitted by the P2P Group Owner without a Notice of Absence attribute, even if this occurs during a scheduled absence in a periodic Notice of Absence.

It should be noted that it may take a number of DTIM intervals to successfully communicate new, updated or cancelled Notice of Absence timing to all P2P Clients in the P2P Group. It is recommended that this should be taken into account in setting appropriate Notice of Absence start times, or P2P Group Owner presence during Notice of Absence updates.

The procedure for Notice of Absence at the P2P Group Owner shall be as follows:

1. The first absence period of the announced Notice of Absence timing schedule shall commence when the lower four bytes of the TSF timer at the P2P Group Owner is equal to the Start Time specified in the Notice of Absence attribute.
2. The P2P Group Owner may remain absent for a maximum time equal to the Duration indicated in the Notice of Absence attribute.
3. At the end of the period of absence, the P2P Group Owner shall return to the active state – this is termed a presence period.
4. The next Group Owner absence period shall start when the TSF timer at the P2P Group Owner is equal to Start Time plus one Interval, where Interval is indicated in the Notice of Absence attribute. Starting at this time, the P2P Group Owner may remain absent for a maximum time equal to the duration indicated in the Notice of Absence attribute.
5. This cycle shall repeat for the number of intervals specified in the Count field of the Notice of Absence attribute. If the Count value is equal to 255, the cycle shall repeat until cancelled.

Figure 9 illustrates an example of Notice of Absence timing at a P2P Group Owner.
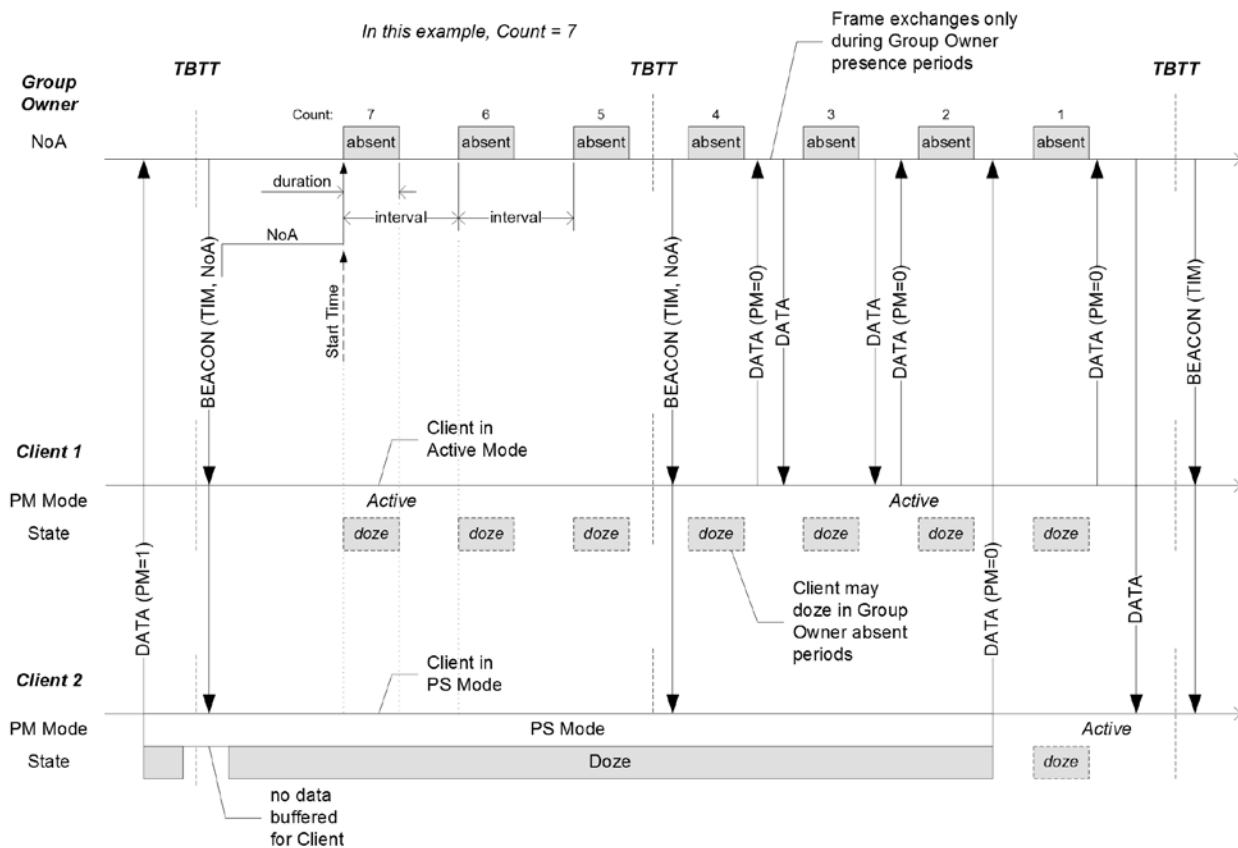


**Figure 9—P2P Group Owner Notice of Absence**

1  There shall be a maximum number of two concurrent Notice of Absence timing
2  schedules each described by a Notice of Absence Descriptor in the Notice of
3  Absence Information attribute.

4  Note — Where Notice of Absence is used in connection with concurrent operation,
5  operational parameters should be chosen, as far as is practical, to balance the needs
6  of both the WLAN and P2P Group. Such operational parameters include Notice of
7  Absence timing and any setting that places requirements on presence on either
8  network, e.g. setting appropriate Max SP Length when using WMM-PS.

9  P2P Clients may submit a P2P Presence Request to the P2P Group Owner to
10  influence P2P Group Owner power management timing. This mechanism may
11  be used whenever the P2P Client has requirements on the interval between
12  and/or duration of P2P Group Owner presence periods, e.g. where the P2P
13  Client has WMM Traffic Stream (TS), or latency sensitive traffic.

14  On receipt of a P2P Presence Request, the P2P Group Owner shall determine
15  whether to accept the request. If the P2P Group Owner accepts the P2P
16  Presence Request, it shall respond with a P2P Presence Response action
17  frame containing a Status attribute indicating success and a Notice of Absence
18  attribute describing the Notice of Absence timing that it will use in response to
19  the request. The P2P Group Owner may adopt revised Notice of Absence
20  timing (including becoming continuously available), or continue any Notice of
21  Absence Timing in use when the P2P Presence Request was made. If the P2P
22  Group Owner has no Notice of Absence schedule, it shall respond with a Notice
23  of Absence attribute with no Notice of Absence descriptors. If the P2P Group
24  Owner adopts a new, or modified Notice of Absence schedule as a result of the
25  P2P Presence request, it shall communicate this in all frames that it sends
26  containing the Notice of Absence attribute.

27  If the P2P Group Owner cannot accommodate a P2P Presence Request, it may
28  deny the request. In this case, the P2P Group Owner shall respond with a P2P
29  Presence Response action frame with a Status attribute indicating the failure
30  status code 'Unable to accommodate request' and a Notice of Absence attribute
31  reflecting any current P2P Group Owner power save timing.

32  A P2P Group Owner may adjust NoA timing upon disassociation of a P2P
33  Device that made a P2P Presence Request. Successful re-association of that
34  P2P Device has no effect on NoA timing.

35  The P2P Group Owner may alter NoA timing at any time.

36  Provided there are no active P2P Presence Requests, Opportunistic Power
37  Save may be combined with a Notice of Absence schedule to allow the P2P
38  Group Owner to gain additional doze time depending on Client PS mode – see
39  Figure 10.
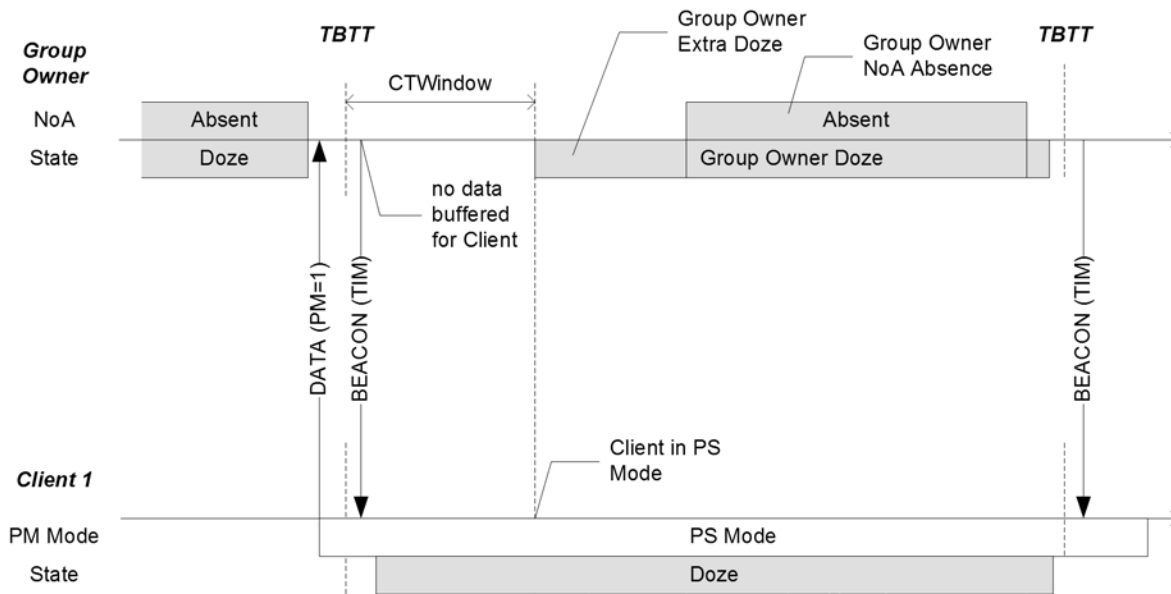
1
2          **Figure 10—P2P Group Owner Notice of Absence with Opportunistic Power Save**

3          The order of precedence for determining P2P Group Owner power save state
4          shall be as follows:
5              1. *Highest*: Absence due to a non-periodic Notice of Absence (Count = 1).
6              2. Presence from TBTT until the end of Beacon frame transmission.
7              3. Presence during the CTWindow.
8              4. *Lowest*: Absence for a periodic Notice of Absence (Count > 1).

9          This means that for any periodic NoA timing schedule (any NoA schedule where
10         the Count value is greater than 1), the P2P Group Owner shall be present for
11         each TBTT to send a Beacon frame independent of that Notice of Absence
12         schedule. It also means that presence during the CTWindow shall take priority
13         over an absence period related to a periodic NoA schedule when both schemes
14         are active.

15         When two overlapping Notice of Absence schedules are established, periods of
16         absence shall take priority.

17         When the P2P Group Owner has accepted a Presence Request frame from one
18         or more of its P2P Clients, the use of a non-periodic NoA that extends across
19         multiple presence periods should be minimized and periods of absence should
20         be kept as short as possible to minimize any negative impact.

21         P2P Group Owner precedence rules are illustrated in Figure 11.

1
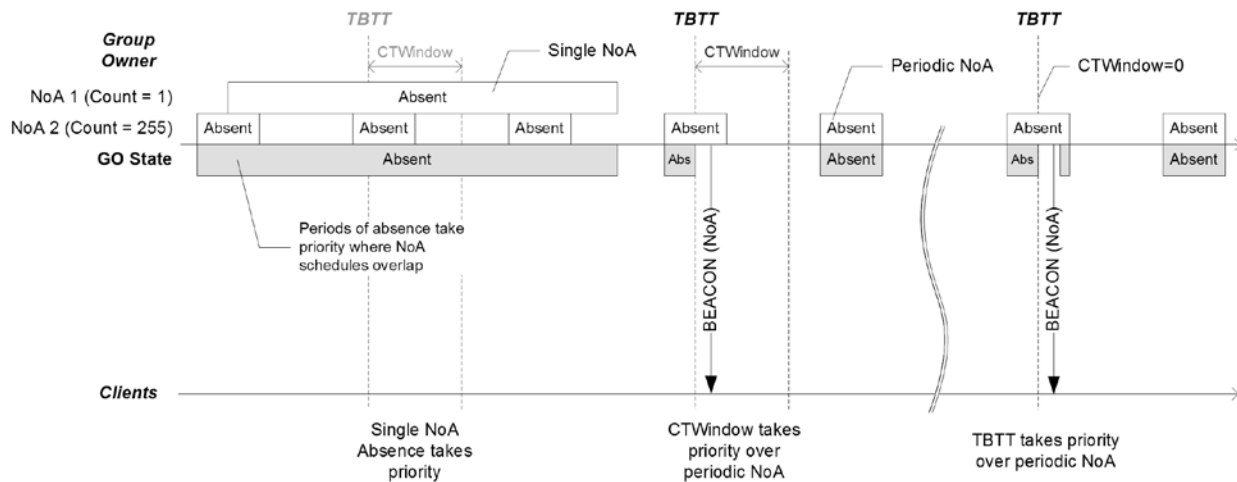
**Figure 11—Illustration of P2P Group Owner power save state precedence rules**

### 3.3.3.3 P2P Group Owner Power Save delivery

A P2P Group Owner shall not send frames within the P2P Group during periods that the P2P Group Owner has indicated it will be absent, subject to the power save state precedence rules above. A P2P Device should not initiate a frame exchange sequence that cannot be completed prior to the start of an absence period. Frames transmitted within the frame exchange sequence need not be received or acknowledged by the receiving P2P Device.

The procedures for data delivery from the P2P Group Owner to Clients using PS mode are as specified for an AP in §11.2.1.5 of IEEE Std 802.11-2007 [1].

If the P2P Group Owner receives a PS-Poll frame from a connected P2P Client and is not able to deliver the buffered frame prior to the start of an absence period, it shall defer its transmission until it receives a new PS-Poll from that P2P Client, see §3.3.4.2.

The procedures for data delivery from the P2P Group Owner to Clients using WMM-PS power save mode are as specified for an Access Point in §3.6.0 and §3.6.1 of the WMM-PS Specification [7]. An example of WMM-PS operation with P2P Group Owner NoA is illustrated in Figure 12.

An additional rule governing the end of a WMM Unscheduled Service Period (USP) shall apply if the P2P Group Owner is using Notice of Absence timing. A USP shall end if a P2P Group Owner absence period occurs prior to signaling the end of the USP. When this occurs, the End of Service Period (EOSP) bit in the last frame delivered prior to the absence is 0 and the More bit is 1, indicating that buffered data remains at the P2P Group Owner. It is possible that no frames can be delivered in a USP that is terminated by an absence period. In either case, the P2P Client shall send another trigger in a subsequent P2P Group Owner NoA presence period to retrieve the undelivered data. This

1     possible shortening of USPs by Group Owner NoA absence periods is
2     illustrated in Figure 13.

3     **3.3.3.4 P2P Group Owner support for Legacy Clients**

4     If a Legacy Client is associated the P2P Group Owner should always be in
5     Active mode, shall not miss more than one consecutive TBTT and shall be
6     present for every TBTT where a DTIM is scheduled. The P2P Group Owner
7     shall support PS and WMM-PS services to associated Legacy Clients.

8     ### 3.3.4 Power Management at a P2P Client

9     **3.3.4.1 P2P Client operation with P2P Group Owner Power Management**

10     A P2P Client that receives a Notice of Absence descriptor shall assume the
11     specified Notice of Absence timing will commence at the indicated Start Time.

12     The P2P Client shall not send frames to a P2P Group Owner during periods
13     that the P2P Group Owner has indicated it will be absent, subject to the power
14     save state precedence rules above. P2P Clients shall buffer frames until frame
15     delivery can be attempted in a presence period. A P2P Device should not
16     initiate a frame exchange sequence that cannot be completed prior to the start
17     of an absence period. Frames transmitted within the frame exchange sequence
18     need not be received or acknowledged by the receiving P2P Device.

19     A P2P Client determines that a P2P Group Owner has Opportunistic Power
20     Save enabled by the OppPS bit being set to 1 in the CTWindow and OppPS
21     Parameters field of received Notice of Absence attributes. In this case, a P2P
22     Client in Power Save mode shall only send frames to a P2P Group Owner
23     during the CTWindow, subject to any non-periodic NoA, and with the exception
24     that the P2P Client shall respond to frames received after the end of the
25     CTWindow in relation to an incomplete WMM Unscheduled Service Period
26     (USP), or outstanding PS-Poll.

27     A P2P Client that has requirements on the P2P Group Owner presence periods
28     may submit a P2P Presence Request to the P2P Group Owner to influence P2P
29     Group Owner power management timing, see §3.3.4.4.

30     A P2P Client shall use P2P PS, or P2P WMM-PS protocols if it uses power
31     save operation.

32     **3.3.4.2 Procedures for P2P Power Save at a P2P Client**

33     The procedures for the operation of a P2P Client using P2P power save are as
34     specified for a non-AP STA in PS mode in §11.2.1.7 of IEEE Std 802.11-2007
35     [1].

36     If a P2P Client using P2P Power Save sends a PS-Poll frame to the P2P Group
37     Owner, the P2P Group Owner may be unable to deliver a buffered frame prior
38     to the start of an absence period. When this occurs, the P2P Client may sleep
39     for the P2P Group Owner absence period and shall send another PS-Poll frame
40     in a subsequent presence period to retrieve the undelivered data.

### 3.3.4.3 Procedures for P2P WMM-PS at a P2P Client

The procedures for the operation of the P2P Client using P2P WMM-PS are as specified for a non-AP STA using U-APSD in §3.6.0 and §3.6.2 of the WMM-PS Specification [7]. An example of P2P WMM-PS operation with P2P Group Owner NoA is illustrated in Figure 12.
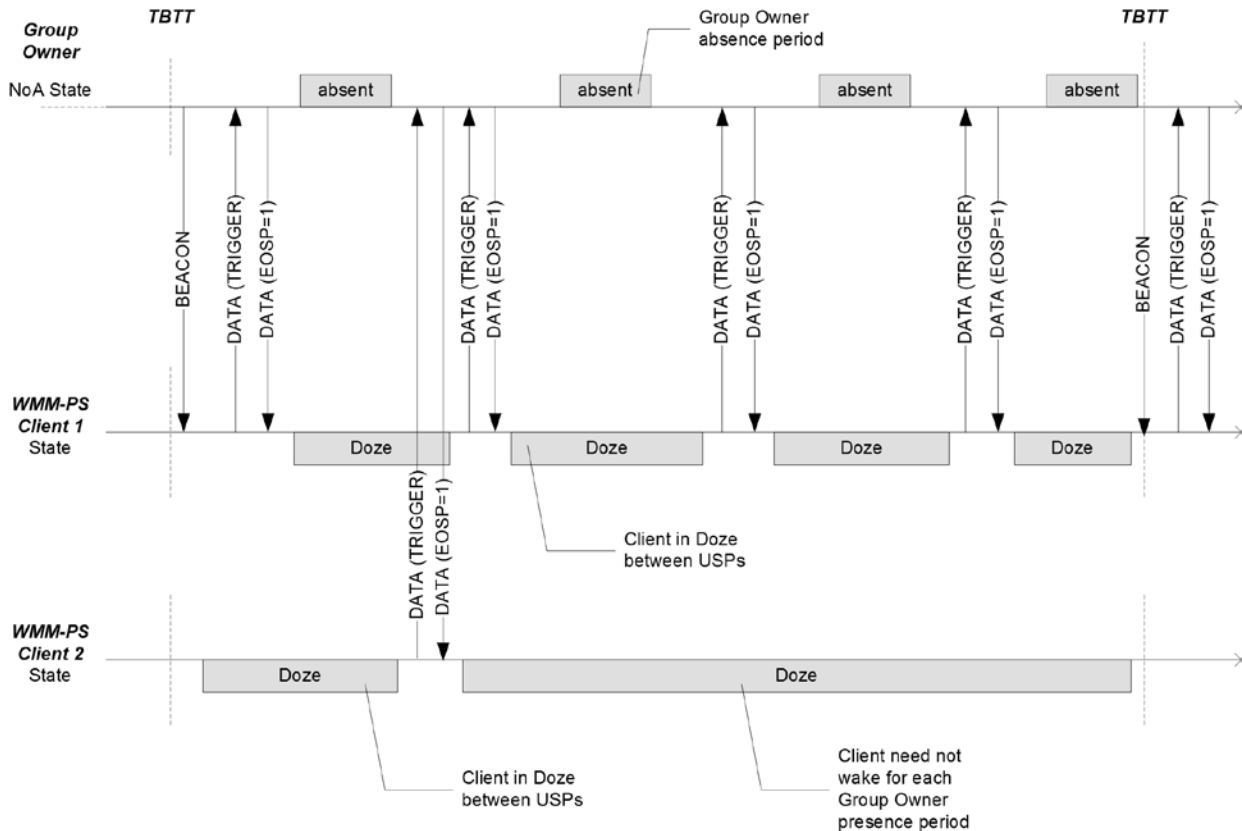


**Figure 12—Example P2P WMM-PS operation with P2P Group Owner NoA**

An additional rule governing the end of a WMM Unscheduled Service Period (USP) shall apply if the P2P Group Owner is using Notice of Absence timing. A USP shall end early if a P2P Group Owner absence period starts prior to signaling the end of the USP. When this occurs, the End of Service Period (EOSP) bit in the last frame delivered prior to the absence is 0 and the More bit is 1, indicating that buffered data remains at the P2P Group Owner. It is possible that no frames can be delivered in a USP that is terminated by an absence period. In either case, the P2P Client shall send another trigger in a subsequent P2P Group Owner NoA presence period to retrieve the undelivered data. This possible shortening of USPs by Group Owner NoA absence periods is illustrated in Figure 13.
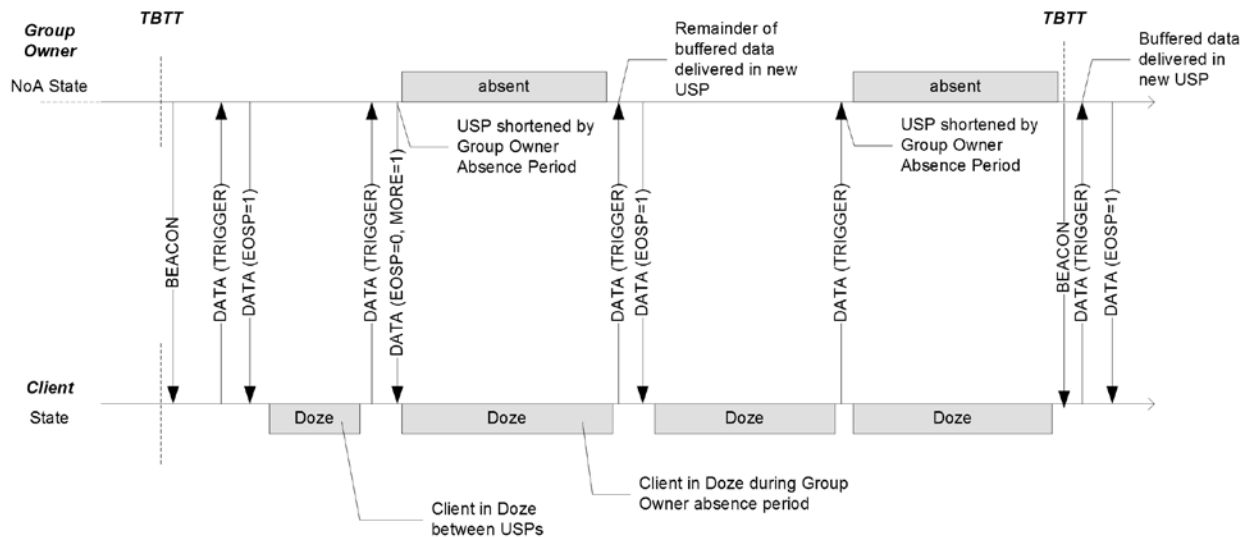
Figure 13—Shortening of P2P WMM-PS USPs by P2P Group Owner absence

### 3.3.4.4 Signaling of Client service requirements

A P2P Client may submit a P2P Presence Request to the P2P Group Owner to influence P2P Group Owner power management timing. This mechanism may be used whenever the P2P Client has requirements on the P2P Group Owner presence periods. A P2P Presence Request may be made at any time after successful association, regardless of whether the P2P Group Owner is using any power save mechanism at the time.

To make a P2P Presence Request, a P2P Client shall send a P2P Presence Request action frame to the P2P Group Owner. The value for the Dialog Token field shall be chosen by the P2P Client to identify the Request-Response transaction.

The P2P Presence Request action frame shall contain a single P2P NoA attribute. The Index field shall be set to 0 on transmission by the P2P Client and ignored on reception by the P2P Group Owner. The CTWindow field is unused and shall be set to 0 on transmission by the P2P Client and ignored on reception by the P2P Group Owner.

The requested P2P Group Owner presence shall be specified by the Duration and Interval fields in up to two NoA descriptors; one indicating the preferred duration and interval timing and one indicating the maximum interval, and minimum duration acceptable to the P2P Client. The Count/Type field is used to indicate whether the Duration and Interval field values are preferred, or the acceptable limit. The Start Time field is reserved and shall be set to 0 on transmission and ignored on reception in NoA descriptors sent by a P2P Client.

