UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF TEXAS
WACO DIVISION

OZMO LICENSING LLC, Plaintiff, v. DELL TECHNOLOGIES INC. and DELL INC., Defendants.	Civil Action No. 6:22-cv-642 JURY TRIAL DEMANDED

COMPLAINT FOR PATENT INFRINGEMENT

Plaintiff, Ozmo Licensing LLC ("Ozmo Licensing"), as and for its Complaint against defendants, Dell Technologies Inc. and Dell Inc. (together, "Dell" or "Defendants"), hereby alleges as follows:

THE PARTIES

1. Ozmo Licensing is a Texas limited liability company having its principal place of business located at 1000 Heritage Center Circle, Suite 508, Round Rock, Texas 78664.

2. Defendant Dell Technologies Inc. is a Delaware corporation with its principal place of business at One Dell Way, Round Rock, Texas 78682.

3. Defendant Dell Inc. is a Delaware corporation with its principal place of business at One Dell Way, Round Rock, Texas 78682. Dell Inc. is a wholly-owned subsidiary of Dell Technologies Inc.

JURISDICTION AND VENUE

4. This is an action for patent infringement brought under the Patent Laws of the United States, 35 U.S.C. §§ 271, *et seq*. This Court has jurisdiction over the subject matter of this action under 28 U.S.C. §§ 1331 and 1338(a).

5. This Court has general personal jurisdiction over Dell because Dell has a principal place of business in Round Rock, Texas. This Court has specific personal jurisdiction over Dell because: (1) Dell has purposely availed itself of the privileges of conducting business activities in this judicial district; (2) Dell has committed acts of infringement in this judicial district; and (3) exercising general personal jurisdiction over Dell would be fair and reasonable given Dell's contacts with, and business activities within, this judicial district and elsewhere in Texas. Accordingly, this Court's exercise of jurisdiction over Dell would not offend traditional notions of fair play and substantial justice.

6. Dell has committed acts of infringement in this District, directly and/or through intermediaries, by, among other things, making, using, offering to sell, selling, and/or importing products and/or services that infringe the Asserted Patents, as alleged herein.

7. Venue is proper in this judicial district pursuant to 28 U.S.C. §§ 1391 and 1400(b) because Dell has a regular and established place of business in Round Rock, Texas and has committed acts of infringement within this judicial district and elsewhere in Texas. Dell is also registered to do business in Texas.

FACTUAL BACKGROUND

The Patents-in-Suit

8. On February 16, 2016, the United States Patent and Trademark Office ("PTO") issued United States Patent No. 9,264,991 ("the '991 patent"), titled APPARATUS AND METHOD FOR INTEGRATING SHORT-RANGE WIRELESS PERSONAL AREA NETWORKS FOR A WIRELESS LOCAL AREA NETWORK INFRASTRUCTURE. The '991 patent is valid and enforceable. A copy of the '991 patent is attached as Exhibit A.

9. Ozmo Licensing is the owner and assignee of all rights, title and interest in and to the ’991 patent and holds all substantial rights therein, including the right to grant licenses, to exclude others, and to enforce and recover past damages for infringement of the ’991 patent.

10. On December 22, 2020, the PTO issued United States Patent No. 10,873,906 (“the ’906 patent”), titled APPARATUS AND METHOD FOR INTEGRATING SHORT-RANGE WIRELESS PERSONAL AREA NETWORKS FOR A WIRELESS LOCAL AREA NETWORK INFRASTRUCTURE. The ’906 patent is valid and enforceable. A copy of the ’906 patent is attached as Exhibit B.

11. Ozmo Licensing is the owner and assignee of all rights, title and interest in and to the ’906 patent and holds all substantial rights therein, including the right to grant licenses, to exclude others, and to enforce and recover past damages for infringement of the ’906 patent.

12. On December 3, 2013, the PTO issued United States Patent No. 8,599,814 (“the ’814 patent”), titled APPARATUS AND METHOD FOR INTEGRATING SHORT-RANGE WIRELESS PERSONAL AREA NETWORKS FOR A WIRELESS LOCAL AREA NETWORK INFRASTRUCTURE. The ’814 patent is valid and enforceable. A copy of the ’814 patent is attached as Exhibit C.

13. Ozmo Licensing is the owner and assignee of all rights, title and interest in and to the ’814 patent and holds all substantial rights therein, including the right to grant licenses, to exclude others, and to enforce and recover past damages for infringement of the ’814 patent.

14. On May 18, 2021, the PTO issued United States Patent No. 11,012,934 (“the ’934 patent”), titled APPARATUS AND METHOD FOR INTEGRATING SHORT-RANGE WIRELESS PERSONAL AREA NETWORKS FOR A WIRELESS LOCAL AREA NETWORK

INFRASTRUCTURE. The ’934 patent is valid and enforceable. A copy of the ’934 patent is attached as Exhibit D.

15. Ozmo Licensing is the owner and assignee of all rights, title and interest in and to the ’934 patent and holds all substantial rights therein, including the right to grant licenses, to exclude others, and to enforce and recover past damages for infringement of the ’934 patent.

16. On September 14, 2021, the PTO issued United States Patent No. 11,122,504 (“the ’504 patent”), titled APPARATUS AND METHOD FOR INTEGRATING SHORT-RANGE WIRELESS PERSONAL AREA NETWORKS FOR A WIRELESS LOCAL AREA NETWORK INFRASTRUCTURE. The ’504 patent is valid and enforceable. A copy of the ’504 patent is attached as Exhibit E.

17. Ozmo Licensing is the owner and assignee of all rights, title and interest in and to the ’504 patent and holds all substantial rights therein, including the right to grant licenses, to exclude others, and to enforce and recover past damages for infringement of the ’504 patent.

18. On February 15, 2022 the PTO issued United States Patent No. 11,252,659 (“the ’659 patent”), titled APPARATUS AND METHOD FOR INTEGRATING SHORT-RANGE WIRELESS PERSONAL AREA NETWORKS FOR A WIRELESS LOCAL AREA NETWORK INFRASTRUCTURE. The ’659 patent is valid and enforceable. A copy of the ’659 patent is attached as Exhibit F.

19. Ozmo Licensing is the owner and assignee of all rights, title and interest in and to the ’659 patent and holds all substantial rights therein, including the right to grant licenses, to exclude others, and to enforce and recover past damages for infringement of the ’659 patent.

The Inventors, Ozmo Devices, and Ozmo Licensing

20. The inventions of the ’991 patent, the ’906 patent, the ’814 patent, the ’934 patent, the ’504 patent, and the ’659 patent (collectively, “the Ozmo Devices patents” or “the patents-in-suit”) were conceived at Ozmo Devices. Founded in 2004 by spouses Katelijn Vleugels and Roel Peeters, Ozmo Devices was a leading provider of low-power Wi-Fi Personal Area Network (“WPAN”) products that may be deployed in proximity to Wi-Fi Local Area Networks (“WLAN”) products without severe interference arising between the two.

21. Named co-inventors of the patents-in-suit, Vleugels, with a Ph.D. in electrical engineering from Stanford University, and Peeters, with an MBA from The Wharton School, are responsible for inventing a solution to integrate WPAN and WLAN functionalities in a way that delivers cost savings to manufacturers, unprecedented performance to users, and solves the interoperability problems that plagued existing methods of attempted WPAN-WLAN integrations. These patented inventions gave rise to what has since been promulgated by the Wi-Fi Alliance as the Wi-Fi Peer-to-Peer Technical Specification (“Wi-Fi Direct Standard”), which specification Vleugels and Peeters helped draft. The Wi-Fi Alliance is headquartered in Austin, Texas. Vleugels and Peeters live in the greater Austin area of Texas.

22. The Ozmo Devices patents relate to an apparatus for a WPAN that is seamlessly integrated with a WLAN, and methods for using such, to enable a WPAN device that can connect with other WPAN devices without losing connectivity to a WLAN, thereby enabling extended communication with WPAN devices from anywhere within the range of a WLAN infrastructure.

23. Ozmo Licensing was founded in 2019. A significant aspect of Ozmo Licensing’s business is widely and reasonably licensing its current patent portfolio, including the Ozmo

Devices patents, with the support of the inventors. Ozmo Licensing is pursuing related patent applications with the support of inventors Katelijn Vleugels and Roel Peeters.

Wireless Communication Technology

24. Significant accomplishments of the Internet era included standardization of various forms of wireless connectivity, including WLANs and WPANs.

25. An example of a WLAN is an 802.11x (x = a, b, g, n, etc.) network, whose operation is specified in a handful of versions of the Institute of Electrical and Electronics Engineers (IEEE) 802.11x standard, including the IEEE Std. 802.11 ("IEEE 802.11-2012," "802.11x," or "IEEE 802.11x"). Since its adoption, the 802.11x standard, commonly known as "Wi-Fi," has been widely deployed for wireless connectivity in a variety of settings, including in homes, offices, and public establishments. 802.11x WLANs generally support two different configurations: infrastructure mode and ad-hoc mode.

26. An 802.11x WLAN operating in infrastructure mode requires at least one access point ("AP") to provide connections between mobile stations (STAs), or to provide connections between an STA and other nodes on the Internet or other WLANs. 802.11x-compliant STAs, such as laptop computers, desktop computers, tablet computers, mobile phones, printers, smart televisions, and the like, are capable of joining 802.11x WLAN to participate in Wi-Fi communications with each other, with all such communications being routed through at least one AP.

27. Devices in a WPAN communicate directly with each other, in a peer-to-peer (also known as "P2P") manner, without the need for an AP to provide connections between those WPAN devices. The most common example of a WPAN is a Bluetooth connection/network formed

between two Bluetooth-equipped devices. Both the range and the data transmission rates of a Bluetooth WPAN are far smaller than those of an 802.11x WLAN.

28. Bluetooth WPAN devices may operate in the same 2.4-GHz frequency band in which WLAN devices frequently operate. The co-existence of WPAN and WLAN communication protocols in a single frequency band often results in severe interference due to their varying methods of accessing the wireless medium and a lack of synchronization between WPAN and WLAN devices when accessing the wireless medium. Furthermore, a device that supports both Bluetooth WPAN and 802.11 WLAN often requires different hardware and software to support each standard, including different transceivers, and drivers for the transceivers and antennas, which can be functionally duplicative and thus wasteful of resources. While the disharmonious coexistence of Bluetooth WPANs and 802.11x WLANs had long been tolerated, there remained a need for a solution that could more seamlessly integrate WPAN and WLAN communication protocols.

29. The "Background of the Invention" sections of the Ozmo Devices patents each describe some of the problems pertaining to then-contemplated integrations of WLANs and WPANs. Vleugels and Peeters addressed these problems with their inventions. For example, the Ozmo Devices patents describe the lack of synchronization that occurred with then-existing integrations of WLANs and WPANs, and resulting interference from such integrations. *See*, *e.g.*, Ex. A at 2:29-36.[1]

30. The Ozmo Devices patents note that the prior art efforts to address these problems were insufficient. For example, one option was to simply implement WLAN protocols in WPAN

[1] The relevant portions of the specification of the patents-in-suit are identical, and so citations are just to the '991 patent.

devices. *Id.* at 2:37-3:6. This led to power dissipation and/or low transmission rate problems, and introduces undesirable amounts of latency in communications involving the WPAN devices.

31. The Ozmo Devices patents describe noise, linearity and/or overhead protocol problems with integrating then-existing WPAN and WLAN networks. *Id.* at 3:6-19. For example, the patents point out that though WLANs typically operate at relatively high-speed data rates compared to WPANs, they cannot be operated at those faster rates when integrated with WPANs. This is because communication between an AP and its associated STAs occurs at the slowest common data rate supported by any of those associated STAs, and because a WLAN-associated STA that is also capable of associating with a Bluetooth WPAN will typically support low-speed data rates that are typical of Bluetooth devices.

32. Also, although the 802.11x standard specifies power-save modes that allow forms of power savings, there was still a need for other power save modes that were better optimized to meet the power-saving needs of WPAN devices operating over direct P2P connections.

33. There was, thus, a recognized need for seamless integration of WPAN into WLAN infrastructure without the aforementioned problems one would encounter by then existing integrations such as those featuring Bluetooth WPAN devices operating inside an 802.11x WLAN network.

COUNT I
(Dell's Infringement of U.S. Patent No. 9,264,991)

34. Paragraphs 1-33 are incorporated by reference as if fully set forth herein.

35. The invention of the '991 patent represented a technical solution to an unsolved technological problem. The written description of the '991 patent describes in technical detail each of the limitations of the claims, allowing a person of ordinary skill in the art to understand what the limitations cover and how the combination of claim elements differed markedly from and

improved upon what may have been considered conventional or generic. For example, the specification and incorporated references detail the inventors' novel approach to seamlessly integrating a WPAN into a WLAN infrastructure.

36. The elements claimed by the '991 patent, taken alone or in combination, were not well-understood, routine or conventional to one of ordinary skill in the art at the time of the invention. Rather, the '991 patent claims and teaches, *inter alia*, an improved network-enabled hub to facilitate communications between WLAN and WPAN wireless devices. The invention improved upon existing wireless communications, which were unable to integrate a WPAN into a WLAN infrastructure without suffering from one or more of the aforementioned problems, by allowing the network-enabled hub to initiate and maintain connections with nodes of an external wireless network via a first network connection using a first network WLAN protocol and, a second network connection using a second network WPAN protocol that is an overlay protocol with respect to the WLAN protocol, and that is partially consistent with respect to the WLAN protocol.

37. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN is also more cost effective, since communications using the second network WPAN protocol impinge on at least some of the antennae used for communications using the first network WLAN protocol.

38. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN allows the two to operate in the same frequency spectrum without causing excessive interference with each other.

39. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN is also more energy efficient, which can extend the battery life of WPAN devices that are

battery powered or otherwise enable power-hungry WPAN devices to enter power-save modes more readily.

40. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN, also enables lower latency communication involving WPAN devices, which enables a device serving as a hub between a WPAN and WLAN to more effectively forward video streams between the two.

41. Participants in the communications industry chose to incorporate a subset of the claimed apparatus into the Wi-Fi Direct Standard to enjoy at least some of their aforementioned advantages.

42. Dell has infringed, and continues to infringe, the ’991 patent by making, importing, using, offering for sale and selling in the United States numerous wireless devices, including laptop computers, desktop computers, tablets, and monitors, that implement the Wi-Fi Direct protocol (i.e., the “Accused Products”). A subset of these Accused Products comprise network-enabled hubs that can receive, for example, video from an IEEE 802.11x AP and forward such video to a Wi-Fi STA device using the Wi-Fi Direct protocol (i.e., the “Hub Accused Products”).

43. Examples of the Hub Accused Products are Dell’s laptop computers (including, but not limited to, XPS Laptops, Inspiron Laptops, Alienware Gaming Laptops, Vostro Laptops, and Latitude Laptops); desktop computers (including, but not limited to, XPS Desktops, Inspiron Desktops, Alienware Gaming Desktops, OptiPlex Desktops, Vostro Desktops, and New Precision Workstations); and tablets (including, but not limited to, Latitude 2-in-1 devices and Latitude Rugged Extreme tablets), and all other Dell products that include Wi-Fi Direct circuitry and drivers.

44. Claim 1 of the ’991 patent is reproduced below:

1. A network-enabled hub, usable for facilitating data communications between two or more wireless devices that are configured to communicate indirectly with each other via the network-enabled hub, comprising:

an interface to a wireless radio circuit that can send and receive data wirelessly, providing the hub with bi-directional wireless data communication capability;

a processor configured to:

process data received via the wireless radio circuit;

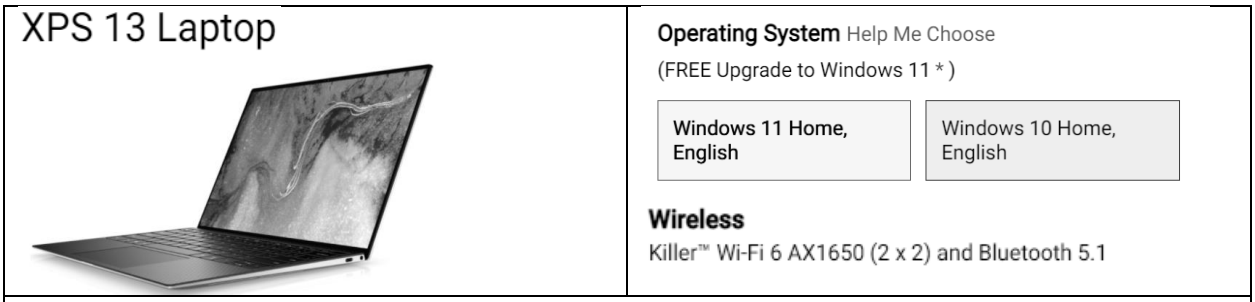
generate data to be transmitted by the wireless radio circuit;

initiate and maintain network connections with nodes of a wireless network external to the network-enabled hub, maintaining at least a first network connection using a first network protocol and a second network connection using a second network protocol, that can be maintained, at times, simultaneously with each other, wherein the second network protocol is an overlay protocol with respect to the first network protocol in that communications using the second network protocol are partially consistent with the first network protocol and wherein at least some of the communications using the second network protocol impinge on at least some antennae used for communications using the first network protocol; and

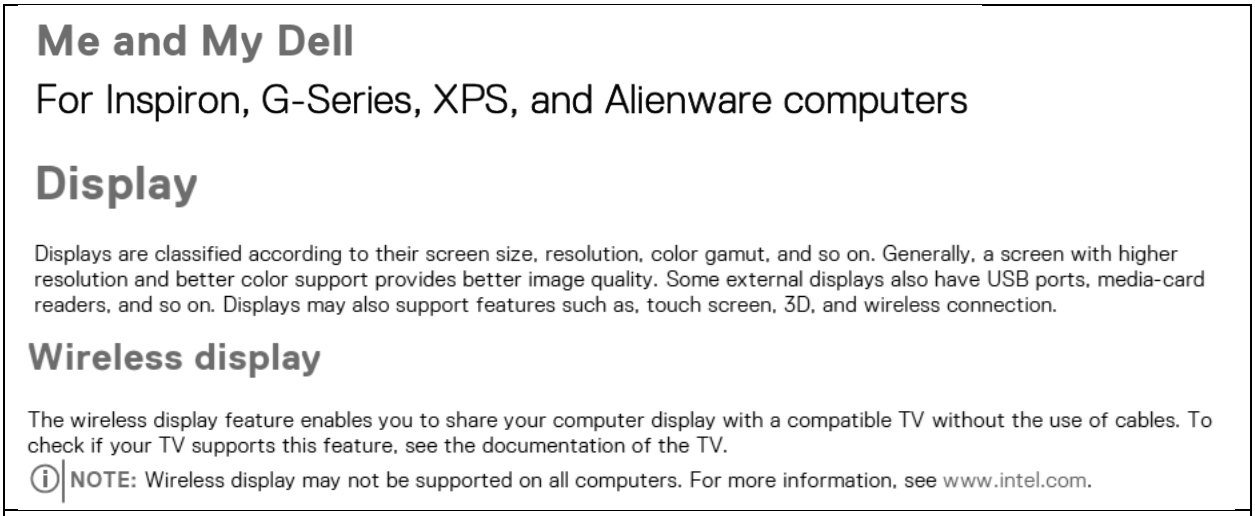
implement data forwarding logic, implemented in a network-enabled hub using hardware and/or software, that forwards data between an originating node and a destination node, wherein the originating node is a node in one of the first and second networks and the destination node is a node in the other of the first and second networks.

45. The Hub Accused Products that infringe the ’991 patent include, *inter alia*, a network-enabled hub, usable for facilitating data communications between two or more wireless devices that are configured to communicate indirectly with each other via the network-enabled hub. For example, the Dell XPS 13 9310 Laptop (“XPS 13 Laptop”) is a Hub Accused Product comprising a network-enabled hub that implements the Wi-Fi and Wi-Fi Direct standards. It also supports applications such as Miracast, which is a standard that allows a user to “mirror” a video image being displayed at one STA onto the display of another STA, by having it communicated over a Wi-Fi Direct connection between the two STAs. The XPS 13 Laptop infringes the ’991

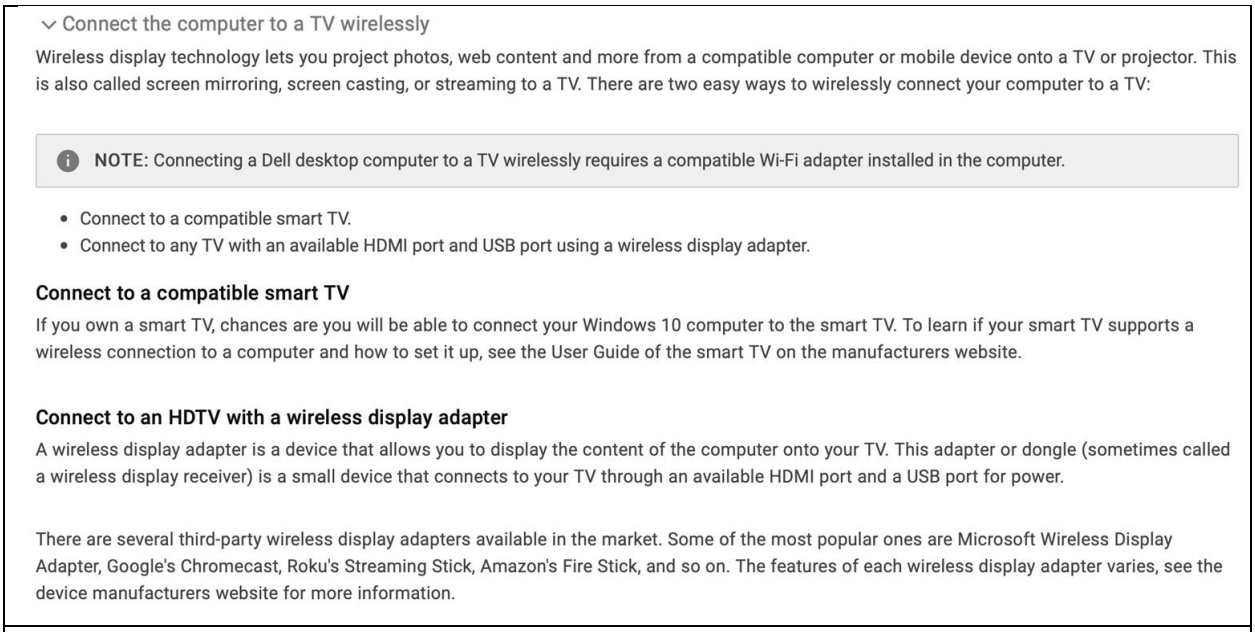
patent because it comprises Wi-Fi and Wi-Fi Direct circuitry and drivers, and applications, such as Miracast, that enable the XPS 13 Laptop to act as a network-enabled hub that concurrently receives data from a node in a WLAN over an 802.11x connection (e.g., streamed video), and forwards that data to a node in a WPAN over a Wi-Fi Direct connection:



Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor



Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_reference-guide_en-us.pdf



Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Connect to a compatible smart TV

If you own a smart TV, chances are you will be able to connect your Windows 10 computer to the smart TV. To learn if your smart TV supports a wireless connection to a computer and how to set it up, see the User Guide of the smart TV on the manufacturers website.

Connect to an HDTV with a wireless display adapter

A wireless display adapter is a device that allows you to display the content of the computer onto your TV. This adapter or dongle (sometimes called a wireless display receiver) is a small device that connects to your TV through an available HDMI port and a USB port for power.

There are several third-party wireless display adapters available in the market. Some of the most popular ones are Microsoft Wireless Display Adapter, Google's Chromecast, Roku's Streaming Stick, Amazon's Fire Stick, and so on. The features of each wireless display adapter varies, see the device manufacturers website for more information.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778

Standards-based Miracast advances life without wires

Miracast is an industry-wide solution, allowing technology to work across device types and vendors. Connections are easy to set up and use since Miracast devices choose the appropriate settings automatically. Miracast can connect two devices using network infrastructure or **Wi-Fi Direct®**. When content to be shared is stored on a Miracast-certified device, such as a smartphone to an automobile infotainment display, a Wi-Fi network connection is not required.

Only devices marked Wi-Fi CERTIFIED Miracast have been certified by Wi-Fi Alliance® to work well with other Wi-Fi CERTIFIED™ devices, employ the latest security protections, and deliver a high-quality user experience.

Source: https://www.wi-fi.org/discover-wi-fi/miracast

2.3 Concurrent operation

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

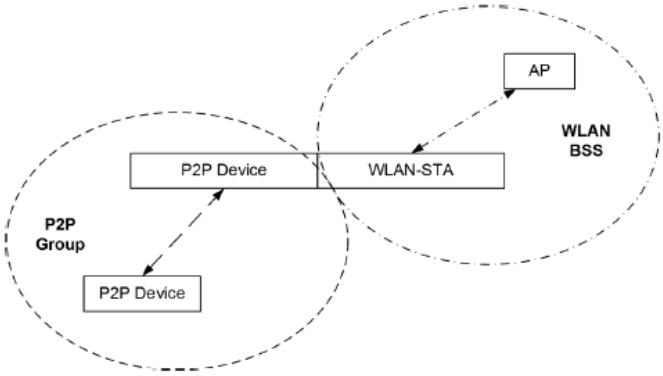
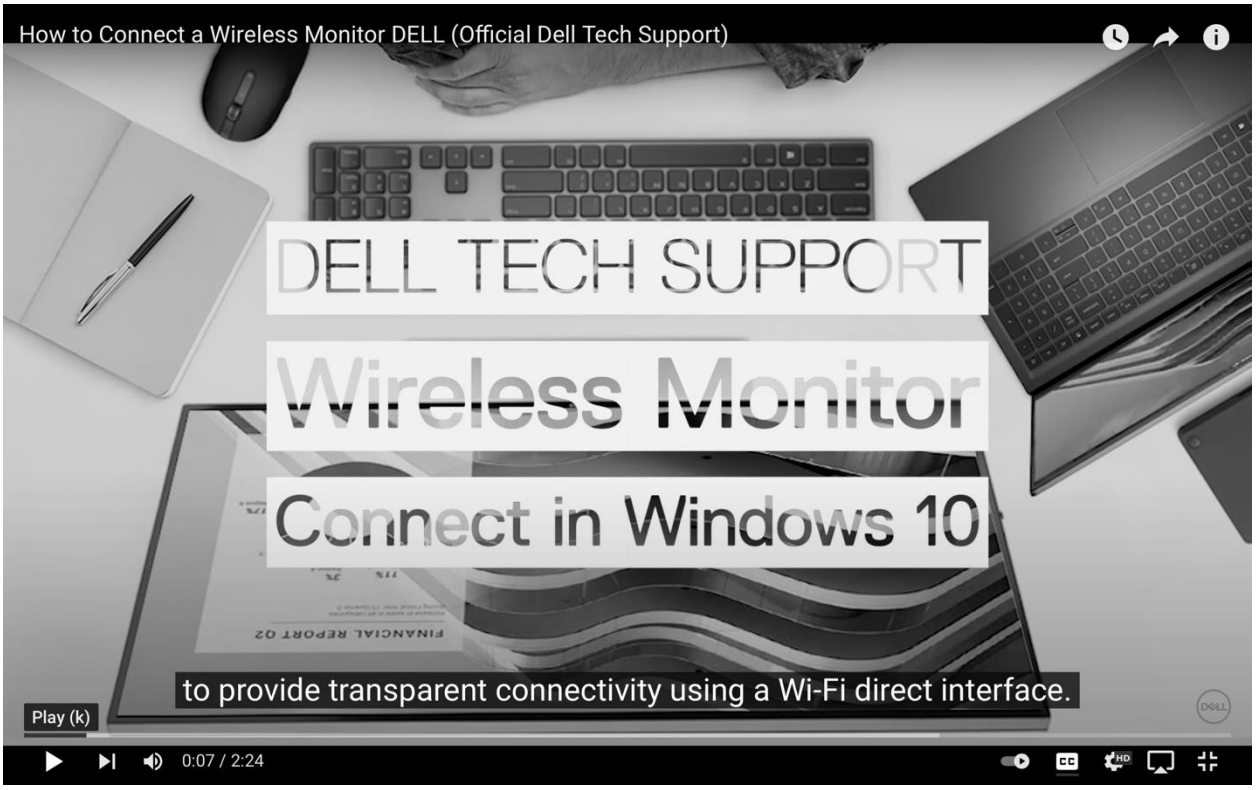


Figure 4—P2P Concurrent device

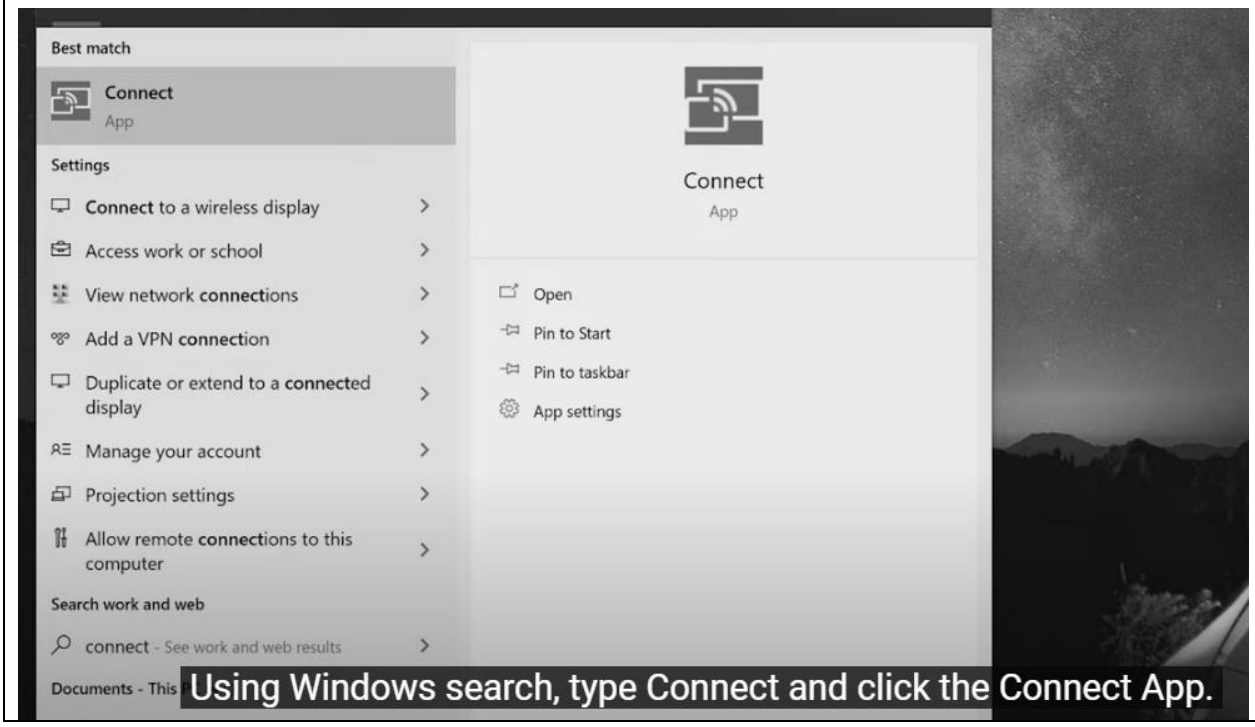
As an example, Figure 4 shows a P2P Concurrent Device that has one MAC entity operating as a WLAN-STA and the second MAC entity operating as a P2P Device. The dual MAC functionality can be provided via two separate physical MAC entities each associated with its own PHY entity, two virtual MAC entities over one PHY entity, or any other approach. Implementation of multiple MAC functionality is out of scope of this specification.

Source: Wi-Fi Direct Standard, v. 1.7, Section 2.3, Fig. 4

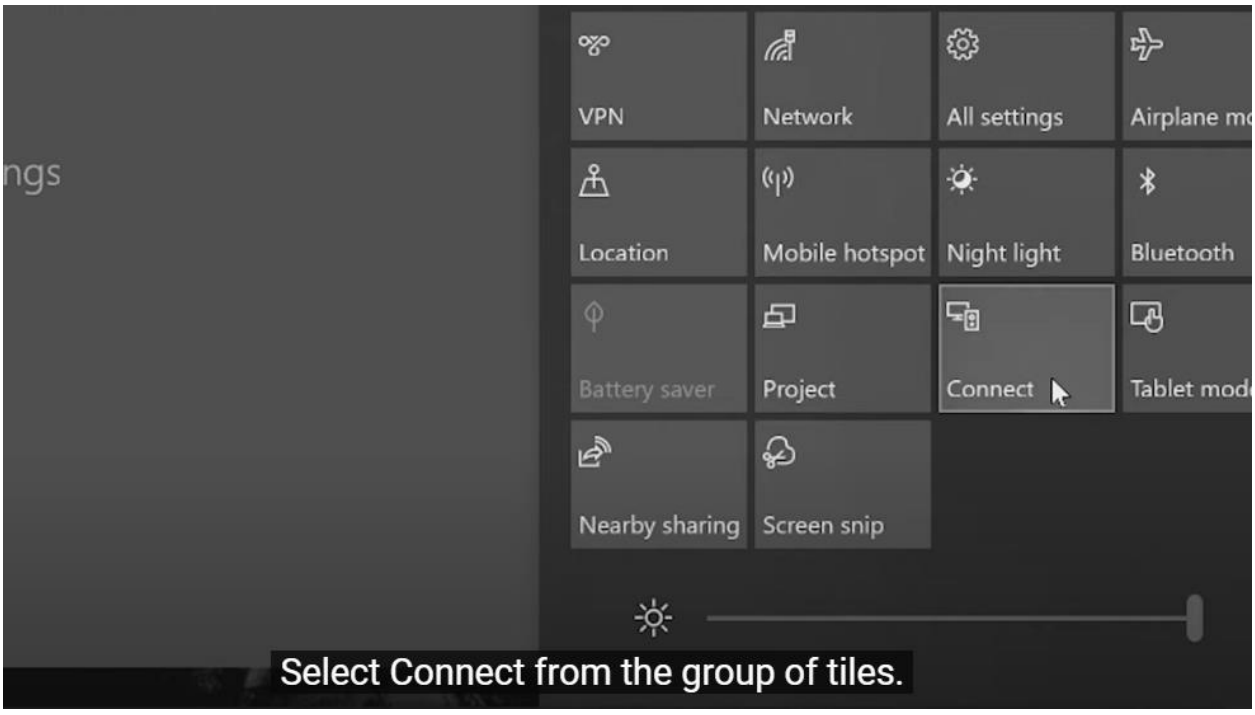

How to Connect a Wireless Monitor DELL (Official Dell Tech Support)
DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
Dell PCs and wireless monitors use Windows and Miracast technology
0:04 / 2:24

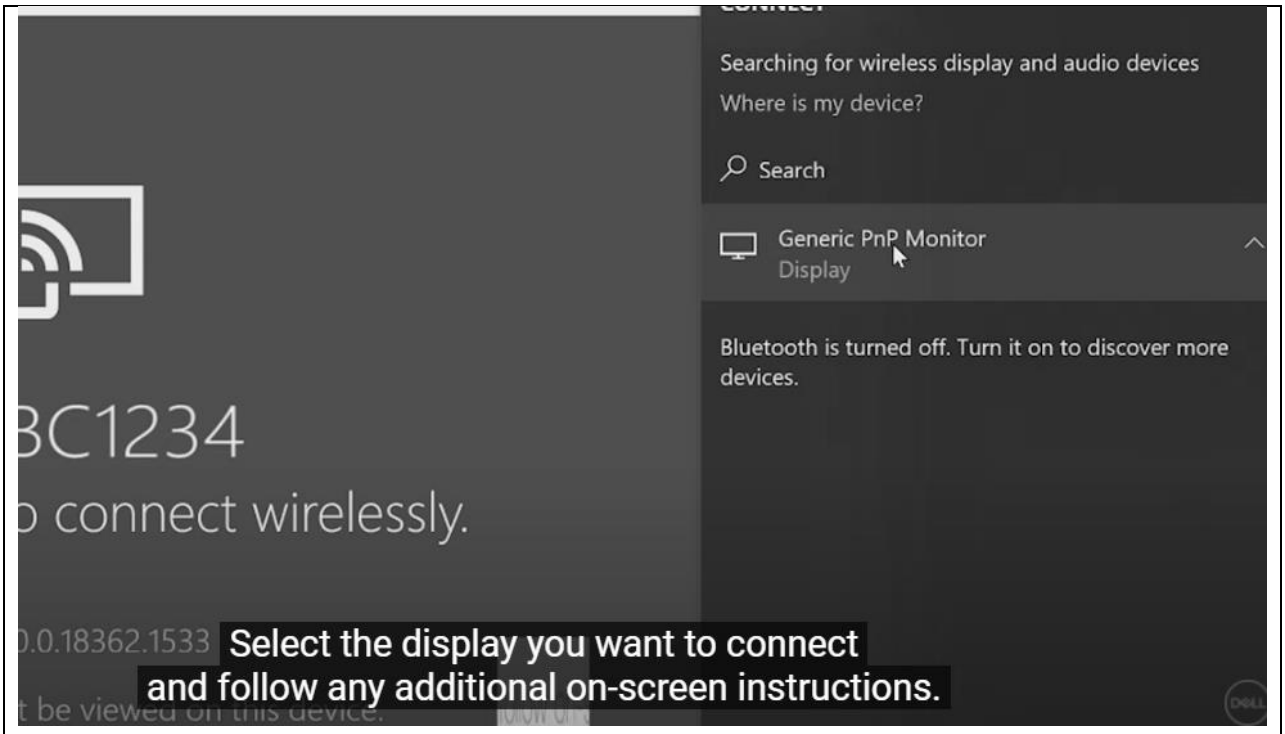

How to Connect a Wireless Monitor DELL (Official Dell Tech Support)
DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
to provide transparent connectivity using a Wi-Fi direct interface.
Play (k)
0:07 / 2:24


DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
In this video, we show you how to connect
your Miracast display to your Windows 10 device.


Best match
Connect
App
Settings
Connect to a wireless display
Access work or school
View network connections
Add a VPN connection
Duplicate or extend to a connected display
Manage your account
Projection settings
Allow remote connections to this computer
Search work and web
connect - See work and web results
Documents - This
Connect
App
Open
Pin to Start
Pin to taskbar
App settings
Using Windows search, type Connect and click the Connect App.


W10ABC1234
is ready for you to connect wirelessly.
Version: 10.0.18362.1533
Protected content can't be viewed on this device.
Press Ctrl + S to open Settings
Connect will open indicating that your Windows 10 Dell PC supports Miracast


VPN
Network
All settings
Airplane mo
Location
Mobile hotspot
Night light
Bluetooth
Battery saver
Project
Connect
Tablet mod
Nearby sharing
Screen snip
Select Connect from the group of tiles.



Source: https://www.youtube.com/watch?v=kXBwdWp7sFM ("How to Connect a Wireless Monitor DELL (Official Dell Tech Support)"

46. The XPS 13 Laptop includes an interface to a wireless radio circuit that can send and receive data wirelessly, providing the hub with bi-directional wireless data communication capability. For example, the XPS 13 Laptop, designed and manufactured by Dell, includes the Intel Killer AX1650 wireless module (wireless radio circuit that can send and receive data wirelessly), which includes Wi-Fi functionality (bi-directional wireless data communications). The XPS 13 Laptop can serve as the claimed hub when, for example, a video is streamed over a Wi-Fi connection from the Internet to the XPS 13 Laptop, and the XPS 13 Laptop's Wi-Fi Direct-circuitry and drivers are used (e.g., under control of, for example, its Miracast application) to mirror that Internet-sourced video to a second device, such as a wireless display:

XPS 13 Laptop

Operating System Help Me Choose

(FREE Upgrade to Windows 11 *)

Windows 11 Home, English	Windows 10 Home, English

Wireless

Killer™ Wi-Fi 6 AX1650 (2 x 2) and Bluetooth 5.1

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Wireless module

The following table lists the Wireless Local Area Network (WLAN) module specifications of your XPS 13 9310.

NOTE: The wireless module is integrated on the system board.

Table 9. Wireless module specifications

Description	Option one
Model number	Intel AX1650
Transfer rate	Up to 2400 Mbps
Frequency bands supported	2.4 GHz/5 GHz
Wireless standards	• WiFi 802.11a/b/g • Wi-Fi 4 (WiFi 802.11n) • Wi-Fi 5 (WiFi 802.11ac) • Wi-Fi 6 (WiFi 802.11ax)
Encryption	• 64-bit/128-bit WEP • AES-CCMP • TKIP
Bluetooth	Bluetooth 5.1

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

TX/RX Streams	2x2
Bands	2.4Ghz, 5Ghz (160Mhz)
Max Speed	2.4Gbps
Wi-Fi CERTIFIED*	WiFi 6 (802.11ax)

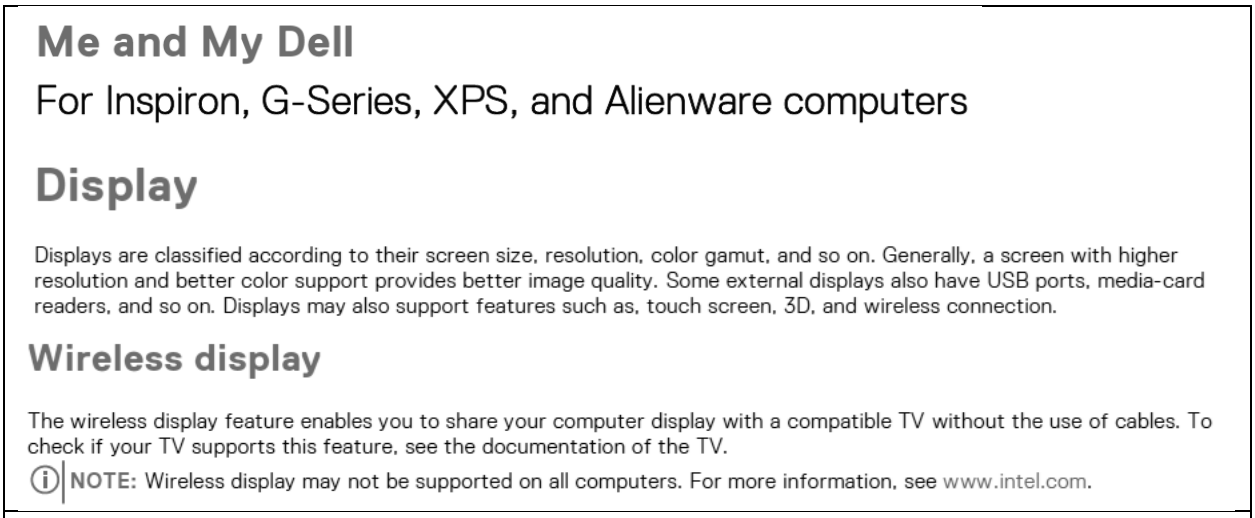
Experience the Intel® Difference

Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.

GENERAL

Dimensions (H x W x D)	M.2 2230: 22mm x 30mm x 2.4mm [1.5mm Max (Top Side)/ 0.1mm Max (Bottom Side)] M.2 1216: 12mm x 16mm x 1.67 (+-0.08) mm
Weight	M.2 2230: 2.83 +/– 0.3 g M.2 1216: 0.67 +/– 0.1 g
Radio ON/OFF Control	Supported
Connector Interface	M.2: PCIe*, USB
Operating Temperature (Adapter Shield)	0°C to +80°C
Humidity Non-Operating	50% to 90% RH non-condensing (at temperatures of 25°C to 35°C)
Operating Systems	Microsoft Windows* 10, Linux*, Chrome OS*
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016
Bluetooth®	Bluetooth® 5.2

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)



Me and My Dell

For Inspiron, G-Series, XPS, and Alienware computers

Display

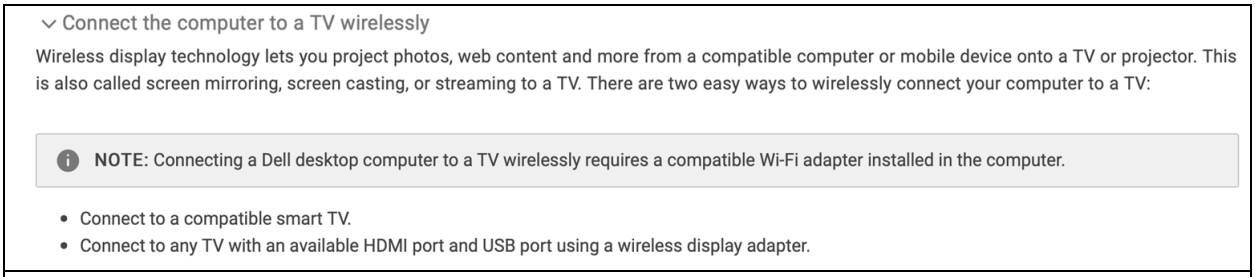
Displays are classified according to their screen size, resolution, color gamut, and so on. Generally, a screen with higher resolution and better color support provides better image quality. Some external displays also have USB ports, media-card readers, and so on. Displays may also support features such as, touch screen, 3D, and wireless connection.

Wireless display

The wireless display feature enables you to share your computer display with a compatible TV without the use of cables. To check if your TV supports this feature, see the documentation of the TV.

NOTE: Wireless display may not be supported on all computers. For more information, see www.intel.com.

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_reference-guide_en-us.pdf



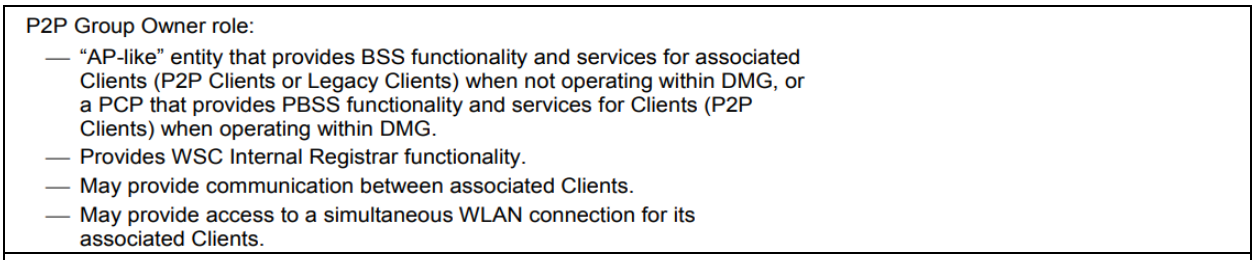
Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778



P2P Group Owner role:

- "AP-like" entity that provides BSS functionality and services for associated Clients (P2P Clients or Legacy Clients) when not operating within DMG, or a PCP that provides PBSS functionality and services for Clients (P2P Clients) when operating within DMG.
- Provides WSC Internal Registrar functionality.
- May provide communication between associated Clients.
- May provide access to a simultaneous WLAN connection for its associated Clients.

Source: Wi-Fi Direct Standard, v. 1.7, Section 2.1

47. The XPS 13 Laptop includes a processor. For example, the XPS 13 Laptop includes the Intel Core i3-1115G4 system processor:

XPS 13 Laptop

Tech Specs

Processor
11th Generation Intel® Core™ i3-1115G4 Processor (6MB Cache, up to 4.1 GHz)

Operating System
(FREE Upgrade to Windows 11)
Windows 11 Home, English

Graphics Card ⓘ
Intel® UHD Graphics with shared graphics memory

Display
13.4" UHD+ (3840 x 2400) InfinityEdge Touch Anti-Reflective 500-Nit Display

Memory ⓘ
8GB 4267MHz LPDDR4x Memory Onboard

Hard Drive
256GB M.2 PCIe NVMe Solid State Drive

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Processor

The following table lists the details of the processors supported by your XPS 13 9310.

Table 4. Processor

Description	Option one
Processor type	11th Generation Intel Core i3-1115G4 processor
Processor wattage	15 W
Processor core count	2
Processor thread count	4
Processor speed	Up to 4.10 GHz
Processor cache	6 MB
Integrated graphics	Intel UHD Graphics

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

48. The processor in the XPS 13 Laptop is configured to process data received via the wireless radio circuit. For example, the XPS 13 Laptop includes the Intel Core i3-1115G4 system processor which is configured to process data received via the Intel Killer AX1650 wireless module (wireless radio circuit):

Processor

The following table lists the details of the processors supported by your XPS 13 9310.

Table 4. Processor

Description	Option one
Processor type	11th Generation Intel Core i3-1115G4 processor
Processor wattage	15 W
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Processor cache	6 MB
Integrated graphics	Intel UHD Graphics

Wireless module

The following table lists the Wireless Local Area Network (WLAN) module specifications of your XPS 13 9310.

NOTE: The wireless module is integrated on the system board.

Table 9. Wireless module specifications

Description	Option one
Model number	Intel AX1650
Transfer rate	Up to 2400 Mbps
Frequency bands supported	2.4 GHz/5 GHz
Wireless standards	• WiFi 802.11a/b/g • Wi-Fi 4 (WiFi 802.11n) • Wi-Fi 5 (WiFi 802.11ac) • Wi-Fi 6 (WiFi 802.11ax)
Encryption	• 64-bit/128-bit WEP • AES-CCMP • TKIP
Bluetooth	Bluetooth 5.1

Chipset

The following table lists the details of the chipset supported by your XPS 13 9310.

Table 5. Chipset

Description	Values
Chipset	Integrated in the processor
Processor	11th Generation Intel Core i3/i5/i7
DRAM bus width	128 bit
Flash EPROM	32 MB (BIOS)
PCIe bus	Up to PCIe Gen 4.0 (Storage)

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

49. The processor in the XPS 13 Laptop is configured to generate data to be transmitted by the wireless radio circuit. For example, the XPS 13 Laptop includes the Intel Core i3-1115G4 system processor, which is configured to generate data to be transmitted by the Intel Killer AX1650 wireless module (wireless radio circuit):

Processor

The following table lists the details of the processors supported by your XPS 13 9310.

Table 4. Processor

Description	Option one
Processor type	11th Generation Intel Core i3-1115G4 processor
Processor wattage	15 W
Processor core count	2
Processor thread count	4
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Processor cache	6 MB
Integrated graphics	Intel UHD Graphics

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NOTE: The wireless module is integrated on the system board.

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Processor	11th Generation Intel Core i3/i5/i7
DRAM bus width	128 bit
Flash EPROM	32 MB (BIOS)
PCIe bus	Up to PCIe Gen 4.0 (Storage)

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

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 Section 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.

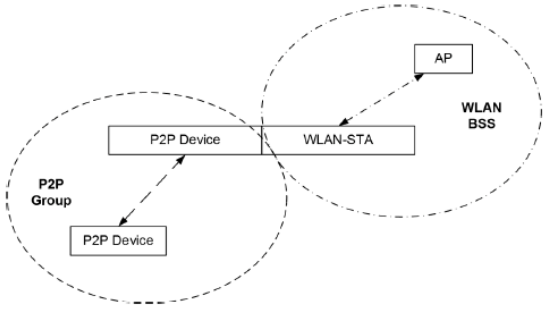
Source: Wi-Fi Direct Standard, v. 1.7, Section 3.2.6.1

50. The processor in the XPS 13 Laptop is configured to initiate and maintain network connections with nodes of a wireless network external to the network-enabled hub. For example, the XPS 13 Laptop (network-enabled hub) may initiate and maintain a connection (network connection) with an AP that is external to the XPS 13 Laptop. The XPS 13 Laptop may also, for

example, initiate and maintain a connection with an STA that is external to the XPS 13 Laptop, such as a wireless monitor or television:

Concurrent operation

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



Source: Wi-Fi Direct Standard, v. 1.7, Section 2.3

Processor

The following table lists the details of the processors supported by your XPS 13 9310.

Table 4. Processor

Description	Option one
Processor type	11th Generation Intel Core i3-1115G4 processor
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The following table lists the Wireless Local Area Network (WLAN) module specifications of your XPS 13 9310.

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Encryption	• 64-bit/128-bit WEP • AES-CCMP • TKIP
Bluetooth	Bluetooth 5.1

Chipset

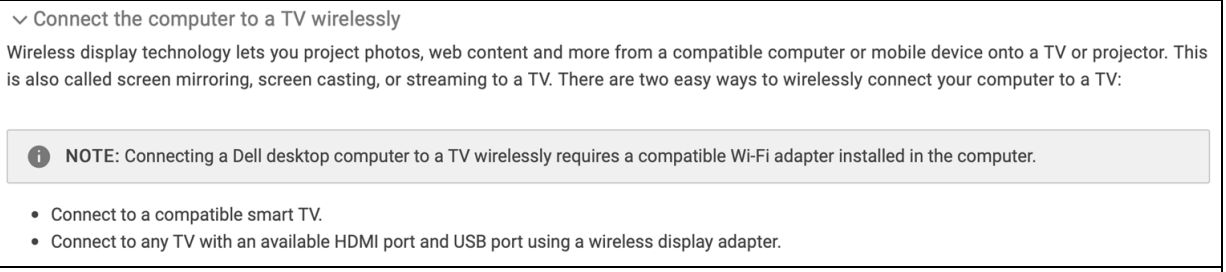
The following table lists the details of the chipset supported by your XPS 13 9310.

Table 5. Chipset

Description	Values
Chipset	Integrated in the processor
Processor	11th Generation Intel Core i3/i5/i7
DRAM bus width	128 bit
Flash EPROM	32 MB (BIOS)
PCIe bus	Up to PCIe Gen 4.0 (Storage)

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

Source: https://www.youtube.com/watch?v=kXBwdWp7sFM ("How to Connect a Wireless Monitor DELL (Official Dell Tech Support)"



Connect the computer to a TV wirelessly

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NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778

and providing added security. Miracast also allows for devices to remain connected to an existing Wi-Fi network while simultaneously connected to a display directly, ensuring network services are always available for presentations or content viewing.

Source: https://www.screenbeam.com/solutions/miracast/

3.2.2 Starting and maintaining a P2P Group session

The P2P Group Owner may be determined through the Group Formation Procedure described in Section 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.

3.2.7 Disconnecting from a P2P Group

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

— the deauthentication procedure in Section 10.3.4.4 of IEEE 802.11-2012 [1] to send a Deauthentication frame to the P2P Group Owner if the P2P Group was established outside DMG, or

— the STA disassociation procedure in Section 10.3.5.6 of IEEE 802.11-2012 [1] to send a Disassociation frame to the P2P Group Owner if operating outside DMG, or the STA disassociation procedure in Section 11.3.5.6 of IEEE 802.11-REVmc [11] to send a Disassociation frame to the P2P Group Owner when operating within DMG.

The P2P Client acquires the Group Credentials through static configuration or through Wi-Fi Simple Configuration [2]. When using Wi-Fi Simple Configuration [2], the P2P Group Owner shall serve as the WSC Registrar and the P2P Client shall serve as the WSC Enrollee. In order to connect to a P2P Group, the P2P Client operating outside DMG, using the Credentials, shall engage in the authentication procedure in Section 10.3.4.2 of IEEE 802.11-2012 [1] and the association procedure in Section 10.3.5.2 of IEEE 802.11-2012 [1] with the P2P Group Owner. In order to connect to a P2P Group, the P2P Client operating within DMG, using the Credentials, shall engage in the association procedure in Section 11.3.5.2 of IEEE 802.11-REVmc [11] with the P2P Group Owner.

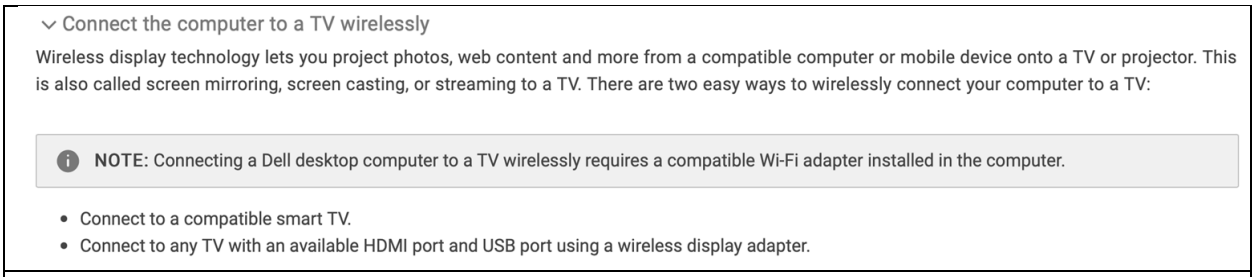
Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.2.2, 3.2.3 & 3.2.7.