Note — If the P2P Client is making a P2P Presence Request in order to support a WMM Traffic Stream where a TSPEC has been accepted and the P2P Group Owner returned a Medium Time in the ADDTS response, it is recommended that the

1 requested presence Duration be based on the Medium Time in combination with the
2 requested presence Interval. Where there is no applicable TSPEC, or no Medium Time
3 information has been returned by the P2P Group Owner in an ADDTS response, it is
4 recommended that the P2P Client use the Medium Time derivation in §A.3 of the WMM
5 Specification [7] to compute a local version of 'Medium Time' that can be used together
6 with Interval to determine an appropriate presence Duration.

7 Figure 14 illustrates the P2P Presence Request-Response procedure.
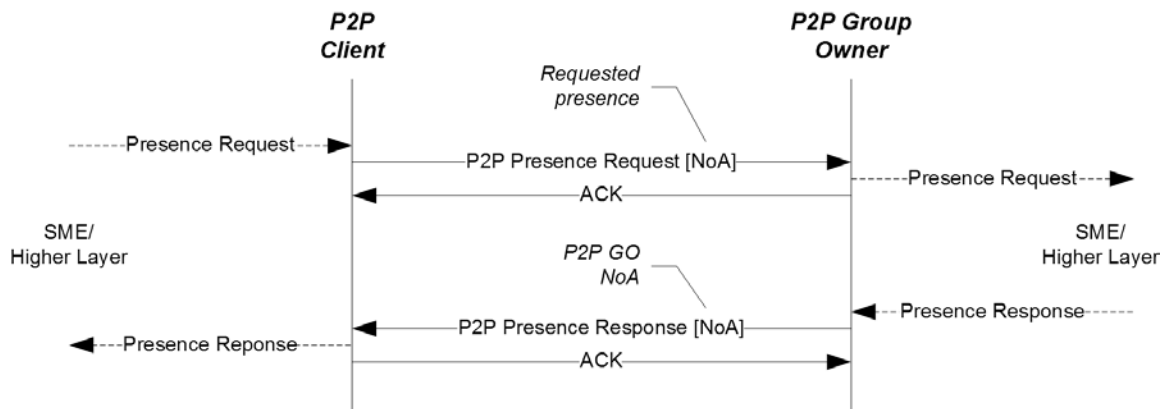


8
9 **Figure 14—P2P Presence Request-Response procedure**

10 The P2P Client shall adopt the timing indicated in the returned Notice of
11 Absence attribute. If the P2P Group Owner responds with a P2P Presence
12 Response frame containing no Notice of Absence descriptors, the P2P Client
13 shall assume the P2P Group Owner has no Notice of Absence Schedule.

14 If the Status element in the P2P Presence Response indicates failure, or if the
15 Status element indicates success, but the timing indicated in the returned
16 Notice of Absence attribute does not meet the requirements of the P2P Client,
17 the P2P Client may:

18 — send a new P2P Presence Request with revised timing,
19 — use the timing indicated in the returned Notice of Absence attribute, or
20 — disconnect from the P2P Group.

21 A P2P Client may submit a request for revised P2P Group Owner presence, by
22 submitting a new P2P Presence Request to the P2P Group Owner.

23 A P2P Client that no longer has presence requirements should indicate this to
24 the P2P Group Owner by sending a P2P Presence Request Action frame
25 containing no NoA descriptors. A P2P Group Owner may assume that a P2P
26 Client no longer has presence requirements upon determining that the P2P
27 Client has left the P2P Group.

The P2P Group Owner may alter NoA timing at any time and indicate this via the methods described in §3.3.3.2. The P2P Client shall adopt the most recently obtained NoA timing.

## 3.4 Managed P2P Device operations

This section describes the ability for P2P Devices to operate in an enterprise environment where P2P Devices may be managed by the Information Technology (IT) department of the enterprise.

### 3.4.1 Managed P2P Device capability

P2P Devices may or may not be managed based on the Managed P2P Device capabilities of P2P Devices and WLAN APs.

A WLAN AP that is capable of managing P2P Devices (e.g. Enterprise IT owned and operated AP) shall include the P2P Manageability attribute with the P2P Device Management bit set to 1 in the P2P IE in Beacon, Probe Response and (Re)association Response frames. The WLAN AP advertises its Managed P2P permissions in the Cross Connection Permitted and Coexistence Optional fields in the P2P Manageability attribute (see §4.1.12) in the P2P IE in Beacon, Probe Response and (Re)association Response frames. A WLAN AP that is capable of managing P2P Devices but is not a P2P Group Owner shall not include in the P2P IE attributes other than the P2P Manageability attribute. The P2P Device Management bit set to 0 indicates that the WLAN AP (e.g. Enterprise IT department) has no desire to manage P2P Devices.

Note — a WLAN AP that is capable of managing P2P Devices may or may not be a P2P Group Owner

A Managed P2P Device shall include the P2P Capability attribute with the Infrastructure Managed bit set to 1 in the P2P IE in Probe Request and (Re)association Request frames that are transmitted to the WLAN AP by the WLAN STA interface. Both P2P Group Owners and P2P Clients may be Managed P2P Devices. A value of 0 indicates the device may not be managed by the enterprise IT department.

If the P2P Device is a P2P Group Owner, supports Concurrent Operation (has set the Concurrent Operation bit to 1 in the P2P Capability Subfield) and will use cross connection to the WLAN AP BSS, the Cross Connection bit in the Group Capability Bitmap field of the P2P Capability attribute in (Re)association Request frame shall be set to 1 and set to 0 otherwise.

A Managed P2P Device may be a P2P Concurrent Device that has one MAC entity operating as a WLAN-STA and the second MAC entity operating as a P2P Group Owner, as shown in Figure 15.

1
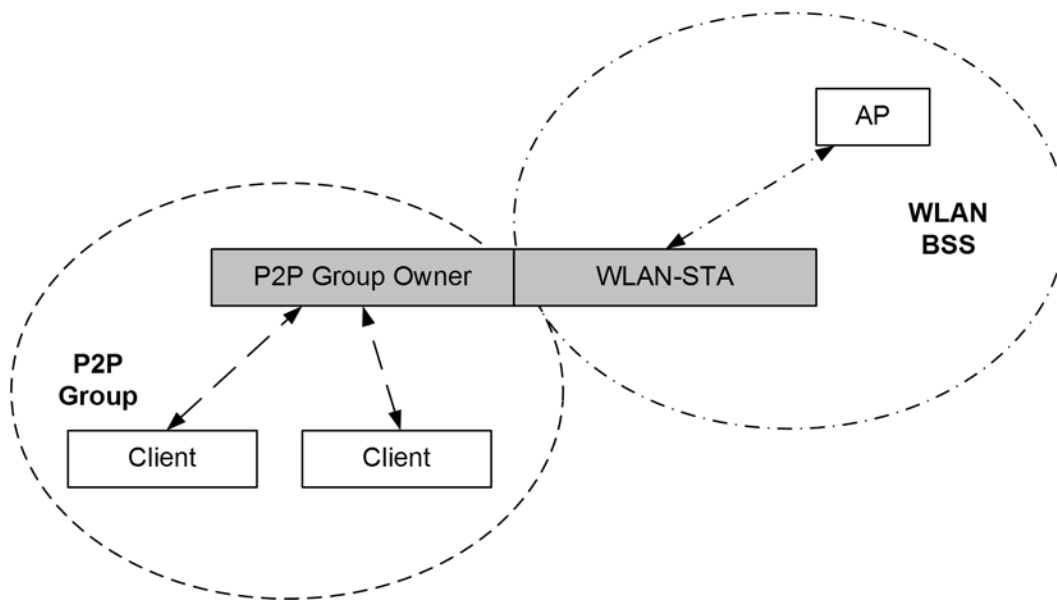
2 **Figure 15—Managed P2P Device that is a P2P Concurrent Device**

3 A Managed P2P Device may also be a P2P Concurrent Device that has one
4 MAC entity operating as a WLAN-STA and the second MAC entity operating as
5 a P2P Client.

6 If a Managed P2P Device is a P2P Concurrent Device, the WLAN-STA interface
7 of the P2P Device shall include the P2P Interface attribute (see 4.1.18) within a
8 P2P IE in the (Re)association Request frame that is transmitted to the WLAN
9 AP. The Managed P2P Device that is a P2P Concurrent Device shall already
10 have assigned all addresses that may be used as P2P Interface Addresses
11 before the (re)association with the WLAN AP.

12 Note — In this way, a WLAN AP that is capable of managing P2P Devices is notified of
13 all potential P2P Interface Addresses of the Managed P2P Device that is a P2P
14 Concurrent Device in use during the current association with the WLAN AP. WLAN
15 APs that are incapable of managing P2P Devices may also receive this information but
16 cannot parse it.

17 ### 3.4.2 P2P Coexistence Parameters operations

18 The Managed P2P Device may gather P2P Coexistence Parameters by using
19 the Channel Usage Procedures as defined in §11.20.14 of IEEE P802.11v [5],
20 or from (Re)association Response frames received on the WLAN-STA interface
21 from the WLAN AP. The WLAN AP that supports Managed P2P Devices shall
22 include P2P Coexistence Parameters in Probe Response and (Re)association
23 Response frames.

24 The P2P Coexistence Parameters consist of Primary P2P Coexistence
25 Parameters and Secondary P2P Coexistence Parameters.

1   The Primary P2P Coexistence Parameters contain Channel Usage information
2   that may be used by IT departments to optimize P2P Devices within the IT
3   defined channel mappings assigned to IT controlled APs. The Managed P2P
4   Device that is a P2P Concurrent Device should use Primary P2P Coexistence
5   Parameters as part of channel selection processing to start a P2P Group. If the
6   P2P Group is already started or the Managed P2P Device is not a P2P
7   Concurrent Device, the Primary P2P Coexistence Parameters may be used by
8   the Managed P2P Device to initiate a channel switch or as part of channel
9   selection processing respectively.

10  The Secondary P2P Coexistence Parameters consist of P2P Client specific
11  parameters such as maximum transmit power (via the Country and Power
12  Constraint elements) and WMM Parameter Element. The Secondary P2P
13  Coexistence Parameters are used to allow Enterprise IT to give WLAN and P2P
14  Devices the same access priority to the medium. The Managed P2P Device that
15  is a P2P Group Owner may use the Secondary P2P Coexistence Parameters
16  as part of determining its maximum transmit power and WMM Parameters
17  Elements for P2P Clients. If the P2P Group Owner is a P2P Concurrent Device
18  in which the P2P Group operates at the same channel with the WLAN BSS, the
19  P2P Group Owner should use the Secondary P2P Coexistence Parameters as
20  part of determining its maximum transmit power and WMM Parameters
21  Elements for P2P Clients. The P2P Group Owner may also set its maximum
22  transmit power and WMM Parameters Elements based on local device
23  decisions that trade off the Enterprise IT benefits and P2P Group benefits. For
24  example, a public printer benefits from longer range more so than a conference
25  room projector; thus, the transmit power may not be the same for the two
26  devices.

27  The normative behaviors of a P2P Group Owner setting P2P Coexistence
28  Parameters are shown in Table 2.

29  **Table 2—P2P Coexistence Parameters setting**

| Device Configuration | Primary P2P Coexistence Parameters | | Secondary P2P Coexistence Parameters |
|---|---|---|---|
| | New Group | Existing Group | |
| Managed P2P Device that is a P2P Concurrent Device | Recommended | Optional | Recommended for a P2P Group that operates in the same channel with the WLAN BSS, and optional otherwise |
| Managed P2P Device that is not a P2P Concurrent Device | Optional | Optional | Optional |

30  In general, application of the P2P Coexistence Parameters to a P2P Group is a
31  device implementation decision. However:

— A P2P Concurrent Device that is a Managed P2P Device shall adopt the Primary P2P Coexistence Parameters and recommended (see Table 2) Secondary P2P Coexistence Parameters while associated to a WLAN AP that advertises Coexistence Optional set to 0, if the Primary P2P Coexistence Parameters include the WLAN AP's serving channel.

— A P2P Concurrent Device that is a Managed P2P Device should adopt the Primary P2P Coexistence Parameters while associated to a WLAN AP that advertises Coexistence Optional set to 0 if (1) the P2P Device is capable of concurrently operating in a WLAN BSS and a P2P Group that are each operating on different bands and (2) the Primary P2P Coexistence Parameters include a channel on a different band than the WLAN AP's serving channel.

The Enterprise IT department may not allow Concurrent P2P Devices to connect to the WLAN infrastructure if these devices do not adhere to these P2P Coexistence Parameters.

A P2P Client that is a Managed P2P Device does not use the P2P Coexistence Parameters since the Operating Class, Channel and Secondary P2P Coexistence Parameters adopted by a P2P Group are chosen by the P2P Group Owner.

### 3.4.3    WLAN Deauthentication/Disassociation

If a WLAN Infrastructure determines that a P2P Managed Device is a P2P Concurrent Device operating with cross connection enabled, the AP may deauthenticate or disassociate the WLAN STA. The WLAN infrastructure may determine that cross-connection is enabled by the P2P Device setting the Cross Connection bit in the Group Capability Bitmap field of the P2P Capability attribute (see §4.1.4) to 1, or via other means. The Deauthenticate or Disassociate frame shall include the P2P IE with the Minor Reason Code field set to 1 in the Minor Reason Code attribute (see §4.1.3). This action may be taken independent of the setting of the P2P Infrastructure Managed bit in the Device Capability Bitmap field of the P2P Capability attribute.

Note — It is advisable that a P2P Device deauthenticated or disassociated with a Minor Reason Code set to 1 not attempt to (re)associate to the WLAN AP:

— while cross connection is enabled at the P2P Device and the WLAN AP sets Cross Connection Permitted to 0 in the P2P Manageability attribute in the P2P IE in transmitted Beacons and Probe Response frames, or

— until P2P Device capability is disabled.

If a WLAN Infrastructure determines that a P2P Concurrent Device is using P2P Coexistence Parameters in any fashion that does not meet IT defined policy, the AP may deauthenticate or disassociate the STA. The Deauthenticate or Disassociate frame shall include the P2P IE with the Minor Reason Code field set to 3 in the Minor Reason Code attribute (see §4.1.3).

Note — It is advisable that a P2P Device deauthenticated or disassociated with a Minor Reason Code set to 3 not attempt to (re)associate to the WLAN until:

1 — the P2P Device has more closely adopted the Primary P2P Coexistence
2 Parameters and Secondary P2P Coexistence Parameters (see §3.4.2) while the
3 WLAN AP sets Coexistence Optional to 0 in the P2P Manageability attribute in
4 the P2P IE in transmitted Beacons and Probe Response frames, or
5 — P2P Device capability is disabled.

6 If a WLAN Infrastructure receives an Association Request frame from a P2P
7 Concurrent Device that contains a P2P Capability attribute (see §4.1.4) with the
8 Infrastructure Managed bit set to 1, the AP may deauthenticate or disassociate
9 the WLAN STA if P2P operation is outside the IT defined policy. The
10 Deauthenticate or Disassociate frame shall include the P2P IE with the Minor
11 Reason Code field set to 4 in the Minor Reason Code attribute (see §4.1.3).

12 Note — It is advisable that a P2P Device deauthenticated or disassociated with a Minor
13 Reason Code set to 4 not attempt to (re)associate to the WLAN AP until:

14 — the P2P Device expects that the WLAN AP permissions could have changed, or
15 — P2P Device capability is disabled.

16 Note — The P2P Device may attempt to re-associate to the WLAN Infrastructure with
17 P2P Device capability disabled. Disabling P2P Device capability includes omitting the
18 P2P IE from all Management frames, leaving all P2P Groups and not responding to
19 Invitation Requests.

20 ### 3.4.4   Managed P2P Device Summary

21 Requirements for different P2P Device states are summarized in Table 3.

22 **Table 3—Summary of requirements on Managed P2P Devices**

| Managed P2P Device | P2P Group Owner or P2P Client | Concurrent P2P Device | Requirements |
|---|---|---|---|
| No | P2P Client | Any | Sets Infrastructure Managed bit to 0. <br> Understands Minor Reason Code set to 2. <br> Alternatively, the P2P Device can disable P2P Device capability before (Re)associating to the WLAN. |
| No | P2P Group Owner | No | Sets Infrastructure Managed bit to 0. <br> Understands Minor Reason Code set to 2. <br> Alternatively, the P2P Device can disable P2P Device capability before (Re)associating to the WLAN. |
| No | P2P Group Owner | Yes | Sets Infrastructure Managed bit to 0. <br> Understands Minor Reason Code set to 1 or 2. <br> Shall not enable cross connection while associated to a WLAN AP that advertises a P2P Manageability attribute with Cross Connection Permitted set to 0. <br> Alternatively, the P2P Device can disable P2P Device capability before (Re)associating to the WLAN. |

| Managed P2P Device | P2P Group Owner or P2P Client | Concurrent P2P Device | Requirements |
|---|---|---|---|
| Yes | P2P Client | No | Sets Infrastructure Managed bit to 1. Sets Cross Connection bit to 0. Understands all values of Minor Reason Code. |
| Yes | P2P Client | Yes | Sets Infrastructure Managed bit to 1. Sets Cross Connection bit to 0. Includes P2P Interface attribute in (Re)association Request. Understands all values of Minor Reason Code. |
| Yes | P2P Group Owner | No | Sets Infrastructure Managed bit to 1. Sets Cross Connection bit to 0. Uses Primary P2P Coexistence Parameters and Secondary P2P Coexistence Parameters as per §3.4.2. Understands all values of Minor Reason Code. |
| Yes | P2P Group Owner | Yes | Sets Infrastructure Managed bit to 1. Sets Cross Connection bit to 0 or 1. Includes P2P Interface attribute in (Re)association Request. Shall not enable cross connection while associated to a WLAN AP that advertises a P2P Manageability attribute with Cross Connection Permitted set to 0. Uses Primary P2P Coexistence Parameters and Secondary P2P Coexistence Parameters as per §3.4.2. Understands all values of Minor Reason Code. |

1

# 4 Frame formats

This section describes the information elements (see §4.1) and frame formats (see §4.2) in support of the capabilities described in clause P2P specific functions and services (see §2.4).

P2P protocol communication is based on the use of P2P Information Element (P2P IE), P2P Action frame and P2P Public Action frame formats. These utilize the Vendor Specific Information Element and Vendor Specific Action frame formats in IEEE Std 802.11-2007 [1] with the WFA OUI and an OUI Type indicating P2P. A number of P2P attributes are defined; a single P2P IE carries one or more P2P attributes.

A P2P Device shall be able to properly construct a subset of the frames specified in this clause for transmission and to decode a (potentially different) subset of the frames specified in this clause upon validation following reception. The particular subset of these frames that a P2P Device constructs and decodes is determined by the functions and roles supported by that P2P Device, as specified in §4.3.

## 4.1 P2P Information Element

### 4.1.1 P2P IE format

The Vendor Specific information element format (as defined in IEEE Std 802.11-2007 [1]) is used to define the P2P information element (P2P IE) in this specification. The format of the P2P IE is shown in Table 4.

**Table 4—P2P IE format**

| Field | Size (octets) | Value (Hexadecimal) | Description |
|---|---|---|---|
| Element ID | 1 | 0xDD | IEEE 802.11 vendor specific usage. |
| Length | 1 | variable | Length of the following fields in the IE in octets. The Length field is a variable, and set to 4 plus the total length of P2P attributes. |
| OUI | 3 | 50 6F 9A | WFA specific OUI. |
| OUI Type | 1 | 0x09 (to be assigned) | Identifying the type or version of P2P IE. Setting to 0x09 indicates WFA P2P v1.0. |
| P2P Attributes | variable | | One of more P2P attributes appear in the P2P IE. |

The P2P attributes are defined to have a common general format consisting of a 1 octet P2P Attribute ID field, a 2 octet Length field and variable-length attribute-specific information fields, as shown in Table 5.

1 **Table 5—General format of P2P attribute**

| Field | Size (octets) | Value (Hexadecimal) | Description |
|---|---|---|---|
| Attribute ID | 1 | variable | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | variable | Length of the following fields in the attribute. |
| Attributes body field | variable | | Attribute-specific information fields. |

2 **Table 6—P2P Attribute ID definitions**

| Attribute ID | Notes |
|---|---|
| 0 | Status |
| 1 | Minor Reason Code |
| 2 | P2P Capability |
| 3 | P2P Device ID |
| 4 | Group Owner Intent |
| 5 | Configuration Timeout |
| 6 | Listen Channel |
| 7 | P2P Group BSSID |
| 8 | Extended Listen Timing |
| 9 | Intended P2P Interface Address |
| 10 | P2P Manageability |
| 11 | Channel List |
| 12 | Notice of Absence |
| 13 | P2P Device Info |
| 14 | P2P Group Info |
| 15 | P2P Group ID |
| 16 | P2P Interface |
| 17 | Operating Channel |
| 18 | Invitation Flags |
| 19 – 220 | Reserved |
| 221 | Vendor specific attribute |

| Attribute ID | Notes |
|---|---|
| 222 – 255 | Reserved |

A P2P Device that encounters an unknown or reserved Attribute ID value in a P2P IE received without error shall ignore that P2P attribute and parse any remaining fields for additional P2P attributes with recognizable Attribute ID values. A P2P Device that encounters a recognizable but unexpected Attribute ID value in the received P2P IE may ignore that P2P attribute.

More than one P2P IE may be included in a single frame. If multiple P2P IEs are present, the complete P2P attribute data consists of the concatenation of the P2P Attribute fields of the P2P IEs. The P2P Attributes field of each P2P IE may be any length up to the maximum (251 octets). The order of the concatenated P2P attribute data shall be preserved in the ordering of the P2P IEs in the frame. All of the P2P IEs shall fit within a single frame and shall be adjacent in the frame. Where a P2P attribute is not contained entirely within a single P2P IE, the P2P Attribute ID and Length fields for that attribute occur only once at the start. Figure 16 illustrates an example where three P2P attributes are carried in two P2P IEs, with the second attribute spanning the P2P IEs.
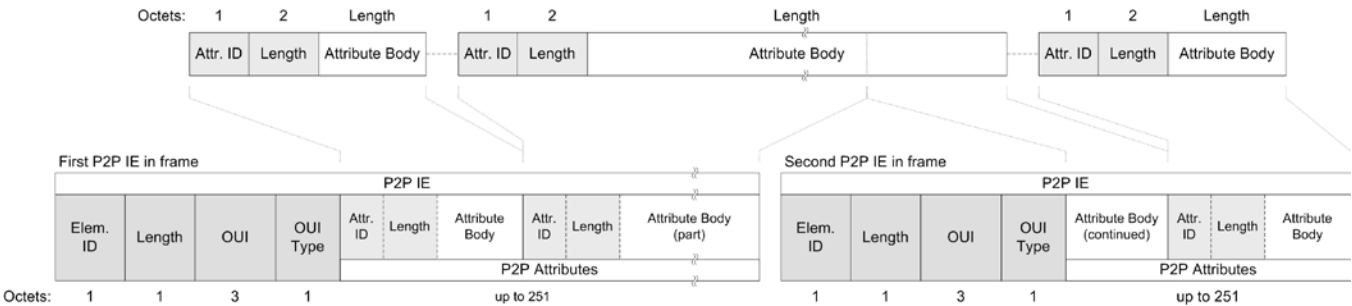


**Figure 16—Example of P2P attributes carried in two P2P IEs**

In general, the ordering of fields within P2P IEs, attributes and action frames shall follow the conventions in §7.1.1 of IEEE Std 802.11-2007 [1]. An exception shall be that any WSC attributes and data shall be in the big-endian format as defined in the WSC Specification [6]. WSC IEs shall follow the conventions in the WSC Specification [6].

Where WSC attribute data appears in both P2P IEs and WSC IEs within the same frame, both occurrences shall contain the same content.

### 4.1.2 Status attribute

The Status attribute is used to signal status information in the response frame of a request-response transaction. The format of the Status attribute is shown in Table 7.

1       **Table 7—Status attribute format**

| Field | Size (octets) | Value | Description |
|---|---|---|---|
| Attribute ID | 1 | 0 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | 1 | Length of the following fields in the attribute. |
| Status Code | 1 | 0-255 | A status code. The list of valid status codes and their meaning is defined in Table 8. |

2      Table 8 lists the valid value for the Status Code field and corresponding
3      descriptions.

4       **Table 8—Status Code definitions**

| Status Code | Description |
|---|---|
| 0 | Success |
| 1 | Fail; information is currently unavailable. |
| 2 | Fail; incompatible parameters. |
| 3 | Fail; limit reached. |
| 4 | Fail; invalid parameters. |
| 5 | Fail; unable to accommodate request. |
| 6 | Fail; previous protocol error, or disruptive behavior. |
| 7 | Fail; no common channels. |
| 8 | Fail; unknown P2P Group. |
| 9 | Fail: both P2P Devices indicated an Intent of 15 in Group Owner Negotiation. |
| 10 | Fail; incompatible provisioning method. |
| 11 | Fail: rejected by user. |
| 12 – 255 | Reserved |

5      The Status attribute shall be included in GO Negotiation Response frames, as
6      described in §4.2.8.3, GO Negotiation Confirmation frames, as described in
7      §4.2.8.4, P2P Invitation Response frames, as described in §4.2.8.6, P2P
8      Presence Response frames, as described in §4.2.9.4, and (Re)association
9      Response frames, as described in §4.2.5.