51. The processor in the XPS 13 Laptop is configured to maintain at least a first network connection using a first network protocol and a second network connection using a second network protocol that can be maintained simultaneously with each other. For example, the XPS 13 Laptop is configured to connect to an access point using 802.11x Wi-Fi (first network connection using a first network protocol) and to a receiver display screen using Wi-Fi Direct (second network connection using a second network protocol):

Experience the Intel® Difference

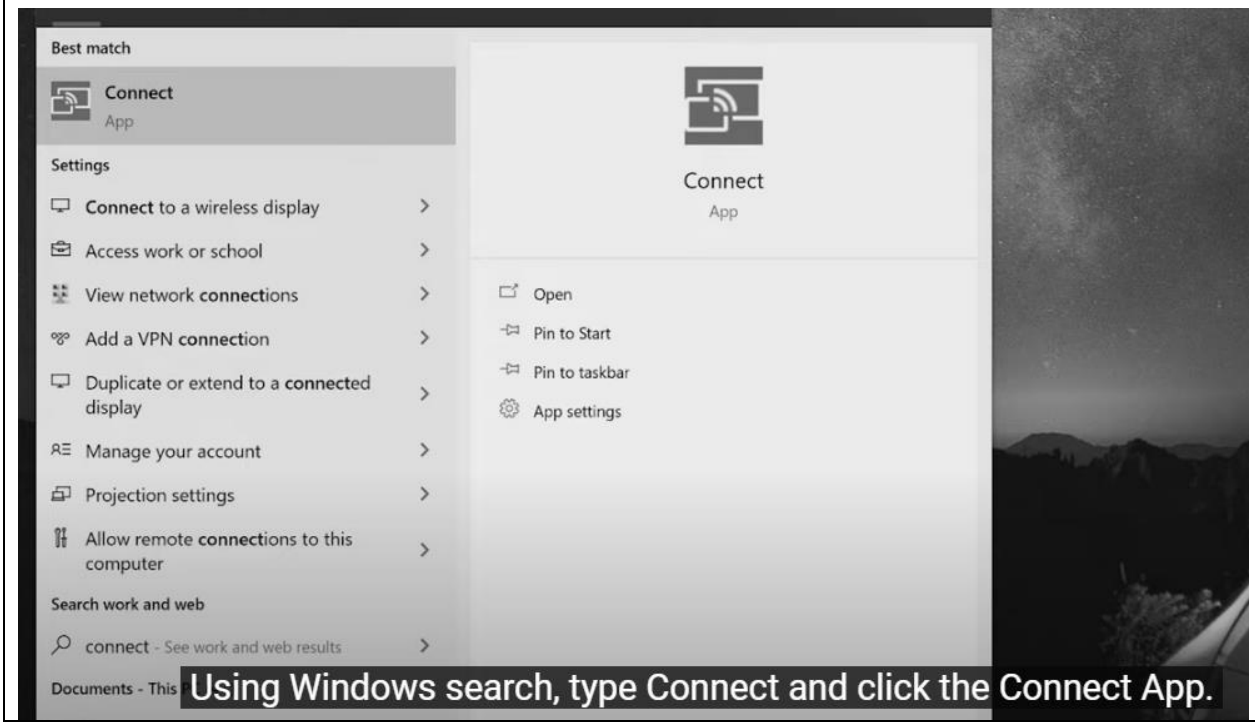
Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html to embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf

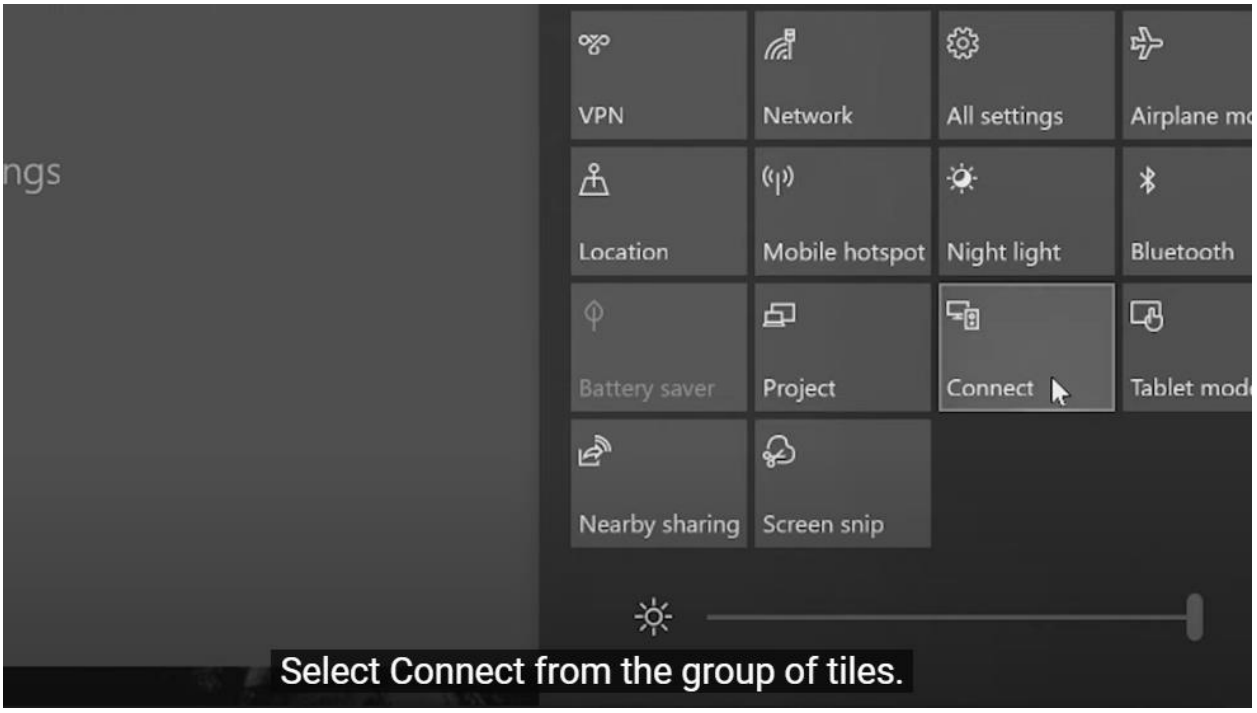


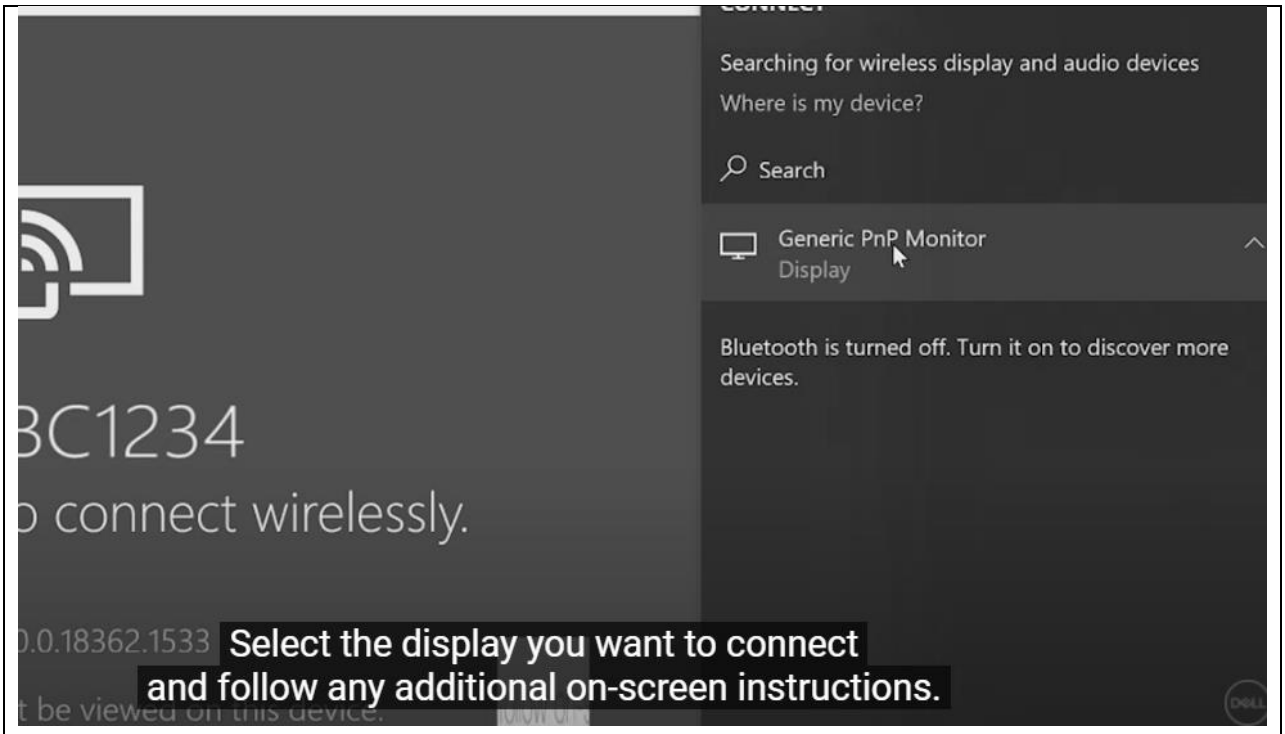
Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778


DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
In this video, we show you how to connect
your Miracast display to your Windows 10 device.


Best match
Connect
App
Settings
Connect to a wireless display
Access work or school
View network connections
Add a VPN connection
Duplicate or extend to a connected display
Manage your account
Projection settings
Allow remote connections to this computer
Search work and web
connect - See work and web results
Connect
App
Open
Pin to Start
Pin to taskbar
App settings
Using Windows search, type Connect and click the Connect App.


W10ABC1234
is ready for you to connect wirelessly.
Version: 10.0.18362.1533
Protected content can't be viewed on this device.
Press Ctrl + S to open Settings
Connect will open indicating that your Windows 10 Dell PC supports Miracast


VPN
Network
All settings
Airplane mo
Location
Mobile hotspot
Night light
Bluetooth
Battery saver
Project
Connect
Tablet mod
Nearby sharing
Screen snip
Select Connect from the group of tiles.



Source: https://www.youtube.com/watch?v=kXBwdWp7sFM ("How to Connect a Wireless Monitor DELL (Official Dell Tech Support)"

Figure 2. Wi-Fi Direct Concurrent Mode

Source: https://arxiv.org/ftp/arxiv/papers/1810/1810.06964.pdf

2.3 Concurrent operation

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

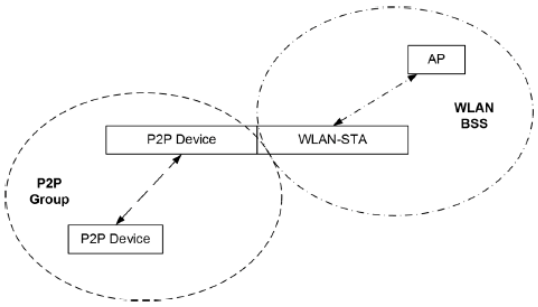


Figure 4—P2P Concurrent device

As an example, Figure 4 shows a P2P Concurrent Device that has one MAC entity operating as a WLAN-STA and the second MAC entity operating as a P2P Device. The dual MAC functionality can be provided via two separate physical MAC entities each associated with its own PHY entity, two virtual MAC entities over one PHY entity, or any other approach. Implementation of multiple MAC functionality is out of scope of this specification.

A P2P Group may operate in the same or different operating class and channel as a concurrently operating WLAN BSS. For example, a WLAN BSS may

Source: Wi-Fi Direct Standard, v. 1.7, Section 2.3

52. The following illustrations provided by Dell include step-by-step instructions, depictions of the user interface prompts as provided in Dell's Hub Accused Products, and provide support to teach and instruct users how to set up a wireless connection to mirror a display, for example, on an XPS 13 Laptop:

Me and My Dell

For Inspiron, G-Series, XPS, and Alienware computers

Display

Displays are classified according to their screen size, resolution, color gamut, and so on. Generally, a screen with higher resolution and better color support provides better image quality. Some external displays also have USB ports, media-card readers, and so on. Displays may also support features such as, touch screen, 3D, and wireless connection.

Wireless display

The wireless display feature enables you to share your computer display with a compatible TV without the use of cables. To check if your TV supports this feature, see the documentation of the TV.

NOTE: Wireless display may not be supported on all computers. For more information, see www.intel.com.

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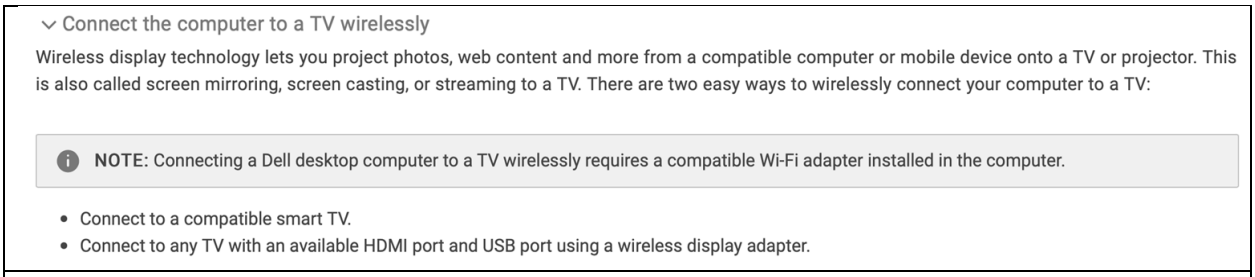

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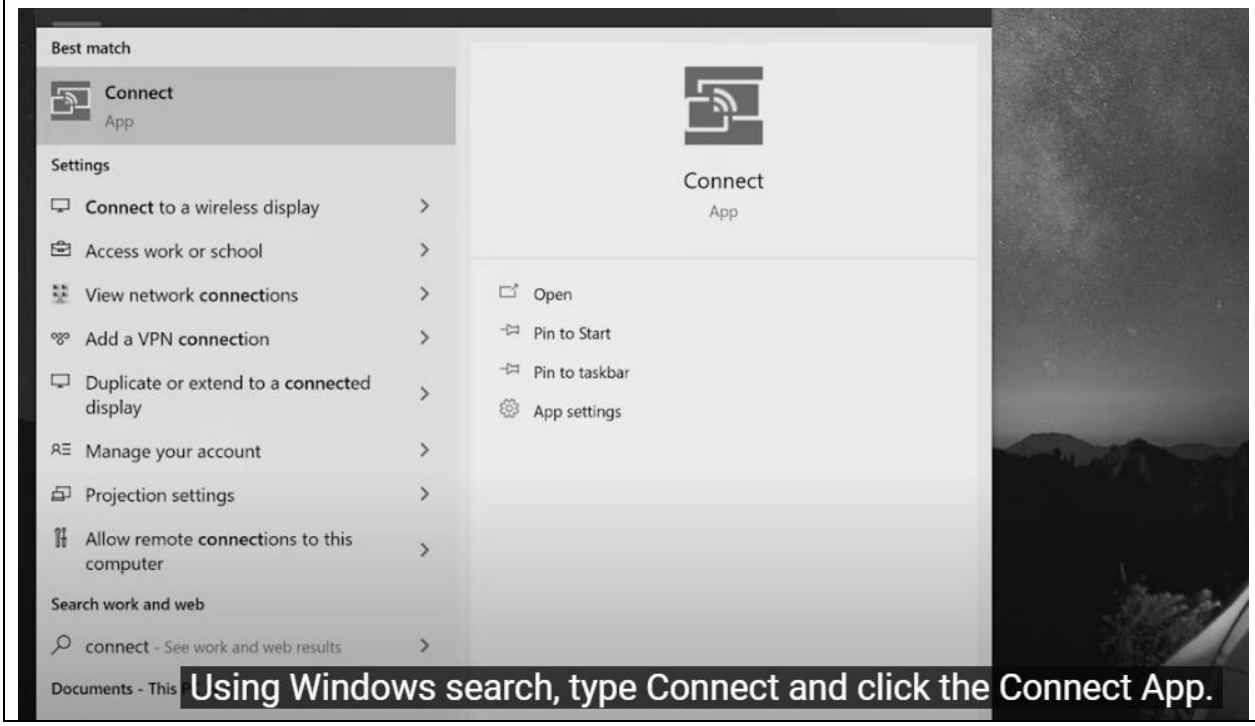
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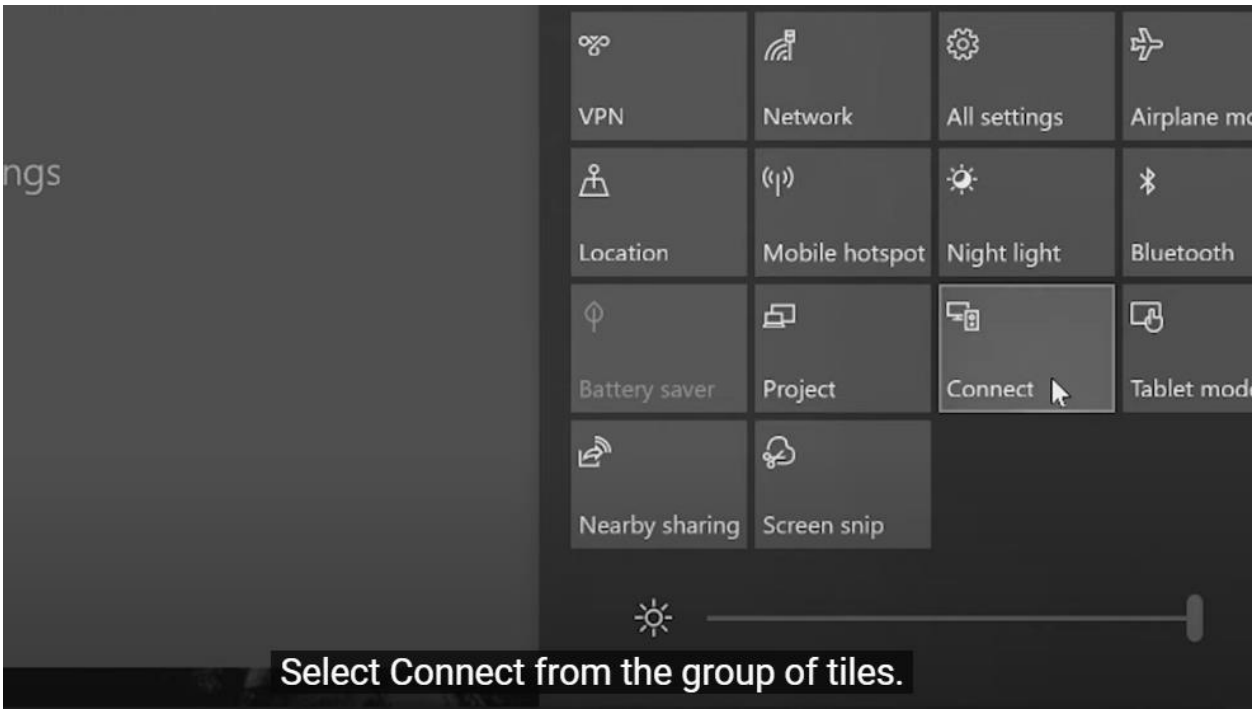
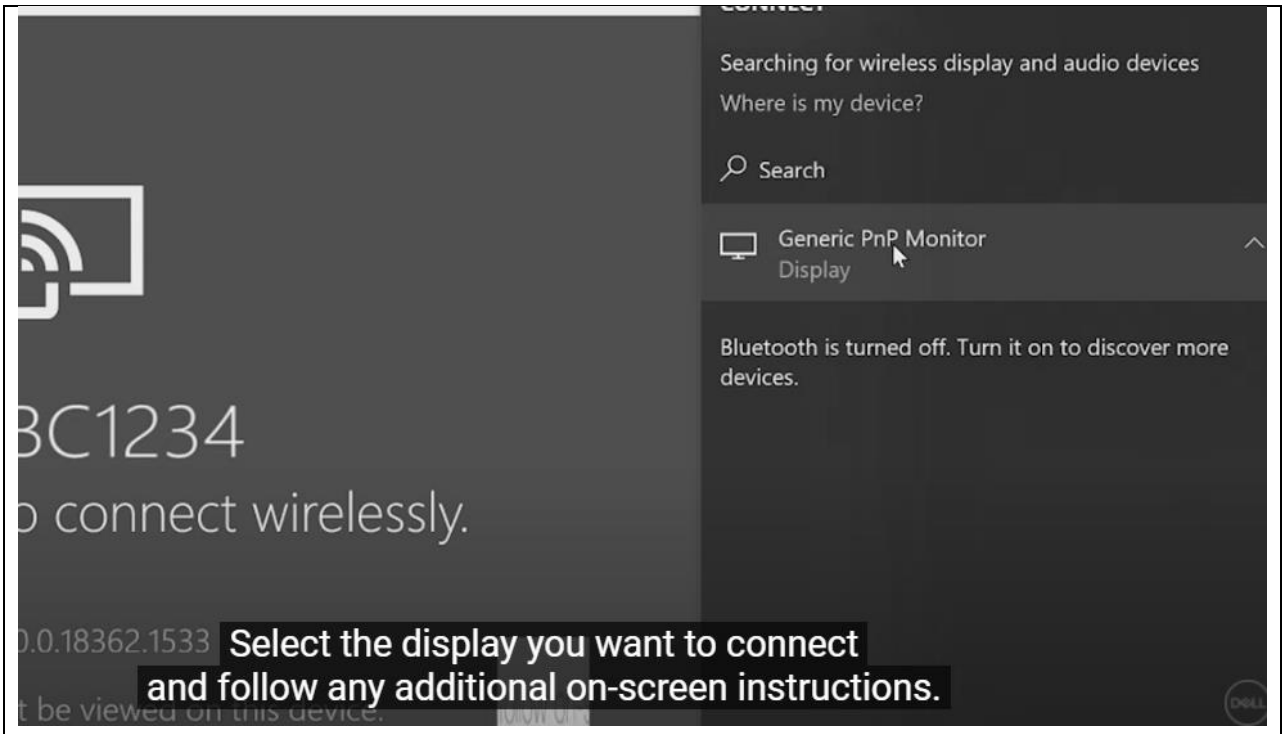
Duplicate or extend to a connected display
Manage your account
Projection settings
Allow remote connections to this computer
Search work and web
connect - See work and web results
Documents - This
Connect
App
Open
Pin to Start
Pin to taskbar
App settings
Using Windows search, type Connect and click the Connect App.


W10ABC1234
is ready for you to connect wirelessly.
Version: 10.0.18362.1533
Protected content can't be viewed on this device.
Press Ctrl + S to open Settings
Connect will open indicating that your Windows 10 Dell PC supports Miracast


VPN
Network
All settings
Airplane mo
Location
Mobile hotspot
Night light
Bluetooth
Battery saver
Project
Connect
Tablet mod
Nearby sharing
Screen snip
Select Connect from the group of tiles.



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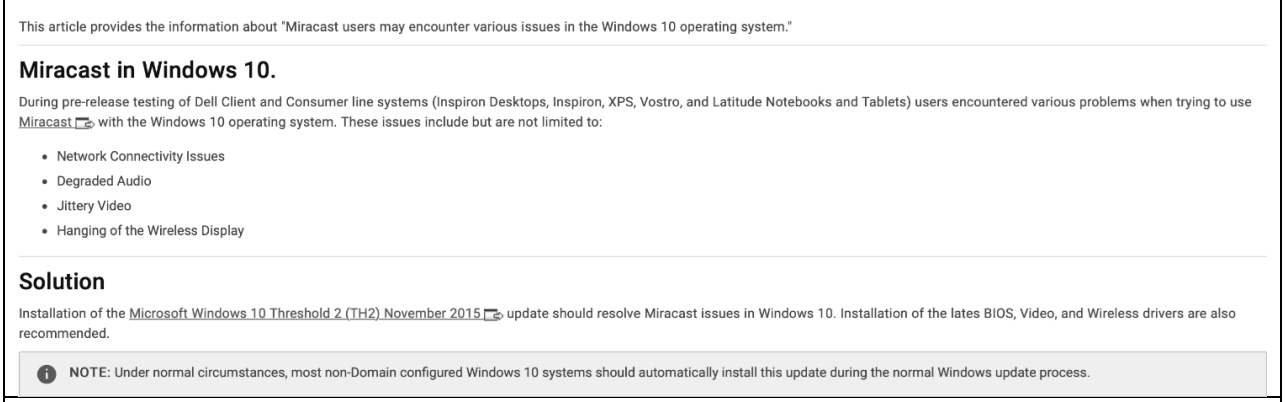


This article provides the information about "Miracast users may encounter various issues in the Windows 10 operating system."

Miracast in Windows 10.

During pre-release testing of Dell Client and Consumer line systems (Inspiron Desktops, Inspiron, XPS, Vostro, and Latitude Notebooks and Tablets) users encountered various problems when trying to use Miracast with the Windows 10 operating system. These issues include but are not limited to:

- Network Connectivity Issues
- Degraded Audio
- Jittery Video
- Hanging of the Wireless Display

Solution

Installation of the Microsoft Windows 10 Threshold 2 (TH2) November 2015 update should resolve Miracast issues in Windows 10. Installation of the lates BIOS, Video, and Wireless drivers are also recommended.

NOTE: Under normal circumstances, most non-Domain configured Windows 10 systems should automatically install this update during the normal Windows update process.

Source: https://www.dell.com/support/kbdoc/en-us/000129880/miracast-users-may-encounter-various-issues-in-the-windows-10-operating-system

53. In further detail, the XPS 13 Laptop, in supporting Wi-Fi, is configured to maintain at least a first network connection using a first network protocol (i.e., Wi-Fi). For example, the XPS 13 Laptop provides connections compliant with IEEE 802.11x:

Wireless module

The following table lists the Wireless Local Area Network (WLAN) module specifications of your XPS 13 9310.

NOTE: The wireless module is integrated on the system board.

Table 9. Wireless module specifications

Description	Option one
Model number	Intel AX1650
Transfer rate	Up to 2400 Mbps
Frequency bands supported	2.4 GHz/5 GHz
Wireless standards	• WiFi 802.11a/b/g • Wi-Fi 4 (WiFi 802.11n) • Wi-Fi 5 (WiFi 802.11ac) • Wi-Fi 6 (WiFi 802.11ax)
Encryption	• 64-bit/128-bit WEP • AES-CCMP • TKIP
Bluetooth	Bluetooth 5.1

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

TX/RX Streams	2x2
Bands	2.4Ghz, 5Ghz (160Mhz)
Max Speed	2.4Gbps
Wi-Fi CERTIFIED*	WiFi 6 (802.11ax)

Wi-Fi Alliance®	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)

10.1.3 Maintaining synchronization

10.1.3.1 General

Each STA shall maintain a TSF timer with modulus 2^{64} counting in increments of microseconds. STAs expect to receive Beacon frames at a nominal rate. The interval between Beacon frames is defined by the dot11BeaconPeriod parameter of the STA. A STA sending a Beacon frame shall set the value of the Beacon frame's timestamp so that it equals the value of the STA's TSF timer at the time that the data symbol containing the first bit of the timestamp is transmitted to the PHY plus the transmitting STA's delays through its local PHY from the MAC-PHY interface to its interface with the WM [e.g., antenna, light-emitting diode (LED) emission surface].

Source: IEEE 802.11-2012, Section 10.1.3.1

10.3.5 Association, reassociation, and disassociation

10.3.5.1 General

Subclause 10.3.5 describes the procedures used for IEEE 802.11 association, reassociation and disassociation.

The states used in this description are defined in 10.3.1.

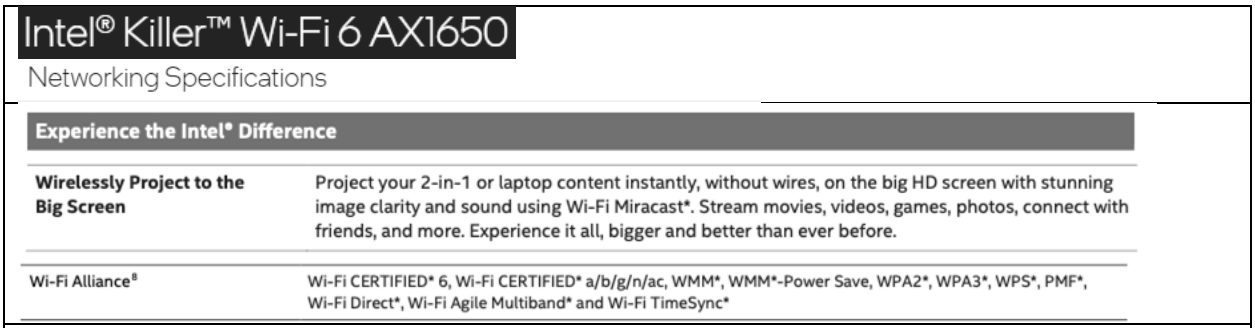
Successful association enables a STA to exchange Class 3 frames. Successful association sets the STA's state to State 3 or State 4.

Successful reassociation enables a STA to exchange Class 3 frames. Unsuccessful reassociation when not in State 1 leaves the STA's state unchanged (with respect to the AP that was sent the Reassociation Request (which may be the current STA)). Successful reassociation sets the STA's state to State 3 or State 4 (with respect to the AP that was sent the Reassociation Request). Successful reassociation when not in State 1 sets the STA's state to State 2 (with respect to the current AP, if this is not the AP that was sent the Reassociation Request). Reassociation shall be performed only if the originating STA is already associated in the same ESS.

Disassociation notification when not in State 1 sets the STA's state to State 2. The STA shall become associated again prior to sending Class 3 frames. A STA may disassociate a peer STA at any time, for any reason.

Source: IEEE 802.11-2012, Section 10.3.5.1

54. In further detail, the XPS 13 Laptop, in supporting Wi-Fi Direct, is configured to maintain a second network connection using a second network protocol (e.g., Wi-Fi Direct). For example, the XPS 13 Laptop, which supports Wi-Fi Direct connections, provides connections using the Wi-Fi Direct Standard:

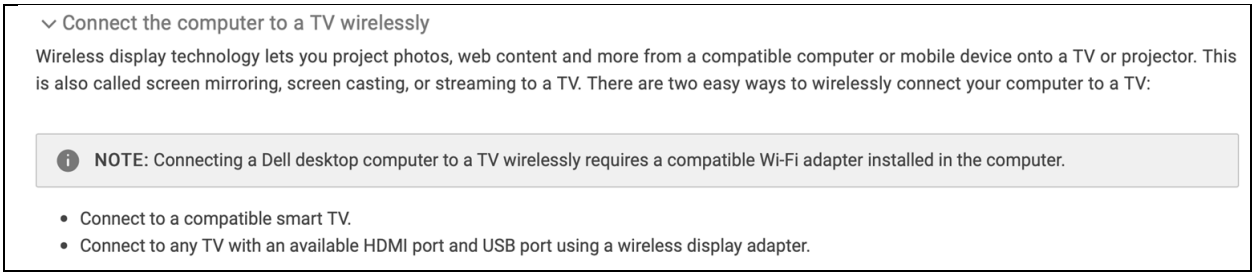


Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

Experience the Intel® Difference	
Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)



Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778

3.2.2 Starting and maintaining a P2P Group session

The P2P Group Owner may be determined through the Group Formation Procedure described in Section 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.

* * *

The P2P Client acquires the Group Credentials through static configuration or through Wi-Fi Simple Configuration [2]. When using Wi-Fi Simple Configuration [2], the P2P Group Owner shall serve as the WSC Registrar and the P2P Client shall serve as the WSC Enrollee. In order to connect to a P2P Group, the P2P Client operating outside DMG, using the Credentials, shall engage in the authentication procedure in Section 10.3.4.2 of IEEE 802.11-2012 [1] and the association procedure in Section 10.3.5.2 of IEEE 802.11-2012 [1] with the P2P Group Owner. In order to connect to a P2P Group, the P2P Client operating within DMG, using the Credentials, shall engage in the association procedure in Section 11.3.5.2 of IEEE 802.11-REVmc [11] with the P2P Group Owner.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.2.2 & 3.2.3

55. In the XPS 13 Laptop, the second network protocol (Wi-Fi Direct) is an overlay protocol with respect to the first network protocol (Wi-Fi). Wi-Fi Direct frames are based on 802.11x frames and use the vendor specific field of an 802.11x management frame. The Wi-Fi Direct protocol processes the data in the vendor-specific field that is overlaid on a Wi-Fi management frame.

2.4.1 Basic functions and services

For P2P operation outside the DMG, this specification assumes that the following STA functions and services are implemented in P2P Devices:

- IEEE 802.11g or newer 2.4 GHz PHY [1]
- IEEE 802.11i (AES-CCMP) [1]
- Wi-Fi Simple Configuration [2]
- Wi-Fi Multimedia [3]

Any required 'AP-like' functions and services required for P2P Group Owner operation outside DMG are described within this specification. A P2P Group Owner operating within DMG is required to support PCP functions and services.

3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.

* * *

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 802.11-2012 [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.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.1, 3.2 & 4

8.3.3 Management frames

8.3.3.1 Format of management frames

The format of a management frame is defined in Figure 8-34. The Frame Control, Duration, Address 1, Address 2, Address 3, and Sequence Control fields are present in all management frame subtypes. The maximum unencrypted MMPDU size, excluding the MAC header and FCS, is 2304 octets.

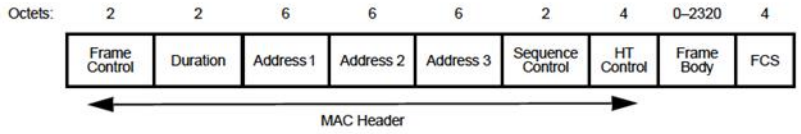


Figure 8-34—Management frame format

The HT Control field is defined in 8.2.4.6. The presence of the HT Control field is determined by the Order subfield of the Frame Control field, as specified in 8.2.4.1.10.

The frame body consists of the fields followed by the elements defined for each management frame subtype. All fields and elements are mandatory unless stated otherwise and appear in the specified, relative order. STAs that encounter an element ID they do not recognize in the frame body of a received management frame ignore that element and continue to parse the remainder of the management frame body (if any) for additional elements with recognizable element IDs. See 9.24.7. Unused element ID codes are reserved.

Gaps may exist in the ordering of fields and elements within frames. The order that remains is ascending.

8.4 Management frame body components

8.4.1 Fields that are not information elements

8.4.2 Information elements

8.4.2.1 General

Elements are defined to have a common general format consisting of a 1 octet Element ID field, a 1 octet Length field, and a variable-length element-specific Information field. Each element is assigned a unique Element ID as defined in this standard. The Length field specifies the number of octets in the Information field. See Figure 8-81.

	Element ID	Length	Information
Octets:	1	1	variable

Figure 8-81—Element format

The set of valid elements is defined in Table 8-54.

Table 8-54—Element IDs

Element	Element ID	Length of indicated element (in octets)	Extensible
SSID (see 8.4.2.2)	0	2 to 34	
Supported rates (see 8.4.2.3)	1	3 to 10	

Table 8-54—Element IDs *(continued)*

Element	Element ID	Length of indicated element (in octets)	Extensible
U-APSD Coexistence (see 8.4.2.93)	142	14 to 257	Subelements
Reserved	143–173		
MCCAOP Advertisement Overview (see 8.4.2.110)	174	8	Yes
Reserved	175–220		
Vendor Specific (see 8.4.2.28)	221	3 to 257	
Reserved	222–255		

8.5.6 Vendor-specific action details

The Vendor Specific Action frame is defined for vendor-specific signaling. The format of the Action field of the Vendor Specific Action frame is shown in Figure 8-437. An Organization Identifier, in the octet field immediately after the Category field, differentiates the vendors (see 8.4.1.31).

NOTE—If management frame protection is negotiated, then Vendor Specific Protected Action frames (see Table 8-38) are protected; otherwise they are unprotected.

	Category	Organization Identifier	Vendor Specific Content
Octets:	1	*j*	Variable

Figure 8-437—Vendor Specific Action frame Action field format

The Category field is set to the value indicating the vendor-specific category, as specified in Table 8-38.

The Organization Identifier contains a public organizationally unique identifier assigned by the IEEE and is specified in 8.4.1.31. The order of the Organization Identifier field is described in 8.2.2.

The Vendor Specific Content contains vendor-specific field(s). The length of the Vendor Specific Content in a Vendor Specific Action frame is limited by the maximum allowed MMPDU size.

Source: IEEE 802.11-2012, Sections 8.3.3.1, 8.4.2.1 & 8.5.6

56. In the XPS 13 Laptop, the WPAN protocol (second wireless network protocol) is an overlay protocol with respect to the WLAN protocol (first wireless network protocol). For example, the WPAN protocol uses a WLAN protocol frame adapted to support a WPAN protocol power-saving procedure that is different as compared to a power-saving protocol supported by the WLAN protocol. For example, in Wi-Fi Direct (the WPAN protocol) the WPAN-adapted frame may utilize the Vendor Specific Information Element (IE) field of an 802.11x protocol frame (a

WLAN protocol frame) to carry information not defined by the IEEE 802.11x Standard so that interoperability operations that are not part of the 802.11x Standard can be implemented, such as those required by the power save features defined by the Wi-Fi Direct Standard. For example, in Wi-Fi Direct, two of the P2P Group Owner's adapted power saving protocol schemes are Notice of Absence and Opportunistic Power Save:

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 802.11-2012 [1] for operation outside DMG and in IEEE 802.11-REVmc [11] for operation within DMG, with the Wi-Fi Alliance OUI and an OUI Type indicating P2P. A number of P2P attributes are defined; a single P2P IE carries one or more P2P attributes.

* * *

3.3 P2P Power Management

The P2P power management approach for operation outside DMG 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.

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.

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

4.1.14 Notice of Absence attribute

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

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.
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.

The Notice of Absence attribute shall be present in the P2P IE in the Beacon frames and Probe Response frames transmitted by a P2P Group Owner when a Notice of Absence schedule is being advertised or when the CTWindow is non-zero, as described in Section 4.2.1 and Section 4.2.3. If there is neither a Notice of Absence schedule nor a CTWindow, the GO may omit the Notice of Absence attribute from Beacon and Probe Response frames. The Notice of Absence shall be also present in Notice of Absence frames, as described in Section 4.2.10.2, P2P Presence Request frames, as described in Section 4.2.10.3, and P2P Presence Response frames, as described in Section 4.2.10.4.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 4, 3.3.1, 3.3.2, & 4.1.14

57. In the XPS 13 Laptop, the second network protocol (Wi-Fi Direct) is an overlay protocol with respect to the first network protocol (Wi-Fi) in that communications using the second network protocol (Wi-Fi Direct) are partially consistent with the first network protocol (Wi-Fi). Aspects of communications using the overlay protocol (Wi-Fi Direct) which are consistent with the first network protocol (Wi-Fi) include, for example, how P2P device communications utilize and access the physical medium. For example, the XPS 13 Laptop, in supporting Wi-Fi Direct, is required to implement the underlying IEEE 802.11g (or newer) Standard at the PHY level, as shown below. By implementing the underlying PHY protocol, P2P device communications (communications in the second wireless network) use and access the physical medium in a manner that is coordinated with 802.11x communications occurring outside of the second wireless network, yet in a common wireless space, such that the problems of device interference are reduced.

2.4.1 Basic functions and services

For P2P operation outside the DMG, this specification assumes that the following STA functions and services are implemented in P2P Devices:

- IEEE 802.11g or newer 2.4 GHz PHY [1]
- IEEE 802.11i (AES-CCMP) [1]
- Wi-Fi Simple Configuration [2]
- Wi-Fi Multimedia [3]

3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.1 & 3.2

58. In the XPS 13 Laptop, the second network protocol (Wi-Fi Direct) is an overlay protocol with respect to the first network protocol (Wi-Fi) in that communications using the Wi-Fi Direct protocol are partially consistent with the Wi-Fi protocol. Aspects of communications using the Wi-Fi Direct protocol which are not consistent with the Wi-Fi protocol include, for example, aspects of P2P Discovery, P2P Power Management, and Managed P2P Device Operation as set out below:

2.4.2 P2P specific functions and services

In addition to the assumed functions listed in Section 2.4.1, a P2P Device supports the 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 802.11-2012 [1] when operating outside DMG and PBSS operation as defined in IEEE 802.11-REVmc [11] when operating within DMG, and provides additions for a P2P Group operation.
- **P2P Power Management** provides a set of functions to reduce power consumption of P2P Devices that operate outside DMG.
- **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.

* * *

A P2P Group Owner shall respond to Probe Request frames following the rules in IEEE 802.11-2012 [1] for operation outside DMG and the rules in IEEE 802.11-REVmc [11] for operation within DMG, 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 802.11-2012 [1], Clause Section 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.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.2 & 3.2.2

59. For example, the Wi-Fi Direct protocol is not consistent with the 802.11x protocol for aspects of P2P Group Operation, such as when a P2P Group Owner shall respond to Probe Request frames. As shown below, there is an 802.11x protocol rule that applies to STAs, in an infrastructure BSS, receiving Probe Request frames which require those STAs to respond with a probe response when one the following are true: (1) the SSID in the probe request frame is the wildcard SSID; (2) the SSID in the probe request frame is the specific SSID of the STA; or (3) the specific SSID of the STA is included in the SSID List element. However, as can be seen in the below Wi-Fi Direct protocol excerpt, there are different rules for setting this same SSID field of a Probe Request frame that include, for example, the use of a P2P wildcard SSID. Thus, when the

XPS 13 Laptop communicates using the Wi-Fi Direct protocol to, for example, respond to Probe Request frames, it disobeys the analogous 802.11x protocol rule.

10.1.4.3.2 Sending a probe response

STAs, subject to the criteria below, receiving Probe Request frames shall respond with a probe response only if:

a) The Address 1 field in the probe request is the broadcast address or the specific MAC address of the STA, and either item b) or item c) below.

b) The STA is a mesh STA and the Mesh ID in the probe request is the wildcard Mesh ID or the specific Mesh ID of the STA.

c) The STA is not a mesh STA and

1) The SSID in the probe request is the wildcard SSID, the SSID in the probe request is the specific SSID of the STA, or the specific SSID of the STA is included in the SSID List element, and

2) The Address 3 field in the probe request is the wildcard BSSID or the BSSID of the STA.

In an infrastructure BSS or in an IBSS, STAs receiving Probe Request frames shall respond with a probe response when the SSID in the probe request is the wildcard SSID or matches the specific SSID of the STA or when the specific SSID of the STA is included in the SSID List element. Furthermore, a STA with dot11RadioMeasurementActivated true receiving a probe request with a DSSS Parameter Set element containing a Current Channel field value that is not the same as the value of dot11CurrentChannel shall not respond with a probe response. An AP shall respond to all probe requests meeting the above criteria. In an IBSS a STA that transmitted a Beacon frame since the last TBTT shall respond to group addressed Probe Request frames. A STA in an IBSS shall respond to Probe Request frames sent to the individual address of the STA.

Source: IEEE 802.11-2012 Standard, Section 10.1.4.3.2

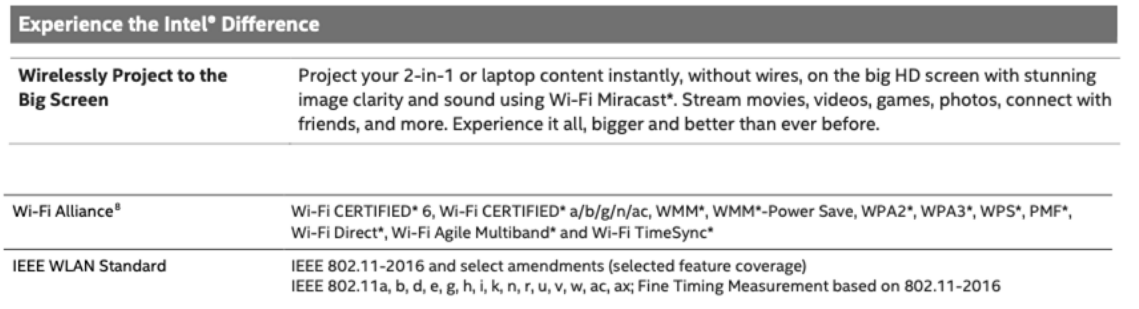
A P2P Group Owner shall respond to Probe Request frames following the rules in IEEE 802.11-2012 [1] for operation outside DMG and the rules in IEEE 802.11-REVmc [11] for operation within DMG, with the following modifications:

— 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 802.11-2012 [1], Clause Section 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,”)

Source: Wi-Fi Direct Standard, v. 1.7, Section 3.2.2

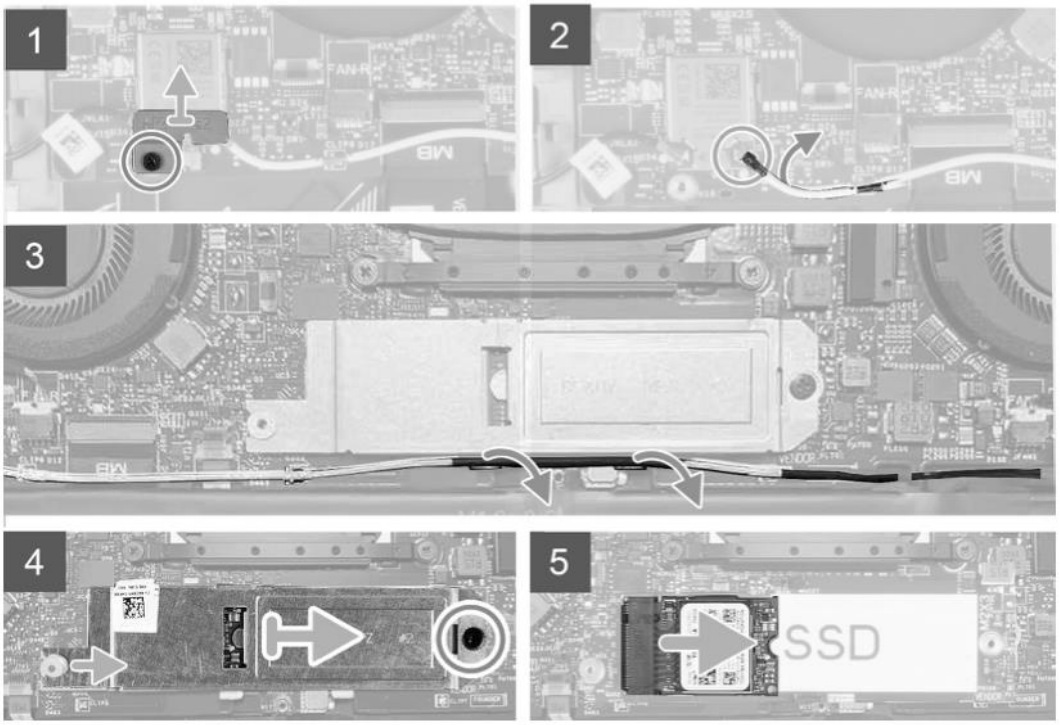
60. In the XPS 13 Laptop, at least some of the communications using the second network protocol (Wi-Fi Direct) impinge on at least some antennae used for communications using the first network protocol (802.11x Wi-Fi). For example, the XPS 13 Laptop contains a wireless radio circuit (Intel Killer AX1650 wireless module) and one or more associated drivers, which

include support for communications using an 802.11x protocol and the Wi-Fi Direct protocol, and which uses the same antennae for both Wi-Fi Direct and 802.11x Wi-Fi communications.



Experience the Intel® Difference	
Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html to embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf



Steps

1. Loosen the captive screw that secures the wireless-card bracket to the system board.
2. Lift the wireless-card bracket off the system board.
3. Using a plastic scribe, disconnect the left antenna cable from the wireless card.
4. Note the routing of the left antenna cable.
5. Starting from the wireless card, remove each antenna cable from the routing guides, toward the respective antennas.

Source: https://dl.dell.com/topicspdf/xps-13-9300-laptop_service-manual_en-us.pdf

61. The processor in the XPS 13 Laptop is configured to implement data forwarding logic, implemented in a network-enabled hub using hardware and/or software, that forwards data between an originating node and a destination node, wherein the originating node is a node in one of the first and second networks and the destination node is a node in the other of the first and second networks. For example, the XPS 13 Laptop (a network-enabled hub) includes Wi-Fi Direct circuitry and drivers, which enable applications that involve forwarding data, including, for example, Miracast (also known as "screen mirroring"). The XPS 13 Laptop forwards data, for example, from a Wi-Fi access point (originating node in the first (802.11x) network) to a wireless screen or television (destination node in the second (Wi-Fi Direct) network):

Processor

The following table lists the details of the processors supported by your XPS 13 9310.

Table 4. Processor

Description	Option one
Processor type	11th Generation Intel Core i3-1115G4 processor
Processor wattage	15 W
Processor core count	2
Processor thread count	4
Processor speed	Up to 4.10 GHz
Processor cache	6 MB
Integrated graphics	Intel UHD Graphics

Wireless module

The following table lists the Wireless Local Area Network (WLAN) module specifications of your XPS 13 9310.

NOTE: The wireless module is integrated on the system board.

Table 9. Wireless module specifications

Description	Option one
Model number	Intel AX1650
Transfer rate	Up to 2400 Mbps
Frequency bands supported	2.4 GHz/5 GHz
Wireless standards	• WiFi 802.11a/b/g • Wi-Fi 4 (WiFi 802.11n) • Wi-Fi 5 (WiFi 802.11ac) • Wi-Fi 6 (WiFi 802.11ax)
Encryption	• 64-bit/128-bit WEP • AES-CCMP • TKIP
Bluetooth	Bluetooth 5.1

Chipset

The following table lists the details of the chipset supported by your XPS 13 9310.

Table 5. Chipset

Description	Values
Chipset	Integrated in the processor
Processor	11th Generation Intel Core i3/i5/i7
DRAM bus width	128 bit
Flash EPROM	32 MB (BIOS)
PCIe bus	Up to PCIe Gen 4.0 (Storage)

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

Experience the Intel® Difference	
Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.
Operating Systems	Microsoft Windows* 10, Linux*, Chrome OS*
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016
Bluetooth®	Bluetooth® 5.2

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)

Me and My Dell

For Inspiron, G-Series, XPS, and Alienware computers

Display

Displays are classified according to their screen size, resolution, color gamut, and so on. Generally, a screen with higher resolution and better color support provides better image quality. Some external displays also have USB ports, media-card readers, and so on. Displays may also support features such as, touch screen, 3D, and wireless connection.

Wireless display

The wireless display feature enables you to share your computer display with a compatible TV without the use of cables. To check if your TV supports this feature, see the documentation of the TV.

NOTE: Wireless display may not be supported on all computers. For more information, see www.intel.com.

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_reference-guide_en-us.pdf

Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778

Figure 2. Wi-Fi Direct Concurrent Mode

Source: https://arxiv.org/ftp/arxiv/papers/1810/1810.06964.pdf

With ***Miracast on Windows 10,*** you can conveniently mirror the content from your computer to any other display, be it a TV, a projector or a set-top box. The best part of the Miracast is that it does not need your home network to work since it creates its own network.

Source: https://www.technorms.com/68339/miracast-windows-10

62. As set forth above, Dell has directly infringed at least claim 1 of the '991 patent by making, importing, using, offering for sale and/or selling the Hub Accused Products into or in the United States.

63. Dell intentionally designed and incorporated the IEEE 802.11x and the Wi-Fi Direct features and functionalities described above into the Hub Accused Products.

64. Dell provides instructions (in the form of at least user interface prompts and customer support instructional videos) to its customers, advertising, encouraging and directing the customers to use the Hub Accused Products in an infringing manner as described above to implement the IEEE 802.11x/Wi-Fi Direct functionality, as intended by Dell. For example, Dell provides operating instructions and the like for the Hub Accused Products, including, but not limited to, the citations above and the following:

- https://www.youtube.com/watch?v=kXBwdWp7sFM
- https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778
- https://www.dell.com/support/kbdoc/en-us/000136674/miracast-to-replace-wi-di
- https://www.dell.com/support/kbdoc/en-us/000129880/miracast-users-may-encounter-various-issues-in-the-windows-10-operating-system
- https://www.dell.com/support/kbdoc/en-us/000130716/guide-to-dell-wireless-monitors
- https://www.dell.com/support/kbdoc/en-us/000152972/how-do-i-enable-widi-miracast-on-my-venue-7-3740-or-venue-8-3840?lang=en
- https://www.dell.com/support/kbdoc/en-us/000129818/a-guide-to-miracast-on-the-latitude-13-7350-tablet-pc?lang=en

- https://www.dell.com/support/kbdoc/en-us/000141601/xps-13-9350-touch-cursor-and-sound-may-have-a-lag-when-system-connected-wifi-miracast-and-bluetooth-audio?lang=en
- https://www.dell.com/support/manuals/en-us/latitude-13-7390-laptop/latitude_7290_7390_7490_tgb/wlan-—-miracast-support-matrix?guid=guid-76975785-70c3-4039-b5bb-eb0b83e669b3&lang=en-us
- https://www.dell.com/support/manuals/en-us/inspiron-11-3179-2-in-1-laptop/inspiron_11_3179_setupandspecs/communications?guid=guid-5fea805b-7f8a-420f-b984-b0e93e13048e&lang=en-us
- https://www.dell.com/support/manuals/en-us/alienware-15-laptop/alienware-15-r3-setupandspecifications/communications?guid=guid-935baab6-b4b4-4960-9783-971e87de151c&lang=en-us

65. By its instructions, including those set forth above, and with intent that its customers use the IEEE 802.11x/Wi-Fi Direct features described above, Dell has induced its customers to infringe the ’991 patent. Dell’s customers who use the Hub Accused Products as described above directly infringe the ’991 patent. Upon information and belief, as a result of attempts by the inventors to sell or license their patents to the PC industry, of which Dell is a member, Dell has had knowledge of (or has been willfully blind to) the ’991 patent. Further, Dell has had knowledge of (or has been willfully blind to) the ’991 patent since at least September 9, 2020, as a result of a letter from Christian Dubuc, Chief Executive Officer of Ozmo Licensing, to Richard Rothberg, General Counsel for Dell, regarding Ozmo Licensing’s patent portfolio and the Accused Dell Products, informing Dell that it required a license. On September 9, 2020, Ozmo Licensing had only eight patents and patent applications that embodied the inventions of Vleugels

and Peeters. In light of the letter from Ozmo Licensing, as well as the size of the portfolio, Dell was, at least, willfully blind to the existence of the '991 patent, in the event that Dell did not have actual knowledge thereof. In addition, upon information and belief, Dell would have gained knowledge of the '991 patent by virtue of the litigation filed against HP Inc. (Docket No: 6:21-cv-00383-ADA) and against Acer Inc. (Docket No. 6:21-cv-01225-ADA). Dell also induces such direct infringement by its customers by failing to remove the infringing features from the Hub Accused Products.

66. By its instructions, including those set forth above, as well as by offering for sale, selling, commercially distributing and importing the Hub Accused Products, Dell has also contributed to its customers' infringement of the '991 patent. The Hub Accused Products are used by Dell's customers to practice the inventions claimed in the '991 patent. The IEEE 802.11x/Wi-Fi Direct features as performed by the Hub Accused Products as described above constitute material parts of the claimed inventions of the '991 patent. Dell knows or was willfully blind that portions of the hardware and software in the Hub Accused Products were specifically made or adapted by Dell solely to provide such functionality and that such features are not staple articles or commodities of commerce suitable for substantial non-infringing use. Dell also knows or was willfully blind that such combinations of hardware and software have no use other than to provide such functionality as intentionally designed into the Hub Accused Products by Dell. As described above, Dell has had knowledge since at the latest September 2020 that its customers were infringing the '991 patent.

67. By the time of trial, Dell will have known and intended that its continued actions would directly infringe, and would induce and contribute to the infringement by its customers of, at least claim 1 of the '991 patent.

68. Ozmo Licensing has been damaged by Dell's past and ongoing direct and indirect infringement of the '991 patent.

69. With knowledge of the allegations set forth herein, Dell continues to incorporate the infringing functionalities in the Hub Accused Products, and has failed to compensate Ozmo Licensing for the use of such features. Dell's unlawful activities described above have continued despite Dell's receipt of the correspondence described above. Dell's infringement will continue unabated unless and until Dell is enjoined or ordered to pay a reasonable royalty for a license to the '991 patent.

COUNT II
(Dell's Infringement of U.S. Patent No. 10,873,906)

70. Paragraphs 1-69 are incorporated by reference as if fully set forth herein.

71. The invention of the '906 patent represented a technical solution to an unsolved technological problem. The written description of the '906 patent describes in technical detail each of the limitations of the claims, allowing a person of ordinary skill in the art to understand what the limitations cover and how the combination of claim elements differed markedly from and improved upon what may have been considered conventional or generic. For example, the specification and incorporated references detail the inventors' novel approach to seamlessly integrating a WPAN into a WLAN infrastructure.

72. The elements claimed by the '906 patent, taken alone or in combination, were not well-understood, routine or conventional to one of ordinary skill in the art at the time of the invention. Rather, the '906 patent claims and teaches, *inter alia*, an improved wireless device for connecting to or coordinating a WPAN. The invention improved upon existing wireless communications, which were unable to integrate a WPAN into a common wireless space with a WLAN infrastructure without suffering from one or more of the aforementioned problems, by

allowing the wireless device to associate with another wireless device over a wireless connection using a WPAN protocol, wherein the WPAN protocol is an overlay protocol with respect to a WLAN protocol, and such that communications using the WPAN protocol are partially consistent with respect to the WLAN protocol.

73. Compared to the prior art, the claimed apparatus for connecting to or coordinating a WPAN is also more cost effective, since communications using the second network WPAN protocol impinge on at least some of the antennae used for communications using a WLAN protocol.

74. Compared to the prior art, the claimed apparatus for connecting to or coordinating a WPAN is also more energy efficient, which can extend the battery life of WPAN devices that are battery powered or otherwise enable power-hungry WPAN devices to enter power-save modes more readily.

75. Compared to the prior art, the claimed apparatus for connecting to or coordinating a WPAN also enables lower latency communication involving WPAN devices, which enables a device serving as a hub between a WPAN and a WLAN to more effectively forward video streams between the two.

76. Participants in the communications industry chose to incorporate a subset of the claimed apparatus into the Wi-Fi Direct Standard to enjoy at least some of their aforementioned advantages.

77. Dell has infringed, and continues to infringe, the ’906 patent by making, importing, using, offering for sale and selling in the United States numerous wireless devices, including laptop computers, desktop computers, tablets, and monitors, that implement the Wi-Fi Direct protocol (i.e., the “Accused Products”).

78. Examples of the Accused Products are Dell's laptop computers (including, but not limited to, XPS Laptops, Inspiron Laptops, Alienware Gaming Laptops, Vostro Laptops, and Latitude Laptops); desktop computers (including, but not limited to, XPS Desktops, Inspiron Desktops, Alienware Gaming Desktops, OptiPlex Desktops, Vostro Desktops, and New Precision Workstations); tablets (including, but not limited to, Latitude 2-in-1 devices and Latitude Rugged Extreme tablets); monitors (including, but not limited to, Dell Wireless Monitors), and all other Dell products that include Wi-Fi Direct circuitry and drivers.

79. Claim 4 of the '906 patent is reproduced below:

> 4. A first wireless device for connecting to a wireless personal area network (WPAN), comprising:
>
> a wireless radio circuit configured to communicate over a physical medium of a wireless local area network (WLAN) using a WLAN protocol;
>
> a memory; and
>
> at least one processor coupled to the wireless radio circuit and the memory, the at least one processor configured to:
>
> discover, via the wireless radio circuit, a second wireless device using a WPAN protocol;
>
> associate, via the wireless radio circuit, with the second wireless device to establish a wireless connection, the wireless connection using the WPAN protocol, wherein upon associating, the first wireless device is configured to become a member of a WPAN network; and
>
> maintain, via the wireless radio circuit, the association with the second wireless device over the wireless connection using the WPAN protocol;
>
> wherein the WPAN protocol is an overlay protocol that is partially compliant with respect to the WLAN protocol such that the WPAN protocol uses a WLAN protocol frame adapted to support a WPAN power-saving protocol that is different as compared to a power-saving protocol supported by the WLAN protocol;
>
> wherein the wireless radio circuit is configured to operate in at least one of a 2.4 GHz or 5 GHz frequency band;
>
> wherein the WLAN protocol is an 802.11x protocol that uses a frame defined by the 802.11x protocol, and the WPAN protocol uses a WPAN-adapted frame in which at least one field of the frame defined by

the 802.11x protocol is adapted to support the WPAN power-saving protocol;

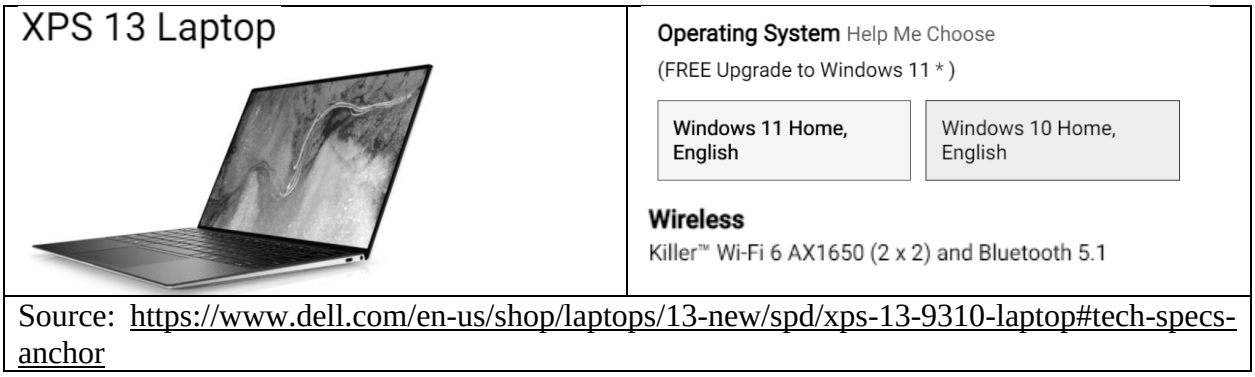
wherein the WPAN-adapted frame is adapted from a WLAN protocol management frame;

wherein the WPAN protocol provides for an inactivity time during which the first and second wireless devices can agree to at least partially disable the wireless connection;

wherein the first wireless device and the second wireless device are configured to agree on the inactivity time in accordance with the WPAN protocol; and

wherein the first wireless device is configured to disable data exchanges with the second wireless device via the wireless connection following a start of the inactivity time, wherein the disabling is such that less power per unit time is consumed by the wireless radio circuit relative to a power per unit time consumed by the wireless radio circuit when the data exchanges are not disabled.