1 **4.1.3 Minor Reason Code attribute**

2 The Minor Reason Code attribute is used to augment the 802.11 Reason Code
3 field to signal additional reason information. The format of the Minor Reason
4 Code attribute is shown in Table 9.

5 **Table 9—Minor Reason Code attribute format**

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| Attribute ID | 1 | 1 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | 1 | Length of the following fields in the attribute. |
| Minor Reason Code | 1 | 0-255 | A Minor Reason Code. The list of valid Minor Reason Codes and their meaning is defined in Table 10. |

6 Table 10 lists the valid values for the Minor Reason Code field and
7 corresponding descriptions.

8 **Table 10—Minor Reason Code definitions**

| Minor Reason Code | Description |
|---|---|
| 0 | Reserved |
| 1 | Disassociated/deauthenticated from the WLAN AP because the Cross Connection capability bit is 1 and this capability within this device is outside the IT defined policy. Note: this may be the returned reason code independent of the value of the P2P Infrastructure Managed capability setting. |
| 2 | Disassociated/deauthenticated from the WLAN AP because the P2P Infrastructure Managed bit is 0. |
| 3 | Disassociated/deauthenticated from the WLAN because a P2P Concurrent Device is not setting P2P Coexistence Parameters within the IT defined policy; this applies to either primary or secondary P2P Coexistence Parameters. |
| 4 | Disassociated/deauthenticated from the WLAN AP because the P2P Device has included the P2P IE with the P2P Infrastructure Managed bit set to 1 and P2P operation within this device is outside the IT defined policy. |
| 5-255 | Reserved. |

1 The inclusion of the Minor Reason Code attribute in Deauthentication and
2 Disassociation frames by the WLAN infrastructure is described in §3.4.3.

3 **4.1.4 P2P Capability attribute**

4 The P2P Capability attribute contains a set of parameters that can be used to
5 establish a P2P connection. The format of the P2P Capability attribute is shown
6 in Table 11.

7 **Table 11—P2P Capability attribute format**

| Field | Size (octets) | Value | Description |
|---|---|---|---|
| Attribute ID | 1 | 2 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | 2 | Length of the following fields in the attribute. |
| Device Capability Bitmap | 1 | variable | A set of parameters indicating P2P Device's capabilities, as defined in Table 12. |
| Group Capability Bitmap | 1 | variable | A set of parameters indicating the current state of a P2P Group, as defined in Table 13. |

8 The format of the Device Capability Bitmap field is described in Table 12.

9 **Table 12—Device Capability Bitmap definition**

| Bit(s) | Information | Notes |
|---|---|---|
| 0 | Service Discovery | The Service Discovery field shall be set to 1 if the P2P Device supports Service Discovery, and is set to 0 otherwise. |
| 1 | P2P Client Discoverability | Within a P2P Group Info attribute and a (Re)association request frame the P2P Client Discoverability field shall be set to 1 when the P2P Device supports P2P Client Discoverability, and is set to 0 otherwise. This field shall be reserved and set to 0 in all other frames or uses. |
| 2 | Concurrent Operation | The Concurrent Operation field shall be set to 1 when the P2P Device supports Concurrent Operation with WLAN, and is set to 0 otherwise. |
| 3 | P2P Infrastructure Managed | The P2P Infrastructure Managed field shall be set to 1 when the P2P interface of the P2P Device is capable of being managed by the WLAN (infrastructure network) based on P2P Coexistence Parameters, and set to 0 otherwise. |

| Bit(s) | Information | Notes |
|---|---|---|
| 4 | P2P Device Limit | The P2P Device Limit field shall be set to 1 when the P2P Device is unable to participate in additional P2P Groups, and set to 0 otherwise. |
| 5 | P2P Invitation Procedure | The P2P Invitation Procedure field shall be set to 1 if the P2P Device is capable of processing P2P Invitation Procedure signaling, and set to 0 otherwise. |
| 6 – 7 | Reserved | — |

1    The format of the Group Capability Bitmap field is described in Table 13.

2                        **Table 13—Group Capability Bitmap definition**

| Bit(s) | Information | Notes |
|---|---|---|
| 0 | P2P Group Owner | The P2P Group Owner field shall be set to 1 when the P2P Device is operating as a Group Owner, and set to 0 otherwise. |
| 1 | Persistent P2P Group | The Persistent P2P Group field shall be set to 1 when the P2P Device is hosting, or intends to host, a persistent P2P Group, and set to 0 otherwise. |
| 2 | P2P Group Limit | The P2P Group Limit field shall be set to 1 when the P2P Group Owner is unable to add additional Clients to its P2P Group, and set to 0 otherwise. |
| 3 | Intra-BSS Distribution | The Intra-BSS Distribution field shall be set to 1 if the P2P Device is hosting, or intends to host, a P2P Group that provides a data distribution service between Clients in the P2P Group. The Intra-BSS Distribution field shall be set to 0, if the P2P Device is not a P2P Group Owner, or is not providing such a data distribution service. |
| 4 | Cross Connection | The Cross Connection field shall be set to 1 if the P2P Device is hosting, or intends to host, a P2P Group that provides cross connection between the P2P Group and a WLAN. The Cross Connection field shall be set to 0 if the P2P Device is not a P2P Group Owner, or is not providing a cross connection service. |
| 5 | Persistent Reconnect | The Persistent Reconnect field shall be set to 1 when the P2P Device is hosting, or intends to host, a persistent P2P Group that allows reconnection without user intervention, and set to 0 otherwise. |
| 6 | Group Formation | The Group Formation field shall be set to 1 when the P2P Device is operating as a Group Owner in the Provisioning phase of Group Formation, and set to 0 otherwise. |

| Bit(s) | Information | Notes |
|--------|-------------|-------|
| 7 | Reserved | |

1  The P2P Capability attribute shall be included in Beacon frames, as described
2  in §4.2.1, Probe Request frames, as described in §4.2.2, Probe Response
3  frames, as described in §4.2.3, GO Negotiation Request frames, as described
4  in §4.2.8.2, GO Negotiation Response frames, as described in §4.2.8.3, GO
5  Negotiation Confirmation frames, as described in §4.2.8.4, (Re)association
6  Request frames, as described in §4.2.4 and Provision Discovery Request
7  frames, as described in §4.2.8.9. The Group Capability Bitmap field in the P2P
8  Capability attribute shall be reserved in Probe Request frames, and in Probe
9  Response frames that are transmitted by a P2P Device that is not a Group
10  Owner. The Group Capability Bitmap field in the P2P Capability attribute is used
11  when associating with a WLAN AP that includes P2P IE in Beacon and Probe
12  Response frames; otherwise, it shall be reserved when the P2P Capability
13  attribute is included in the (Re)association Request frames. The use of the P2P
14  Capability attribute is described in §3.1.2.

## 4.1.5 P2P Device ID attribute

16  The P2P Device ID attribute contains P2P Device Address. The format of the
17  P2P Device ID attribute is shown in Table 14.

18  **Table 14—P2P Device ID attribute format**

| Field Name | Size (octets) | Value | Description |
|------------|---------------|-------|-------------|
| Attribute ID | 1 | 3 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | 6 | Length of the following fields in the attribute. |
| P2P Device Address | 6 | — | An identifier used to uniquely reference a P2P Device. |

19  The P2P Device ID attribute shall be present in the P2P IE in the Beacon frame,
20  as described in §4.2.1 and the Device Discoverability Request frame, as
21  described in §4.2.8.7.

## 4.1.6 Group Owner Intent attribute

23  The Group Owner Intent attribute contains intent value of a P2P Device's
24  willingness of being the P2P Group Owner. The format of the Group Owner
25  Intent attribute is shown in Table 15.

1    **Table 15—Group Owner Intent attribute format**

| Field | Size (octets) | Value | Description |
|---|---|---|---|
| Attribute ID | 1 | 4 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | 1 | Length of the following fields in the attribute. |
| GO Intent | 1 | Variable | Information that is used to decide which P2P Device will be the P2P Group Owner. See Table 16. |

2    The Group Owner Intent attribute shall be included in GO Negotiation Request
3    frames, as described in §4.2.8.2, and GO Negotiation Response frames, as
4    described in §4.2.8.3. The use of the Group Owner Intent attribute is described
5    in §3.1.4.

6    **Table 16—GO Intent field definition**

| Bit(s) | Information | Value | Notes |
|---|---|---|---|
| 0 | Tie breaker | 0 or 1 | Indicates which device becomes the GO when the Intent values are the same. |
| 1 – 7 | Intent | 0 – 15 | Relative value between 0 and 15 used to indicate the desire of the P2P Device to be the P2P Group Owner, with a larger value indicating a higher desire. |

7

8    ### 4.1.7   Configuration Timeout attribute

9    The Configuration Timeout attribute contains details on the time required by the
10   P2P Device to change from its current mode of operation into P2P Group
11   Owner or P2P Client mode. The format of the Configuration Timeout attribute is
12   shown in Table 17.

13    **Table 17—Configuration Timeout attribute format**

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| Attribute ID | 1 | 5 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | 2 | Length of the following fields in the attribute. |
| GO Configuration Timeout | 1 | 0-255 | Time needed by the device to get configured and function as a GO in units of 10 milliseconds. |

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| Client Configuration Timeout | 1 | 0-255 | Time needed by the device to get configured and function as a P2P Client in units of 10 milliseconds. |

1      The Configuration Timeout attribute shall be present in the P2P IE in GO
2      Negotiation Request and Response frames, as described in §3.1.4. The
3      Configuration Timeout attribute shall be present in P2P Invitation Request and
4      Response frames, as described in §3.1.5.

5    ## 4.1.8 Listen Channel attribute

6      The Listen Channel attribute contains the Listen Channel and Operating Class
7      information. The format of the Listen Channel attribute is shown in Table 18.

8                  **Table 18—Listen Channel attribute format**

| Field | Size (octets) | Value | Description |
|---|---|---|---|
| Attribute ID | 1 | 6 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | 5 | Length of the following fields in the attribute. |
| Country String | 3 | | The Country String field is set to the value contained in the dot11CountryString attribute in [13], specifying the country code in which the Operating Class and Channel Number fields are valid. The third octet of the Country String field is set to x"04" to indicate that Table J-4 is used. |
| Operating Class | 1 | As defined in [13] Annex J | Indicating the frequency band at which the P2P Device is in the Listen State. |
| Channel Number | 1 | As defined in [13] Annex J | Indicating the channel number on which the P2P Device is in the Listen State. |

9      The Listen Channel attribute shall be included in Probe Request frames, as
10    described in §4.2.2, and GO Negotiation Request frames, as described in
11    §4.2.8.2.

12    ## 4.1.9 P2P Group BSSID attribute

13      The P2P Group BSSID attribute contains the BSSID used by a P2P Group
14    Owner for a P2P Group. The format of the P2P Group BSSID attribute is shown
15    in Table 19.

1    **Table 19—P2P Group BSSID attribute format**

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| Attribute ID | 1 | 7 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | 6 | Length of the following fields in the attribute. |
| P2P Group BSSID | 6 | variable | BSSID used by a P2P Group Owner for a P2P Group. |

2    The P2P Group BSSID attribute shall be included in the P2P Invitation Request
3    frames, as described in §4.2.8.5, and P2P Invitation Response frames as
4    described in §4.2.8.6.

5    ## 4.1.10  Extended Listen Timing attribute

6    The Extended Listen Timing attribute may be used by a P2P Device to
7    communicate the Listen State availability timing it uses in a discoverable state.
8    A P2P Device may also use the Extended Listen Timing Element to suggest a
9    desirable Listen State Timing to a P2P Device that is a P2P Group Owner for a
10   Persistent P2P Group. The format of the Extended Listen Timing attribute is
11   shown in Table 20.

12   **Table 20—Extended Listen Timing attribute format**

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| Attribute ID | 1 | 8 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | 4 | Length of the following fields in the attribute. |
| Availability Period | 2 | 1-65535 | The minimum period of continuous availability in Listen State in milliseconds. Availability Period shall be reserved and set to 0 in (Re)association Request frames. See note. |
| Availability Interval | 2 | 1-65535 | The interval between the start of periods of continuous availability in Listen State in units of milliseconds. See note. |

13   Note — A P2P Device using the Extended Listen Timing attribute to communicate that
14   it is continuously available (in Listen State) shall set both Availability Period and
15   Availability Interval to 65535.

16   The Extended Listen Timing attribute may be present in the P2P IE in Probe
17   Request, Probe Response, GO Negotiation Request and (Re)Association

1       Response frames transmitted by a P2P Device to indicate the Extended Listen
2       Timing of the P2P Device. The Extended Listen Timing attribute may be present
3       in the P2P IE in (Re)association Request frames transmitted by a P2P Device
4       to indicate the Extended Listen Timing desired of a Persistent P2P Group
5       Owner.

6   **4.1.11 Intended P2P Interface Address attribute**

7       The Intended P2P Interface Address attribute contains the P2P Interface Device
8       a P2P Device intends to use in a P2P Group. The format of the Intended P2P
9       Interface Address attribute is shown in Table 21.

10         **Table 21—Intended P2P Interface Address attribute format**

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| Attribute ID | 1 | 9 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | 6 | Length of the following fields in the attribute. |
| P2P Interface Address | 6 | variable | P2P Interface Address intended to be used in a P2P Group. |

11       The Intended P2P Interface Address attribute shall be present in the P2P IE in
12       GO Negotiation Request and Response frames, as described in §3.1.4.

13   **4.1.12 P2P Manageability attribute**

14       The P2P Manageability attribute contains infrastructure manageability
15       information from the WLAN AP to a scanning or associating WLAN STA, which
16       may or may not be a P2P Device. The format of the P2P Manageability attribute
17       is shown in Table 22.

18         **Table 22—P2P Manageability attribute format**

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| Attribute ID | 1 | 10 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | 1 | Length of the following fields in the attribute. |
| Manageability Bitmap field | 1 | See Table 23 | Identifying the WLAN AP's P2P Manageability. |

1          **Table 23—Manageability Bitmap field format**

| Bit | Description |
|-----|-------------|
| B0 | P2P Device Management |
| B1 | Cross Connection Permitted |
| B2 | Coexistence Optional |
| B3–B7 | Reserved |

2   The P2P Device Management field set to 1 indicates that the WLAN AP
3   supports Managed P2P Device. The P2P Device Management field set to 0
4   indicates that the WLAN has no desire to manage P2P Devices.

5   The Cross Connection Permitted field set to 1 indicates that the WLAN AP
6   permits P2P Concurrent Devices to offer cross connection. The Cross
7   Connection Permitted field set to 0 indicates that the WLAN AP does not permit
8   P2P Devices that the WLAN AP determines are P2P Concurrent Devices to
9   offer cross connection. See §3.4.3.

10  The Coexistence Optional field set to 1 indicates that the Primary P2P
11  Coexistence Parameters and recommended (see Table 2) Secondary P2P
12  Coexistence Parameters advertised by the WLAN AP are not required. The
13  Coexistence Optional field set to 0 indicates that the Primary P2P Coexistence
14  Parameters and recommended Secondary P2P Coexistence Parameters
15  advertised by the WLAN AP are required for P2P Devices that the WLAN AP
16  determines are P2P Concurrent Devices in order to remain associated to the
17  WLAN. See §3.4.3.

18  The P2P Manageability attribute shall be included in Beacon, Probe Response,
19  and (Re)association Response frames that are transmitted by the WLAN AP as
20  described in §3.4.1.

## 21  4.1.13  Channel List attribute

22  The Channel List attribute contains a list of Operating Class and Channel pair
23  information. The format of the Channel List attribute is shown in Table 24.

24          **Table 24—Channel List attribute format**

| Field | Size (octets) | Value | Description |
|-------|---------------|-------|-------------|
| Attribute ID | 1 | 11 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | variable | Length of the following fields in the attribute. |

| Field | Size (octets) | Value | Description |
|---|---|---|---|
| Country String | 3 | | The Country String field is set to the value contained in the dot11CountryString attribute in [13], specifying the country code in which the Channel Entry List is valid. The third octet of the Country String field is set to x"04" to indicate that Table J-4 is used. |
| Channel Entry List | variable | | Including one or more Channel Entries. The format of Channel Entry field is shown in Table 25. |

1 **Table 25—Channel Entry field format**

| Field | Size (octets) | Value | Description |
|---|---|---|---|
| Operating Class | 1 | As defined in [13] Annex J | The Operating Class field contains an enumerated value from Annex J, specifying the operating class in which the Channel List is valid. |
| Number of Channels | 1 | | Indicating the number of channels contained in the Channel List field. |
| Channel List | variable | As defined in [13] Annex J | The Channel List field contains a variable number of octets, where each octet describes a single channel number. Channel numbering is dependent on Operating Class according to Annex J [13]. |

2 The Channel List attribute shall be included in GO Negotiation Request frames,
3 as described in §4.2.8.2, GO Negotiation Response frames, as described in
4 §4.2.8.3, GO Negotiation Confirmation frames, as described in §4.2.8.4, P2P
5 Invitation Request frames, as described in §4.2.8.5, and P2P Invitation
6 Response frames, as described in §4.2.8.6.

7 **4.1.14 Notice of Absence attribute**

8 The Notice of Absence attribute is used by the P2P Group Owner to signal its
9 absence due to power save timing, concurrent operation, or off-channel
10 scanning. It is also used in the P2P Presence Request-Response mechanism.
11 The format of the Notice of Absence attribute is shown in Table 26.

12 **Table 26—Notice of Absence attribute format**

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| Attribute ID | 1 | 12 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| Length | 2 | n*(13)+2 | Length of the P2P Notice of Absence attribute body in octets |
| Index | 1 | 0 – 255 | Identifies an instance of Notice of Absence timing. |
| CTWindow and OppPS Parameters | 1 | — | Parameters indicating P2P Group Owner's availability window and opportunistic power save capability – see Table 27. |
| Notice of Absence Descriptor(s) | n*13 | — | Zero or more Notice of Absence Descriptors each defining a Notice of Absence timing schedule – see Table 28. |

1  The format of the CTWindow and OppPS Parameters field is described in Table
2  27.

3  **Table 27— CTWindow and OppPS Parameters field format**

| Bit | Subfield | Notes |
|---|---|---|
| 7 | OppPS | Set to 1 to indicate that the P2P Group Owner is using opportunistic power save. Set to 0 if opportunistic power save is disabled. The CTWindow field shall be non-zero when the OppPS bit is set to 1. |
| | | Set to 0 in Notice of Absence attributes transmitted by a P2P Client in a P2P Presence Request frame. |
| 0-6 | CTWindow | Client Traffic Window (CTWindow). A period of time in TU after a TBTT during which the P2P Group Owner is present. 0 indicates that there shall be no CTWindow. |
| | | Set to 0 in Notice of Absence attributes transmitted by a P2P Client in a P2P Presence Request frame. |

4  The format of the Notice of Absence Descriptor is shown in Table 28.

1 **Table 28—Notice of Absence Descriptor format**

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| Count/Type | 1 | 1 – 255 | Count in Notice of Absence Descriptors sent by a P2P Group Owner; indicates the number of absence intervals. 255 shall mean a continuous schedule; 0 is reserved and shall not be used. |
|  |  |  | Type in Notice of Absence Descriptors sent by a P2P Client in a P2P Presence Request; qualifies the Duration and Interval fields. A Type value of 1 shall indicate preferred values, a Type value of 2 shall indicate acceptable limits. |
| Duration | 4 | — | In Notice of Absence Descriptors sent by a P2P Group Owner; indicates the maximum duration in units of microseconds that the P2P Group Owner can remain absent following the start of a Notice of Absence interval. |
|  |  |  | In Notice of Absence Descriptors sent by a P2P Client in a P2P Presence Request; indicates a preferred, or minimum acceptable presence period duration. |
| Interval | 4 | — | In Notice of Absence Descriptors sent by a P2P Group Owner; indicates the length of the Notice of Absence interval in units of microseconds. |
|  |  |  | In Notice of Absence Descriptors sent by a P2P Client in a P2P Presence Request; indicates a preferred, or maximum acceptable interval between presence periods. |
| Start Time | 4 | — | The start time for the schedule expressed in terms of the lower 4 bytes of the TSF timer. |
|  |  |  | The Start Time field is reserved and shall be set to 0 on transmission and ignored on reception in Notice of Absence attributes transmitted by a P2P Client. |

2 The Notice of Absence attribute shall be present in the P2P IE in the Beacon
3 frames and Probe Response frames transmitted by a P2P Group Owner when a
4 Notice of Absence schedule is being advertised or when the CTWindow is non-
5 zero, as described in §4.2.1 and §4.2.3. If there is neither a Notice of Absence
6 schedule nor a CTWindow, the GO may omit the Notice of Absence attribute
7 from Beacon and Probe Response frames. The Notice of Absence shall be also
8 present in Notice of Absence frames, as described in §4.2.9.2, P2P Presence
9 Request frames, as described in §4.2.9.3, and P2P Presence Response frames,
10 as described in §4.2.9.4.

11 **4.1.15 P2P Device Info attribute**

12 The P2P Device Info attribute contains information on a P2P Device. The format
13 of the P2P Device Info attribute is shown in Table 29.

1                              **Table 29—Device Info attribute format**

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| Attribute ID | 1 | 13 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | variable | Length of the following fields in the attribute. |
| P2P Device address | 6 | — | An identifier used to uniquely reference a P2P Device. |
| Config Methods | 2 | As defined in [6] | The WSC Methods that are supported by this device e.g. PIN from a Keypad, PBC etc. Contains only the Data part of the WSC Config Methods attribute (see [6]).<br>Note — Byte ordering within the Config Methods field shall be big-endian. |
| Primary Device Type | 8 | As defined in Annex B | Primary Device Type of the P2P Device (see Annex B). Contains only the Data part of the WSC Primary Device Type attribute (excludes the Attribute ID and Length fields).<br>Note — Byte ordering within the Primary Device Type field shall be big-endian. |
| Number of Secondary Device Types | 1 | variable | Indicating number of Secondary Device Types in the Secondary Device Type List field. This field set to 0 indicates no Secondary Device Type List. |
| Secondary Device Type List | variable | 8*n | List of Secondary Device Types of the P2P Client (see [6]). This field is optional. This field is present only if the Number of Secondary Device Types field is not 0 and contains only the Data part of the WSC Secondary Device Type List attribute (excludes the Attribute ID and Length fields).<br>Note — Byte ordering within the Secondary Device Type List field shall be big-endian. |
| Device Name | Variable | As defined in [6] | Friendly name of the P2P Device. Contains the entire WSC Device Name attribute in TLV format (see [6]).<br>Note — Byte ordering within the Device Name field shall be big-endian. |

2          The P2P Device Info attribute shall be included in the (Re)association Request
3          frame as described in §4.2.4, the Probe Response frame as described in §4.2.3,
4          the GO Negotiation Request frame as described in §4.2.8.2, the GO Negotiation
5          Response frame as described in §4.2.8.3 and the Provision Discovery Request
6          frame as described in §4.2.8.9.

1 **4.1.16 P2P Group Info attribute**

2    The P2P Group Info attribute contains device information of P2P Clients that
3    are members of the P2P Group. The format of the P2P Group Info attribute is
4    shown in Table 30.