80. The Accused Products that infringe the ’906 patent include, *inter alia*, a first wireless device for connecting to a wireless personal area network (WPAN). For example, the Dell XPS 13 9310 Laptop (“XPS 13 Laptop”) is an Accused Product comprising a first wireless device that implements the Wi-Fi Direct standard to connect to a WPAN. The XPS 13 Laptop infringes the ’906 patent because it comprises Wi-Fi Direct circuitry and drivers, and applications, such as Miracast, that enable the XPS 13 Laptop to connect to and/or coordinate a WPAN:



Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

TX/RX Streams	2x2
Bands	2.4Ghz, 5Ghz (160Mhz)
Max Speed	2.4Gbps
Wi-Fi CERTIFIED*	WiFi 6 (802.11ax)

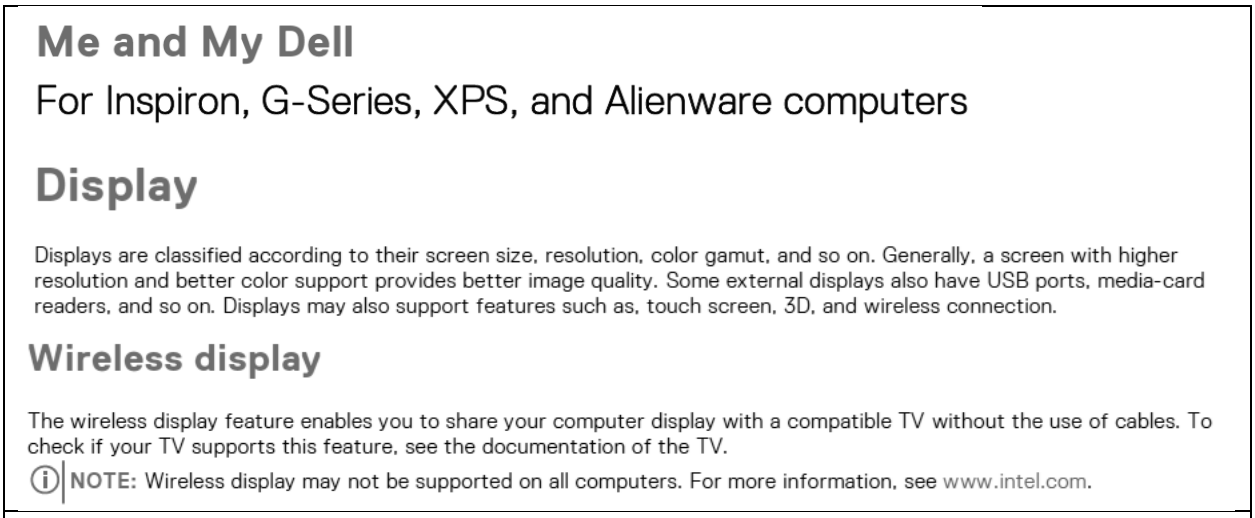
Experience the Intel® Difference

Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.

GENERAL

Dimensions (H x W x D)	M.2 2230: 22mm x 30mm x 2.4mm [1.5mm Max (Top Side)/ 0.1mm Max (Bottom Side)] M.2 1216: 12mm x 16mm x 1.67 (+-0.08) mm
Weight	M.2 2230: 2.83 +/– 0.3 g M.2 1216: 0.67 +/– 0.1 g
Radio ON/OFF Control	Supported
Connector Interface	M.2: PCIe*, USB
Operating Temperature (Adapter Shield)	0°C to +80°C
Humidity Non-Operating	50% to 90% RH non-condensing (at temperatures of 25°C to 35°C)
Operating Systems	Microsoft Windows* 10, Linux*, Chrome OS*
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016
Bluetooth®	Bluetooth® 5.2

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)



Me and My Dell

For Inspiron, G-Series, XPS, and Alienware computers

Display

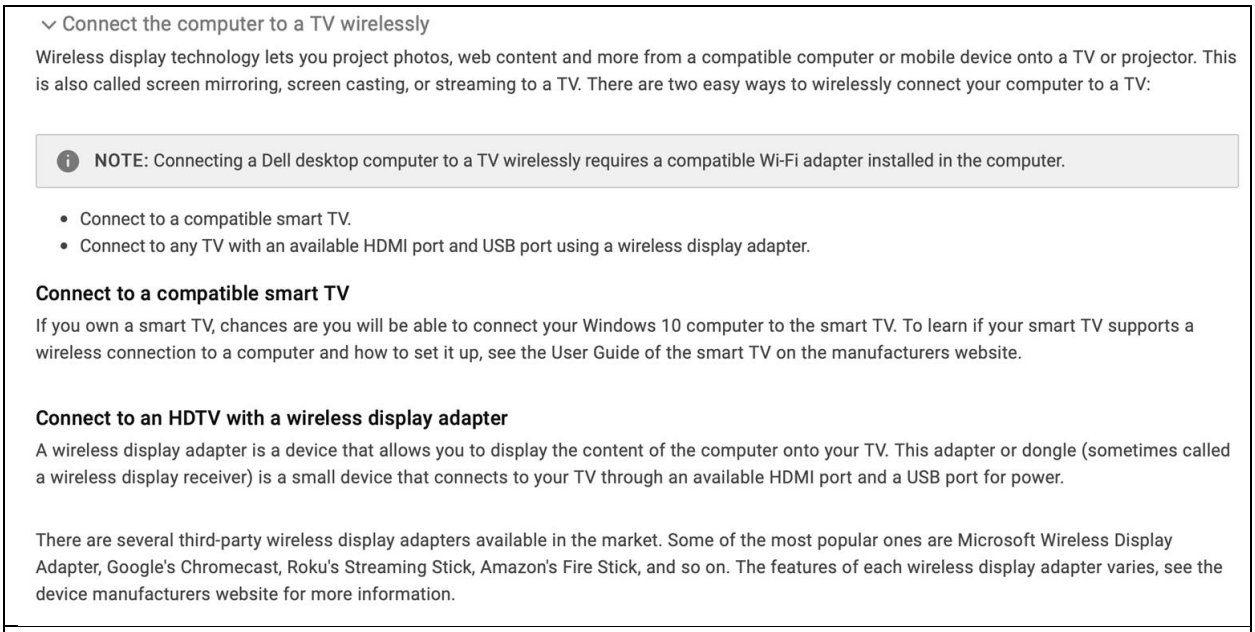
Displays are classified according to their screen size, resolution, color gamut, and so on. Generally, a screen with higher resolution and better color support provides better image quality. Some external displays also have USB ports, media-card readers, and so on. Displays may also support features such as, touch screen, 3D, and wireless connection.

Wireless display

The wireless display feature enables you to share your computer display with a compatible TV without the use of cables. To check if your TV supports this feature, see the documentation of the TV.

NOTE: Wireless display may not be supported on all computers. For more information, see www.intel.com.

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_reference-guide_en-us.pdf



Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Connect to a compatible smart TV

If you own a smart TV, chances are you will be able to connect your Windows 10 computer to the smart TV. To learn if your smart TV supports a wireless connection to a computer and how to set it up, see the User Guide of the smart TV on the manufacturers website.

Connect to an HDTV with a wireless display adapter

A wireless display adapter is a device that allows you to display the content of the computer onto your TV. This adapter or dongle (sometimes called a wireless display receiver) is a small device that connects to your TV through an available HDMI port and a USB port for power.

There are several third-party wireless display adapters available in the market. Some of the most popular ones are Microsoft Wireless Display Adapter, Google's Chromecast, Roku's Streaming Stick, Amazon's Fire Stick, and so on. The features of each wireless display adapter varies, see the device manufacturers website for more information.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778

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.

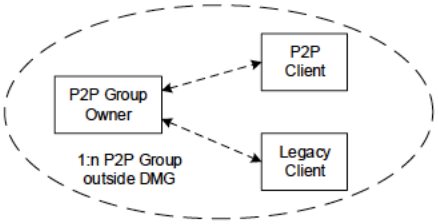


Figure 1—P2P components and topology when operating outside DMG

Source: Wi-Fi Direct Standard, v. 1.7, Section 2.1, Fig. 1

81. The Accused Products are first wireless devices comprising a wireless radio circuit configured to communicate over a physical medium of a wireless local area network (WLAN) using a WLAN protocol. For example, the XPS 13 Laptop (first wireless device) includes the Intel Killer AX1650 wireless module (wireless radio circuit configured to communicate over a physical medium), which is a wireless radio circuit with 802.11x capabilities (802.11x WLAN protocol), as seen below:

XPS 13 Laptop

Operating System Help Me Choose

(FREE Upgrade to Windows 11 *)

Windows 11 Home, English | Windows 10 Home, English

Wireless

Killer™ Wi-Fi 6 AX1650 (2 x 2) and Bluetooth 5.1

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Wireless module

The following table lists the Wireless Local Area Network (WLAN) module specifications of your XPS 13 9310.

NOTE: The wireless module is integrated on the system board.

Table 9. Wireless module specifications

Description	Option one
Model number	Intel AX1650
Transfer rate	Up to 2400 Mbps
Frequency bands supported	2.4 GHz/5 GHz
Wireless standards	• WiFi 802.11a/b/g • Wi-Fi 4 (WiFi 802.11n) • Wi-Fi 5 (WiFi 802.11ac) • Wi-Fi 6 (WiFi 802.11ax)
Encryption	• 64-bit/128-bit WEP • AES-CCMP • TKIP
Bluetooth	Bluetooth 5.1

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

TX/RX Streams	2x2
Bands	2.4Ghz, 5Ghz (160Mhz)
Max Speed	2.4Gbps
Wi-Fi CERTIFIED*	WiFi 6 (802.11ax)

Experience the Intel® Difference

Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.

GENERAL

Dimensions (H x W x D)	M.2 2230: 22mm x 30mm x 2.4mm [1.5mm Max (Top Side)/ 0.1mm Max (Bottom Side)] M.2 1216: 12mm x 16mm x 1.67 (+-0.08) mm
Weight	M.2 2230: 2.83 +/– 0.3 g M.2 1216: 0.67 +/– 0.1 g
Radio ON/OFF Control	Supported
Connector Interface	M.2: PCIe*, USB
Operating Temperature (Adapter Shield)	0°C to +80°C
Humidity Non-Operating	50% to 90% RH non-condensing (at temperatures of 25°C to 35°C)
Operating Systems	Microsoft Windows* 10, Linux*, Chrome OS*
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016
Bluetooth®	Bluetooth® 5.2

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)

82. The Accused Products are first wireless devices comprising a memory. For example, the XPS 13 Laptop includes system memory as seen below:

XPS 13 Laptop

Memory ⓘ

8GB 4267MHz LPDDR4x Memory Onboard

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Memory

The following table lists the memory specifications of your XPS 13 9310.

Table 6. Memory specifications

Description	Values
Memory slots	No memory slots ⓘ NOTE: The memory module is integrated on the system board.
Memory type	LPDDR4x
Memory speed	4267 MHz
Maximum memory configuration	32 GB
Minimum memory configuration	8 GB
Memory configurations supported	• 8 GB (4 x 2 GB) LPDDR4x at 4267 MHz • 16 GB (4 x 4 GB) LPDDR4x at 4267 MHz • 32 GB (4 x 8 GB) LPDDR4x at 4267 MHz

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

83. The Accused Products are first wireless devices comprising at least one processor coupled to the wireless radio circuit and the memory. For example, the XPS 13 Laptop includes the Intel Core i3-1115G4 system processor coupled to the wireless radio circuit and the memory, as seen below:

XPS 13 Laptop

Tech Specs

Processor
11th Generation Intel® Core™ i3-1115G4 Processor (6MB Cache, up to 4.1 GHz)

Operating System
(FREE Upgrade to Windows 11)
Windows 11 Home, English

Graphics Card ⓘ
Intel® UHD Graphics with shared graphics memory

Display
13.4" UHD+ (3840 x 2400) InfinityEdge Touch Anti-Reflective 500-Nit Display

Memory ⓘ
8GB 4267MHz LPDDR4x Memory Onboard

Hard Drive
256GB M.2 PCIe NVMe Solid State Drive

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Processor

The following table lists the details of the processors supported by your XPS 13 9310.

Table 4. Processor

Description	Option one
Processor type	11th Generation Intel Core i3-1115G4 processor
Processor wattage	15 W
Processor core count	2
Processor thread count	4
Processor speed	Up to 4.10 GHz
Processor cache	6 MB
Integrated graphics	Intel UHD Graphics

Wireless module

The following table lists the Wireless Local Area Network (WLAN) module specifications of your XPS 13 9310.

NOTE: The wireless module is integrated on the system board.

Table 9. Wireless module specifications

Description	Option one
Model number	Intel AX1650
Transfer rate	Up to 2400 Mbps
Frequency bands supported	2.4 GHz/5 GHz
Wireless standards	• WiFi 802.11a/b/g • Wi-Fi 4 (WiFi 802.11n) • Wi-Fi 5 (WiFi 802.11ac) • Wi-Fi 6 (WiFi 802.11ax)
Encryption	• 64-bit/128-bit WEP • AES-CCMP • TKIP
Bluetooth	Bluetooth 5.1

Chipset

The following table lists the details of the chipset supported by your XPS 13 9310.

Table 5. Chipset

Description	Values
Chipset	Integrated in the processor
Processor	11th Generation Intel Core i3/i5/i7
DRAM bus width	128 bit
Flash EPROM	32 MB (BIOS)
PCIe bus	Up to PCIe Gen 4.0 (Storage)

Memory

The following table lists the memory specifications of your XPS 13 9310.

Table 6. Memory specifications

Description	Values
Memory slots	No memory slots NOTE: The memory module is integrated on the system board.
Memory type	LPDDR4x
Memory speed	4267 MHz
Maximum memory configuration	32 GB
Minimum memory configuration	8 GB
Memory configurations supported	• 8 GB (4 x 2 GB) LPDDR4x at 4267 MHz • 16 GB (4 x 4 GB) LPDDR4x at 4267 MHz • 32 GB (4 x 8 GB) LPDDR4x at 4267 MHz

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

84. The Accused Products are first wireless devices comprising at least one processor configured to discover, via the wireless radio circuit, a second wireless device using a WPAN

protocol. For example, the XPS 13 Laptop (a first wireless device) includes the Intel Core i3-1115G4 system processor configured to support the Wi-Fi Direct protocol (as shown above) by, for example, discovering a second wireless device, such as a wireless monitor or other peripheral (including, but not limited to, other Accused Products), using Wi-Fi Direct (a WPAN protocol):

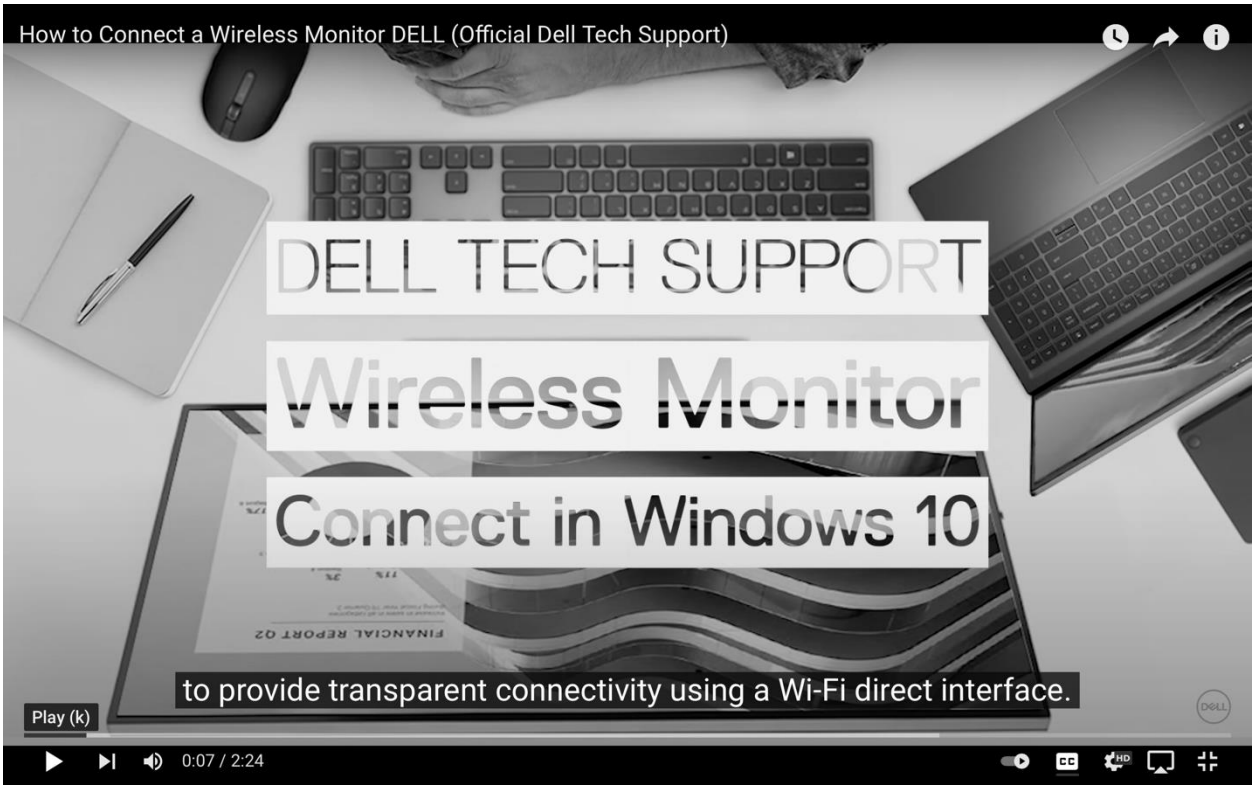
Standards-based Miracast advances life without wires

Miracast is an industry-wide solution, allowing technology to work across device types and vendors. Connections are easy to set up and use since Miracast devices choose the appropriate settings automatically. Miracast can connect two devices using network infrastructure or **Wi-Fi Direct®**. When content to be shared is stored on a Miracast-certified device, such as a smartphone to an automobile infotainment display, a Wi-Fi network connection is not required.

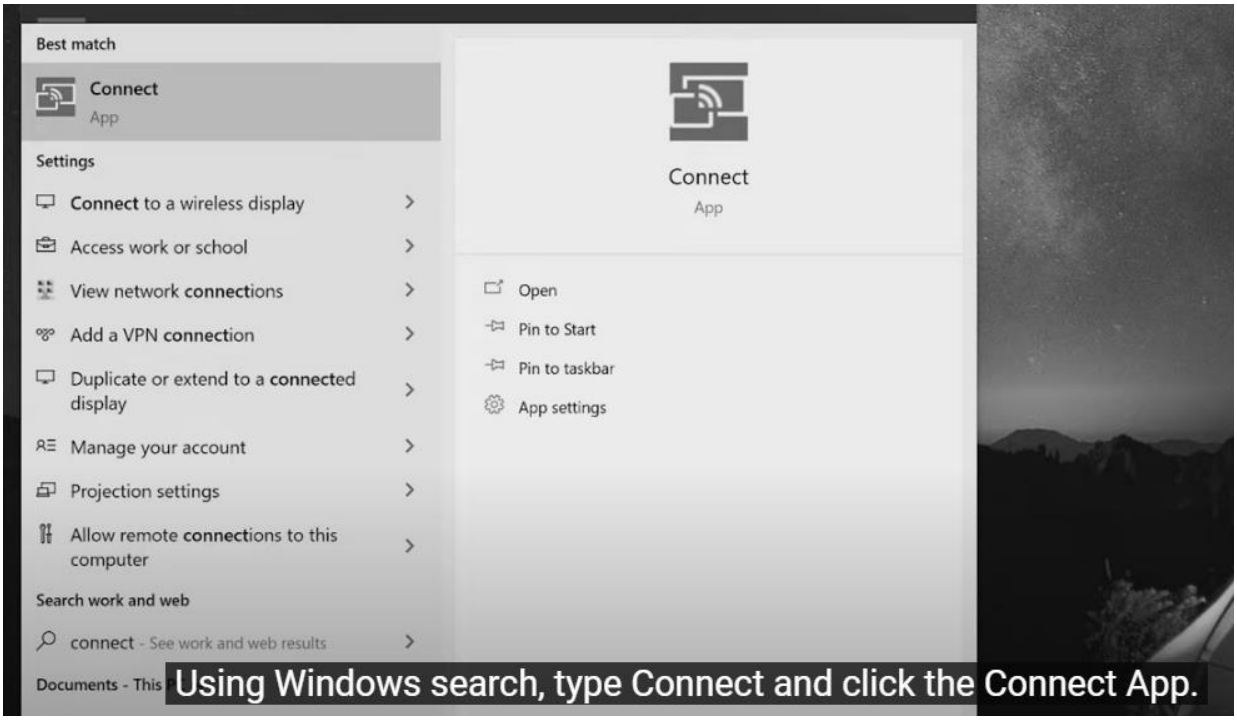
Only devices marked Wi-Fi CERTIFIED Miracast have been certified by Wi-Fi Alliance® to work well with other Wi-Fi CERTIFIED™ devices, employ the latest security protections, and deliver a high-quality user experience.

Source: https://www.wi-fi.org/discover-wi-fi/miracast

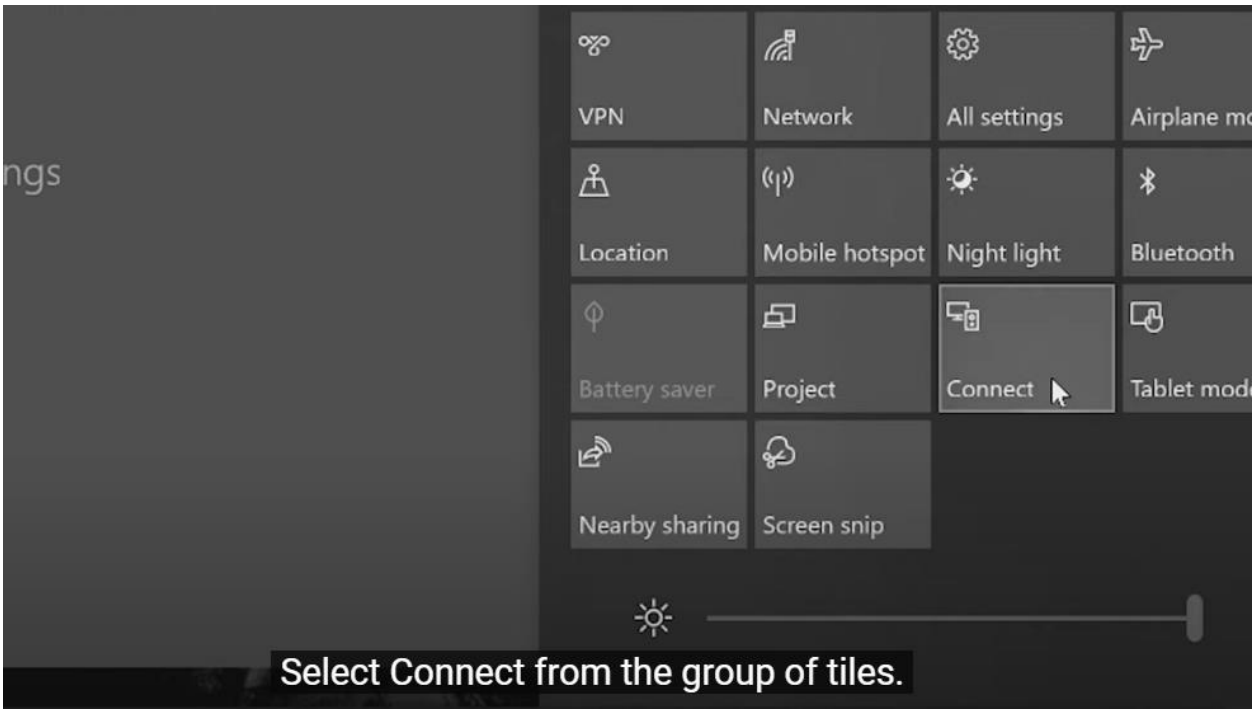

How to Connect a Wireless Monitor DELL (Official Dell Tech Support)
DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
Dell PCs and wireless monitors use Windows and Miracast technology
0:04 / 2:24

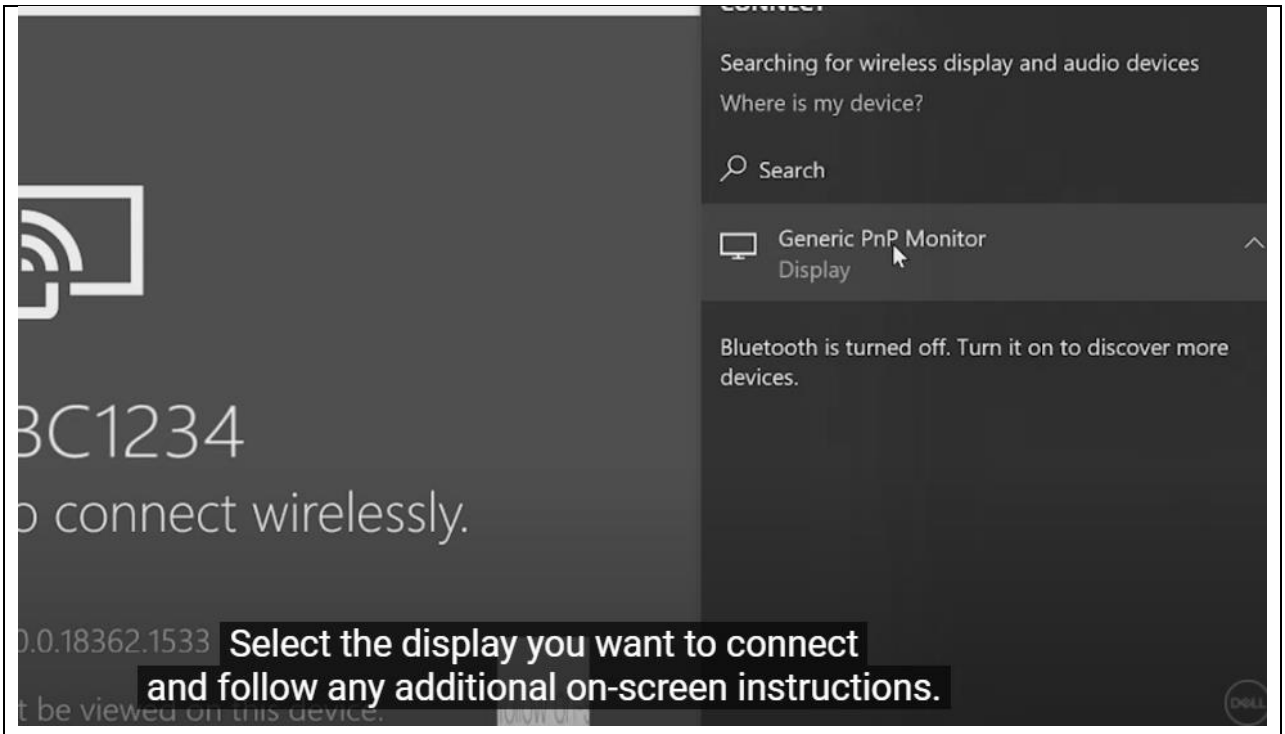

How to Connect a Wireless Monitor DELL (Official Dell Tech Support)
DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
to provide transparent connectivity using a Wi-Fi direct interface.
Play (k)
0:07 / 2:24


DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
In this video, we show you how to connect
your Miracast display to your Windows 10 device.


Best match
Connect
App
Settings
Connect to a wireless display
Access work or school
View network connections
Add a VPN connection
Duplicate or extend to a connected display
Manage your account
Projection settings
Allow remote connections to this computer
Search work and web
connect - See work and web results
Documents - This
Connect
App
Open
Pin to Start
Pin to taskbar
App settings
Using Windows search, type Connect and click the Connect App.


W10ABC1234
is ready for you to connect wirelessly.
Version: 10.0.18362.1533
Protected content can't be viewed on this device.
Press Ctrl + S to open Settings
Connect will open indicating that your Windows 10 Dell PC supports Miracast


VPN
Network
All settings
Airplane mo
Location
Mobile hotspot
Night light
Bluetooth
Battery saver
Project
Connect
Tablet mod
Nearby sharing
Screen snip
Select Connect from the group of tiles.



Source: https://www.youtube.com/watch?v=kXBwdWp7sFM ("How to Connect a Wireless Monitor DELL (Official Dell Tech Support)"

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.

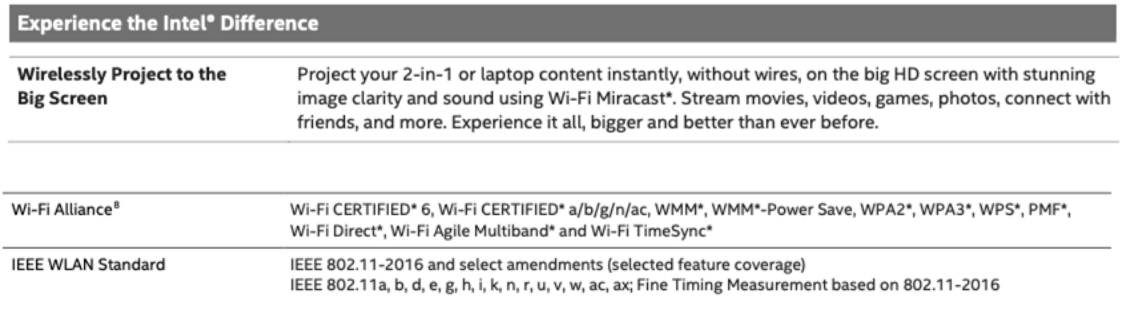
3.1.2.2 P2P Device discovering a P2P Device that is in a P2P Group

A searching P2P Device discovers a P2P Group Owner in the Scan Phase through received Beacon, DMG Beacon, SSW, or Probe Response frames. The searching P2P Device will also discover other P2P Devices that are associated to that P2P Group Owner from Group Information Advertisement (see Section 3.2.4) or, when operating within DMG, through a STA Availability element or Information Response frame (see Section 11.30.1 of IEEE 802.11-REVmc [11]).

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.1.1 & 3.1.2.2

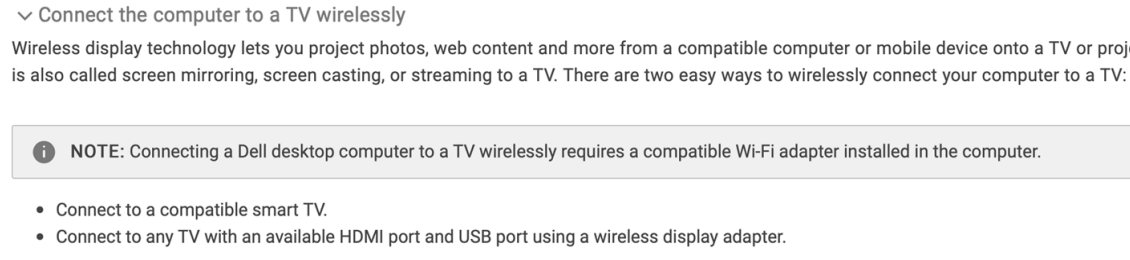
85. The Accused Products are first wireless devices comprising at least one processor configured to associate, via the wireless radio circuit, with the second wireless device to establish

a wireless connection, the wireless connection using the WPAN protocol, wherein upon associating, the first wireless device is configured to become a member of a WPAN network. For example, the XPS 13 Laptop (a first wireless device) includes the Intel Core i3-1115G4 system processor (a processor) configured to support the Wi-Fi Direct protocol (as shown above) by, for example, establishing a Wi-Fi Direct connection (a wireless connection using a WPAN protocol) with a second wireless device, such as a wireless monitor or other peripheral (including, but not limited to, other Accused Products), wherein, upon associating, the XPS 13 Laptop and the second wireless device are members of the Wi-Fi Direct network (WPAN network):



Experience the Intel® Difference	
Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html to embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf



Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778

3.2.3 Connecting to a P2P Group

The P2P Client acquires the Group Credentials through static configuration or through Wi-Fi Simple Configuration [2]. When using Wi-Fi Simple Configuration [2], the P2P Group Owner shall serve as the WSC Registrar and the P2P Client shall serve as the WSC Enrollee. In order to connect to a P2P Group, the P2P Client operating outside DMG, using the Credentials, shall engage in the authentication procedure in Section 10.3.4.2 of IEEE 802.11-2012 [1] and the association procedure in Section 10.3.5.2 of IEEE 802.11-2012 [1] with the P2P Group Owner. In order to connect to a P2P Group, the P2P Client operating within DMG, using the Credentials, shall engage in the association procedure in Section 11.3.5.2 of IEEE 802.11-REVmc [11] with the P2P Group Owner.

When a P2P Client associates with a P2P Group Owner, it provides its Device Name, Primary Device Type, and optionally Secondary Device Type List information to the P2P Group Owner by including the P2P Device Info attribute (see Section 4.1.15) and the P2P Capability attribute (see Section 4.1.4) in the P2P IE in the Association Request frame. This information shall be used by the

Source: Wi-Fi Direct Standard, v. 1.7, Section 3.2.3

Source: https://www.youtube.com/watch?v=kXBwdWp7sFM ("How to Connect a Wireless Monitor DELL (Official Dell Tech Support)"

86. The Accused Products are first wireless devices comprising at least one processor configured to maintain, via the wireless radio circuit, the association with the second wireless device over the wireless connection using the WPAN protocol. For example, the XPS 13 Laptop (a first wireless device) includes the Intel Core i3-1115G4 system processor (a processor) configured to support the Wi-Fi Direct protocol (as shown above) by, for example, maintaining the association with the second wireless device, such as a wireless monitor or other peripheral (including, but not limited to, other Accused Products), in providing connections compliant with the Wi-Fi Direct Standard (a WPAN protocol):

3.2.2 Starting and maintaining a P2P Group session

The P2P Group Owner may be determined through the Group Formation Procedure described in Section 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.

Source: Wi-Fi Direct Standard, v. 1.7, Section 3.2.2

The P2P Client acquires the Group Credentials through static configuration or through Wi-Fi Simple Configuration [2]. When using Wi-Fi Simple Configuration [2], the P2P Group Owner shall serve as the WSC Registrar and the P2P Client shall serve as the WSC Enrollee. In order to connect to a P2P Group, the P2P Client operating outside DMG, using the Credentials, shall engage in the authentication procedure in Section 10.3.4.2 of IEEE 802.11-2012 [1] and the association procedure in Section 10.3.5.2 of IEEE 802.11-2012 [1] with the P2P Group Owner. In order to connect to a P2P Group, the P2P Client operating within DMG, using the Credentials, shall engage in the association procedure in Section 11.3.5.2 of IEEE 802.11-REVmc [11] with 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

— in the Search State and the P2P Device operates within DMG, 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, or

— a P2P Client supporting Peer-to-Peer services (P2Ps) [10], having a Service Advertiser with a Service Hash matching the hash value in the incoming Probe Request, as described in 3.4.3.2 (Advertise Service fields in Probe Response) of [10], on the operating channel of the P2P group that the client connected.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.2.3 & 3.1.2.1

Source: https://www.youtube.com/watch?v=kXBwdWp7sFM ("How to Connect a Wireless Monitor DELL (Official Dell Tech Support)"

87. In the Accused Products, the WPAN protocol (Wi-Fi Direct) is an overlay protocol with respect to the WLAN protocol (802.11x Wi-Fi). For example, Wi-Fi Direct frames are based on 802.11x frames and use the vendor specific field of an 802.11x management frame. The Wi-Fi Direct protocol processes the data in the vendor-specific field that is overlaid on a Wi-Fi management frame.

2.4.1 Basic functions and services

For P2P operation outside the DMG, this specification assumes that the following STA functions and services are implemented in P2P Devices:

- IEEE 802.11g or newer 2.4 GHz PHY [1]
- IEEE 802.11i (AES-CCMP) [1]
- Wi-Fi Simple Configuration [2]
- Wi-Fi Multimedia [3]

Any required 'AP-like' functions and services required for P2P Group Owner operation outside DMG are described within this specification. A P2P Group Owner operating within DMG is required to support PCP functions and services.

3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.

* * *

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 802.11-2012 [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.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.1, 3.2 & 4

8.3.3 Management frames

8.3.3.1 Format of management frames

The format of a management frame is defined in Figure 8-34. The Frame Control, Duration, Address 1, Address 2, Address 3, and Sequence Control fields are present in all management frame subtypes. The maximum unencrypted MMPDU size, excluding the MAC header and FCS, is 2304 octets.

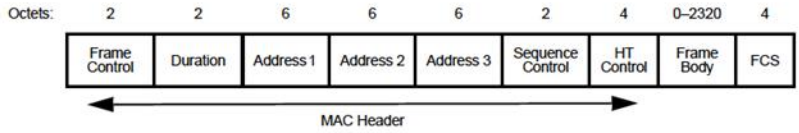


Figure 8-34—Management frame format

The HT Control field is defined in 8.2.4.6. The presence of the HT Control field is determined by the Order subfield of the Frame Control field, as specified in 8.2.4.1.10.

The frame body consists of the fields followed by the elements defined for each management frame subtype. All fields and elements are mandatory unless stated otherwise and appear in the specified, relative order. STAs that encounter an element ID they do not recognize in the frame body of a received management frame ignore that element and continue to parse the remainder of the management frame body (if any) for additional elements with recognizable element IDs. See 9.24.7. Unused element ID codes are reserved.

Gaps may exist in the ordering of fields and elements within frames. The order that remains is ascending.

8.4 Management frame body components

8.4.1 Fields that are not information elements

8.4.2 Information elements

8.4.2.1 General

Elements are defined to have a common general format consisting of a 1 octet Element ID field, a 1 octet Length field, and a variable-length element-specific Information field. Each element is assigned a unique Element ID as defined in this standard. The Length field specifies the number of octets in the Information field. See Figure 8-81.

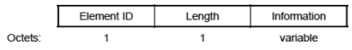


Figure 8-81—Element format

The set of valid elements is defined in Table 8-54.

Table 8-54—Element IDs

Element	Element ID	Length of indicated element (in octets)	Extensible
SSID (see 8.4.2.2)	0	2 to 34	
Supported rates (see 8.4.2.3)	1	3 to 10	

Table 8-54—Element IDs *(continued)*

Element	Element ID	Length of indicated element (in octets)	Extensible
U-APSD Coexistence (see 8.4.2.93)	142	14 to 257	Subelements
Reserved	143–173		
MCCAOP Advertisement Overview (see 8.4.2.110)	174	8	Yes
Reserved	175–220		
Vendor Specific (see 8.4.2.28)	221	3 to 257	
Reserved	222–255		

8.5.6 Vendor-specific action details

The Vendor Specific Action frame is defined for vendor-specific signaling. The format of the Action field of the Vendor Specific Action frame is shown in Figure 8-437. An Organization Identifier, in the octet field immediately after the Category field, differentiates the vendors (see 8.4.1.31).

NOTE—If management frame protection is negotiated, then Vendor Specific Protected Action frames (see Table 8-38) are protected; otherwise they are unprotected.

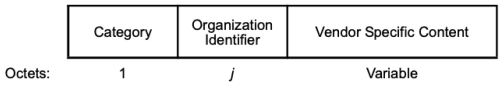


Figure 8-437—Vendor Specific Action frame Action field format

The Category field is set to the value indicating the vendor-specific category, as specified in Table 8-38.

The Organization Identifier contains a public organizationally unique identifier assigned by the IEEE and is specified in 8.4.1.31. The order of the Organization Identifier field is described in 8.2.2.

The Vendor Specific Content contains vendor-specific field(s). The length of the Vendor Specific Content in a Vendor Specific Action frame is limited by the maximum allowed MMPDU size.

Source: IEEE 802.11-2012, Sections 8.3.3.1, 8.4.2.1 & 8.5.6

88. In the Accused Products, the WPAN protocol is an overlay protocol with respect to the WLAN protocol, such that the WPAN protocol uses a WLAN protocol frame adapted to support a WPAN protocol power-saving procedure that is different as compared to a power-saving protocol supported by the WLAN protocol. For example, in Wi-Fi Direct (the WPAN protocol) the WPAN-adapted frame may utilize the Vendor Specific Information Element (IE) field of an 802.11x protocol frame (a WLAN protocol frame) to carry information not defined by the IEEE 802.11x Standard so that interoperability operations that are not part of the 802.11x standard can be implemented, such as those required by the power save features defined by the Wi-Fi Direct Standard. For example, in Wi-Fi Direct, two of the P2P Group Owner's adapted power saving protocol schemes are Notice of Absence and Opportunistic Power Save:

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 802.11-2012 [1] for operation outside DMG and in IEEE 802.11-REVmc [11] for operation within DMG, with the Wi-Fi Alliance OUI and an OUI Type indicating P2P. A number of P2P attributes are defined; a single P2P IE carries one or more P2P attributes.

* * *

3.3 P2P Power Management

The P2P power management approach for operation outside DMG 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.

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.

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

4.1.14 Notice of Absence attribute

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

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.
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.

The Notice of Absence attribute shall be present in the P2P IE in the Beacon frames and Probe Response frames transmitted by a P2P Group Owner when a Notice of Absence schedule is being advertised or when the CTWindow is non-zero, as described in Section 4.2.1 and Section 4.2.3. If there is neither a Notice of Absence schedule nor a CTWindow, the GO may omit the Notice of Absence attribute from Beacon and Probe Response frames. The Notice of Absence shall be also present in Notice of Absence frames, as described in Section 4.2.10.2, P2P Presence Request frames, as described in Section 4.2.10.3, and P2P Presence Response frames, as described in Section 4.2.10.4.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 4, 3.3.1, 3.3.2, & 4.1.14

89. In the Accused Products, the WPAN protocol is an overlay protocol that is partially compliant with respect to the WLAN protocol. Aspects of the overlay protocol (Wi-Fi Direct) which are compliant with the WLAN protocol (Wi-Fi) include, for example, how P2P devices utilize and access the physical medium. For example, the XPS 13 Laptop, in supporting Wi-Fi Direct, is required to implement the underlying IEEE 802.11g (or newer) Standard at the PHY level, as shown below. By implementing the underlying PHY protocol, WPAN devices use and access the physical medium in a manner that is coordinated with 802.11x communications

occurring outside of the WPAN, yet in a common wireless space, such that the problems of device interference are reduced.

2.4.1 Basic functions and services

For P2P operation outside the DMG, this specification assumes that the following STA functions and services are implemented in P2P Devices:

- IEEE 802.11g or newer 2.4 GHz PHY [1]
- IEEE 802.11i (AES-CCMP) [1]
- Wi-Fi Simple Configuration [2]
- Wi-Fi Multimedia [3]

3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.1 & 3.2

90. In the Accused Products, the WPAN protocol is an overlay protocol that is partially compliant with respect to the WLAN protocol. Aspects of the overlay protocol (Wi-Fi Direct) which are not compliant with the WLAN protocol (Wi-Fi) include, for example, aspects of P2P Discovery, P2P Power Management, and Managed P2P Device Operation as set out below:

2.4.2 P2P specific functions and services

In addition to the assumed functions listed in Section 2.4.1, a P2P Device supports the 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 802.11-2012 [1] when operating outside DMG and PBSS operation as defined in IEEE 802.11-REVmc [11] when operating within DMG, and provides additions for a P2P Group operation.
- **P2P Power Management** provides a set of functions to reduce power consumption of P2P Devices that operate outside DMG.
- **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.

* * *

A P2P Group Owner shall respond to Probe Request frames following the rules in IEEE 802.11-2012 [1] for operation outside DMG and the rules in IEEE 802.11-REVmc [11] for operation within DMG, 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 802.11-2012 [1], Clause Section 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.
Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.2 & 3.2.2

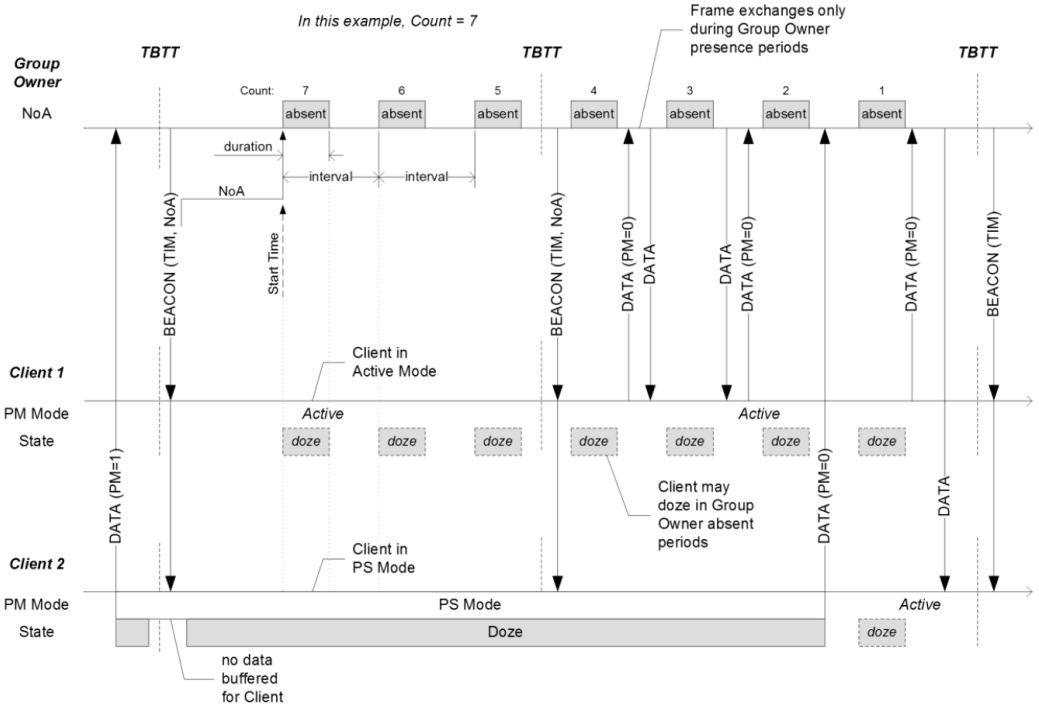
91. In the Accused Products, the WPAN protocol is partially compliant with respect to the WLAN protocol such that the WPAN protocol uses a WLAN protocol frame adapted to support a WPAN power-saving protocol that is different as compared to a power-saving protocol supported by the WLAN protocol. For example, the Wi-Fi Direct protocol is not compliant with the 802.11x protocol for aspects of P2P Power Management including, for example, the Wi-Fi Direct rules that modify 802.11x protocol rules to permit the Accused Products to be absent for defined periods. For example, the 802.11x protocol rule requiring an AP to "remain in the Awake state and always respond to probe requests" is not followed when the second wireless device (a P2P Group Owner which, per the Wi-Fi Direct protocol, assumes the role of an 802.11x AP) is "Absent."

3.3 P2P Power Management

3.3.1 Introduction

P2P power management supports power save mechanisms for P2P Group Owners and P2P Clients when the P2P Group operates outside DMG. If the

The P2P power management approach for operation outside DMG 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.



Source: Wi-Fi Direct Standard, v. 1.7, Section 3.3.1 & Fig. 15

Only APs and STAs in an IBSS or in an MBSS respond to probe requests. A result of the procedures defined in this subclause is that in each infrastructure BSS and IBSS there is at least one STA that is awake at any given time to receive and respond to probe requests. In an MBSS, STAs might not be awake at any given time to respond to probe requests. In an infrastructure BSS or in an IBSS, a STA that sent a Beacon frame shall remain in the Awake state and shall respond to probe requests, subject to criteria in the next paragraph, until a Beacon frame with the current BSSID is received. If the STA is contained within an AP, it shall remain in the Awake state and always respond to probe requests, subject to criteria in the next paragraph. There may be more than one STA in an IBSS that responds to any given probe request, particularly in cases where more than one STA transmitted a Beacon frame following the most recent TBTT, either due to not receiving successfully a previous Beacon frame or due to collisions between beacon transmissions.

Source: IEEE 802.11-2012 Standard, Section 10.1.4.3.2

92. As another example, the 802.11x protocol rule requiring there "is at least one STA awake at any given time" is not followed when the first wireless device (a P2P Client which, per the Wi-Fi Direct protocol, assumes the role of an 802.11x STA) enters a "Doze" state.

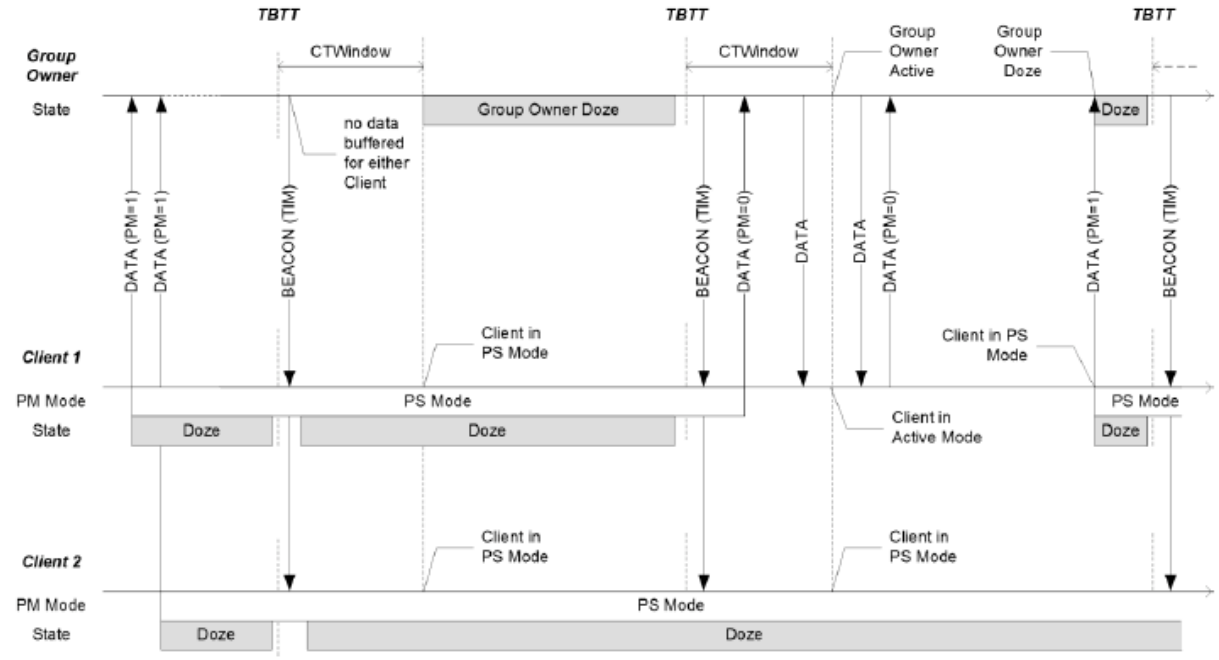


Figure 14—Example of P2P Group Owner Opportunistic Power Save

Source: Wi-Fi Direct Standard, v. 1.7, Fig. 14

Only APs and STAs in an IBSS or in an MBSS respond to probe requests. A result of the procedures defined in this subclause is that in each infrastructure BSS and IBSS there is at least one STA that is awake at any given time to receive and respond to probe requests. In an MBSS, STAs might not be awake at any given time to respond to probe requests. In an infrastructure BSS or in an IBSS, a STA that sent a Beacon frame shall remain in the Awake state and shall respond to probe requests, subject to criteria in the next paragraph, until a Beacon frame with the current BSSID is received. If the STA is contained within an AP, it shall remain in the Awake state and always respond to probe requests, subject to criteria in the next paragraph. There may be more than one STA in an IBSS that responds to any given probe request, particularly in cases where more than one STA transmitted a Beacon frame following the most recent TBTT, either due to not receiving successfully a previous Beacon frame or due to collisions between beacon transmissions.

Source: IEEE 802.11-2012 Standard, Section 10.1.4.3.2

93. In the Accused Products, the wireless radio circuit is configured to operate in at least one of a 2.4 GHz or 5 GHz frequency band. For example, the XPS 13 Laptop (a first wireless device) includes the Intel Killer AX1650 wireless module (a wireless radio circuit) that operates in both the 2.4 and 5 GHz frequency bands:

XPS 13 Laptop

Wireless
Killer™ Wi-Fi 6 AX1650 (2 x 2) and Bluetooth 5.1

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

TX/RX Streams	2x2
Bands	2.4Ghz, 5Ghz (160Mhz)
Max Speed	2.4Gbps
Wi-Fi CERTIFIED*	WiFi 6 (802.11ax)

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html

In-band: Data transfer using the WLAN communication channel, including WLAN multiband devices (e.g. 2.4GHz, 5GHz, and 60GHz).

Source: Wi-Fi Direct Standard, v. 1.7, Section 1.4

In-band Device Discovery uses Probe Request and Probe Response frames to exchange device information. When operating outside DMG, the P2P Devices in a P2P Group are discovered via a Probe Response frame from the P2P Group Owner. When operating within DMG, P2P Devices in a P2P Group are
Source: Wi-Fi Direct Standard, v. 1.7, Section 3.1.2.1

94. In the Accused Products, the WLAN protocol is an 802.11x protocol that uses a frame defined by the 802.11x protocol, and the WPAN protocol uses a WPAN-adapted frame in which at least one field of the frame defined by the 802.11x protocol is adapted to support the WPAN power-saving protocol. For example, in Wi-Fi Direct (the WPAN protocol) the WPAN-adapted frame may utilize the Vendor Specific Information Element (IE) of an 802.11x protocol frame to specify the organizationally unique identifier (OUI) as the Wi-Fi Alliance OUI and the type indicating P2P (an 802.11x protocol that uses a frame defined by the 802.11x protocol). The modified frame is used to carry information not defined by the IEEE 802.11x Standard when implementing operations that are not part of the 802.11x standard, such as those required by the power save features defined by the Wi-Fi Direct Standard. P2P attributes used in this manner may, for example, enable a power-saving protocol that allows the P2P Group Owner (the second wireless device) to take on a role similar to that of an AP in an IEEE 802.11x network, while also implementing power management for a P2P Group, by for example allowing the P2P Group Owner to be absent for certain periods of time (using a WPAN-adapted frame in which at least one field of the frame defined by the 802.11x protocol, namely the aforementioned vendor-specific field, is adapted to support the WPAN power-saving protocol). In the Wi-Fi Direct protocol, two of the P2P Group Owner's adapted power saving protocol schemes are Notice of Absence and Opportunistic Power Save:

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 802.11-2012 [1] for operation outside DMG and in IEEE 802.11-REVmc [11] for operation within DMG, with the Wi-Fi Alliance OUI and an OUI Type indicating P2P. A number of P2P attributes are defined; a single P2P IE carries one or more P2P attributes.

Source: Wi-Fi Direct Standard, v. 1.7, Section 4

P2P PS	IEEE802.11 Power Save adapted for P2P operation
P2P WMM-PS	WMM-PS adapted for P2P operation

Source: Wi-Fi Direct Standard, v. 1.7, Section 1.4

4.1.14 Notice of Absence attribute

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

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.
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.

The Notice of Absence attribute shall be present in the P2P IE in the Beacon frames and Probe Response frames transmitted by a P2P Group Owner when a Notice of Absence schedule is being advertised or when the CTWindow is non-zero, as described in Section 4.2.1 and Section 4.2.3. If there is neither a Notice of Absence schedule nor a CTWindow, the GO may omit the Notice of Absence attribute from Beacon and Probe Response frames. The Notice of Absence shall be also present in Notice of Absence frames, as described in Section 4.2.10.2, P2P Presence Request frames, as described in Section 4.2.10.3, and P2P Presence Response frames, as described in Section 4.2.10.4.

Source: Wi-Fi Direct Standard, v. 1.7, Section 4.1.14

95. In the Accused Products, the WPAN-adapted frame is adapted from a WLAN protocol management frame; *i.e.*, a WPAN-adapted MAC frame of type management (as defined by IEEE 802.11-2012 at Section 8.2.4.1). For example, per IEEE 802.11x, management frames are used by stations (STAs) to join and leave a Basic Service Set (BSS). By adapting a WLAN protocol management frame to specify, for example, the Wi-Fi Alliance OUI and an OUI type indicating P2P, all devices in the P2P Group may communicate according to the Wi-Fi Direct Standard, however with reduced interference from Wi-Fi STA devices, and potentially at reduced power dissipation:

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 802.11-2012 [1] for operation outside DMG and in IEEE 802.11-REVmc [11] for operation within DMG, with the Wi-Fi Alliance OUI and an OUI Type indicating P2P. A number of P2P attributes are defined; a single P2P IE carries one or more P2P attributes.

Source: Wi-Fi Direct Standard, v. 1.7, Section 4

8.4 Management frame body components

8.4.1 Fields that are not information elements

8.4.2 Information elements

8.4.2.1 General

Elements are defined to have a common general format consisting of a 1 octet Element ID field, a 1 octet Length field, and a variable-length element-specific Information field. Each element is assigned a unique Element ID as defined in this standard. The Length field specifies the number of octets in the Information field. See Figure 8-81.

	Element ID	Length	Information
Octets:	1	1	variable

Figure 8-81—Element format

The set of valid elements is defined in Table 8-54.

Table 8-54—Element IDs

Element	Element ID	Length of indicated element (in octets)	Extensible
SSID (see 8.4.2.2)	0	2 to 34	
Supported rates (see 8.4.2.3)	1	3 to 10	

Table 8-54—Element IDs *(continued)*

Element	Element ID	Length of indicated element (in octets)	Extensible
U-APSD Coexistence (see 8.4.2.93)	142	14 to 257	Subelements
Reserved	143–173		
MCCAOP Advertisement Overview (see 8.4.2.110)	174	8	Yes
Reserved	175–220		
Vendor Specific (see 8.4.2.28)	221	3 to 257	
Reserved	222–255		

Source: IEEE 802.11-2012, Section 8.4

96. In the Accused Products, the WPAN protocol provides for an inactivity time during which the first and second wireless devices can agree to at least partially disable the wireless connection. For example, a P2P Group Owner (the second wireless device) utilizing the Notice of Absence procedure shall not send frames within the P2P Group during periods it has indicated it

will be absent, and a P2P Client (the first wireless device) that received the Notice of Absence and that does not try modifying any of the periods using P2P Presence procedures, shall not send frames to a P2P Group Owner during the specified absence. According to the Wi-Fi Direct Standard, for example, during a P2P Group Owner's absence, the P2P Client shall buffer frames until frame delivery may be attempted in a presence period, such that during the absence, the wireless connection between the P2P Group Owner and the P2P Client is partially disabled (an inactivity time during which the first and second wireless devices can agree to at least partially disable the wireless connection):

3.3.3.2 P2P Group Owner Notice of Absence procedure

Notice of Absence timing is specified by the values of the combination of Start Time, Interval, Duration and Count fields in the Notice of Absence attribute — 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.