5                          **Table 30—P2P Group Info attribute format**

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| Attribute ID | 1 | 14 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | variable | Length of the following fields in the attribute. |
| P2P Client Info Descriptor(s) | Sum of all P2P Client Info Descriptor(s) | — | List of P2P Client Info Descriptor(s) for P2P Devices associated with this P2P Group Owner (see Table 31). |

6    The format of the P2P Client Info Descriptor is shown in Table 31.

7                          **Table 31—P2P Client Info Descriptor format**

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| Length | 1 | variable | Length of the following fields. |
| P2P Device address | 6 | — | An identifier used to uniquely reference a P2P Device. |
| P2P Interface address | 6 | — | An address used to identify a P2P Device within a P2P Group. |
| Device Capability Bitmap | 1 | variable | A set of parameters indicating P2P Device's capabilities, as defined in Table 12. |
| Config Methods | 2 | As defined in [6] | The WSC Methods that are supported by this device e.g. PIN from a Keypad, PBC etc. Contains only the Data part of the WSC Config Methods attribute (see [6]). Note — Byte ordering within the Config Methods field shall be big-endian. |
| Primary Device Type | 8 | As defined in Annex B | Primary Device Type of the P2P Client (see Annex B). Contains only the Data part of the WSC Primary Device Type attribute (excludes the Attribute ID and Length fields). Note — Byte ordering within the Primary Device Type field shall be big-endian. |

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| Number of Secondary Device Types | 1 | variable | Indicating number of Secondary Device Types in the Secondary Device Type List field. This field set to 0 indicates no Secondary Device Type List. |
| Secondary Device Type List | variable | 8*n | List of Secondary Device Types of the P2P Client (see [6]). This field is optional. This field is present only if the Number of Secondary Device Types field is not 0 and contains only the Data part of the WSC Secondary Device Type List attribute (excludes the Attribute ID and Length fields).<br><br>Note — Byte ordering within the Secondary Device Type List field shall be big-endian. |
| Device Name | variable | As defined in [6] | Friendly name of the P2P Client. Contains the entire WSC Device Name attribute in TLV format (see [6]).<br><br>Note — Byte ordering within the Device Name field shall be big-endian. |

1 The P2P Group Info attribute shall be included in the Probe Response frame
2 transmitted by a P2P Group Owner unless there are zero connected P2P
3 Clients, as described in §4.2.3.

4 **4.1.17 P2P Group ID attribute**

5 The P2P Group ID attribute contains a unique P2P Group identifier of the P2P
6 Group. The format of the P2P Group ID attribute is shown in Table 32.

7 **Table 32—P2P Group ID attribute format**

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| Attribute ID | 1 | 15 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | 6 – 38 | Length of the following fields in the attribute. |
| P2P Device address | 6 | — | An identifier used to uniquely reference a P2P Device. |
| SSID | 0 – 32 | — | SSID field of SSID element as described in §7.3.2.1 of [1]. |

8 The P2P Group ID attribute shall be included in the P2P Invitation Request
9 frames, as described in §4.2.8.5.

1 ## 4.1.18 P2P Interface attribute

2 The P2P Interface attribute contains address information of P2P devices. The
3 format of the P2P Interface attribute is shown in Table 33.

4 **Table 33—P2P Interface attribute format**

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| Attribute ID | 1 | 16 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | variable | Length of the following fields in the attribute. |
| P2P Device Address | 6 | — | An identifier used to uniquely reference a P2P Device. |
| P2P Interface Address Count | 1 | 0-41 | Number of P2P Interface Addresses in the P2P Interface Address List field. |
| P2P Interface Address List | (P2P Interface Address Count) x 6 | — | A list of all assigned and non-expired addresses that may be used as P2P Interface Addresses (see §2.4.3) by the P2P device within P2P Groups. |

5 The P2P Interface attribute may be present in the P2P IE in the (Re)association
6 Request frame that is transmitted to the WLAN AP by the WLAN-STA interface
7 of the P2P Device, as described in §3.4.1.

8 ## 4.1.19 Operating Channel attribute

9 The Operating Channel attribute contains Operating Channel and Operating
10 Class information. The format of the Operating Channel attribute is shown in
11 Table 18.

12 **Table 34—Operating Channel attribute format**

| Field | Size (octets) | Value | Description |
|---|---|---|---|
| Attribute ID | 1 | 17 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | 5 | Length of the following fields in the attribute. |
| Country String | 3 | | The Country String field is set to the value contained in the dot11CountryString attribute in [13], specifying the country code in which the Operating Class and Channel Number fields are valid. The third octet of the Country String field is set to x"04" to indicate that Table J-4 is used. |

| Field | Size (octets) | Value | Description |
|---|---|---|---|
| Operating Class | 1 | As defined in [13] Annex J | Indicating the frequency band at which the P2P Device is operating as the P2P Group Owner, or a preferred operating frequency band. |
| Channel Number | 1 | As defined in [13] Annex J | Indicating the channel number on which the P2P Device is operating as the P2P Group Owner, or a preferred operating channel. |

1       The Operating Channel attribute shall be included in Probe Request frames, as
2       described in §4.2.2, GO Negotiation Request frames, as described in §4.2.8.2,
3       GO Negotiation Response frames, as described in §4.2.8.3, GO Negotiation
4       Confirmation frames, as described in §4.2.8.4, P2P Invitation Request frames,
5       as described in §4.2.8.5, and P2P Invitation Response frames, as described in
6       §4.2.8.6.

## 7   4.1.20   Invitation Flags attribute

8       The Invitation Flags attribute contains flags used in the P2P Invitation procedure.
9       The format of the Invitation Flags attribute is shown in Table 11.

10       **Table 35—Invitation Flags attribute format**

| Field | Size (octets) | Value | Description |
|---|---|---|---|
| Attribute ID | 1 | 18 | Identifying the type of P2P attribute. The specific value is defined in Table 6. |
| Length | 2 | 1 | Length of the following fields in the attribute. |
| Invitation Flags Bitmap | 1 | variable | A set of flags used in the P2P Invitation procedure, as defined in Table 36. |

11       The format of the Invitation Flags Bitmap field is described in Table 36.

12       **Table 36—Invitation Flags Bitmap definition**

| Bit | Information | Notes |
|---|---|---|
| 0 | Invitation Type | Differentiates between uses of P2P Invitation Request. Set to 1 to indicate a P2P Invitation Request to re-invoke a Persistent Group, set to 0 to indicate a P2P Invitation Request to join an active P2P Group. |
| 1 – 7 | Reserved | — |

1  The Invitation Flags attribute shall be included in P2P Invitation Request frames,
2  as described in §4.2.8.5.

## 4.2 Management Frames

4  This section defines extensions to 802.11 management frames in support of
5  P2P capabilities.

### 4.2.1 Beacon frame format

7  One or more P2P IEs and the WSC IE shall be inserted after other information
8  elements in the Beacon frames transmitted by a P2P Group Owner. P2P
9  attributes for a P2P IE that is included in the Beacon frame are shown in Table
10  37.

11                      **Table 37—P2P attributes in the Beacon frame**

| Attributes | Attribute ID | Note |
|---|---|---|
| P2P Capability | 2 | The P2P Capability attribute shall be present in the P2P IE. |
| P2P Device ID | 3 | The P2P Device ID attribute shall be present in the P2P IE. |
| Notice of Absence | 12 | The Notice of Absence attribute shall be present in the P2P IE in the Beacon frames transmitted by a P2P Group Owner when a Notice of Absence schedule is being advertised (see §3.3.3.2), or when the CTWindow is non-zero (see §3.3.2). |

### 4.2.2 Probe Request frame format

13  The Probe Request frames can be transmitted by any P2P Device.

14  One or more P2P IEs and the WSC IE shall be inserted after other information
15  elements in the Probe Request frames transmitted by a P2P Device as shown
16  in Table 38.

17                      **Table 38—Probe Request frame format**

| Order | Information Element | Note |
|---|---|---|
|  | WSC IE | The WSC IE shall be present in the frames transmitted by a P2P Device. |
| Last | P2P IE | The P2P IE shall be present in the frames transmitted by a P2P Device. |

1　Additional attributes shall be inserted in the WSC IE that is included in the
2　Probe Request frame as shown in Table 39.

3　**Table 39—Additional attributes in WSC IE in the Probe Request frame**

| Attributes | Required/ Optional | Note |
|---|---|---|
| Device Name | Required | The Device Name attribute shall be present in WSC IE in the Probe Request frame that is transmitted by a P2P Device. |
| Requested Device Type | Optional | The Requested Device Type attribute may be present in WSC IE in the Probe Request frame that is transmitted by a P2P Device. |

4　P2P attributes for a P2P IE that is included in the Probe Request frame are
5　shown in Table 40.

6　**Table 40—P2P attributes in the Probe Request frame**

| Attributes | Attribute ID | Note |
|---|---|---|
| P2P Capability | 2 | The P2P Capability attribute shall be present in the P2P IE. |
| P2P Device ID | 3 | The P2P Device ID attribute may be present in the Probe Request frame when using the discovery protocol to find a P2P Device with a specific Device Address. |
| Listen Channel | 6 | The Listen Channel attribute shall be present in the P2P IE indicating the operating class and channel number on which the P2P Device is in the Listen State. If the P2P Device has not selected a Listen Channel, the Listen Channel attribute shall be omitted. |
| Extended Listen Timing | 8 | The Extended Listen Timing attribute may be present in the P2P IE to advertise Listen State availability of the P2P Device sending the Probe Request. |
| Operating Channel | 17 | The Operating Channel attribute shall only be present in the P2P IE if the P2P Device is an operating P2P Group Owner and indicates the operating class and channel number on which the P2P Device is operating as P2P Group Owner. |

1  **4.2.3   Probe Response frame format**

2  The Probe Response frames can be transmitted by a P2P Device either in its
3  Operating Channel or Listen Channel.

4  One or more P2P IEs and the WSC IE shall be inserted after other information
5  elements in Probe Response frames transmitted by a P2P Device. P2P
6  attributes for a P2P IE that is included in the Probe Response frame are shown
7  in Table 41.

8  **Table 41—P2P attributes in the Probe Response frame**

| Attributes | Attribute ID | Note |
|---|---|---|
| P2P Capability | 2 | The P2P Capability attribute shall be present in the P2P IE. |
| Extended Listen Timing | 8 | The Extended Listen Timing attribute may be present in the P2P IE. |
| Notice of Absence | 12 | The Notice of Absence attribute shall only be present in the P2P IE in the Probe Response frames transmitted by a P2P Group Owner when a Notice of Absence schedule (see §3.3.3.2) or non-zero CTWindow (see §3.3.2) is being advertised in the Beacon frames (see §3.3.3.2). |
| P2P Device Info | 13 | The P2P Device Info attribute shall be present in the P2P IE to indicate the P2P Device information. |
| P2P Group Info | 14 | The P2P Group Info attribute shall only be present in the P2P IE in the Probe Response frame that is transmitted by a P2P Group Owner. The P2P Group Info attribute shall be omitted if there are zero connected P2P Clients. |

9  **4.2.4   Association/Reassociation Request frame format**

10  One or more P2P IEs shall be inserted after other information elements in the
11  Association Request or Reassociation Request frame transmitted by a P2P
12  Device.

13  P2P attributes for a P2P IE that is included in the Association Request or
14  Reassociation Request frame Response frames sent to a P2P Device are
15  shown in Table 42.

16  **Table 42—P2P attributes in the Association/Reassociation Request frame**

| Attributes | Attribute ID | Note |
|---|---|---|
| P2P Capability | 2 | The P2P Capability attribute shall be present in the P2P IE. |

| Attributes | Attribute ID | Note |
|---|---|---|
| Extended Listen Timing | 8 | The Extended Listen Timing attribute may be present in the P2P IE in Association Request or Reassociation Request frames transmitted by a P2P Client. |
| P2P Device Info | 13 | The P2P Device Info attribute shall be present in the P2P IE. |

1   P2P attributes for a P2P IE that is included in the Association Request or
2   Reassociation Request frame Response frames sent to a WLAN AP by the
3   WLAN-STA interface of a Managed P2P Device are shown in Table 43.

4   **Table 43—P2P attributes in the Association/Reassociation Request**
5   **frame sent to a WLAN AP by a Managed P2P Device**

| Attributes | Attribute ID | Note |
|---|---|---|
| P2P Capability | 2 | The P2P Capability attribute shall be present in the P2P IE. |
| P2P Interface | 16 | The P2P Interface attribute shall be present in the P2P IE if the Managed P2P Device is a P2P Concurrent Device. |

6   ## 4.2.5   Association/Reassociation Response frame format

7   One or more P2P IEs shall be inserted after other information elements in the
8   Association Response or Reassociation Response frame transmitted by a P2P
9   Device. P2P attributes for a P2P IE that is included in the Association Response
10  or Reassociation Response frames are shown in Table 44.

11  **Table 44—P2P attributes in the Association/Reassociation Response frame**

| Attributes | Attribute ID | Note |
|---|---|---|
| Status | 0 | The Status attribute shall be present in the P2P IE to provide status information when a (Re) association Request frame is denied. |
| Extended Listen Timing | 8 | The Extended Listen Timing attribute may be present in the P2P IE in Association Response or Reassociation Response frames transmitted by a P2P Group Owner. |

1 Note — At least one P2P IE is always included in the Association/Reassociation
2 Response frame. If neither P2P attribute is required according to the conditions in
3 Table 44, then a P2P IE containing no P2P attributes is included.

## 4.2.6 Deauthentication frame format

5 A P2P IE containing the P2P attributes in Table 45 may be included in a
6 Deauthentication frame transmitted by a WLAN AP that is capable of managing
7 P2P Devices.

8 **Table 45—P2P attributes in the Deauthentication frame**

| Attributes | Attribute ID | Note |
|---|---|---|
| Minor Reason Code | 1 | The Minor Reason Code attribute shall be present in the P2P IE. |

## 4.2.7 Disassociation frame format

10 A P2P IE containing the P2P attributes in Table 46 may be included in a
11 Disassociation frame transmitted by a WLAN AP that is capable of managing
12 P2P Devices.

13 **Table 46—P2P attributes in the Disassociation frame**

| Attributes | Attribute ID | Note |
|---|---|---|
| Minor Reason Code | 1 | The Minor Reason Code attribute shall be present in the P2P IE. |

## 4.2.8 P2P public action frames

### 4.2.8.1 General format

16 The Public Action frame format (as defined in IEEE Std 802.11k [2]) is used to
17 define the P2P public action frames in this specification. The general format of
18 the P2P public action frames is shown in Table 47.

19 **Table 47—General format of P2P public action frame**

| Field | Size (octets) | Value (Hexadecimal) | Description |
|---|---|---|---|
| Category | 1 | 0x04 | IEEE 802.11 public action usage. |
| Action field | 1 | 0x09 | IEEE 802.11 vendor specific usage. |
| OUI | 3 | 50 6F 9A | WFA specific OUI. |

| Field | Size (octets) | Value (Hexadecimal) | Description |
|---|---|---|---|
| OUI type | 1 | 0x09 (to be assigned) | Identifying the type or version of action frame. Setting to 09 indicates WFA P2P v1.0. |
| OUI Subtype | 1 | | Identifying the type of P2P public action frame. The specific value is defined in Table 48. |
| Dialog Token | 1 | | Set to a nonzero value to identify the request/response transaction. |
| Elements | variable | | Including P2P IE or any information elements defined in IEEE Std 802.11-2007 [1]. |

1 **Table 48—P2P public action frame type**

| Type | Notes |
|---|---|
| 0 | GO Negotiation Request |
| 1 | GO Negotiation Response |
| 2 | GO Negotiation Confirmation |
| 3 | P2P Invitation Request |
| 4 | P2P Invitation Response |
| 5 | Device Discoverability Request |
| 6 | Device Discoverability Response |
| 7 | Provision Discovery Request |
| 8 | Provision Discovery Response |
| 9 – 255 | Reserved |

2 **4.2.8.2 GO Negotiation Request frame**

3 The GO Negotiation Request frame uses the P2P public action frame format
4 and is transmitted by a P2P Device to another P2P Device to initiate a P2P
5 connection.

6 The Dialog Token field is set to a nonzero value chosen by the P2P Device
7 sending the GO Negotiation Request frame to identify the request/response
8 /confirm transaction.

9 The Elements field in the GO Negotiation Request frame contains a P2P IE and
10 WSC IE. P2P attributes for a P2P IE that is included in the GO Negotiation
11 Request frame are shown in Table 49.

1           **Table 49—P2P attributes in the GO Negotiation Request frame**

| Attributes | Attribute ID | Note |
|---|---|---|
| P2P Capability | 2 | The P2P Capability attribute shall be present in the P2P IE. |
| Group Owner Intent | 4 | The Group Owner Intent attribute shall be present in the P2P IE. |
| Configuration Timeout | 5 | The Configuration Timeout attribute shall be present in the P2P IE. |
| Listen Channel | 6 | The Listen Channel attribute shall be present in the P2P IE. |
| Extended Listen Timing | 8 | The Extended Listen Timing attribute may be present in the P2P IE to advertise Listen State availability of the P2P Device sending the GO Negotiation Request, |
| Intended P2P Interface Address | 9 | The Intended P2P Interface Address attribute shall be present in the P2P IE. |
| Channel List | 11 | The Channel List attribute shall be present in the P2P IE. |
| P2P Device Info | 13 | The P2P Device Information attribute shall be present in the P2P IE. |
| Operating Channel | 17 | The Operating Channel attribute shall be present in the P2P IE. |

2           The WSC IE that is included in the GO Negotiation Request frame contains the
3           Device Password ID and other attributes as shown in Table 50. The value of
4           Device Password ID attribute shall be set to the specific configuration method
5           that the P2P Device is currently using.

6           **Table 50—WSC IE in the GO Negotiation Request frame**

| Attribute | R/O | Allowed Values |
|---|---|---|
| Version | R | 0x10 = version1.0, 0x11 = version 1.1, etc. |
| Device Password ID | R | The value of Device Password ID attribute shall be set to the specific configuration method that the P2P Device is currently using. See §11 of the WSC Specification [6]. |
| <other…> | O | Multiple attributes are permitted. |

1 **4.2.8.3 GO Negotiation Response frame**

2 The GO Negotiation Response frame uses the P2P public action frame format
3 and is transmitted by a P2P Device in response of a GO Negotiation frame.

4 The Dialog Token field is set to a nonzero value received in the GO Negotiation
5 Request frame to identify the request/response/confirm transaction.

6 The Elements field in the GO Negotiation Response frame contains a P2P IE
7 and WSC IE. P2P attributes for a P2P IE that is present in the GO Negotiation
8 Response frame are shown in Table 51.

9 **Table 51—P2P attributes in the GO Negotiation Response frame**

| Attributes | Attribute ID | Note |
|---|---|---|
| Status | 0 | The Status attribute shall be present in the P2P IE. |
| P2P Capability | 2 | The P2P Capability attribute shall be present in the P2P IE. |
| Group Owner Intent | 4 | The Group Owner Intent attribute shall be present in the P2P IE. |
| Configuration Timeout | 5 | The Configuration Timeout attribute shall be present in the P2P IE. |
| Operating Channel | 17 | The Operating Channel attribute may be present in the P2P IE. |
| Intended P2P Interface Address | 9 | The Intended P2P Interface Address attribute shall be present in the P2P IE. |
| Channel List | 11 | The Channel List attribute shall be present in the P2P IE. |
| P2P Device Info | 13 | The P2P Device Information attribute shall be present in the P2P IE. |
| P2P Group ID | 15 | The P2P Group ID attribute shall be present if the P2P Device sending the GO Negotiation Response frame will become P2P Group Owner following Group Owner Negotiation. |

10 The WSC IE that is included in the GO Negotiation Response frame contains
11 the Device Password ID and other attributes as shown in Table 52. The value of
12 Device Password ID attribute shall be set to the specific configuration method
13 that the P2P Device is currently using.

14 **Table 52—WSC IE in the GO Negotiation Response frame**

| Attribute | R/O | Allowed Values |
|---|---|---|
| Version | R | 0x10 = version1.0, 0x11 = version 1.1, etc. |

| Attribute | R/O | Allowed Values |
|---|---|---|
| Device Password ID | R | The value of Device Password ID attribute shall be set to the specific configuration method that the P2P Device is currently using. See §11 of the WSC Specification [6]. |
| <other…> | O | Multiple attributes are permitted. |

1 **4.2.8.4  GO Negotiation Confirmation frame**

2 The GO Negotiation Confirmation frame uses the P2P public action frame
3 format and is transmitted by a P2P Device transmitting the Group Owner
4 Request frame to confirm the negotiation completeness.

5 The Dialog Token field is set to a nonzero value received in the GO Negotiation
6 Response frame to identify the request/response/confirm transaction.

7 The Elements field in the GO Negotiation Confirmation frame contains a P2P IE.
8 P2P attributes for a P2P IE that is included in the GO Negotiation Confirmation
9 frame are shown in Table 53.

10 **Table 53—P2P attributes in the GO Negotiation Confirmation frame**

| Attributes | Attribute ID | Note |
|---|---|---|
| Status | 0 | The Status attribute shall be present in the P2P IE. |
| P2P Capability | 2 | The P2P Capability attribute shall be present in the P2P IE. |
| Operating Channel | 17 | The Operating Channel attribute shall be present in the P2P IE. |
| Channel List | 11 | The Channel List attribute shall be present in the P2P IE. |
| P2P Group ID | 15 | The P2P Group ID attribute shall be present if the P2P Device sending the GO Negotiation Confirmation frame will become P2P Group Owner following Group Owner Negotiation. |

11 **4.2.8.5  P2P Invitation Request frame**

12 The P2P Invitation Request frame uses the P2P public action frame format.

13 The Dialog Token field is set to a nonzero value chosen by the P2P Device
14 sending the P2P Initiation Request frame to identify the request/response
15 transaction.

1  The Elements field in the P2P Invitation Request frame contains a P2P IE. P2P
2  attributes for a P2P IE that is present in the P2P Invitation Request frame are
3  shown in Table 54.

4  **Table 54—P2P attributes in the P2P Invitation Request frame**

| Attributes | Attribute ID | Note |
|---|---|---|
| Configuration Timeout | 5 | The Configuration Timeout attribute shall be present in the P2P IE. |
| Invitation Flags | 18 | The Invitation Flags attribute shall be present in the P2P IE. |
| Operating Channel | 17 | The Operating Channel attribute shall be present in the P2P IE if the P2P Invitation Request frame is transmitted by the P2P Group Owner. The Operating Channel attribute may be present in the P2P IE if the P2P Invitation Request frame is transmitted by a P2P Client. |
| P2P Group BSSID | 7 | The P2P Group BSSID attribute shall be present in the P2P IE if the P2P Invitation Request frame is transmitted by the P2P Group Owner or by a P2P Client if the Invitation Type in the Invitation Flags attribute is 0, indicating a P2P Invitation Request to join an active P2P Group. |
| Channel List | 11 | The Channel List attribute shall be present in the P2P IE. |
| P2P Group ID | 15 | The P2P Group ID attribute shall be present in the P2P IE. |
| P2P Device Info | 13 | The P2P Device Info attribute shall be present in the P2P IE. |

5  **4.2.8.6  P2P Invitation Response frame**

6  The P2P Invitation Response frame uses the P2P public action frame format.

7  The Dialog Token field is set to a nonzero value received in the P2P Invitation
8  Request frame to identify the request/response transaction.

9  The Elements field in the P2P Invitation Response frame contains a P2P IE.
10  P2P attributes for a P2P IE that is present in the P2P Invitation Response frame
11  are shown in Table 55.

12  **Table 55—P2P attributes in the P2P Invitation Response frame**

| Attributes | Attribute ID | Note |
|---|---|---|
| Status | 0 | The Status attribute shall be present in the P2P IE. |

| Attributes | Attribute ID | Note |
|---|---|---|
| Configuration Timeout | 5 | The Configuration Timeout attribute shall be present in the P2P IE. |
| Operating Channel | 17 | The Operating Channel attribute shall be present in the P2P IE if the P2P Invitation Request frame is transmitted by the P2P Group Owner and the Status field is set to "Success". The Operating Channel attribute may be present in the P2P IE if the P2P Invitation Request frame is transmitted by a P2P Client. |
| P2P Group BSSID | 7 | The P2P Group BSSID attribute shall be present in the P2P IE if the P2P Invitation Response frame is transmitted by the P2P Group Owner and the Status field is set to "Success". |
| Channel List | 11 | The Channel List attribute shall be present in the P2P IE if the Status field is set to 'Success'. |

### 4.2.8.7 Device Discoverability Request frame

The Device Discoverability Request frame uses the P2P public action frame format.

The Dialog Token field is set to a nonzero value chosen by the P2P Device sending the Device Discoverability Request frame to identify the request/response transaction.

The Elements field in the Device Discoverability Request frame contains a P2P IE. P2P attributes for a P2P IE that is present in the Device Discoverability Request frame are shown in Table 56.

**Table 56—P2P attributes in the Device Discoverability Request frame**

| Attributes | Attribute ID | Note |
|---|---|---|
| P2P Device ID | 3 | The P2P Device ID attribute shall be present in the P2P IE. |
| P2P Group ID | 15 | The P2P Group ID attribute shall be present in the P2P IE. |

### 4.2.8.8 Device Discoverability Response frame

The Device Discoverability Response frame uses the P2P public action frame format.

The Dialog Token field is set to a nonzero value received in the Device Discoverability Request frame to identify the request/response transaction.

1      The Elements field in the Device Discoverability Response frame contains a
2      P2P IE. P2P attributes for a P2P IE that is present in the Device Discoverability
3      Response frame are shown in Table 57

4      **Table 57—P2P attributes in the Device Discoverability Response frame**

| Attributes | Attribute ID | Note |
|---|---|---|
| Status | 0 | The Status attribute shall be present in the P2P IE. |

5      **4.2.8.9   Provision Discovery Request frame**

6      The Provision Discovery Request frame uses the P2P public action frame
7      format.

8      The Dialog Token field is set to a nonzero value chosen by the P2P Device
9      sending the Provision Discovery Request frame to identify the request/response
10      transaction.