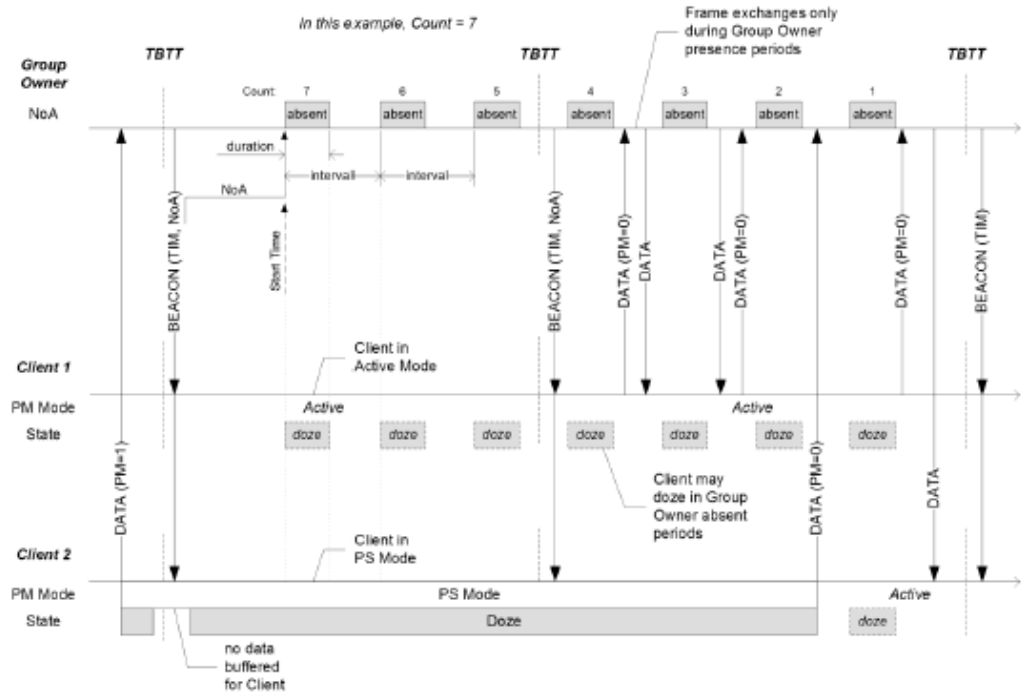


Figure 15—P2P Group Owner Notice of Absence

P2P Clients 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 interval between and/or duration of P2P Group Owner presence periods, e.g. where the P2P Client has WMM Traffic Stream (TS), or latency sensitive traffic.

On receipt of a P2P Presence Request, the P2P Group Owner shall determine whether to accept the request. If the P2P Group Owner accepts the P2P Presence Request, it shall respond with a P2P Presence Response action frame containing a Status attribute indicating success and a Notice of Absence attribute describing the Notice of Absence timing that it will use in response to the request. The P2P Group Owner may adopt revised Notice of Absence

3.3.4.4 Signaling of Client service requirements

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

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

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

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 Section 10.2.1.6 of IEEE 802.11-2012 [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 Section 3.3.4.2.

3.3.4 Power Management at a P2P Client

3.3.4.1 P2P Client operation with P2P Group Owner Power Management

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

The P2P Client shall not send frames to a P2P Group Owner during periods that the P2P Group Owner has indicated it will be absent, subject to the power save state precedence rules above. P2P Clients shall buffer frames until frame delivery can be attempted in a presence period. 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.

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

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

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

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.3.3.2, 3.3.4.4, 3.3.3.3, & 3.3.4.1

97. As another example, the Wi-Fi Direct protocol provides for an inactivity time during which the first and second wireless devices can agree to at least partially disable the wireless connection using the Opportunistic Power Save procedure:

3.3.3.1 P2P Group Owner Opportunistic Power Save procedure

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

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

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

As long as any Client is determined to be in Awake state, the P2P Group Owner shall remain in Awake state subject to any advertised Notice of Absence schedule. A P2P Group Owner shall determine that a P2P Client is in the Awake state if it is in the Active mode or if it is in the Power Save mode and has a WMM Unscheduled Service Period (USP) in progress or an unanswered PS-Poll. Figure 14 illustrates an example of P2P Group Owner Opportunistic Power Save with two connected P2P Clients, both using P2P PS.

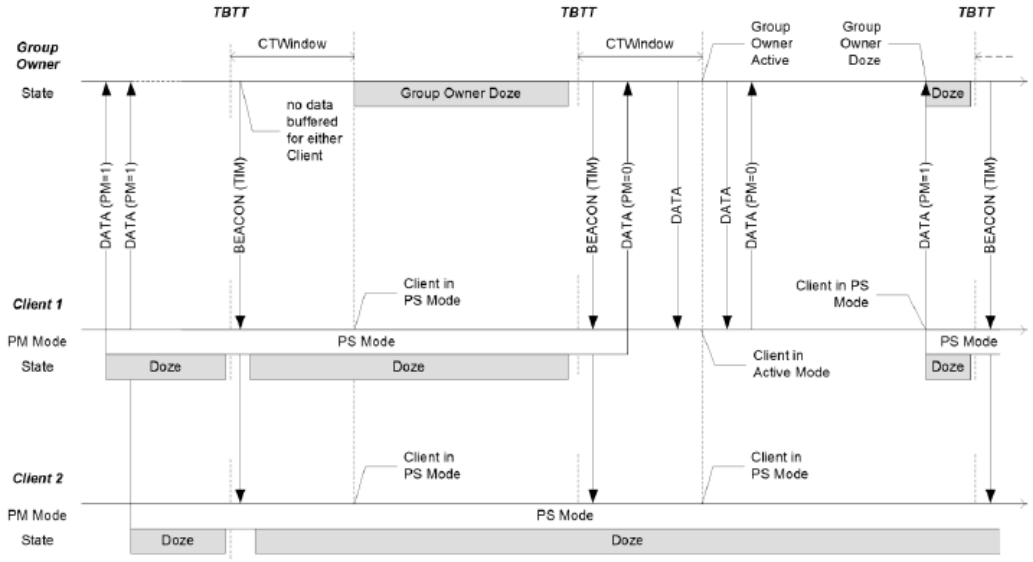


Figure 14—Example of P2P Group Owner Opportunistic Power Save

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.

3.3.4.4 Signaling of Client service requirements

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

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

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

3.3.4 Power Management at a P2P Client

3.3.4.1 P2P Client operation with P2P Group Owner Power Management

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

The P2P Client shall not send frames to a P2P Group Owner during periods that the P2P Group Owner has indicated it will be absent, subject to the power save state precedence rules above. P2P Clients shall buffer frames until frame delivery can be attempted in a presence period. 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.

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

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

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

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.3.3.1, Fig. 14, 3.3.2, 3.3.4.4, & 3.3.4.1

98. In the Accused Products, the first wireless device and the second wireless device are configured to agree on the inactivity time in accordance with the WPAN protocol as described above and reiterated below when utilizing, for example, the Notice of Absence procedure:

3.3.3.2 P2P Group Owner Notice of Absence procedure

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

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

P2P Clients 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 interval between and/or duration of P2P Group Owner presence periods, e.g. where the P2P Client has WMM Traffic Stream (TS), or latency sensitive traffic.

On receipt of a P2P Presence Request, the P2P Group Owner shall determine whether to accept the request. If the P2P Group Owner accepts the P2P Presence Request, it shall respond with a P2P Presence Response action frame containing a Status attribute indicating success and a Notice of Absence attribute describing the Notice of Absence timing that it will use in response to the request. The P2P Group Owner may adopt revised Notice of Absence

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.

3.3.4.4 Signaling of Client service requirements

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

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

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

4.2.10.2 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.

4.2.10.3 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 Section 3.3.4.4.

4.1.14 Notice of Absence attribute

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

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.
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.

4.2.1 Beacon frame format

One or more P2P IEs and the WSC IE shall be inserted after other information elements in the Beacon frames transmitted by a P2P Group Owner. P2P attributes for a P2P IE that is included in the Beacon frame are shown in Table 48.

Table 48—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.

Attributes	Attribute ID	Note
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 Section 3.3.3.2), or when the CTWindow is non-zero (see Section 3.3.2).

4.2.3 Probe Response frame format

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

One or more P2P IEs and the WSC IE shall be inserted after other information elements in Probe Response frames transmitted by a P2P Device. P2P attributes for a P2P IE that is included in the Probe Response frame are shown in Table 52.

Table 52—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 Section 3.3.3.2) or non-zero CTWindow (see Section 3.3.2) is being advertised in the Beacon frames (see Section 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.
Advertised Service Info	25	The Service Instance attribute may be present in the P2P IE if P2Ps is supported. The usage of this attribute is defined in the Wi-Fi Peer-to-Peer Services specification [10].

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 Section 10.2.1.6 of IEEE 802.11-2012 [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 Section 3.3.4.2.

3.3.4 Power Management at a P2P Client

3.3.4.1 P2P Client operation with P2P Group Owner Power Management

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

The P2P Client shall not send frames to a P2P Group Owner during periods that the P2P Group Owner has indicated it will be absent, subject to the power save state precedence rules above. P2P Clients shall buffer frames until frame delivery can be attempted in a presence period. 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.

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

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

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

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.3.3.2, Table 28, 3.3.4.4, 4.2.10.2, 4.2.10.3, 4.1.14, Table 26, 4.2.1, 4.2.3, 3.3.3.3, & 3.3.4.1

99. Alternatively, in the Accused Products, the first and second wireless devices are configured to agree on the inactivity time in accordance with the WPAN protocol as described above and reiterated below when utilizing, for example, the Opportunistic Power Save procedure:

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.

3.3.3.1 P2P Group Owner Opportunistic Power Save procedure

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

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

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

As long as any Client is determined to be in Awake state, the P2P Group Owner shall remain in Awake state subject to any advertised Notice of Absence schedule. A P2P Group Owner shall determine that a P2P Client is in the Awake state if it is in the Active mode or if it is in the Power Save mode and has a WMM Unscheduled Service Period (USP) in progress or an unanswered PS-Poll. Figure 14 illustrates an example of P2P Group Owner Opportunistic Power Save with two connected P2P Clients, both using P2P PS.

3.3.4 Power Management at a P2P Client

3.3.4.1 P2P Client operation with P2P Group Owner Power Management

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

The P2P Client shall not send frames to a P2P Group Owner during periods that the P2P Group Owner has indicated it will be absent, subject to the power save state precedence rules above. P2P Clients shall buffer frames until frame delivery can be attempted in a presence period. 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.

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

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

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

4.1.14 Notice of Absence attribute

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

The Notice of Absence attribute shall be present in the P2P IE in the Beacon frames and Probe Response frames transmitted by a P2P Group Owner when a Notice of Absence schedule is being advertised or when the CTWindow is non-zero, as described in Section 4.2.1 and Section 4.2.3. If there is neither a Notice of Absence schedule nor a CTWindow, the GO may omit the Notice of Absence attribute from Beacon and Probe Response frames. The Notice of Absence shall be also present in Notice of Absence frames, as described in Section 4.2.10.2, P2P Presence Request frames, as described in Section 4.2.10.3, and P2P Presence Response frames, as described in Section 4.2.10.4.

4.2.10.2 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.

4.2.10.3 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 Section 3.3.4.4.

3.3.4.4 Signaling of Client service requirements

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

— send a new P2P Presence Request with revised timing,

— use the timing indicated in the returned Notice of Absence attribute, or

— disconnect from the P2P Group.

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

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.
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.

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.

4.2.1 Beacon frame format

One or more P2P IEs and the WSC IE shall be inserted after other information elements in the Beacon frames transmitted by a P2P Group Owner. P2P attributes for a P2P IE that is included in the Beacon frame are shown in Table 48.

Table 48—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 Section 3.3.3.2), or when the CTWindow is non-zero (see Section 3.3.2).

4.2.3 Probe Response frame format

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

One or more P2P IEs and the WSC IE shall be inserted after other information elements in Probe Response frames transmitted by a P2P Device. P2P attributes for a P2P IE that is included in the Probe Response frame are shown in Table 52.

Table 52—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 Section 3.3.3.2) or non-zero CTWindow (see Section 3.3.2) is being advertised in the Beacon frames (see Section 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.
Advertised Service Info	25	The Service Instance attribute may be present in the P2P IE if P2Ps is supported. The usage of this attribute is defined in the Wi-Fi Peer-to-Peer Services specification [10].

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.3.2, 3.3.3.1, 3.3.4.1, 4.1.14, 4.2.10.2, 4.2.10.3, 3.3.4.4, Table 26, Table 27, 4.2.1, & 4.2.3

100. In the Accused Products, the first wireless device is configured to disable data exchanges with the second wireless device via the wireless connection following a start of the inactivity time, wherein the disabling is such that less power per unit time is consumed by the wireless radio circuit relative to a power per unit time consumed by the wireless radio circuit when the data exchanges are not disabled, such as can be seen in the following:

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 Section 10.2.1.6 of IEEE 802.11-2012 [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 Section 3.3.4.2.

3.3.4 Power Management at a P2P Client

3.3.4.1 P2P Client operation with P2P Group Owner Power Management

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

The P2P Client shall not send frames to a P2P Group Owner during periods that the P2P Group Owner has indicated it will be absent, subject to the power save state precedence rules above. P2P Clients shall buffer frames until frame delivery can be attempted in a presence period. 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.

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

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

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

3.3.3.2 P2P Group Owner Notice of Absence procedure

Notice of Absence timing is specified by the values of the combination of Start Time, Interval, Duration and Count fields in the Notice of Absence attribute — 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.

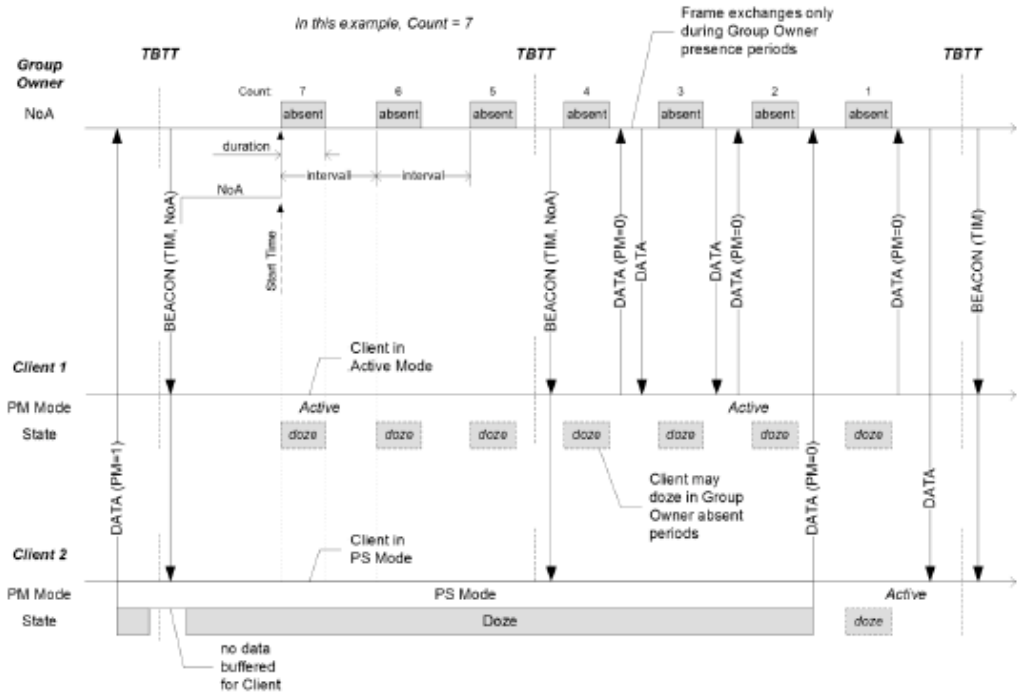


Figure 15—P2P Group Owner Notice of Absence

At any time after the end of each CTWindow, if all of the connected P2P Clients are determined to be in Doze state by the P2P Group Owner, the P2P Group Owner may enter Doze state from that time until the next TBTT. After a DTIM,

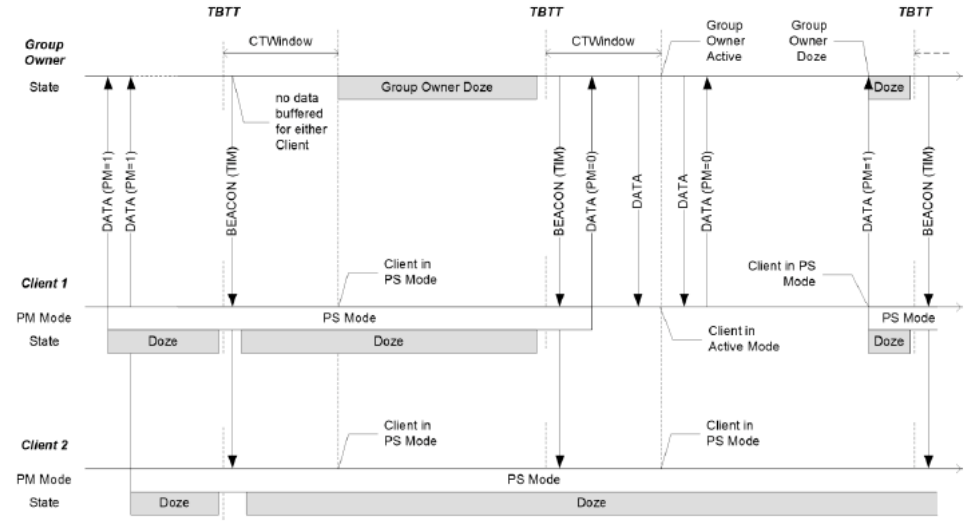


Figure 14—Example of P2P Group Owner Opportunistic Power Save

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.3.3.3, 3.3.4.1, 3.3.3.2, Fig. 15, 3.3.3.1, & Fig. 14

101. As set forth above, Dell has directly infringed at least claim 4 of the '906 patent by making, importing, using, offering for sale and/or selling the Accused Products into or in the United States.

102. Dell intentionally designed and incorporated the IEEE 802.11x and the Wi-Fi Direct features and functionalities described above into the Accused Products.

103. Dell provides instructions (in the form of at least user interface prompts and customer support instructional videos) to its customers, advertising, encouraging and directing the customers to use the Accused Products in an infringing manner as described above to implement the IEEE 802.11x/Wi-Fi Direct functionality, as intended by Dell. For example, Dell provides operating instructions and the like for the Accused Products, including, but not limited to, the citations above and the following:

- https://www.youtube.com/watch?v=kXBwdWp7sFM
- https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778
- https://www.dell.com/support/kbdoc/en-us/000136674/miracast-to-replace-wi-di
- https://www.dell.com/support/kbdoc/en-us/000129880/miracast-users-may-encounter-various-issues-in-the-windows-10-operating-system
- https://www.dell.com/support/kbdoc/en-us/000130716/guide-to-dell-wireless-monitors
- https://www.dell.com/support/kbdoc/en-us/000152972/how-do-i-enable-widi-miracast-on-my-venue-7-3740-or-venue-8-3840?lang=en

- https://www.dell.com/support/kbdoc/en-us/000129818/a-guide-to-miracast-on-the-latitude-13-7350-tablet-pc?lang=en
- https://www.dell.com/support/kbdoc/en-us/000141601/xps-13-9350-touch-cursor-and-sound-may-have-a-lag-when-system-connected-wifi-miracast-and-bluetooth-audio?lang=en
- https://www.dell.com/support/manuals/en-us/latitude-13-7390-laptop/latitude_7290_7390_7490_tgb/wlan-—-miracast-support-matrix?guid=guid-76975785-70c3-4039-b5bb-eb0b83e669b3&lang=en-us
- https://www.dell.com/support/manuals/en-us/inspiron-11-3179-2-in-1-laptop/inspiron_11_3179_setupandspecs/communications?guid=guid-5fea805b-7f8a-420f-b984-b0e93e13048e&lang=en-us
- https://www.dell.com/support/manuals/en-us/alienware-15-laptop/alienware-15-r3-setupandspecifications/communications?guid=guid-935baab6-b4b4-4960-9783-971e87de151c&lang=en-us

104. By its instructions, including those set forth above, and with intent that they use the IEEE 802.11x/Wi-Fi Direct features described above, Dell has induced its customers to infringe the ’906 patent. Dell’s customers who use the Accused Products as described above directly infringe the ’906 patent. Upon information and belief, as a result of attempts by the inventors to sell or license their patents to the PC industry, of which Dell is a member, Dell has had knowledge of (or has been willfully blind to) the ’906 patent, a child of the ’991 patent. Further, Dell has had knowledge of (or has been willfully blind to) the ’906 patent since at least September 9, 2020, as a result of a letter from Christian Dubuc, Chief Executive Officer of Ozmo Licensing, to Richard Rothberg, General Counsel for Dell, regarding Ozmo Licensing’s patent portfolio and the Accused

Dell Products, informing Dell that it required a license. On September 9, 2020, Ozmo Licensing had only eight patents and patent applications that embodied the inventions of Vleugels and Peeters. In addition, upon information and belief, Dell would have gained knowledge of the '906 patent by virtue of the litigation filed against HP Inc. (Docket No. 6:21-cv-00383-ADA) and against Acer Inc. (Docket No. 6:21-cv-01225-ADA). Dell also induces such direct infringement by its customers by failing to remove the infringing features from the Accused Products.

105. By its instructions, including those set forth above, as well as by offering for sale, selling, commercially distributing and importing the Accused Products, Dell has also contributed to its customers' infringement of the '906 patent. The Accused Products are used by Dell's customers to practice the inventions claimed in the '906 patent. The IEEE 802.11x/Wi-Fi Direct features as performed by the Accused Products as described above constitute material parts of the claimed inventions of the '906 patent. Dell knows or was willfully blind that portions of the hardware and software in the Accused Products were specifically made or adapted by Dell solely to provide such functionality and that such features are not staple articles or commodities of commerce suitable for substantial non-infringing use. Dell also knows or was willfully blind that such combinations of hardware and software have no use other than to provide such functionality as intentionally designed into the Accused Products by Dell. As described above, Dell has had knowledge since, at the latest, September 2020 that its customers were infringing the '906 patent.

106. By the time of trial, Dell will have known and intended that its continued actions would directly infringe, and would induce and contribute to the infringement by its customers of, at least claim 4 of the '906 patent.

107. Ozmo Licensing has been damaged by Dell's past and ongoing direct and indirect infringement of the '906 patent.

108. With knowledge of the allegations set forth herein, Dell nonetheless refuses to remove the infringing functionalities from the Accused Products or to compensate Ozmo Licensing for the use of such features. Dell's infringement described above will continue unabated unless and until Dell is enjoined or ordered to pay a reasonable royalty for a license to the '906 patent.

COUNT III
(Dell's Infringement of U.S. Patent No. 8,599,814)

109. Paragraphs 1-108 are incorporated by reference as if fully set forth herein.

110. The invention of the '814 patent represented a technical solution to an unsolved technological problem. The written description of the '814 patent describes in technical detail each of the limitations of the claims, allowing a person of ordinary skill in the art to understand what the limitations cover and how the combination of claim elements differed markedly from and improved upon what may have been considered conventional or generic. For example, the specification and incorporated references detail the inventors' novel approach to seamlessly integrating a WPAN into a WLAN infrastructure.

111. The elements claimed by the '814 patent, taken alone or in combination, were not well-understood, routine or conventional to one of ordinary skill in the art at the time of the invention. Rather, the '814 patent claims and teaches, *inter alia*, an improved network-enabled hub to facilitate communications between WLAN and WPAN wireless devices. The invention improved upon existing wireless communications, which were unable to integrate a WPAN into a WLAN infrastructure without suffering from one or more of the aforementioned problems, by allowing the network-enabled hub to initiate and maintain connections with nodes of an external

wireless network via a first network connection using a first network WLAN protocol and, a second network connection using a second network WPAN protocol that is an overlay protocol with respect to the WLAN protocol, and that is partially consistent with respect to the WLAN protocol.

112. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN is also more cost effective, since communications using the second network WPAN protocol impinge on at least some of the antennae used for communications using the first network WLAN protocol.

113. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN allows the two to operate in the same frequency spectrum without causing excessive interference with each other.

114. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN is also more energy efficient, which can extend the battery life of WPAN devices that are battery powered or otherwise enable power-hungry WPAN devices to enter power-save modes more readily.

115. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN, also enables lower latency communication involving WPAN devices, which enables a device serving as a hub between a WPAN and a WLAN to more effectively forward video streams between the two.

116. Participants in the communications industry chose to incorporate a subset of the claimed apparatus into the Wi-Fi Direct Standard to enjoy at least some of their aforementioned advantages.

117. Dell has infringed, and continues to infringe, the ’814 patent by making, importing, using, offering for sale and selling in the United States numerous wireless devices, including laptop computers, desktop computers, tablets, and monitors, that implement the Wi-Fi Direct protocol (i.e., the “Accused Products”). A subset of these Accused Products comprise network-enabled hubs that can receive, for example, video from an IEEE 802.11x AP and forward such video to a Wi-Fi STA device using the Wi-Fi Direct protocol (i.e., the “Hub Accused Products”).

118. Examples of the Hub Accused Products are Dell’s laptop computers (including, but not limited to, XPS Laptops, Inspiron Laptops, Alienware Gaming Laptops, Vostro Laptops, and Latitude Laptops); desktop computers (including, but not limited to, XPS Desktops, Inspiron Desktops, Alienware Gaming Desktops, OptiPlex Desktops, Vostro Desktops, and New Precision Workstations); and tablets (including, but not limited to, Latitude 2-in-1 devices and Latitude Rugged Extreme tablets), and all other Dell products that include Wi-Fi Direct circuitry and drivers. Examples of the Accused Products are Dell’s aforementioned Hub Accused Products, as well as Dell’s monitors (including, but not limited to, Dell Wireless Monitors), and all other Dell products that include Wi-Fi Direct circuitry and drivers.

119. Claim 1 of the ’814 patent is reproduced below:

> 1. A network-enabled hub, usable for facilitating data communications between two or more wireless devices that are configured to communicate indirectly with each other via the network-enabled hub, comprising:
>
> an interface to a wireless radio circuit that can send and receive data wirelessly, providing the hub with bi-directional wireless data communication capability;
>
> logic for processing data received via the wireless radio circuit;
>
> logic for generating data to be transmitted by the wireless radio circuit;
>
> logic for initiating and maintaining wireless network connections with nodes of a wireless network external to the network-enabled hub, maintaining at least a first wireless network connection using a first wireless network protocol and a second wireless network connection using a second

> wireless network protocol, that can be maintained, at times, simultaneously with each other in a common wireless space, wherein the second wireless network protocol is an overlay protocol with respect to the first wireless network protocol in that communications using the second wireless network protocol are partially consistent with the first wireless network protocol and at least some of the communications using the second wireless network protocol impinge on at least some antennae used for the first wireless network; and
>
> data forwarding logic, implemented in the network-enabled hub using hardware and/or software, that forwards data between an originating node and a destination node, wherein the originating node is a node in one of the first and second wireless networks and the destination node is a node in the other of the first and second wireless networks.

120. The Hub Accused Products that infringe the '814 patent include, *inter alia*, a network-enabled hub, usable for facilitating data communications between two or more wireless devices that are configured to communicate indirectly with each other via the network-enabled hub. For example, the Dell XPS 13 9310 Laptop ("XPS 13 Laptop") is a Hub Accused Product comprising a network-enabled hub that implements the Wi-Fi and Wi-Fi Direct standards. It also supports applications such as Miracast, which is a standard that allows a user to "mirror" a video image being displayed at one STA onto the display of another STA, by having it communicated over a Wi-Fi Direct connect between the two STAs. The XPS 13 Laptop infringes the '814 patent because it comprises Wi-Fi and Wi-Fi Direct circuitry and drivers, and applications, such as Miracast, that enable the XPS 13 Laptop to act as a network-enabled hub that concurrently receives data from a node in a WLAN over an 802.11x connection (e.g., streamed video), and forwards that data to a node in a WPAN over a Wi-Fi Direct connection:

XPS 13 Laptop

Operating System Help Me Choose

(FREE Upgrade to Windows 11 *)

Windows 11 Home, English | Windows 10 Home, English

Wireless

Killer™ Wi-Fi 6 AX1650 (2 x 2) and Bluetooth 5.1

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Me and My Dell

For Inspiron, G-Series, XPS, and Alienware computers

Display

Displays are classified according to their screen size, resolution, color gamut, and so on. Generally, a screen with higher resolution and better color support provides better image quality. Some external displays also have USB ports, media-card readers, and so on. Displays may also support features such as, touch screen, 3D, and wireless connection.

Wireless display

The wireless display feature enables you to share your computer display with a compatible TV without the use of cables. To check if your TV supports this feature, see the documentation of the TV.

NOTE: Wireless display may not be supported on all computers. For more information, see www.intel.com.

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_reference-guide_en-us.pdf

Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Connect to a compatible smart TV

If you own a smart TV, chances are you will be able to connect your Windows 10 computer to the smart TV. To learn if your smart TV supports a wireless connection to a computer and how to set it up, see the User Guide of the smart TV on the manufacturers website.

Connect to an HDTV with a wireless display adapter

A wireless display adapter is a device that allows you to display the content of the computer onto your TV. This adapter or dongle (sometimes called a wireless display receiver) is a small device that connects to your TV through an available HDMI port and a USB port for power.

There are several third-party wireless display adapters available in the market. Some of the most popular ones are Microsoft Wireless Display Adapter, Google's Chromecast, Roku's Streaming Stick, Amazon's Fire Stick, and so on. The features of each wireless display adapter varies, see the device manufacturers website for more information.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778

Standards-based Miracast advances life without wires

Miracast is an industry-wide solution, allowing technology to work across device types and vendors. Connections are easy to set up and use since Miracast devices choose the appropriate settings automatically. Miracast can connect two devices using network infrastructure or **Wi-Fi Direct®**. When content to be shared is stored on a Miracast-certified device, such as a smartphone to an automobile infotainment display, a Wi-Fi network connection is not required.

Only devices marked Wi-Fi CERTIFIED Miracast have been certified by Wi-Fi Alliance® to work well with other Wi-Fi CERTIFIED™ devices, employ the latest security protections, and deliver a high-quality user experience.