11      The Elements field in the Provision Discovery Request frame contains a P2P IE
12      and WSC IE. P2P attributes for a P2P IE that is included in the Provision
13      Discovery Request frame are shown in Table 58.

14      **Table 58—P2P attributes in the Provision Discovery Request frame**

| Attributes | Attribute ID | Note |
|---|---|---|
| P2P Capability | 2 | The P2P Capability attribute shall be present in the P2P IE. |
| P2P Device Info | 13 | The P2P Device Info attribute shall be present in the P2P IE. |
| P2P Group ID | 15 | The P2P Group ID attribute shall be present in the P2P IE when joining an operating P2P Group. |

15      The Config Methods attribute shall be present in the WSC IE that is included in
16      the Provision Discovery Request frame. A single method shall be set in the
17      Config Methods attribute. The method set in the Config Methods attribute shall
18      indicate which of the receiving P2P Device's configuration methods that the
19      P2P Device intends to use in Provisioning. For example, if the sending P2P
20      Device intends to use a PIN that the receiving P2P Device Displays it shall use
21      the value 'Display'; if the sending P2P Device intends to use a PIN that the user
22      of the receiving P2P Device enters it shall use the value 'Keypad'.

23      **4.2.8.10 Provision Discovery Response frame**

24      The Provision Discovery Response frame uses the P2P public action frame
25      format.

1　The Dialog Token field is set to a nonzero value received in the Provision
2　Discovery Request frame to identify the request/response transaction.

3　The Elements field in the Provision Discovery Response frame contains a single
4　WSC IE.

5　The Config Methods attribute shall be present in the WSC IE that is included in
6　the Provision Discovery Response frame. The value of the Config Methods
7　attribute shall be set to the same value received in the Provision Discovery
8　Request frame to indicate success or shall be null to indicate failure of the
9　request.

10　## 4.2.9　P2P action frames

11　### 4.2.9.1　General format

12　The Vendor Specific action frame format (as defined in IEEE Std 802.11-2007
13　[1]) is used to define the P2P action frames in this specification. The general
14　format of the P2P action frames is shown in Table 59.

15　**Table 59—General format of P2P action frame**

| Field | Size (octets) | Value (Hexadecimal) | Description |
|---|---|---|---|
| Category | 1 | 0x7F | IEEE 802.11 vendor specific usage (IEEE Std 802.11-2007 [1] Table 7-24). |
| OUI | 3 | 50 6F 9A | WFA specific OUI. |
| OUI type | 1 | 0x09 (to be assigned) | Identifying the type or version of action frame. Setting to 09 indicates Wi-Fi P2P v1.0. |
| OUI Subtype | 1 | | Identifying the type of P2P action frame. The specific value is defined in Table 60. |
| Dialog Token | 1 | | When set to a nonzero value, used to identify the request/response transaction. |
| Elements | variable | | Including P2P IE or any information elements defined in IEEE Std 802.11-2007 [1]. |

16　**Table 60—P2P action frame type**

| Type | Notes |
|---|---|
| 0 | Notice of Absence |
| 1 | P2P Presence Request |
| 2 | P2P Presence Response |
| 3 | GO Discoverability Request |

| Type | Notes |
|---|---|
| 4 – 255 | Reserved |

#### 4.2.9.2  Notice of Absence frame

The Notice of Absence P2P action frame uses the P2P Specific Action frame format and may be transmitted by a P2P Group Owner to advertise a Notice of Absence schedule.

The Dialog Token field in a Notice of Absence P2P action frame shall be set to 0 on transmission and ignored on reception.

The Elements field in a Notice of Absence action frame shall contain a P2P IE with a single Notice of Absence attribute.

#### 4.2.9.3  P2P Presence Request frame

The P2P Presence Request action frame uses the P2P Action frame format and may be transmitted by a P2P Client to influence P2P Group Owner power management timing.

The Dialog Token field in a Client P2P action frame shall be set to a non-zero value selected by the P2P Client to identify the P2P Presence Request-Response transaction.

The Elements field in a P2P Presence Request action frame shall contain a P2P IE with a single Notice of Absence attribute describing the requested P2P Group Owner presence timing, see §3.3.4.4.

#### 4.2.9.4  P2P Presence Response frame

The P2P Presence Response P2P action frame uses the P2P Action frame format and is transmitted by a P2P Group Owner in response to a P2P Presence Request frame.

The Dialog Token field in the P2P Presence Response P2P action frame shall be set to the value received in the corresponding P2P Presence Request frame.

The Elements field in a P2P Presence Response frame shall contain a P2P IE with a Status attribute, followed by one Notice of Absence attribute describing the P2P Group Owner power save timing that the P2P Group Owner will use in response to the P2P Presence Request.

#### 4.2.9.5  GO Discoverability Request frame

The GO Discoverability Request P2P action frame uses the P2P Action frame format and is transmitted by a P2P Group Owner to a P2P Client when a P2P Device has sent the P2P Group Owner a P2P Device Discoverability Request frame.

1  The Dialog Token field in the GO Discoverability Request P2P action frame
2  shall be NULL.

3  There is no Elements field in a GO Discoverability Request frame.

4  ## 4.2.10 Service Discovery action frames

5  ### 4.2.10.1 Service Discovery Query frame

6  The Service Discovery Query frame uses the GAS Initial Request action frame
7  (see IEEE P802.11u [4]). This section defines the structure and content of the
8  Vendor-Specific content of this frame. Details on the complete frame construct
9  can be found in IEEE P802.11u [4]. Annex C defines the values for GAS Initial
10  Request frame fields.

11  The Vendor-Specific content field is illustrated in Table 61.

12  **Table 61—Service Discovery Vendor-specific Content**

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| OUI Subtype | 1 | 0x09 | WFA OUI Subtype |
| Service Update Indicator | 2 | Variable | The Service Update Indicator is a counter that is incremented when a change has occurred in the service information of the P2P Device sending this Service Discovery Query or Response frame. |
| Service TLV | Variable | Variable | Service TLV (refer to Table 62) |

13  The Service Request TLV (Type-Length-Value) format is defined in Table 62.

14  **Table 62—Service Request TLV Fields**

| Field Name | Size (octets) | Value | Description |
|---|---|---|---|
| Length | 2 | Variable | Length of the Service Request TLV |
| Service Protocol Type | 1 | Table 63 | Service protocol types |
| Service Transaction ID | 1 | Variable | Service transaction ID is a nonzero value used to match the Service Request/Response TLVs. |
| Query Data | Variable | NA | Query data for the requested service information. |

15  The Length is a 2-octet field whose value is equal to 2 plus the number of octets
16  in the Query Data field.

1  The Service Protocol Type is a 1-octet field that shall be equal to one of the
2  values defined in Table 63

3                          **Table 63—Service Protocol Types**

| Value | Meaning |
|---|---|
| 0 | All Service Protocol Types |
| 1 | Bonjour |
| 2 | UPnP |
| 3 | WS-Discovery |
| 4 | Wi-Fi Display |
| 5 – 254 | Reserved |
| 255 | Vendor Specific |

4  The Service Transaction ID is a 1-octet field set to a nonzero value by the
5  device sending the request. This field is used to identify the Service Request
6  TLV.

7  The Query Data field value is dependent on the requested Service Protocol
8  Type. The Query Data field shall include the service information type pertaining
9  to the requested service protocol type. If the Service Protocol Type is vendor
10 specific, the value of the Query Data field shall be pre-pended with the vendor's
11 OUI.

12 The Bonjour services are registered in the DNS SRV (RFC 2782) Service Types
13 website (http://www.dns-sd.org/ServiceTypes.html).

14 The UPnP services are registered in the Universal Plug and Play Forum
15 website (http://www.upnp.org).

16 Web Services Dynamic Discovery (WS-Discovery) is specified in [11].

17 **4.2.10.2 Service Discovery Response frame**

18 The Service Discovery Response uses the GAS Initial Response action frame.
19 This section defines the structure and content of the Vendor-Specific content of
20 this frame. Details on the complete frame construct can be found in IEEE
21 P802.11u [4]. Annex C defines the values for GAS Initial Response frame fields.

22 The Vendor-Specific content field is illustrated in Table 61.

23 The Service Response TLV (Type-Length-Value) format is defined in Table 64.

1                                **Table 64—Service Response TLV Fields**

| Field Name | Size (octets) | Value (Hexadecimal) | Description |
|---|---|---|---|
| Length | 2 | Variable | Length of the Service Response TLV |
| Service Protocol Type | 1 | Table 63 | Service protocol types |
| Service Transaction ID | 1 | Variable | Service transaction ID is a nonzero value used to match the Service Request/Response TLVs. |
| Status Code | 1 | Table 65 | Status code for the requested service information. |
| Response Data | Variable | NA | Response Data is dependent on the requested service information type in the Query Data field of the Service Request. |

2    The Length is a 2-octet field whose value is equal to 3 plus the number of octets
3    in the Response Data field.

4    The Service Protocol Type is a 1-octet field that shall be equal to one of the
5    values defined in Table 63.

6    The Service Transaction ID is a 1-octet field set to the Service Transaction ID
7    value in the corresponding Service Request TLV.

8    The Status Code is a 1-octet field that shall be equal to one of the values
9    defined in Table 65.

10                               **Table 65—Service Discovery Status Codes**

| Value | Meaning |
|---|---|
| 0 | Success |
| 1 | Service Protocol Type not available |
| 2 | Requested information not available |
| 3 | Bad Request |
| 4–255 | Reserved |

11    The value of the Response Data field is dependent on the requested Service
12    Protocol Type and the service information type encoded in the Query Data field.
13    The value of the Response Data field shall contain the requested service
14    information type and relevant service data. If the Service Protocol Type is
15    vendor specific, the value of the Response Data field shall be pre-pended with
16    the vendor's OUI.

1 **4.3     Frame Usage**

2      Table 66 shows which frame subtypes are transmitted and received by a P2P
3      Group Owner, P2P Client or P2P Device during P2P Discovery.

4

1                                   **Table 66—Frame subtype usage**

| Frame Subtype | P2P Device in the Listen State | P2P Device in the Scan Phase or Search State | GO Formation Procedure | P2P Client | P2P Group Owner |
|---|---|---|---|---|---|
| Beacon | — | R | — | R | T |
| Probe Request | R | T | — | T | R |
| Probe Response | T | R | — | R | T |
| Service Discovery Query | T, R | T, R | — | T, R | T, R |
| Service Discovery Response | T, R | T, R | — | T, R | T, R |
| P2P Invitation Request | R | T | — | T, R | T, R |
| P2P Invitation Response | T | R | — | T, R | T, R |
| GO Negotiation Request | R | R | T, R | — | — |
| GO Negotiation Response | — | — | T, R | — | — |
| GO Negotiation Confirmation | — | — | T, R | — | — |
| (Re)Association Request | — | — | T, R | T | R |
| (Re)Association Response | — | — | T, R | R | T |
| Notice of Absence | — | — | — | R | T |
| P2P Presence Request | — | — | — | T | R |
| P2P Presence Response | — | — | — | R | T |
| Device Discoverability Request | — | T | — | — | R |
| Device Discoverability Response | — | R | — | — | T |
| GO Discoverability Request | — | — | — | R | T |

| Frame Subtype | P2P Device in the Listen State | P2P Device in the Scan Phase or Search State | GO Formation Procedure | P2P Client | P2P Group Owner |
|---|---|---|---|---|---|
| Provision Discovery Request | R | T | — | — | R |
| Provision Discovery Response | T | R | — | — | T |

1          Note: T = Transmit; R = Receive; — = not available.

1 **Annex A P2P State Machine**

2

3     This Annex is for informational purposes. It is intended to illustrate the various
4     states and phases defined in the specification and possible transitions between
5     them. The informative diagram of the P2P State Machine is illustrated in Figure
6     A1. It depicts a number of common transitions, and it is neither meant to
7     represent any particular implementation nor meant to be exhaustive of all
8     possible protocol uses. The explanatory text identifies some additional possible
9     transitions, and it is also not meant to be exhaustive.



10
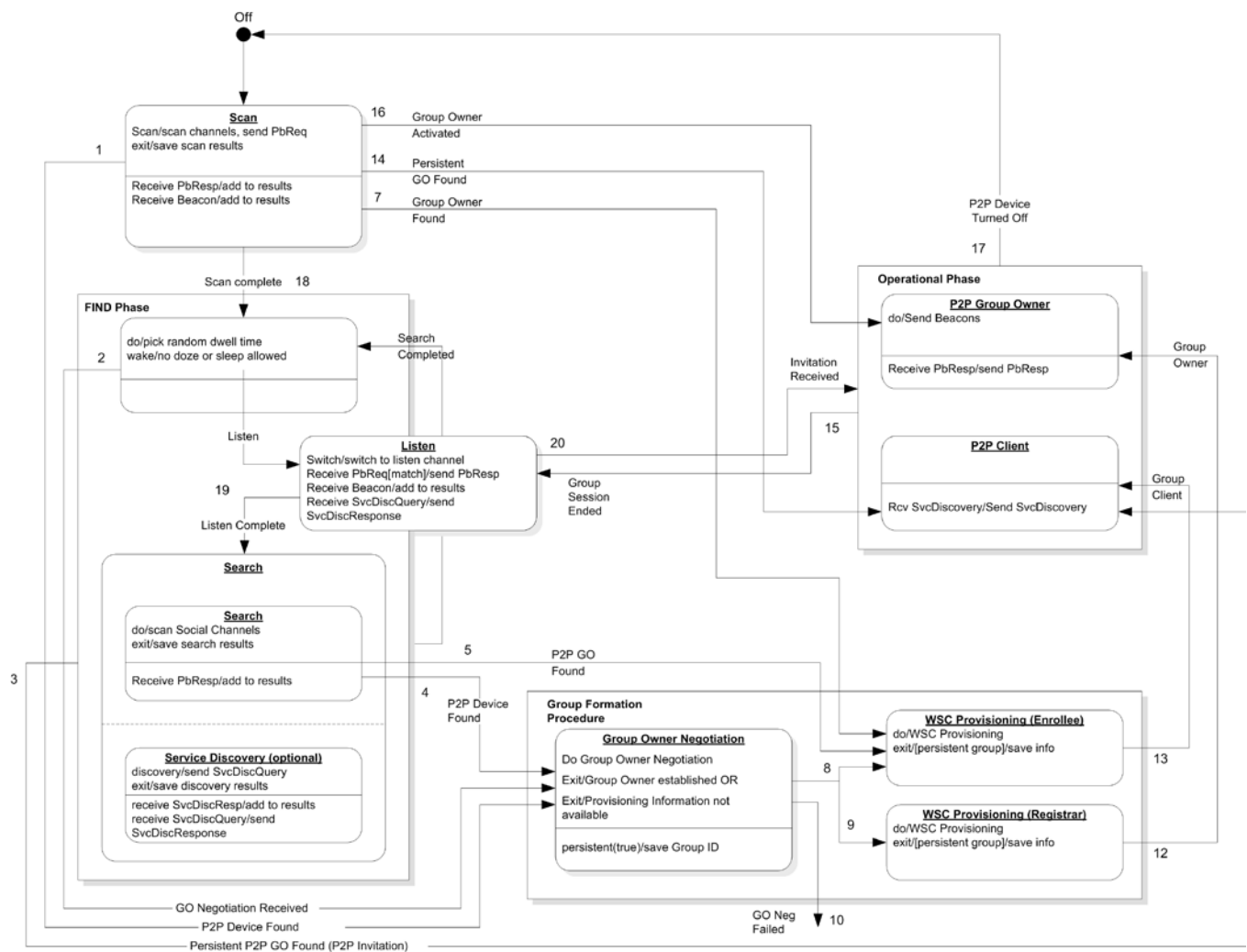
11                **Figure A1—P2P State Machine**

1. **Scan Phase**

2. *State: Scan*

3. *Actions:*

4. – *Scan*
5. This action includes scanning all – or a subset of all - supported
6. channels, including possibly passive scanning of certain 5GHz bands.
7. Active scanning is performed by sending Probe Request frames with
8. the P2P IE. Optionally the Probe Request carries information about the
9. type or Device Address of the device that it is asking to respond.
10. – *Exit*
11. This action stores the gathered information for use while in Find phase,
12. or directly for use in the Group Owner Negotiation and Provisioning
13. phase or Operational phase

14. *Internal Behavior:*

15. – *Receive Probe Response*
16. When a Probe Response message is received, the pertinent
17. information (e.g. Device Name, Device Type, Operating Channel, P2P
18. IE, P2P Device Address – of the Group Owner and all P2P Clients in
19. its Group) is stored for later use and the Scan action is continued.
20. – *Receive Beacon*
21. When a Beacon is received, the pertinent information (e.g. Channel,
22. P2P IE) is stored for later use and the Scan action is continued.

23. *Transitions:*

24. – *(1) P2P Device found.*
25. When another P2P Device is found, the P2P Device may transition to
26. the Group Owner Negotiation and Provisioning phase to negotiate P2P
27. Group ownership.
28. – *(7) P2P Group Owner found.*
29. When a P2P Group Owner is found, the P2P Device may transition
30. directly to the Provisioning state – if not yet provisioned – or to the
31. Operational state. Note that this would be similar to the flow of a
32. Legacy Client.
33. – *(14) P2P Group Owner of a previously connected persistent group*
34. *found.*
35. When a P2P Device is found which is the Group Owner of a persistent
36. group, the discovering device may send a P2P Invitation. When
37. accepted, the P2P Device shall transition to the Operational phase.
38. – *(16) Group Owner functionality activated.*
39. An active P2P Group Owner may send out beacons, even with no
40. other devices connected.
41. – *(18) Scan Complete.*
42. When the scan is completed, the Device may transition to the Find
43. phase.

**Find Phase**

*State: Listen*

*Actions:*

– *Pick Random Dwell Time*
On entering the Listen state, the P2P Device chooses a random dwell between minDiscoverableInterval and maxDiscoverableInterval (the default values for these are 1 and 3 times 100TU respectively).

– *Listen on Social Channel*
The P2P Device listens on the chosen Social Channel for the chosen dwell time.

*Internal Behavior:*

– *Receive Probe Request with matching parameters*
When a Probe Request with matching parameters (e.g. P2P IE, P2P Wildcard SSID, Requested Device Type, P2P Device ID) is received, a Probe Response message is sent.

– *Receive Beacon*
When a Beacon is received, the pertinent information (e.g. Channel, P2P IE) is stored for later use and the Listen action is continued.

– *Receive Service Discovery Query*
When a Service Discovery query message is received, and Service Discovery is supported, a Service Discovery Response message is sent.

*Transitions:*

– *(2) Group Owner Negotiation Received.*
When the P2P Device receives a Group Owner Negotiation message, it shall transition to the Group Formation phase.

– *(19) Listen State Completed.*
When either the chosen random dwell time has passed, or some other (e.g. higher layer or user level) action terminates the Listen State, the P2P Device shall transition to the Search composite state.

– *(20)*
If a P2P Device that is a member of a persistent group is in the listen phase, it may receive a P2P Invitation Request from a previously provisioned P2P Client or Group Owner. In that case it may transition to the Operational phase.

– *(Other)*
A P2P Device may also receive an Invitation Request to join a P2P Group that it has not stored credentials for. In that case it may transition to the WSC Provisioning Enrollee state of the Group Formation procedure.

_Composite State: Search_

    _Sub-State: Search_

    _Actions:_

       − _Scan Social Channels_

        Send Probe Request messages on Social Channels only. Note that the Probe Request message may include either a specific Requested Device Type being searched for, or a P2P Device ID. In the first case, P2P Devices that receive a Probe Request with a Requested Device Type that does not match their own or (in the case that the P2P Device is a Group owner) of that of their Clients should not respond with a Probe Response message. In the second case, P2P Devices that receive a Probe Request with a P2P Device ID containing a Device Address that does not match their own or (in the case that the P2P Device is a Group owner) of that of their Clients should not respond with a Probe Response message.

       − _Exit_

        This action stores the gathered information from the Search state for later use.

    _Internal Behavior:_

       − _Receive Probe Response_

        When a Probe Response message is received, the pertinent information (e.g. Device Name, Device Type, Operating Channel, P2P IE, P2P Device Address – of the Group Owner and all P2P Clients in its Group) is stored for later use and the Search action is continued.

    _Sub-State: Service Discovery (optional)_

    _Actions:_

       − _Discovery_

        Send Service Discovery Request messages to previously found P2P Devices that have indicated support for Service Discovery functionality.

       − _Exit_

        This action stores the gathered information from the Service Discovery state for later use.

    _Internal Behavior:_

       − _Receive Service Discovery Response_

        When a Service Discovery Response message is received, the pertinent information (e.g. Service Name, Service Information) is stored for later use and the Discovery action is continued.

  _Transitions:_

    − _(3) Persistent P2P Group Owner Found._

        When a persistent P2P Group Owner is found, for which credentials have been provisioned previously, the P2P Device may send a P2P

Invitation. If accepted, the P2P Device may transition to the Operational phase.

– *(6) Search State Completed.*
When all Social Channels have been scanned, and no other transition has been initiated, the P2P Device may transition back to the Listen state of the Find phase.

– *(4) P2P Device Found.*
When another P2P Device is found, the device may move to the Group Formation Procedure.

– *(5) P2P Group Owner Found.*
When a P2P Group Owner is found, the device may transition to the WSC Provisioning Enrollee state – if not yet provisioned – or to the Operational phase. Note that it is also allowed to transition to the Group Formation procedure, to negotiate a new (possibly concurrent) P2P Group.

– *(Other)*
When no other P2P Device can be found, the P2P Device may transition back to the Scan phase. Note that an active Group Owner may operate on any channel and has no requirement to listen on a social channel. Therefore it may be that it can only be found during the Scan phase. Note also that as a Group Owner may be in Power Save, it may be hard to find during a short scan of a channel.

**Group Formation Procedure**

*State: Group Owner Negotiation*

*Actions:*

– *Group Owner Negotiation*
The P2P Device either initiates Group Formation, or responds to the Group Owner Negotiation request message received from another P2P Device.

– *Exit*
At the end of the negotiation both parties are in agreement of who is the P2P Group Owner and who is the P2P Client, OR the negotiation fails. Negotiation will fail immediately if provisioning information is not (yet) available on both sides.

*Internal Behavior:*

– *Persistent*
If during the Group Formation it is established that this is to be a persistent P2P Group, pertinent information (e.g. Device MAC Address, P2P Group ID) is stored for later use

*Transitions:*

- *(9) P2P Device becomes Group Owner.*
  When the P2P Device becomes Group Owner in the Negotiation state, it may transition to the WSC Provisioning Registrar state to establish WSC credentials with the Client.
- *(8) P2P Group becomes Client.*
  When the P2P Device becomes a Client in the Negotiation phase, it may transition to the WSC Provisioning Enrollee state to establish WSC credentials with the Group Owner.
- *(10) Group Owner Negotiation fails.*
  When Group Owner Negotiation fails for some reason the P2P Device may transition to the Scan or Search Phase, or may seek additional user level input. If the Group Owner Negotiation fails dues to Provisioning Information not being available, either P2P Device may try entering Group Owner Negotiation again at a later time.

*State: WSC Provisioning Enrollee*

*Actions:*

- *WSC Provisioning*
  This action includes the whole WSC provisioning process in the role of Enrollee. It is assumed that user level input such as a PIN is already available when Group Owner Negotiation takes place.
- *Exit*
  When WSC provisioning is completed, and if this is a persistent P2P Group, the credentials for this group are stored for later use.

*Internal Behavior: None*

*Transitions:*

- *(13) WSC Provisioning Completed.*
  When WSC Provisioning is completed the P2P Device may transition to the Operational phase.
- *(Other)*
  Note that it is possible that WSC provisioning fails, in which case the P2P Device may transition to:
  - Scan phase (if the P2P Device is not a Group Owner of a persistent group)
  - Operational phase (if it is a Group Owner of an active persistent group)
  - Listen state (if it is a Group Owner of one or more persistent groups that are not currently active)
  - It may restart Group Formation with a different P2P Device.
  Note that these transitions are not explicitly included in the state diagram.

*State: WSC Provisioning Registrar*

*Actions:*

– *WSC Provisioning*
  This action includes the whole WSC provisioning process in the role of
  Registrar. It is assumed that user level input such as a PIN is already
  available when Group Owner Negotiation takes place.

– *Exit*
  When WSC provisioning is completed, and if this is a persistent P2P
  Group, the credentials for this group are stored for later use.

*Internal Behavior: None*

*Transitions:*

– *(12) WSC Provisioning Completed.*
  When WSC Provisioning is completed the P2P Device may transition
  to the Operational phase.

– *(Other)*
  Note that it is possible that WSC provisioning fails, in which case the
  P2P Device may transition to:

  • Scan phase (if the P2P Device is not a Group Owner of a persistent
    group)
  • Operational phase (if it is a Group Owner of an active persistent
    group)
  • "Permanent" Listen state (if it is a Group Owner of one or more
    persistent groups that are not currently active)
  • It may restart the Group Formation phase with a different P2P
    Device.

  Note that these transitions are not explicitly included in the state
  diagram.

**Operational Phase**

*State: P2P Group Owner*

*Actions:*

– *Send Beacons*
  The P2P Group Owner shall send Beacon frames.

*Internal Behavior:*

– *Receive Probe Request*
  When a Probe Request message is received, and (if present in a
  Probe Request that also carries the P2P IE) the Device Type matches
  the type of the Group Owner or any of the associated P2P Clients, it
  shall respond with a Probe Response message.

*Transitions:*

– *(17) P2P Device Turned Off*
  When the P2P Device is turned off, it returns to the Off state.

- *(15) P2P Group Session Ended*
  When the P2P Group session ends, i.e. there are no other P2P
  Devices associated with the group, the P2P Device may transition to
  the Listen state. Note that the P2P Device may remain in the Listen
  State indefinitely, and it may also alternate listening with periods of
  sleep. The P2P Device may also transition to the Scan phase, or to the
  Search phase and of course it may transition to the Off state.

*State: P2P Client*

*Actions: None*

*Internal Behavior:*

- *Receive Service Discovery Request*
  When a Service Discovery Request is received, and Service Discovery
  is supported by the P2P Device, it shall send a P2P Service Discovery
  Response message.

*Transitions:*

- *(17) P2P Device Turned Off*
  When the P2P Device is turned off, it returns to the Off state.
- *(15) P2P Group Dissolved*
  When the P2P Group session ends, i.e. there are no other P2P
  Devices associated with the group, the P2P Device may transition to
  the Scan phase. Alternatively it may transition to the Listen state.

# 1 Annex B P2P Specific WSC IE Attributes

## 2 B.1 Requested Device Type

3 The Requested Device Type attribute is a P2P specific WSC IE attribute that
4 needs to be added to the WSC specification. The Requested Device Type
5 attribute is optionally present in the WSC IE in the Probe Request frame.

6 Add this attribute to the WSC IE in the Probe Request frame (Section §7.2.4 of
7 the Wi-Fi Simple Configuration specification [6]):

8

| Attribute | Required/Optional | Notes |
|---|---|---|
| Requested Device Type | Optional | |

9 The Requested Device Type attribute needs to be added to Table 2: Master
10 Table – Data Component Set in Section 11 of the Wi-Fi Simple Configuration
11 specification [6]:

12

| Description | ID (Type) | Length |
|---|---|---|
| Requested Device Type | 0x106A | 8B |

13 The following text needs to be added to the list of data elements definitions in
14 section 11 of the Wi-Fi Simple Configuration specification [6].

15 **Requested Device Type**

16 This attribute contains the requested device type of a device.

17 This attribute allows a device to specify the Primary Device Type or the
18 Secondary Device Type of other devices it is interested in. Only a device that
19 receives a Probe Request containing a WSC IE with this attribute and with a
20 Primary Device Type or Secondary Device Type that matches the Requested
21 Device Type will respond with a Probe Response.

22 Its format and contents is identical to the 'Primary Device Type' attribute as
23 defined in the Wi-Fi Simple Configuration specification [6]

24 Both the Category ID and Sub Category ID can be used as a filter. If only
25 looking for devices with a certain Category ID, the OUI and Sub Category ID
26 fields will have to be set to zero.

1 **B.2    Primary Device Type**

2   The Primary Device Type attribute contains the primary type of the device. Its
3   format is defined as follows:

4

```
5       0                       1                       2                       3
6       0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
7      +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
8      |        Attribute ID           |              Length           |
9      +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
10     |       Category ID             |            OUI (1-2)          |
11     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
12     |          OUI (3-4)            |         Sub Category ID       |
13     +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

14
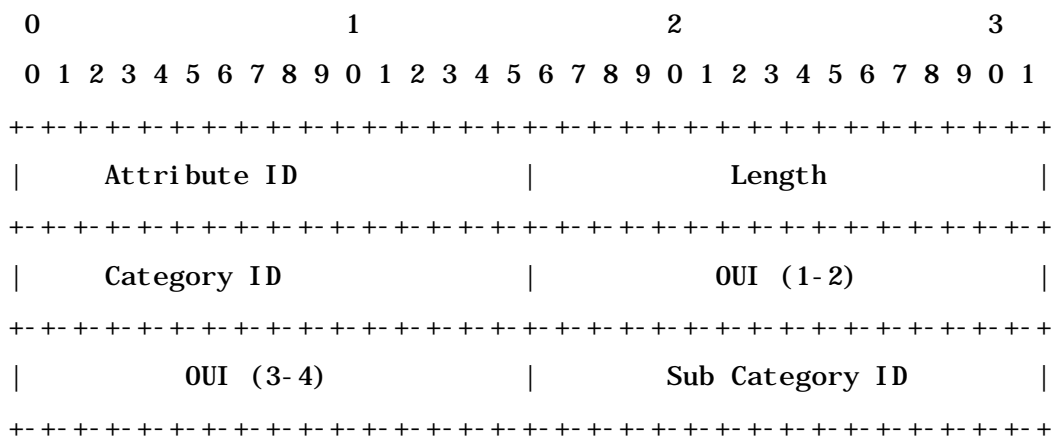
15  Vendor-specific sub-categories are designated by setting the OUI to the value
16  associated with that vendor. Note that a four-byte subdivided OUI is used. For
17  the predefined values, the Wi-Fi Alliance OUI of 00 50 F2 04 is used. The
18  predefined values for Category ID and Sub Category ID are provided in Table
19  B1. There is no way to indicate a vendor-specific main device category. The
20  OUI applies only to the interpretation of the Sub Category. If a vendor does not
21  use sub categories for their OUI, the three-byte OUI occupies the first three
22  bytes of the OUI field and the fourth byte is set to zero.

23          **Table B1—Predefined values for Category ID and Sub Category ID**

| Category | ID Value | Sub Category | ID Value |
|---|---|---|---|
| Computer | 1 | PC | 1 |
| | | Server | 2 |
| | | Media Center | 3 |
| | | Ultra-mobile PC | 4 |
| | | Notebook | 5 |
| | | Desktop | 6 |
| | | MID (Mobile Internet Device) | 7 |
| | | Netbook | 8 |
| | | Tablet | 9 |

| Category | ID Value | Sub Category | ID Value |
|---|---|---|---|
| Input Device | 2 | Keyboard | 1 |
| | | Mouse | 2 |
| | | Joystick | 3 |
| | | Trackball | 4 |
| | | Gaming controller | 5 |
| | | Remote | 6 |
| | | Touchscreen | 7 |
| | | Biometric reader | 8 |
| | | Barcode reader | 9 |
| Printers, Scanners, Faxes and Copiers | 3 | Printer or Print Server | 1 |
| | | Scanner | 2 |
| | | Fax | 3 |
| | | Copier | 4 |
| | | All-in-one (Printer, Scanner, Fax, Copier) | 5 |
| Camera | 4 | Digital Still Camera | 1 |
| | | Video Camera | 2 |
| | | Web Camera | 3 |
| | | Security Camera | 4 |
| Storage | 5 | NAS | 1 |
| Network Infrastructure | 6 | AP | 1 |
| | | Router | 2 |
| | | Switch | 3 |
| | | Gateway | 4 |
| Displays | 7 | Television | 1 |
| | | Electronic Picture Frame | 2 |
| | | Projector | 3 |
| | | Monitor | 4 |

| Category | ID Value | Sub Category | ID Value |
|---|---|---|---|
| Multimedia Devices | 8 | DAR | 1 |
| | | PVR | 2 |
| | | MCX | 3 |
| | | Set-top box | 4 |
| | | Media Server/Media Adapter/Media Extender | 5 |
| | | Portable Video Player | 6 |
| | | | |
| Gaming Devices | 9 | Xbox | 1 |
| | | Xbox360 | 2 |
| | | Playstation | 3 |
| | | Game Console/Game Console Adapter | 4 |
| | | Portable Gaming Device | 5 |
| | | | |
| Telephone | 10 | Windows Mobile | 1 |
| | | Phone – single mode | 2 |
| | | Phone – dual mode | 3 |
| | | Smartphone – single mode | 4 |
| | | Smartphone – dual mode | 5 |
| | | | |
| Audio Devices | 11 | Audio tuner/receiver | 1 |
| | | Speakers | 2 |
| | | Portable Music Player (PMP) | 3 |
| | | Headset (headphones + microphone) | 4 |
| | | Headphones | 5 |
| | | Microphone | 6 |
| Others | 255 | | |

# 1 Annex C GAS Frame Field Value

## 2 C.1 GAS Initial Request action frame

3 The format of the GAS Initial Request frame is defined in IEEE P802.11u [4].
4 This section defines the values that should be used for this frame. Figure C1
5 illustrates the GAS Initial Request Action Frame Format and its fields.

6

| GAS Initial Request Action Frame | | | | | |
|---|---|---|---|---|---|
| Category | Action | Dialog Token | Advertisement Protocol IE | Query Request Length | Query Request |
| 4 | 10 | Token ID | See below | Length | See below |
| 1 octet | 1 octet | 1 octet | Variable | 2 octets | Variable |

7 **Figure C1—GAS Initial Request Action Frame Format**

8 The Category field is set to a value of 4, indicating Public Action Frame.

9 The Action field is set to a value of 10 for a GAS Initial Request Action Frame.

10 The Dialog Token is defined in §7.3.1.12 of IEEE Std 802.11-2007 [1] and set
11 by the requesting P2P Device.

12 Figure C2 illustrates the Advertisement Protocol IE subfield.

13

| Advertisement Protocol Information Element | | | | |
|---|---|---|---|---|
| Element ID | Length | Advertisement Protocol Tuple | | |
| 108 | Length | Query Response Length Limit | PAME-BI | Advertisement Protocol ID |
| | | 0000000 | 0 | 0 |
| 1 octet | 1 octet | 7 bits | 1 bit | 1 octet |

14 **Figure C2—Advertisement Protocol Information Element**

15 The Advertisement Protocol Information Element (IE) is defined in §7.3.2.91 in
16 IEEE P802.11u [4]. The Advertisement Protocol element has Element ID 108
17 (refer to §7.3.2 in IEEE P802.11u [4]), a Length field with value 2 and includes
18 exactly one Advertisement Protocol Tuple.

19 The Advertisement Protocol Tuple is defined in Figure 7-95o122 in IEEE
20 P802.11u [4]. The Query Response Length Limit shall be set to 0 (bits 0 – 6).
21 The Pre-Associated Message Exchange BSSID Independent (PAME-BI) bit

1  shall be set to 0 (bit 7). The Advertisement Protocol ID field shall be equal to 0,
2  Access Network Query Protocol (ANQP).

3  The Query Request Length field is the total number of octets in the Query
4  Request field.

5  The Query Request field is a variable container that is illustrated in Figure C3.

6

| ANQP Query Request Field | | | |
|---|---|---|---|
| Info ID | Length | OI | Vendor-Specific Content |
| 56797 | Length | 50 6F 9A | See below |
| 2 octet | 2 octets | 3 octets | Variable |

7                          **Figure C3—ANQP Query Request Field**

8   The Info ID field is set to 56797, which is the value corresponding to the Access
9   Network Query Protocol (ANQP) vendor-specific list.

10  The Length is a 2-octet field whose value is equal to 3 plus the number of octets
11  in the Vendor-Specific content field.

12  The OI field shall be equal to 0x50 6F 9A (WFA OUI).

13  Figure C4 illustrates the Vendor-specific content of the ANQP Query Request
14  Frame.

15

| ANQP Query Request Vendor-specific Content | | | | | |
|---|---|---|---|---|---|
| OUI Subtype | Service Update Indicator | ANQP Query Request Vendor-Specific Content TLV | | | |
| | | Length | Service Protocol Type | Service Transaction ID | Query Data |
| 9 | See below | Length | Table 63 | Transaction ID | See below |
| 1 octet | 2 octets | 2 octets | 1 octet | 1 octet | Variable |

16               **Figure C4—ANQP Query Request Frame Vendor-specific Content**

17  The OUI Subtype is a 1-octet field and is set to 9.

18  The Service Update Indicator is a counter that is incremented when a change
19  has occurred in the service information of the P2P Device sending this Query
20  Request frame. See §3.1.3.1.

21  The Length is a 2-octet field whose value is equal to 2 plus the number of octets
22  in the Query Data field.

23  The Service Protocol Type is a 1-octet field set to the corresponding value in
24  Table 63.

1    The Service Transaction ID is a 1-octet field.

2    The Query Data is a variable container based on the requested Service
3    Protocol Type.

4    The Length, Service Protocol Type, Service Transaction ID and Query Data
5    fields form a TLV structure. There may one or more such TLV structures in the
6    Vendor-specific Content field of the ANQP Query Request frame.

## 7    C.2    GAS Initial Response Action Frame

8    The format of the GAS Initial Response frame is defined in IEEE P802.11u [4].
9    This section defines the values that should be used for this frame. Figure C5
10    illustrates the GAS Initial Response Action Frame Format and its fields.

11

| GAS Initial Response Action Frame | | | | | | | |
|---|---|---|---|---|---|---|---|
| Category | Action | Dialog Token | Status Code | GAS Comeback Delay | Advertisement Protocol IE | Query Response Length | Query Response |
| 4 | 11 | Token ID | Table 7-23 | See below | See below | Length | See below |
| 1 octet | 1 octet | 1 octet | 2 octets | 2 octets | Variable | 2 octets | Variable |

12    **Figure C5—GAS Initial Response Action Frame Format**

13    The Category field is set to a value of 4 indicating Public Action Frame.

14    The Action field is set to a value of 11 for a GAS Initial Response Action Frame.

15    The Dialog Token is copied from the corresponding GAS Initial Request Action
16    frame.

17    The Status Code values are defined in Table 7-23 of IEEE P802.11u [4].

18    The GAS Comeback Delay field specifies the delay time value in TU. If the
19    Query Response fits in a single GAS Initial Response frame, the GAS
20    Comeback Delay field shall be set to zero. If the Query Response does not fit in
21    a single GAS Initial Response frame, the GAS Comeback Delay field shall be
22    set to one and the Query Response Length field shall be set to zero, indicating
23    that GAS fragmentation will be used (refer to Section C.3 for information on
24    GAS fragmentation).

25    Figure C6 illustrates the Advertisement Protocol IE subfield.

26

| Advertisement Protocol Information Element | | | | |
|---|---|---|---|---|
| Element ID | Length | Advertisement Protocol Tuple | | |
| 108 | Length | Query Response Length Limit | PAME-BI | Advertisement Protocol ID |
| | | 1111111 | 0 | 0 |
| 1 octet | 1 octet | 7 bits | 1 bit | 1 octet |

1                    **Figure C6—Advertisement Protocol Information Element**

2         The Advertisement Protocol Information Element (IE) is defined in §7.3.2.91 in
3         IEEE P802.11u [4]. The Advertisement Protocol element includes exactly one
4         Advertisement Protocol ID where the Element ID field is set to 108 (refer to
5         §7.3.2 in IEEE P802.11u [4]). The Length is a one-octet field whose value is
6         equal to 2.

7         The Advertisement Protocol Tuple is defined in Figure 7-95o122 in IEEE
8         P802.11u [4]. The Query Response Length Limit shall be set to 127 (bits 0 – 6).
9         The Pre-Associated Message Exchange BSSID Independent (PAME-BI) bit
10       shall be set to 0 (bit 7). The Advertisement Protocol ID field shall be equal to 0,
11       Access Network Query Protocol (ANQP).

12       The Query Response Length field is the total number of octets in the Query
13       Response field.

14       The Query Response field is a variable container as defined in Figure C7.

15

| ANQP Query Response Field | | | |
|---|---|---|---|
| Info ID | Length | OI | Vendor-Specific Content |
| 56797 | Variable | 50 6F 9A | See below |
| 2 octets | 2 octets | 3 octets | Variable |

16                    **Figure C7—ANQP Query Response Field Format**

17       The Info ID field is set to 56797, which is the value corresponding to the Access
18       Network Query Protocol (ANQP) vendor-specific list.

19       The Length is a 2-octet field whose value is equal to 3 plus the number of octets
20       in the Vendor-Specific content field.

21       The Status Code values are defined in Table 7-23 of IEEE P802.11u [4].

22       The OI field shall be equal to 0x50 6F 9A (WFA OUI).

23       Figure C8 illustrates the Vendor-specific content field of the ANQP Query
24       Response Frame.

25

| ANQP Query Response Vendor-specific Content Field | | | | | | |
|---|---|---|---|---|---|---|
| OUI Subtype | Service Update Indicator | ANQP Query Response Vendor-Specific Content TLV | | | | |
| | | Length | Service Protocol Type | Service Transaction ID | Status Code | Response Data |
| 9 | See below | Length | Table 63 | Transaction ID | Table 65 | See below |
| 1 octet | 2 octets | 2 octets | 1 octet | 1 octet | 1 octet | Variable |

1    **Figure C8—ANQP Query Response Frame Vendor-specific Content Field**

2    The OUI Subtype is a 1-octet field and is set to 9.

3    The Service Update Indicator is a counter that is incremented when a change
4    has occurred in the service information of the P2P Device sending this Query
5    Response frame. See §3.1.3.2.

6    The Length is a 2-octet field whose value is equal to 3 plus the number of octets
7    in the Response Data field.

8    The Service Protocol Type is a 1-octet field set to the corresponding value in
9    Table 63.

10   The Service Transaction ID is a 1-octet field set to the corresponding Service
11   Transaction ID in the Service TLV.

12   The Status Code is a 1-octet field set to the corresponding value in Table 65.

13   The Response Data is a variable container based on the requested Service
14   Protocol Type.

15   The Length, Service Protocol Type, Service Transaction ID, Status Code and
16   Response Data fields form a TLV structure. There may one or more such TLV
17   structures in the Vendor-specific Content field of the ANQP Query Response
18   frame.

19   ## C.3    GAS Fragmentation

20   If the GAS Query Response is too large to fit in a single MMPDU, the GAS
21   Fragmentation procedure shall be used. The GAS Fragmentation procedure
22   uses the GAS Comeback Request and GAS Comeback Response frame
23   exchange as defined in IEEE P802.11u [4]. This section defines the GAS
24   Comeback Request and Response frames.

25   The format of the GAS Comeback Request frame is defined in IEEE P802.11u
26   [4]. This section defines the values that should be used for this frame. Figure C9
27   illustrates the GAS Comeback Request and its fields.

28

| GAS Comeback Request Frame | | |
|---|---|---|
| Category | Action | Dialog Token |
| 4 | 12 | Token ID |
| 1 octet | 1 octet | 1 octet |

1 **Figure C9—GAS Comeback Request Frame Format**

2 The Category field is set to a value of 4, indicating Public Action Frame.

3 The Action field is set to a value of 12 for a GAS Comeback Request.

4 The Dialog Token is obtained from the corresponding GAS Initial Request
5 Frame.

6 The format of the GAS Comeback Response frame is defined in IEEE P802.11u
7 [4]. This section defines the values that should be used for this frame. Figure
8 C10 illustrates the GAS Comeback Response Frame Format and its fields.

9

| GAS Comeback Response Frame | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Category | Action | Dialog Token | Status Code | GAS Query Response Fragment ID | GAS Comeback Delay | Advertisement Protocol IE | Query Response Length | Query Response |
| 4 | 13 | Token ID | Table 7-23 | See below | See below | See below | Length | See below |
| 1 octet | 1 octet | 1 octet | 2 octets | 1 octet | 2 octets | Variable | 2 octets | Variable |

10 **Figure C10—GAS Comeback Response Frame Format**

11 The Category field is set to a value of 4 indicating Public Action Frame.

12 The Action field is set to a value of 13 for a GAS Comeback Response Frame.

13 The Dialog Token is copied from the corresponding GAS Initial Request Action
14 frame.

15 The Status Code values are defined in Table 7-23 of IEEE P802.11u [4].

16 The GAS Query Response Fragment ID is used by a responding P2P Device to
17 indicate when GAS fragmentation is being used. A P2P Device responding to a
18 GAS request uses this field to inform the requesting P2P Device/Client of the
19 GAS fragment number of the transmitted frames as well as identifying the last
20 GAS fragment of the Query Response. The first 7 bits (B0-B6) represent the
21 GAS Query Response Fragment ID and the last bit (B7) represents the More
22 GAS Fragments bit. The GAS Query Response Fragment ID is set to 0 for the
23 initial fragment and increments by 1 for each subsequent Comeback Response

1 in the fragmented Query Response. The More GAS Fragments field is set to 0
2 for the final GAS fragment in the fragmented response.

3 The GAS Comeback Delay field is set to a value of 0.

4 Figure C11 illustrates the Advertisement Protocol IE subfield.

5

| Advertisement Protocol Information Element | | | | |
|---|---|---|---|---|
| Element ID | Length | Advertisement Protocol Tuple | | |
| 108 | Length | Query Response Length Limit | PAME-BI | Advertisement Protocol ID |
| | | 1111111 | 0 | 0 |
| 1 octet | 1 octet | 7 bits | 1 bit | 1 octet |

6 **Figure C11—Advertisement Protocol IE**

7 The Advertisement Protocol Information Element (IE) is defined in §7.3.2.91 in
8 IEEE P802.11u [4]. The Advertisement Protocol element includes exactly one
9 Advertisement Protocol ID where the Element ID field is set to 108 (refer to
10 §7.3.2 in IEEE P802.11u [4]). The Length is a one-octet field whose value is
11 equal to 2.

12 The Advertisement Protocol Tuple is defined in Figure 7-95o122 in IEEE
13 P802.11u [4]. The Query Response Length Limit shall be set to 127 (bits 0 – 6).
14 The Pre-Associated Message Exchange BSSID Independent (PAME-BI) bit
15 shall be set to 0 (bit 7). The Advertisement Protocol ID field shall be equal to 0,
16 Access Network Query Protocol (ANQP).

17 The Query Response Length field is the total number of octets in the Query
18 Response field.

19 The Query Response field is a variable container that contains either a
20 complete, or if the response is fragmented, a partial ANQP Query Response
21 field. The ANQP Query Response field is as defined in Figure C7.

22 Figure C12 illustrates an example GAS Fragmentation frame exchange
23 sequence. In this example, the fragmented response consists of two TLVs
24 (labeled TLV 1 and TLV 2 in the sequence), with fragmentation of the first TLV
25 (TLV 1). Note the duplication of the following fields in each GAS Comeback
26 Response: Dialog Token, Status Code, GAS Query Response Fragment ID
27 (with incrementing value), GAS Comeback Delay, Advertisement Protocol IE
28 and Query Response Length (with an appropriate value for the response).
29

**P2P Device 1**                                                                                   **P2P Device 2**

**GAS Initial Request**

| | | | | | ANQP Query Request Field | | | | | | | | | | | | |
| | | | | | | | | ANQP Query Request Vendor Specific Content | | | | | | | | | |
| | | | | | | | | | | ANQP Query Request Vendor Specific Content TLV | | | | | | | |
| Category | Action | Dialog Token | Advertisement Protocol IE | Query Request Length | Info ID | Length | OI | OUI Subtype | Service Update Indicator | Length | Service Protocol Type | Service Transaction ID | Query Data | Length | Service Protocol Type | Service Transaction ID | Query Data |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 10 | Token "A" | Fixed Value (see Figure C2) | Length | 56797 | Length | 50 6F 9A | 9 | SUI-Dev1 | Length | 0 | TID | Variable | Length | 0 | TID + 1 | Variable |

*GAS Initial Request Action Frame*

**GAS Initial Response**

| Category | Action | Dialog Token | Status Code | GAS Comeback Delay | Advertisement Protocol IE | Query Response Length |
|---|---|---|---|---|---|---|
| 4 | 11 | Token "A" | Table 7-23 | 1 | Fixed Value (see Figure C6) | 0 |

*GAS Initial Response Action Frame*

**GAS Comeback Request**

| Category | Action | Dialog Token |
|---|---|---|
| 4 | 12 | Token "A" |

*GAS Comeback Request Action Frame*

**GAS Comeback Response**

| | | | | | | | | | ANQP Query Response Field | | | | | | | | | |
| | | | | | | | | | | | | ANQP Query Response Vendor Specific Content | | | | | | |
| | | | | | | | | | | | | | | TLV 1 (Fragment) | | | | |
| Category | Action | Dialog Token | Status Code | GAS Query Response Fragment ID | More GAS Fragments | GAS Comeback Delay | Advertisement Protocol IE | Query Response Length | Info ID | Length | OI | OUI Subtype | Service Update Indicator | Length | Service Protocol Type | Service Transaction ID | Status Code | Query Data |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 13 | Token "A" | 0 | 000000 | 1 | 0 | Fixed Value (see Figure C6) | 1415 | 56797 | 2810 | 50 6F 9A | 9 | SUI-Dev2 | 2000 | 0 | TID | 0 | 1400 Octets |

*GAS Comeback Response Action Frame*

**GAS Comeback Request**

| Category | Action | Dialog Token |
|---|---|---|
| 4 | 12 | Token "A" |

*GAS Comeback Request Action Frame*

**GAS Comeback Response**

| | | | | | | | | | ANQP Query Response Field | | | | | |
| | | | | | | | | | ANQP Query Response Vendor Specific Content (Continued) | | | | | |
| | | | | | | | | | TLV 1 cont. | TLV 2 | | | | |
| Category | Action | Dialog Token | Status Code | GAS Query Response Fragment ID | More GAS Fragments | GAS Comeback Delay | Advertisement Protocol IE | Query Response Length | Query Data | Length | Service Protocol Type | Service Transaction ID | Status Code | Query Data |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 13 | Token "A" | 0 | 000001 | 0 | 0 | Fixed Value (see Figure C6) | 1399 | 597 octets | 800 | 0 | TID + 1 | 0 | 797 Octets |

*GAS Comeback Response Action Frame*

**Figure C12—Example GAS Fragmentation Frame Exchange Sequence**

# 1   **Annex D P2P Discovery Diagrams**

2      This Annex is for informational purposes. It contains a number of message
3      sequence diagrams that are intended to illustrate possible uses of the P2P
4      Discovery protocol in various example scenarios. No attempt made to cover all
5      possible scenarios or protocol uses and for clarity the diagrams omit many
6      parameters from the exchanged messages.

7

1



Scenario 1a: Two P2P Devices discovering each other; group formation occurs on Listen Channel of P2P Device 1

Notes:
1) Active, or passive scan.
2) Devices select Listen Channels.
3) P2P Device 1 enters FIND Listen state on its Listen Channel prior to sending GO Negotiation Request (and in this example, receives a Probe Request from P2P Device 2).
4) This Probe Response is optional; P2P Device 1 may just send the GO Negotiation Request.
5) P2P Device 1 retries after initial GO Negotiation Request fails.
6) P2P Device 2 determines it will be GO, starts a P2P Group session on the Operating Channel and acts as WSC Registrar to issue Credentials to Client (WSC Enrollee). The Group Formation bit is set to 1 until Provisioning succeeds.
7) Startup may be delayed according to Configuration Timeout information exchanged during GO Negotiation.
8) Diagram does not show all message parameters.

Scenario 1b: Two P2P Devices
discovering each other; group formation
occurs on Listen Channel of P2P Device 2

Notes:
1) Active, or passive scan.
2) Devices select Listen Channels.
3) P2P Device 1 enters Listen state as part of a FIND phase prior to sending Provision Discover Request on the Channel upon which P2P Device 2 was discovered.
4) Optional Provision Discovery Request-Response message exchange precedes GO Negotiation Request in this scenario.
5) P2P Device 2 determines it will be GO, starts a P2P Group session on the Operating Channel and acts as WSC Registrar to issue Credentials to Client (WSC Enrollee). The Group Formation bit is set to 1 until Provisioning succeeds.
6) Startup may be delayed according to Configuration Timeout information exchanged during GO Negotiation.
7) Diagram does not show all message parameters.

1



Scenario 2: P2P Device discovering an operational P2P Group
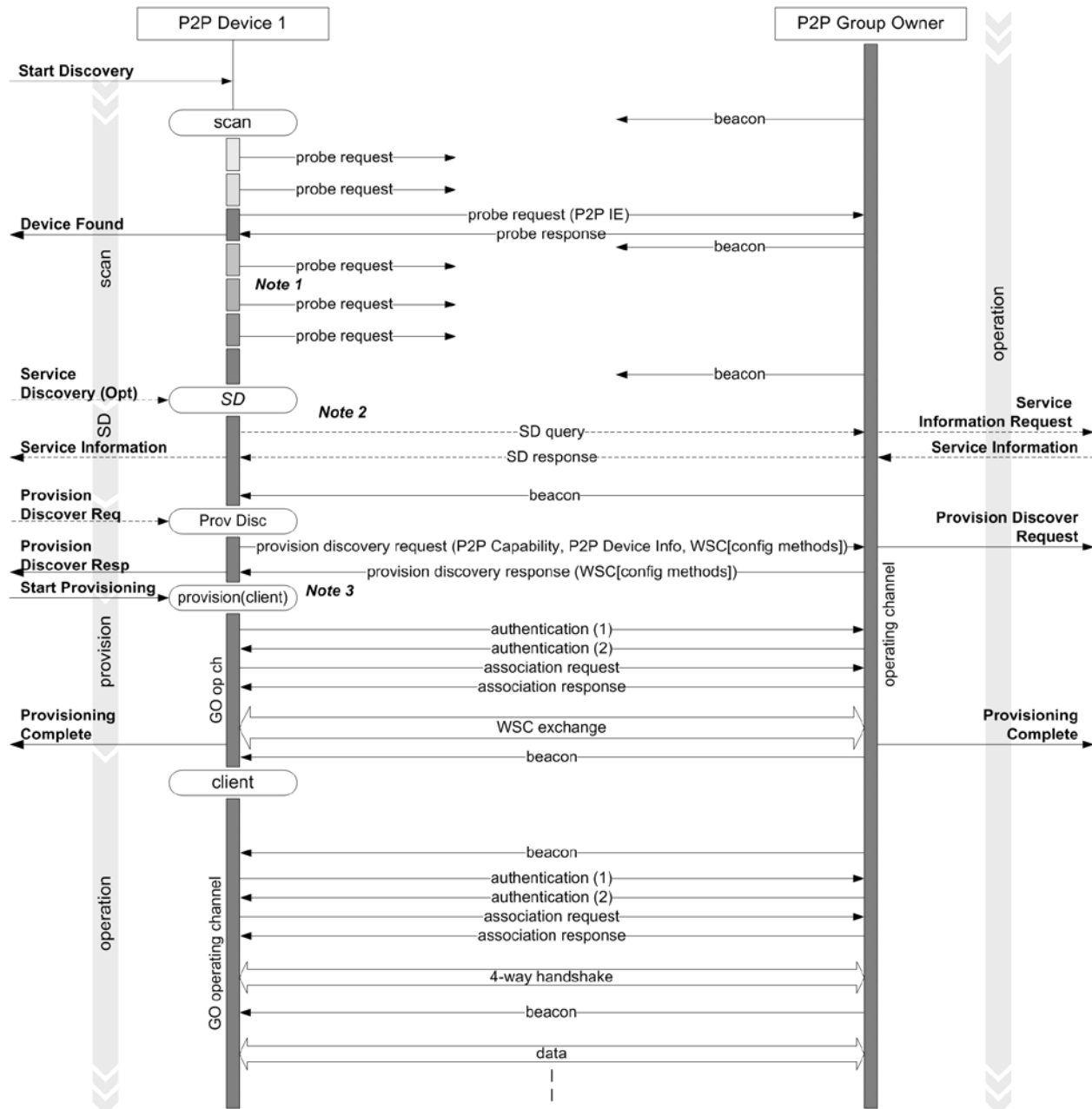
Notes:
1) Active, or passive scan.
2) Support of Service Discovery (SD) is optional.
3) When a P2P Device joins an existing P2P Group it shall send a Provision Discovery Request frame so as to indicate the desire to enroll in the network.
4) Diagram does not show all message parameters.

Scenario 3: P2P Device discovering a P2P Device that is the Group Owner of a Persistent P2P Group in Listen State & reinvoking the Persistent Group
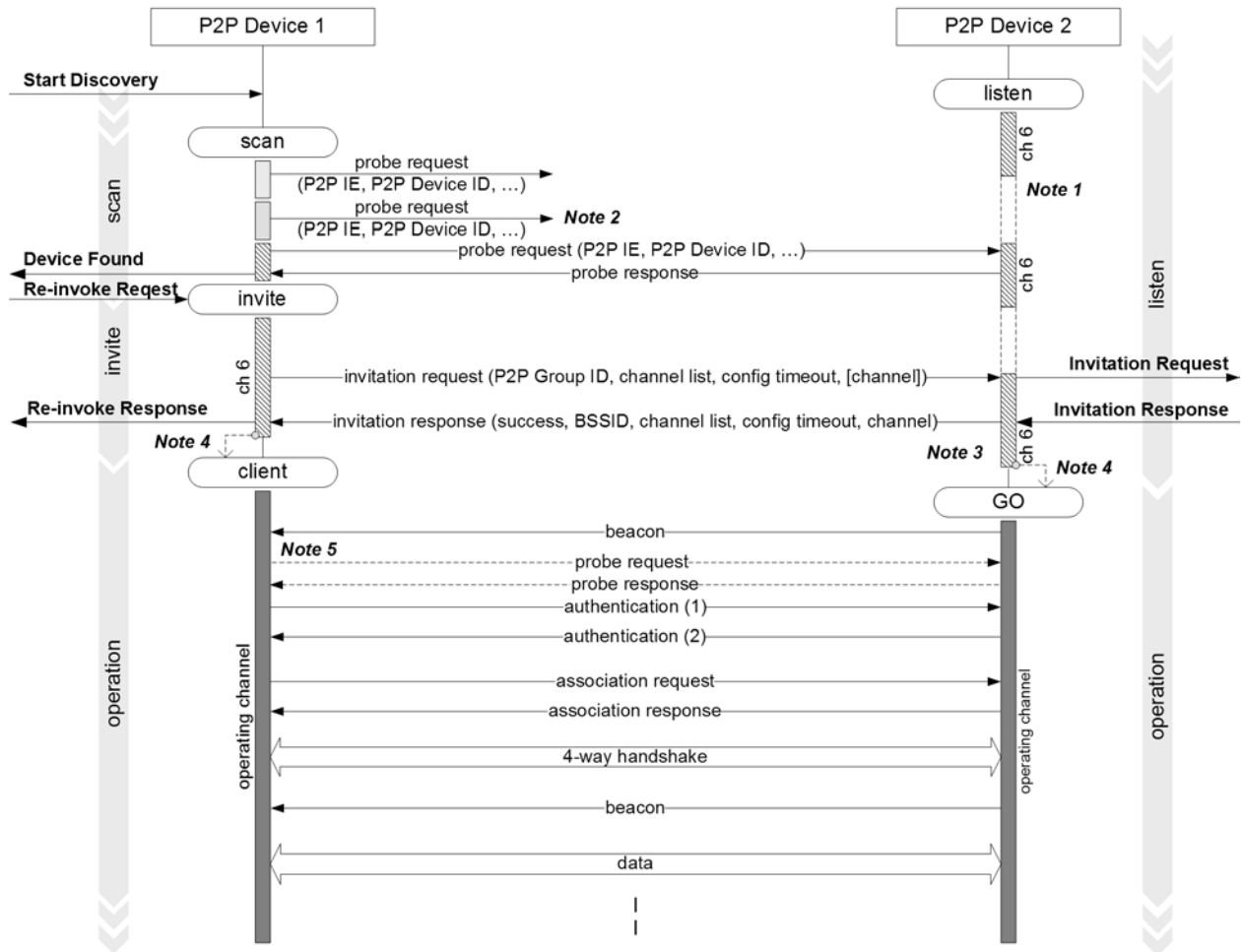
**Notes:**
1) Device availability in extended listen subject to recommendations and extended listen timing in Specification.
2) Probe Request to P2P Device that is the GO of the Persistent P2P Group that is being sought could either be sent directly to the Device Address, or contain the P2P Device ID.
3) In this example, P2P Device 1 is a Client in the Persistent P2P Group and requests P2P Device 2 to re-invoke the Group as P2P Group Owner. It would also be possible for P2P Device 1 to be the Group Owner of the Persistent P2P Group and invite P2P Device 2 to join as a P2P Client of that Persistent Group.
4) Startup may be delayed according to Configuration Timeout information exchanged during invitation.
5) Device may scan to verify GO is on expected operating channel.
6) Diagram does not show all message parameters.

1

1

1

**Notes:**
1) P2P Client indicates discoverability in association request.
2) P2P GO using opportunistic PS in this example – wakes for CTWindow.
3) Searching device includes the Device ID in the Probe Request to elicit a probe Response only from the device it knows to be Go of the Persistent Group it wishes to re-invoke.
4) Searching P2P Device may send Device Discoverability Request immediately after receiving Probe Response from P2P GO, though in this example it waits until the next CTWindow.
5) Successful delivery of Device Discoverability Request triggers Device Discoverability Response to searching device.
6) In this example, P2P Device is a Client in the Persistent P2P Group and requests P2P Client to re-invoke the Group as P2P Group Owner. It would also be possible for P2P Device to be the Group Owner of the Persistent P2P Group and invite P2P Client to join as a P2P Client of that Persistent Group.
7) Startup may be delayed according to Configuration Timeout information exchanged during invitation.
8) In this scenario, P2P Client is capable of acting as a P2P Client in the existing P2P Group and also as P2P GO for new group (both P2P Groups on the same channel in this example). Alternatively, P2P Client could disconnect from the existing P2P Group and just join the new P2P Group.
9) Device may scan to verify GO is on expected operating channel.
10) Diagram does not show all message parameters.
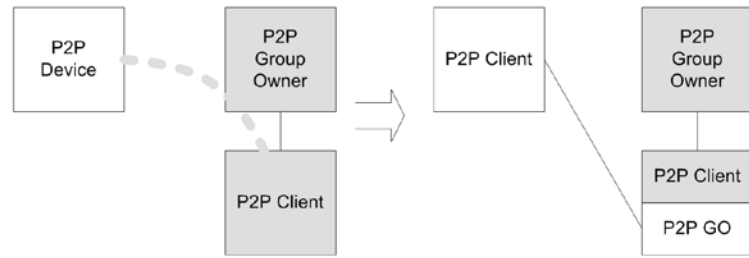


Scenario 4: P2P Device discovering a P2P Device that is the Client in an existing P2P Group and requesting device to reinvoke a Persistent P2P Group
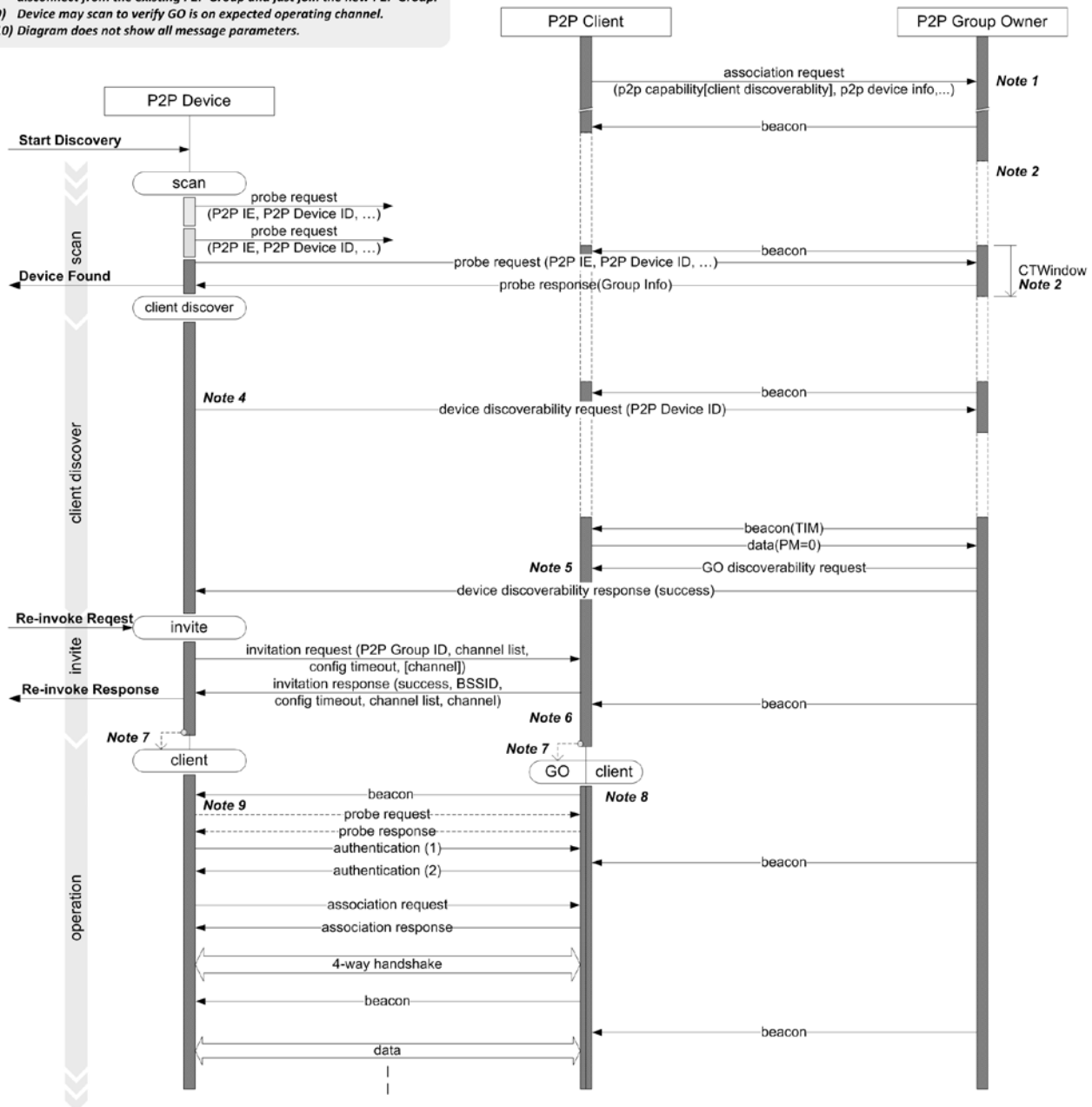
**Scenario 5: P2P Device that is Group owner invites P2P Device to join P2P Group**
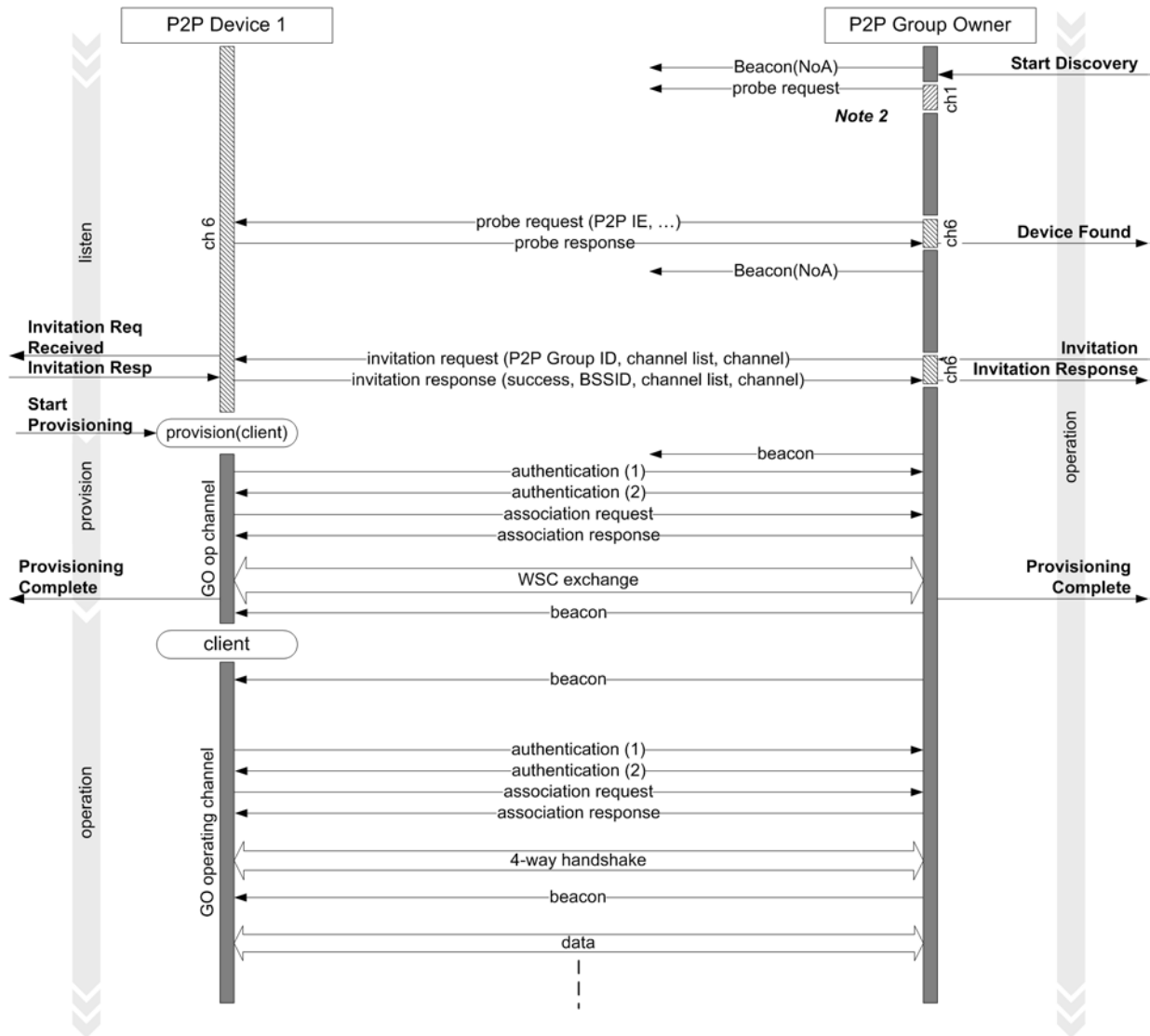
Notes:
1) Diagram does not show all message parameters.
2) NoA can be used to signal GO absence.

1
2

Legacy Client

P2P Group Owner

**Scenario 6: Legacy Client discovering and joining an operational P2P Group**

Legacy Client

P2P Group Owner

Start Scan

scan

← beacon

probe request →

probe request →

probe request →

Network Found

← probe response

*Note 1*

← beacon

scan

probe request →

probe request →

probe request →

*Note 2*

← beacon

Join/Start WSC

WSC

WSC

GO operating channel

operating channel

operation

authentication (1) →

**Provisioning Start (legacy)**

← authentication (2)

association request →

← association response

← beacon

WSC exchange

**Provisioning Complete**

WSC complete

operation

Join

**Legacy Client Connect**

operation

GO operating channel

← beacon

authentication (1) →

← authentication (2)

association request →

← association response

4-way handshake

← beacon

data

**Notes:**
1) P2P Group Owner determines that scanning Device is a Legacy Client from Probe Request; Group Owner does not include P2P Group Info in Probe Response.
2) Active, or passive scan.
3) Diagram does not show all message parameters.

1

# 1 Annex E Recommended Practices for Bonjour using Wi-Fi
# 2 P2P Service Discovery

3  The following section provides recommended practices for using Bonjour and
4  DNS-SD using the service discovery mechanism defined in this specification. In
5  addition, some service discovery examples are provided for Apple File Sharing
6  (AFP) and IP Printing (IPP) Bonjour services.

7  The Service TLV in the ANQP Query Request frame is illustrated in Figure E1
8  below.

9

| ANQP Vendor-specific Content | | | | | |
|---|---|---|---|---|---|
| OUI Subtype | Service Update Indicator | Length | Service Protocol Type | Service Transaction ID | Query Data |
| 9 | See below | Length | 1 | Transaction ID | See below |
| 1 octet | 2 octets | 2 octets | 1 octet | 1 octet | Variable |

10  **Figure E1—Query Request Vendor-specific Content**

11  The OUI Subtype shall be set to 9.

12  The Service Update Indicator is a counter that is incremented when a change
13  has occurred in the service information of the P2P Device sending this Query
14  Request frame. See §3.1.3.1.

15  The Length is equal to 2 plus the number of octets in the Query Data field.

16  The Service Protocol Type is set to 1 (Bonjour).

17  The Service Transaction ID is a 1-octet field.

18  The Query Data variable container for the Bonjour service protocol is illustrated
19  in Figure E2.

20

| Query Data | | |
|---|---|---|
| DNS Name | DNS Type | Version |
| Refer to example | Refer to example | Refer to example |
| Variable | 2 octets | 1 octet |

21  **Figure E2—Bonjour Query Data**

22  The Query Data container is divided into 3 fields as illustrated in Figure E2. The
23  complete Query Data is referred to as the key.

1 The Service TLV in the ANQP Query Response frame is illustrated in Figure E3
2 below.

3

| ANQP Vendor-specific Content | | | | | | |
|---|---|---|---|---|---|---|
| OUI Subtype | Service Update Indicator | Length | Service Protocol Type | Service Transaction ID | Status Code | Response Data |
| 9 | See below | Length | 1 | Transaction ID | Table 65 | See below |
| 1 octet | 2 octets | 2 octets | 1 octet | 1 octet | 1 octet | Variable |

4 **Figure E3—Query Response Vendor-specific Content**

5 The OUI Subtype is set to 9.

6 The Service Update Indicator is a counter that is incremented when a change
7 has occurred in the service information of the P2P Device sending this Query
8 Response frame. See §3.1.3.2.

9 The Length is equal to 3 plus the number of octets in the Response Data field.

10 The Service Protocol Type is set to 1 (Bonjour)

11 The Service Transaction ID is a 1-octet field set to the corresponding Service
12 Transaction ID in the Service TLV.

13 The Status Code is set to the corresponding value in Table 65.

14 The Response Data variable container for the Bonjour service protocol is
15 illustrated in Figure E4.

16

| Response Data | | | |
|---|---|---|---|
| DNS Name | DNS Type | Version | RDATA |
| Refer to example | Refer to example | Refer to example | Refer to example |
| Variable | 2 octets | 1 octet | Variable |

17 **Figure E4—Response Data**

18 The Response Data contains the same fields as the Query Data plus the
19 Record Data (RDATA) as illustrated in Figure E4. The RDATA is referred to as
20 the value. Therefore, the query contains the key and the response contains the
21 key and value pair. The content of the Query Data and Response Data fields
22 shall use DNS name compressions as defined in Section E.3.

23 The DNS Type shall be set to one of the defined DNS record types as used by
24 DNS Service Discovery (DNS-SD). For information on DNS record types refer to
25 http://en.wikipedia.org/wiki/List_of_DNS_record_types. Pointer (PTR) and Text

1 (TXT) service record types are defined in http://tools.ietf.org/html/rfc1035 with
2 usage information in http://www.dns-sd.org/. Byte ordering within the DNS Type
3 field shall be big-endian.

4 The Version field shall be set to 0x01.

5 If the request is for all services, i.e. the Query Data field in the ANQP Query
6 Request frame has a length of 0, the responding P2P Device shall include in the
7 ANQP Query Response frame (or series of GAS Comeback Response frames
8 as necessary) a TLV for every RDATA record it is advertising.

9 Other useful links and references:
10 — http://www.zeroconf.org/Rendezvous/txtrecords.html
11 — http://en.wikipedia.org/wiki/Fully_qualified_domain_name
12 — http://tools.ietf.org/html/rfc4343
13 — http://www.dns-sd.org/
14 — http://www.dns.net/dnsrd/rr.html
15 — http://www.multicastdns.org/
16 — http://www.iana.org/assignments/dns-parameters

17 ## E.1    Example for Apple File Sharing over TCP

18 In this example, the DNS-SD service type is Apple File Sharing (AFP) over TCP
19 which is _afpovertcp._tcp.local. The DNS-SD record type is PTR. The Version
20 is 1.

21 The human readable DNS Service Type is _afpovertcp._tcp.local.

22 The DNS Record Type is PTR (12d, 0x000C).

23 The Version is 1 (1d, 0x01).

24 The complete human readable Query Data (key) is illustrated in Figure E5
25 below.

26

| Query Data (Key) | | |
|---|---|---|
| Human Readable DNS Name | DNS Type | Version |
| _afpovertcp._tcp.local. | 12 (PTR) | 1 |
| Variable | 2 octets | 1 octet |

27 **Figure E5—AFP Over TCP Query Data (human readable)**

28 The encoded Query Data using DNS name compression is provided in Figure
29 E6.

| Query Data (Key) | | |
|---|---|---|
| Encoded and Compressed DNS Name | DNS Type | Version |
| 0B 5F 61 66 70 6F 76 65 72 74 63 70 C0 0C | 00 0C | 01 |
| Variable | 2 octets | 1 octet |

1        **Figure E6—AFP Over TCP Query Data (encoded and compressed)**

2        In this example, the DNS-SD service instance name is Example for the AFP
3        over TCP service type. The DNS-SD record type is PTR. The Version is 1.

4        The human readable DNS service instance and type is
5        Example._afpovertcp._tcp.local.

6        The DNS Record Type is PTR (12d, 0x000C).

7        The Version is 1 (1d, 0x01).

8        The Response Data shall contain the key (Query Data) and value (Response
9        Data) pair. Therefore, the complete human readable Response Data is
10       illustrated in Figure E7.

11

| Response Data (key/value) | | | |
|---|---|---|---|
| Human Readable DNS Name | DNS Type | Version | RDATA |
| _afpovertcp._tcp.local. | 12 (PTR) | 1 | Example._afpovertcp._tcp.local. |
| Variable | 2 octets | 1 octet | Variable |

12       **Figure E7—AFP over TCP Response Data (human readable)**

13       The encoded Response Data using name compression is illustrated in Figure
14       E8.

15

| Response Data (key/value) | | | |
|---|---|---|---|
| Encoded and Compressed DNS Name | DNS Type | Version | RDATA |
| 0B 5F 61 66 70 6F 76 65 72 74 63 70 C0 0C | 00 0C | 01 | 07 45 78 61 6D 70 6C 65 C0 27 |
| Variable | 2 octets | 1 octet | Variable |

16       **Figure E8—AFP over TCP Response Data (encoded and compressed)**

17       In this example, there is a text (TXT) record associated to the Example instance
18       of the AFP over TCP service. Text (TXT) records are required for DNS-SD,
19       even if there is only a null byte to show that there is no data for the service.

1    Therefore, in this example, the human readable text (TXT) record is null.

2    The DNS Record Type is TXT (16d, 0x0010).

3    The Version is 1 (1d, 0x01).

4    The complete human readable Query Data (key) is illustrated in Figure E9
5    below.

6

| Query Data (Key) | | |
|---|---|---|
| Human Readable DNS Name | DNS Type | Version |
| Example._afpovertcp._tcp.local. | 16 (TXT) | 1 |
| Variable | 2 octets | 1 octet |

7    **Figure E9—AFP Over TCP Query Data for Example (human readable)**

8    The encoded Query Data using DNS name compression is illustrated in Figure
9    E10.

10

| Query Data (Key) | | |
|---|---|---|
| Encoded and Compressed DNS Name | DNS Type | Version |
| 07 65 78 61 6D 70 6C 65 0B 5F 61 66 70 6F 76 65 72 74 63 70 C0 0C | 00 10 | 01 |
| Variable | 2 octets | 1 octet |

11    **Figure E10—AFP Over TCP Query Data for Example (encoded and compressed)**

12    The Response Data shall contain the key (Query Data) and value (Response
13    Data) pair. Therefore, the complete human readable Response Data is provided
14    in Figure E11.

15

| Response Data (key/value) | | | |
|---|---|---|---|
| Human Readable DNS Name | DNS Type | Version | RDATA |
| Example_afpovertcp._tcp.local. | 16 (TXT) | 1 | null |
| Variable | 2 octets | 1 octet | Variable |

16    **Figure E11—AFP over TCP Response Data for Example (human readable)**

17    The encoded Response Data using DNS name compression is illustrated in
18    Figure E12.

19

| Response Data (key/value) | | | |
|---|---|---|---|
| Encoded and Compressed DNS Name | DNS Type | Version | RDATA |
| 07 65 78 61 6D 70 6C 65 0B 5F 61 66 70 6F 76 65 72 74 63 70 C0 0C | 00 10 | 01 | 00 |
| Variable | 2 octets | 1 octet | Variable |

1    **Figure E12—AFP over TCP Response Data for Example (encoded and compressed)**

2    ## E.2    Example for IP Printing over TCP

3    In this example, the DNS-SD service type is Internet Printing Protocol over TCP
4    which is _ipp._tcp.local. The DNS-SD record type is PTR. The version is 1.

5    The human readable DNS Service Type is _ipp._tcp.local.

6    The DNS Record Type is PTR (12d, 0x000C).

7    The Version is 1 (1d, 0x01).

8    The complete human readable Query Data (key) is illustrated in Figure E13.

9

| Query Data (Key) | | |
|---|---|---|
| Human Readable DNS Name | DNS Type | Version |
| _ipp._tcp.local. | 12 (PTR) | 1 |
| Variable | 2 octets | 1 octet |

10    **Figure E13—IPP Over TCP Query Data (human readable)**

11    The encoded Query Data using DNS name compression is illustrated in Figure
12    E14.

13

| Query Data (Key) | | |
|---|---|---|
| Encoded and Compressed DNS Name | DNS Type | Version |
| 04 5F 69 70 70 C0 0C | 00 0C | 01 |
| Variable | 2 octets | 1 octet |

14    **Figure E14—IPP Over TCP Query Data (encoded and compressed)**

15    In this example, the DNS-SD service instance name is MyPrinter for the IPP
16    over TCP service type. The DNS-SD record type is PTR. The Version is 1.

17    The human readable DNS service instance and type is MyPrinter._ipp._tcp.local.

18    The DNS Record Type is PTR (12d, 0x000C).

1    The Version is 1 (1d, 0x01).

2    The Response Data shall contain the key (Query Data) and value (Response
3    Data) pair. Therefore, the complete human readable Response Data is
4    illustrated in Figure E15.

5

| Response Data (key/value) | | | |
|---|---|---|---|
| Human Readable DNS Name | DNS Type | Version | RDATA |
| _ipp._tcp.local. | 12 (PTR) | 1 | MyPrinter._ipp._tcp.local. |
| Variable | 2 octets | 1 octet | Variable |

6    **Figure E15—IPP over TCP Response Data (human readable)**

7    The encoded Response Data using name compression is illustrated in Figure
8    E16.

9

| Response Data (key/value) | | | |
|---|---|---|---|
| Encoded and Compressed DNS Name | DNS Type | Version | RDATA |
| 04 5F 69 70 70 C0 0C | 00 0C | 01 | 09 4D 79 50 72 69 6E 74 65 72 C0 27 |
| Variable | 2 octets | 1 octet | Variable |

10    **Figure E16—IPP over TCP Response Data (encoded and compressed)**

11    In this example, there is a text (TXT) record associated to the MyPrinter
12    instance of the IPP over TCP service.

13    The human readable text (TXT) record is: txtvers=1, pdl=application/postscript

14    The DNS Record Type is TXT (16d, 0x0010).

15    The Version is 1 (1d, 0x01).

16    The complete human readable Query Data (key) is illustrated in Figure E17
17    below.

18

| Query Data (Key) | | |
|---|---|---|
| Human Readable DNS Name | DNS Type | Version |
| MyPrinter_ipp._tcp.local. | 16 (TXT) | 1 |
| Variable | 2 octets | 1 octet |

19    **Figure E17—IPP Over TCP Query Data for MyPrinter (human readable)**

1 The encoded Query Data using DNS name compression is illustrated in Figure
2 E18.

3

| Query Data (Key) | | |
|---|---|---|
| Encoded and Compressed DNS Name | DNS Type | Version |
| 09 6D 79 70 72 69 6E 74 65 72 04 5F 69 70 70 C0 0C | 00 10 | 01 |
| Variable | 2 octets | 1 octet |

4 **Figure E18—IPP Over TCP Query Data for MyPrinter (encoded and compressed)**

5 The Response Data shall contain the key (Query Data) and value (Response
6 Data) pair. Therefore, the complete human readable Response Data is provided
7 in Figure E19.

8

| Response Data (key/value) | | | |
|---|---|---|---|
| Human Readable DNS Name | DNS Type | Version | RDATA |
| MyPrinter_ipp._tcp.local. | 16 (TXT) | 1 | txtvers=1,pdl=application/postscript |
| Variable | 2 octets | 1 octet | Variable |

9 **Figure E19—IPP over TCP Response Data for MyPrinter (human readable)**

10 The encoded Response Data using DNS name compression is illustrated in
11 Figure E20 below.

12

| Response Data (key/value) | | | |
|---|---|---|---|
| Encoded and Compressed DNS Name | DNS Type | Version | RDATA |
| 09 6D 79 70 72 69 6E 74 65 72 04 5F 69 70 70 C0 0C | 00 10 | 01 | 09 74 78 74 76 65 72 73 3D 31 1A 70 64 6C 3D 61 70 70 6C 69 63 61 74 69 6F 6E 2F 70 6F 73 74 73 63 72 69 70 74 |
| Variable | 2 octets | 1 octet | Variable |

13 **Figure E20—IPP over TCP Response Data for MyPrinter (encoded and compressed)**

## 14 **E.3 DNS Name Compression**

15 The DNS Name in the Query Data and Response Data are compressed using
16 DNS Name Compression as defined in section 4.1.4 of RFC 1035.

With traditional DNS Name Compression, the domain name is replaced with a pointer to a prior occurrence of the same name in the DNS query. For P2P SD using GAS, the pointer refers to a virtual in-memory DNS packet with two implied queries (the domain header of the packet is not used for the purposes of compression):

— _tcp.local. PTR IN

— _udp.local. PTR IN

Note that the domain name in the second query is one actual label (_udp) followed by a compression pointer to the second & third labels of the first query (local.). That is, the data of the virtual in-memory DNS packet is (encoded as a C string) as follows.

"\x04_tcp\x05local\x00\x00\x0C\x00\x01\x04_udp\xC0\x11\x00\x0C\x00\x01"

Again, note that the domain header of the packet is used when calculating compression pointers (offsets from the beginning of the virtual in-memory packet), but otherwise is not used.

The Resource Record (RR, refer to section 3.2 of RFC 1035) is written starting at byte 27 of the virtual in-memory packet, which is just after the two implied queries. If possible, the RR name is compressed to the queries in the virtual in-memory packet. The two DNS Type bytes are written after the name. The two DNS Class bytes are skipped. If possible and compliant with DNS-SD practice (for example, for SRV and PTR records), the RDATA bytes are also compressed to the RR name and queries in the virtual in-memory packet.

The key is the RR name plus the two bytes of RR Type plus the single Version byte 0x01 (the Version byte is not in the virtual in-memory packet). That is, the RR Class bytes are not included in the key. The value is the RDATA bytes.

For Query Requests (which do not have RDATA), the DNS Name in the Query Data is written starting at byte 27 of the virtual in-memory packet, which is just after the two implied queries. If possible, the RR name is compressed to the queries in the virtual in-memory packet. The two DNS Type bytes are written after the name. The two DNS Class bytes are unused. DNS names in the key must be canonicalized to lower-case, because DNS names are case-insensitive.

The key is the DNS Name in the Query Data plus the two bytes of RR Type plus the single Version byte 0x01 (the Version byte not in the in-memory packet).

Note, not all service types have compressible RDATA. There are certain DNS service types that are compressible, such as text (TXT) service types. Text (TXT) records are not compressible, since they do not contain a DNS name. The RDATA should only be compressed for those DNS types whose RDATA is compressible per the DNS-SD specification.

## E.4    Supported Service Type Hash (SSTH)

The Supported Service Type Hash is a mechanism to improve the efficiency of exchanging service information between P2P devices. The SSTH is a bitwise hash table that contains information about the service types supported by a P2P device. The SSTH has a length of 32 bytes (256 bits). A CRC-8 is computed on the Encoded and Compressed DNS Name of the Query Data (key), which results in a number between 0 – 255. In order to indicate that a service type is supported (advertising a given service), the P2P Device shall set the bit corresponding to that number in the SSTH. For example, a CRC-8 of the compressed name of a given service type (key) results in a value of 201. The 201st bit of the SSTH shall be set to 1 if the service is supported. DNS names in the key must be canonicalized to lower-case, because DNS names are case-insensitive, but the hash for the SSTH is case-sensitive. Therefore, one would get the same hit whether browsing for MyPrinter._ipp._tcp.local. or myprinter._ipp._tcp.local.

If P2P device A queries for the SSTH of P2P device B and only the n-th bit in the SSTH is set, but the service type (key) P2P device A is looking for hashes to the m-th bit (the CRC-8 of the key is m), then P2P device A knows P2P device B does not support the requested service type (key). If the service type (key) hashes to the n-th bit, then P2P device A will have to perform additional SD queries in order to confirm that requested service type (key) is supported and to get additional information (service records) about the requested service type.

The exchange of the SSTH is done using the Service Discovery mechanism (IEEE802.11u GAS) defined in this Specification.

To request the SSTH from a P2P device, the Service Discovery frame shall include a single Service Request TLV with the Service Protocol Type set to 1 (Bonjour). The Query Data shall contain the DNS Encoded name set to null value (zero length string), the DNS Type set to 0, and the version set to 0.

In response to a Service Discovery query for the SSTH, a single Service Response TLV shall contain the Service Protocol Type set to 1 (Bonjour). The Service Transaction ID is set to the value corresponding to the Service Transaction ID in the Service Request TLV. If the SSTH is available, the Status Code field is set to Service available (value 0 in Table 55) and the Response Data field shall contain the DNS Encoded Name is set to null value (zero length string), the DNS Type set to 0, the version set to 0, and the RDATA shall contain the corresponding SSTH for the P2P device. If the SSTH is not available, the Status Code field is set to 2 (Requested information not available) and the Response Data field shall contain a DNS Encoded Name set to a null value (zero length string), the DNS Type set to 0, the version set to 0, and the RDATA is set to a null value.

# 1 Annex F Recommended Practices for UPnP using Wi-Fi P2P
# 2 Service Discovery

3         The following section provides recommended practices for using UPnP/SSDP
4         with the service discovery mechanism defined in this Specification. In addition
5         some UPnP service discovery examples are provided.

6

| Vendor-specific Content in ANQP Query Request | | | | | |
|---|---|---|---|---|---|
| OUI Subtype | Service Update Indicator | Length | Service Protocol Type | Service Transaction ID | Query Data |
| 0x09 | See §3.1.3.1 | Length | Table 63 | Transaction ID | See below |
| 1 octet | 2 octets | 2 octets | 1 octet | 1 octet | Variable |

7         **Figure F1—Vendor-specific Content in ANQP Query Request**

| Vendor-specific Content in ANQP Query Response | | | | | | |
|---|---|---|---|---|---|---|
| OUI Subtype | Service Update Indicator | Length | Service Protocol Type | Service Transaction ID | Status Code | Response Data |
| 0x09 | See §3.1.3.2 | Length | Table 63 | Transaction ID | Table 65 | See below |
| 1 octet | 2 octets | 2 octets | 1 octet | 1 octet | 1 octet | Variable |

8         **Figure F2—Vendor-specific content in ANQP Query Response**

| Query Data | |
|---|---|
| Query Version | Query Value |
| NA | NA |
| 1 octet | Variable |

9         **Figure F3—Query Data**

| Response Data | |
|---|---|
| Response Version | Response Value |
| NA | NA |
| 1 octet | Variable |

1 **Figure F4—Response Data**

2 Service Protocol Type for UPnP = 2

3 Query Version should always be set to 0x10 if the query values are compatible
4 with UPnP Device Architecture 1.0. For more information, please refer to:
5 http://www.upnp.org/specs/arch/UPnP-arch-DeviceArchitecture-v1.0.pdf. Note
6 that version 1.1 of the UPnP Device Architecture is also compatible with version
7 1.0.

8 If Query Version is 0x10, then Query Value must contain the SSDP value of the
9 Search Target (ST:) header of an M-SEARCH discovery request.

10 Table F1 lists the defined Search Target header values.

11 **Table F1— Query Values**

| Query Value Syntax | Description |
|---|---|
| ssdp:all | Searches for all UPnP devices and services |
| upnp:rootdevice | Searches for all UPnP root devices |
| uuid:*device-uuid* | Searches for a particular device |
| urn:schemas-upnp-org:device:*deviceType:ver* | Searches for devices of the given type |
| urn:*domain-name*:device:*deviceType:ver* | Searches for devices with a vendor-specific type |
| urn:schemas-upnp-org:service:serviceType:ver | Searches for devices containing a service of the given type |
| urn:*domain-name*:service:serviceType:ver | Searches for devices containing a vendor-specific service |

12 Response Version should always be set to 0x10 if the response values are
13 compatible with UPnP Device Architecture 1.0. For more information, please
14 refer to: http://www.upnp.org/specs/arch/UPnP-arch-DeviceArchitecture-
15 v1.0.pdf.

16 Response Value must contain a comma-separated list of values from the USN:
17 headers of SSDP Discovery Response messages. If no devices matching the
18 Query are found, the Status Code field is set to 2 (Requested information not
19 available) and Response Value must be empty.

1  The rationale behind returning only the USN: header value is that the complete
2  UPnP discovery should still take place after the IP connection is established.
3  There would be little benefit and a lot of overhead and complexity to duplicate
4  the entire UPnP service discovery stack over Layer 2. The USN: data in the
5  Response Data tells the initiator that a service or UPnP device of interest is
6  present, and it also provides the UUID of the specific device.

7  The UUID is useful because once the control point device is connected at the IP
8  layer, it can direct its UPnP discovery stack to search for a device with that
9  particular UUID using a minimal value for the SSDP MX: header. Doing this can
10 substantially increase the performance of the UPnP discovery process.

11 ## F.1    Example 1—Search for UPnP internet gateway devices

12

| ANQP Query Request for UPnP Internet Gateway devices | | | | | |
|---|---|---|---|---|---|
| OUI Subtype | Service Update Indicator | Length | Service Protocol Type | Service Transaction ID | Query Data |
| 0x09 | 1 | Length | 2 (UPnP) | 1 | 0x10 urn:schemas-upnp-org:device:InternetGatewayDevice:1 |

13 **Figure F5—Query Request for UPnP Internet Gateway Devices**

| ANQP Query Response for UPnP Internet Gateway devices | | | | | | |
|---|---|---|---|---|---|---|
| OUI Subtype | Service Update Indicator | Length | Service Protocol Type | Service Transaction ID | Status Code | Response Data |
| 0x09 | 1 | Length | 2 (UPnP) | 1 | 0 | 0x10 uuid:6859dede-8574-59ab-9332-123456789012::urn:schemas-upnp-org:device:InternetGatewayDevice:1 |

14 **Figure F6—Query Response for UPnP Internet Gateway Devices**

15 ## F.2    Example 2—Search for all UPnP root devices

16

| ANQP Query Request for all UPnP root devices | | | | | |
|---|---|---|---|---|---|
| OUI Subtype | Service Update Indicator | Length | Service Protocol Type | Service Transaction ID | Query Data |
| 0x09 | 1 | Length | 2 (UPnP) | 2 | 0x10 upnp:rootdevice |

17 **Figure F7—Query Request for all UPnP root devices**

| ANQP Query Response for all UPnP root devices | | | | | | |
|---|---|---|---|---|---|---|
| OUI Subtype | Service Update Indicator | Length | Service Protocol Type | Service Transaction ID | Status Code | Response Data |
| 0x09 | 1 | Length | 2 (UPnP) | 2 | 0 | 0x10 uuid:6859dede-8574-59ab-9332-123456789012::upnp:rootdevice, uuid:5566d33e-9774-09ab-4822-333456785632::upnp:rootdevice |

**Figure F8—Query Response for all UPnP root devices**

## F.3    Example 3—Search for a specific device by its UUID

| ANQP Query Request for a UPnP device by its UUID | | | | | |
|---|---|---|---|---|---|
| OUI Subtype | Service Update Indicator | Length | Service Protocol Type | Service Transaction ID | Query Data |
| 0x09 | 1 | Length | 2 (UPnP) | 3 | 0x10 uuid:6859dede-8574-59ab-9332-123456789012 |

**Figure F9—Query Request for a UPnP device by its UUID**

| ANQP Query Response for a UPnP device by its UUID | | | | | | |
|---|---|---|---|---|---|---|
| OUI Subtype | Service Update Indicator | Length | Service Protocol Type | Service Transaction ID | Status Code | Response Data |
| 0x09 | 1 | Length | 2 (UPnP) | 3 | 0 | 0x10 uuid:6859dede-8574-59ab-9332-123456789012 |

**Figure F10—Query Response for a UPnP device by its UUID**

## F.4    Example 4—Search for all instances of a UPnP Media Server Content Directory Service

| ANQP Query Request for all instances of a UPnP Media Server CDS | | | | | |
|---|---|---|---|---|---|
| OUI Subtype | Service Update Indicator | Length | Service Protocol Type | Service Transaction ID | Query Data |
| 0x09 | 1 | Length | 2 (UPnP) | 4 | 0x10 urn:schemas-upnp-org:service:ContentDirectory:2 |

**Figure F11—Query Request for all instances of a UPnP Media Server CDS**

| ANQP Query Response for all instances of a UPnP Media Server CDS | | | | | | |
|---|---|---|---|---|---|---|
| OUI Subtype | Service Update Indicator | Length | Service Protocol Type | Service Transaction ID | Status Code | Response Data |
| 0x09 | 1 | Length | 2 (UPnP) | 4 | 0 | 0x10 uuid:1122de4e-8574-59ab-9322-333456789044::urn:schemas-upnp-org:service:ContentDirectory:2,uuid:5566d33e-9774-09ab-4822-333456785632::urn:schemas-upnp-org:service:ContentDirectory:2 |

1 **Figure F12—Query Response for all instances of a UPnP Media Server CDS**

2