Source: https://www.wi-fi.org/discover-wi-fi/miracast

2.3 Concurrent operation

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

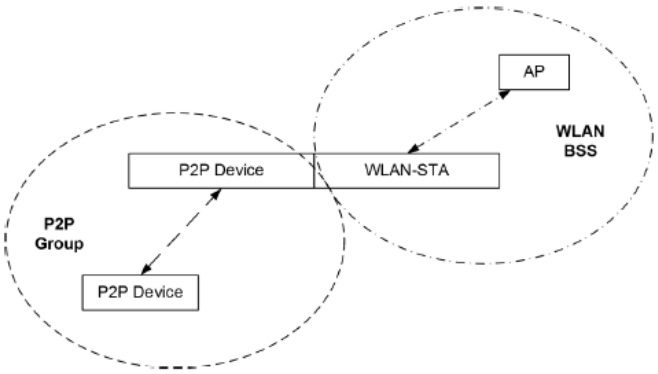
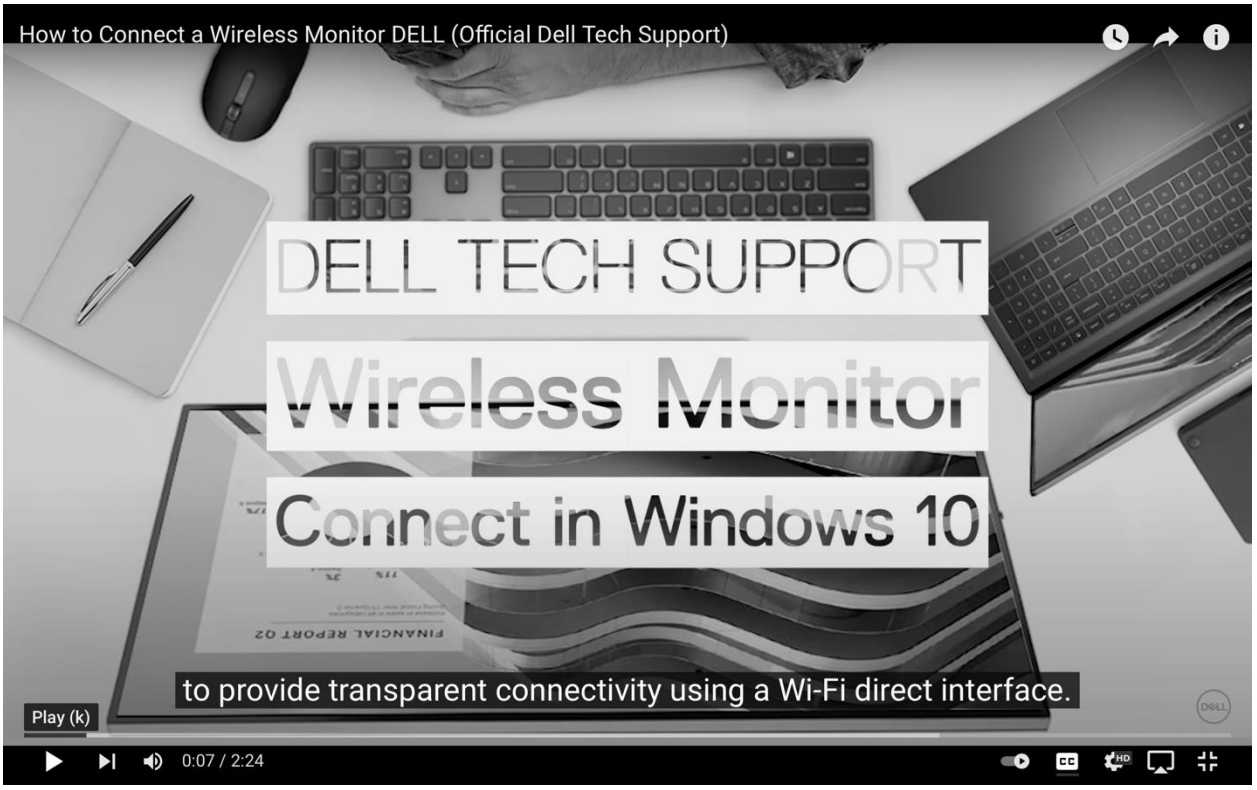


Figure 4—P2P Concurrent device

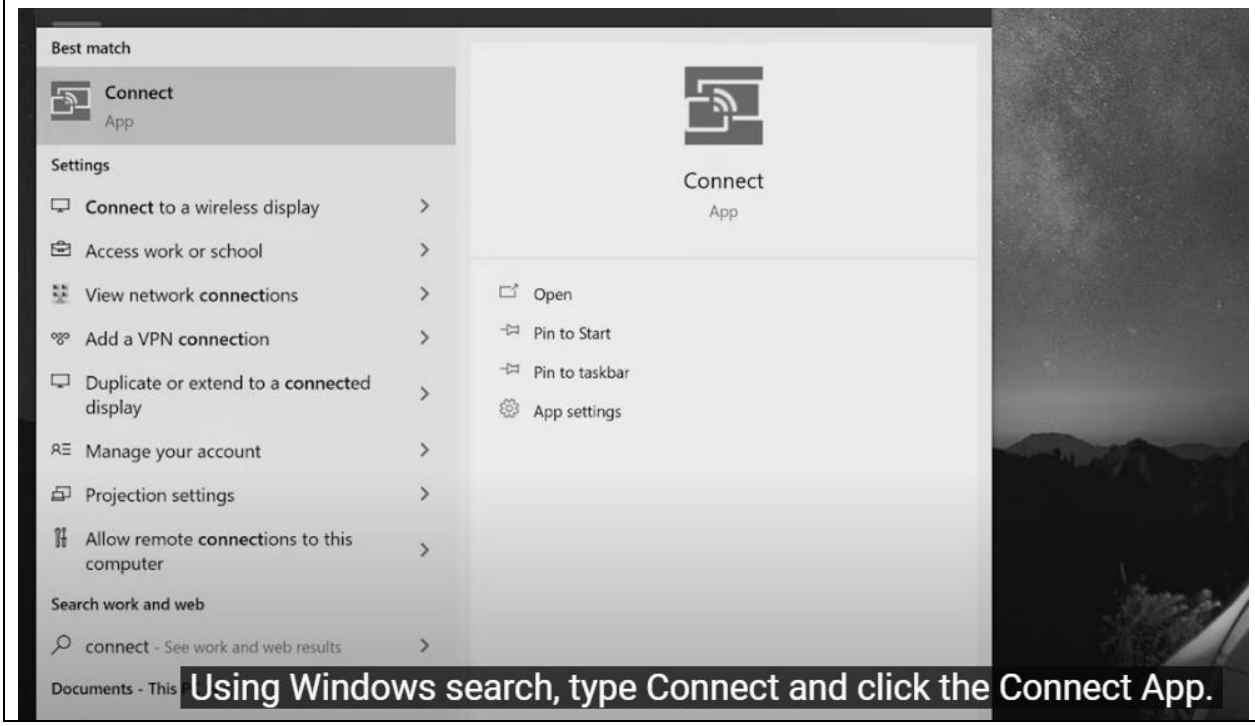
As an example, Figure 4 shows a P2P Concurrent Device that has one MAC entity operating as a WLAN-STA and the second MAC entity operating as a P2P Device. The dual MAC functionality can be provided via two separate physical MAC entities each associated with its own PHY entity, two virtual MAC entities over one PHY entity, or any other approach. Implementation of multiple MAC functionality is out of scope of this specification.

Source: Wi-Fi Direct Standard, v. 1.7, Section 2.3, Fig. 4

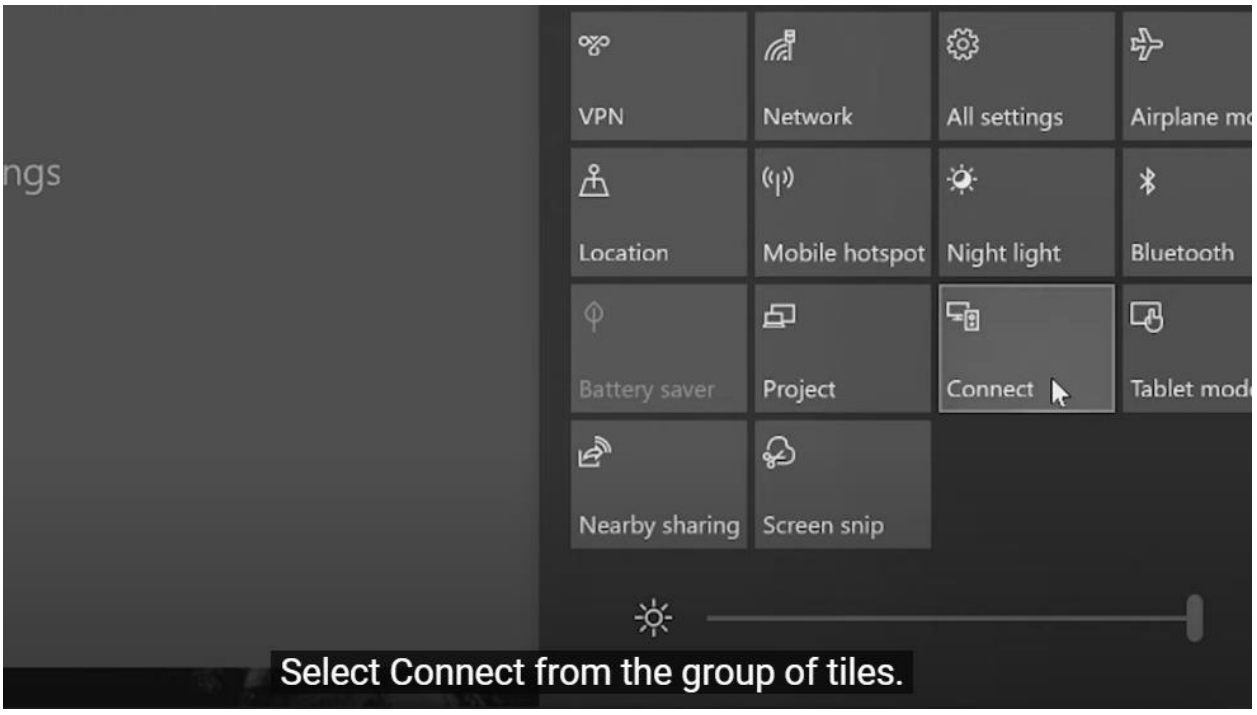

How to Connect a Wireless Monitor DELL (Official Dell Tech Support)
DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
Dell PCs and wireless monitors use Windows and Miracast technology
0:04 / 2:24

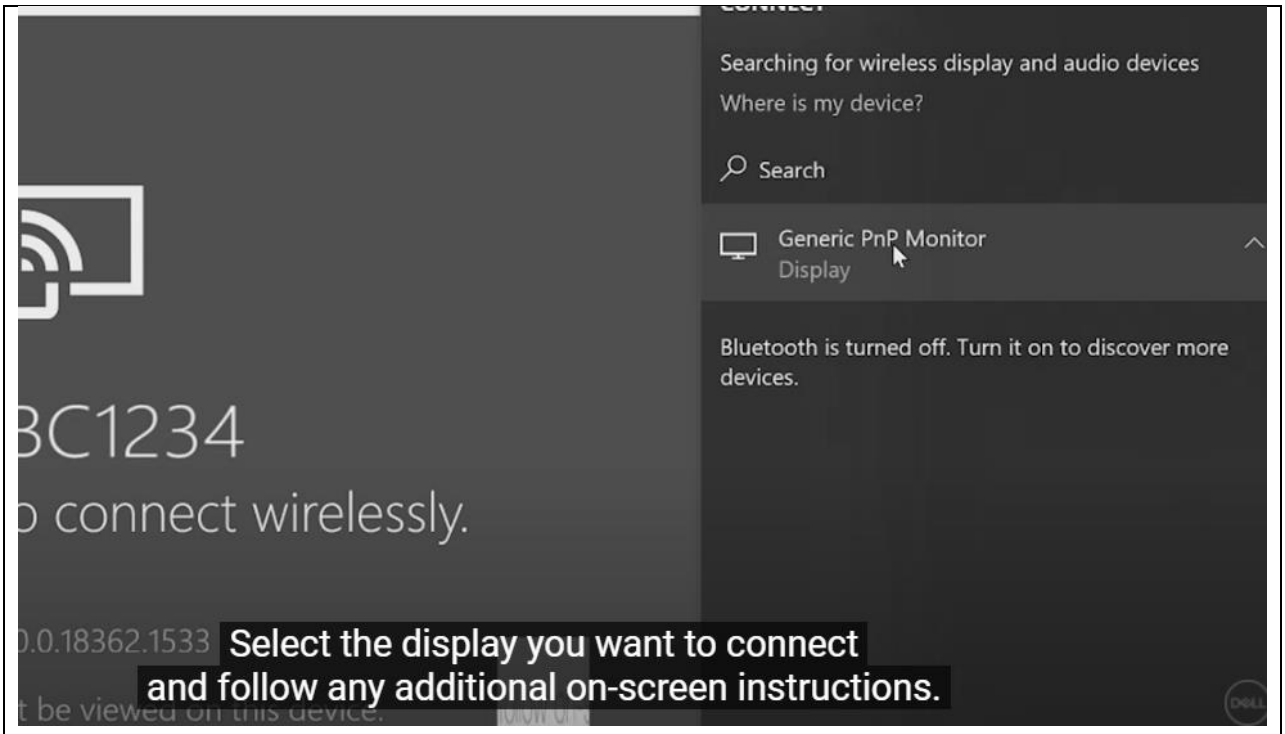

How to Connect a Wireless Monitor DELL (Official Dell Tech Support)
DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
to provide transparent connectivity using a Wi-Fi direct interface.
Play (k)
0:07 / 2:24


DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
In this video, we show you how to connect
your Miracast display to your Windows 10 device.


Best match
Connect
App
Settings
Connect to a wireless display
Access work or school
View network connections
Add a VPN connection
Duplicate or extend to a connected display
Manage your account
Projection settings
Allow remote connections to this computer
Search work and web
connect - See work and web results
Documents - This
Connect
App
Open
Pin to Start
Pin to taskbar
App settings
Using Windows search, type Connect and click the Connect App.


W10ABC1234
is ready for you to connect wirelessly.
Version: 10.0.18362.1533
Protected content can't be viewed on this device.
Press Ctrl + S to open Settings
Connect will open indicating that your Windows 10 Dell PC supports Miracast


VPN
Network
All settings
Airplane mo
Location
Mobile hotspot
Night light
Bluetooth
Battery saver
Project
Connect
Tablet mod
Nearby sharing
Screen snip
Select Connect from the group of tiles.



Source: https://www.youtube.com/watch?v=kXBwdWp7sFM ("How to Connect a Wireless Monitor DELL (Official Dell Tech Support)"

121. The XPS 13 Laptop includes an interface to a wireless radio circuit that can send and receive data wirelessly, providing the hub with bi-directional wireless data communication capability. For example, the XPS 13 Laptop, designed and manufactured by Dell, includes the Intel Killer AX1650 wireless module (wireless radio circuit that can send and receive data wirelessly), which includes Wi-Fi functionality (bi-directional wireless data communications). The XPS 13 Laptop can serve as the claimed hub when, for example, a video is streamed over a Wi-Fi connection from the Internet to the XPS 13 Laptop, and the XPS 13 Laptop's Wi-Fi Direct-circuitry and drivers are used (e.g., under control of, for example, its Miracast application) to mirror that Internet-sourced video to a second device, such as a wireless display:

XPS 13 Laptop

Operating System Help Me Choose

(FREE Upgrade to Windows 11 *)

Windows 11 Home, English	Windows 10 Home, English

Wireless

Killer™ Wi-Fi 6 AX1650 (2 x 2) and Bluetooth 5.1

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Wireless module

The following table lists the Wireless Local Area Network (WLAN) module specifications of your XPS 13 9310.

NOTE: The wireless module is integrated on the system board.

Table 9. Wireless module specifications

Description	Option one
Model number	Intel AX1650
Transfer rate	Up to 2400 Mbps
Frequency bands supported	2.4 GHz/5 GHz
Wireless standards	• WiFi 802.11a/b/g • Wi-Fi 4 (WiFi 802.11n) • Wi-Fi 5 (WiFi 802.11ac) • Wi-Fi 6 (WiFi 802.11ax)
Encryption	• 64-bit/128-bit WEP • AES-CCMP • TKIP
Bluetooth	Bluetooth 5.1

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

TX/RX Streams	2x2
Bands	2.4Ghz, 5Ghz (160Mhz)
Max Speed	2.4Gbps
Wi-Fi CERTIFIED*	WiFi 6 (802.11ax)

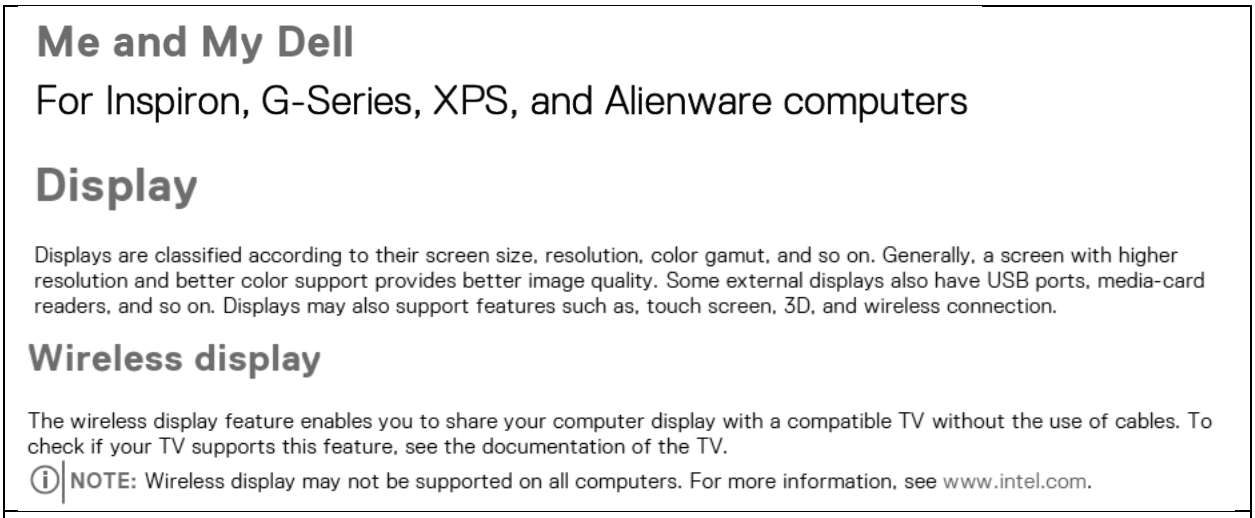
Experience the Intel® Difference

Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.

GENERAL

Dimensions (H x W x D)	M.2 2230: 22mm x 30mm x 2.4mm [1.5mm Max (Top Side)/ 0.1mm Max (Bottom Side)] M.2 1216: 12mm x 16mm x 1.67 (+-0.08) mm
Weight	M.2 2230: 2.83 +/– 0.3 g M.2 1216: 0.67 +/– 0.1 g
Radio ON/OFF Control	Supported
Connector Interface	M.2: PCIe*, USB
Operating Temperature (Adapter Shield)	0°C to +80°C
Humidity Non-Operating	50% to 90% RH non-condensing (at temperatures of 25°C to 35°C)
Operating Systems	Microsoft Windows* 10, Linux*, Chrome OS*
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016
Bluetooth®	Bluetooth® 5.2

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)



Me and My Dell

For Inspiron, G-Series, XPS, and Alienware computers

Display

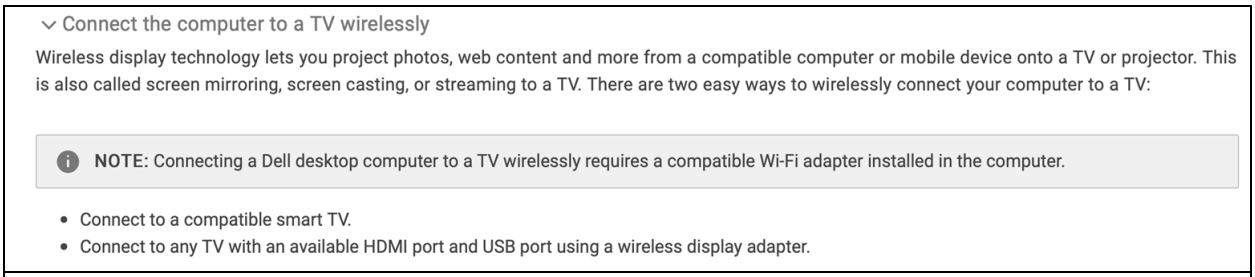
Displays are classified according to their screen size, resolution, color gamut, and so on. Generally, a screen with higher resolution and better color support provides better image quality. Some external displays also have USB ports, media-card readers, and so on. Displays may also support features such as, touch screen, 3D, and wireless connection.

Wireless display

The wireless display feature enables you to share your computer display with a compatible TV without the use of cables. To check if your TV supports this feature, see the documentation of the TV.

NOTE: Wireless display may not be supported on all computers. For more information, see www.intel.com.

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_reference-guide_en-us.pdf



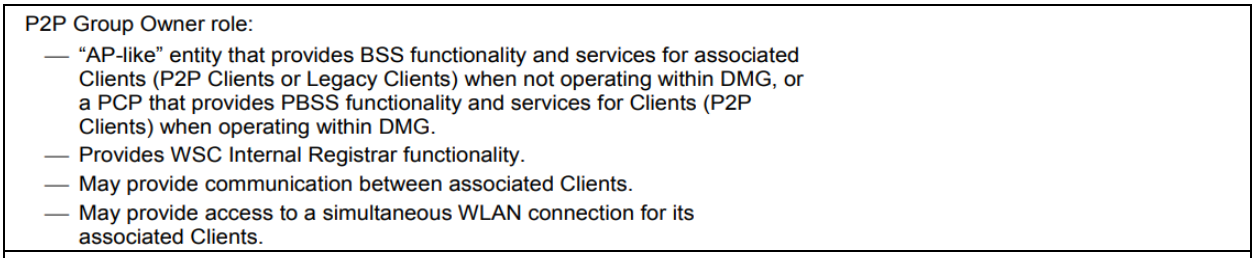
Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778



P2P Group Owner role:

- "AP-like" entity that provides BSS functionality and services for associated Clients (P2P Clients or Legacy Clients) when not operating within DMG, or a PCP that provides PBSS functionality and services for Clients (P2P Clients) when operating within DMG.
- Provides WSC Internal Registrar functionality.
- May provide communication between associated Clients.
- May provide access to a simultaneous WLAN connection for its associated Clients.

Source: Wi-Fi Direct Standard, v. 1.7, Section 2.1

122. The XPS 13 Laptop includes logic for processing data received via the wireless radio circuit and logic for generating data to be transmitted by the wireless radio circuit. For example, the XPS 13 Laptop includes the Intel Core i3-1115G4 system processor which processes data received from the Intel Killer AX1650 wireless module and generates data to be transmitted by the Intel Killer AX1650 wireless module:

XPS 13 Laptop

Tech Specs

Processor
11th Generation Intel® Core™ i3-1115G4 Processor (6MB Cache, up to 4.1 GHz)

Operating System
(FREE Upgrade to Windows 11)
Windows 11 Home, English

Graphics Card
Intel® UHD Graphics with shared graphics memory

Display
13.4" UHD+ (3840 x 2400) InfinityEdge Touch Anti-Reflective 500-Nit Display

Memory
8GB 4267MHz LPDDR4x Memory Onboard

Hard Drive
256GB M.2 PCIe NVMe Solid State Drive

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Processor

The following table lists the details of the processors supported by your XPS 13 9310.

Table 4. Processor

Description	Option one
Processor type	11th Generation Intel Core i3-1115G4 processor
Processor wattage	15 W
Processor core count	2
Processor thread count	4
Processor speed	Up to 4.10 GHz
Processor cache	6 MB
Integrated graphics	Intel UHD Graphics

Wireless module

The following table lists the Wireless Local Area Network (WLAN) module specifications of your XPS 13 9310.

NOTE: The wireless module is integrated on the system board.

Table 9. Wireless module specifications

Description	Option one
Model number	Intel AX1650
Transfer rate	Up to 2400 Mbps
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Encryption	• 64-bit/128-bit WEP • AES-CCMP • TKIP
Bluetooth	Bluetooth 5.1

Chipset

The following table lists the details of the chipset supported by your XPS 13 9310.

Table 5. Chipset

Description	Values
Chipset	Integrated in the processor
Processor	11th Generation Intel Core i3/i5/i7
DRAM bus width	128 bit
Flash EPROM	32 MB (BIOS)
PCIe bus	Up to PCIe Gen 4.0 (Storage)

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

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 Section 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.

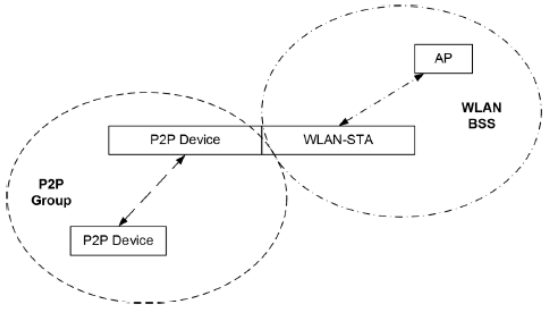
Source: Wi-Fi Direct Standard, v. 1.7, Section 3.2.6.1

123. The XPS 13 Laptop includes logic for initiating and maintaining wireless network connections with nodes of a wireless network external to the network-enabled hub. For example, the XPS 13 Laptop (network-enabled hub) may initiate and maintain a connection (network connection) with an AP that is external to the XPS 13 Laptop. The XPS 13 Laptop may also, for

example, initiate and maintain a connection with an STA that is external to the XPS 13 Laptop, such as a wireless monitor or television:

Concurrent operation

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



Source: Wi-Fi Direct Standard, v. 1.7, Section 2.3

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Chipset

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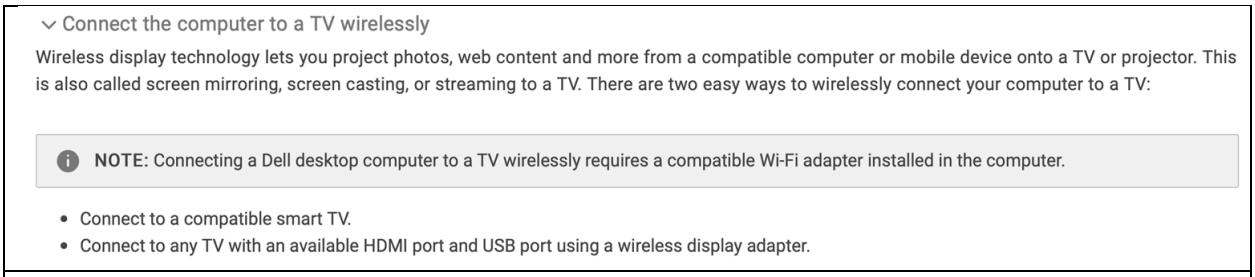
Source: https://www.youtube.com/watch?v=kXBwdWp7sFM ("How to Connect a Wireless Monitor DELL (Official Dell Tech Support)"



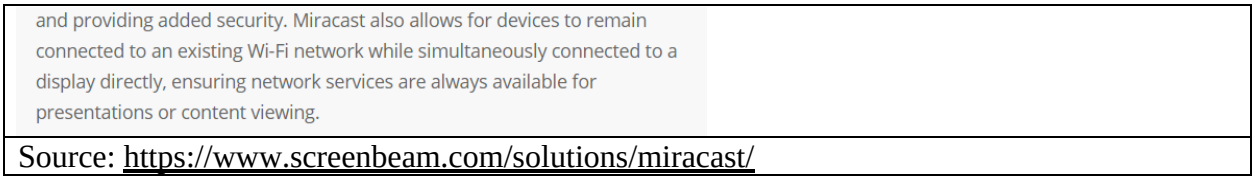
Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

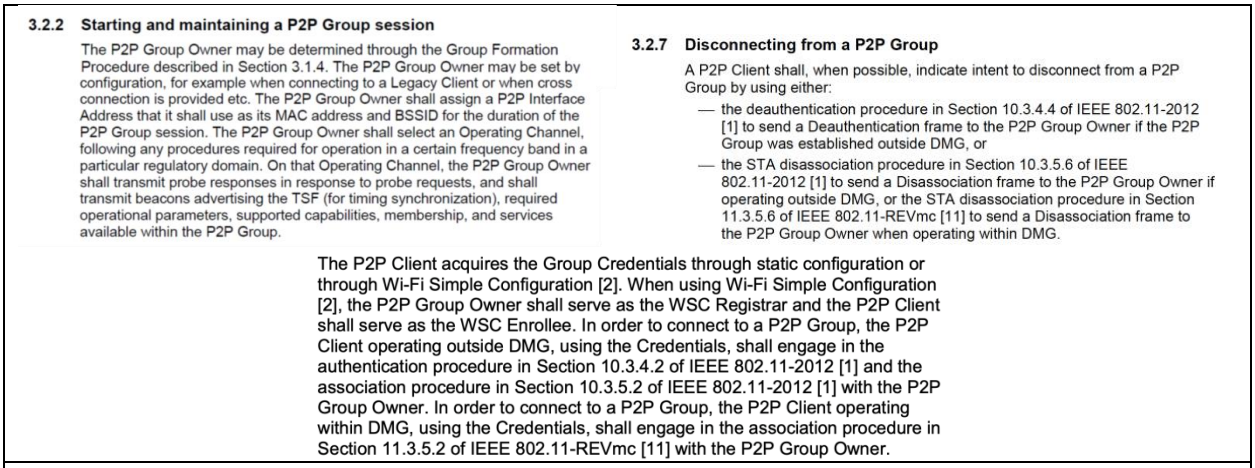
- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778



and providing added security. Miracast also allows for devices to remain connected to an existing Wi-Fi network while simultaneously connected to a display directly, ensuring network services are always available for presentations or content viewing.

Source: https://www.screenbeam.com/solutions/miracast/



3.2.2 Starting and maintaining a P2P Group session

The P2P Group Owner may be determined through the Group Formation Procedure described in Section 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.

3.2.7 Disconnecting from a P2P Group

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

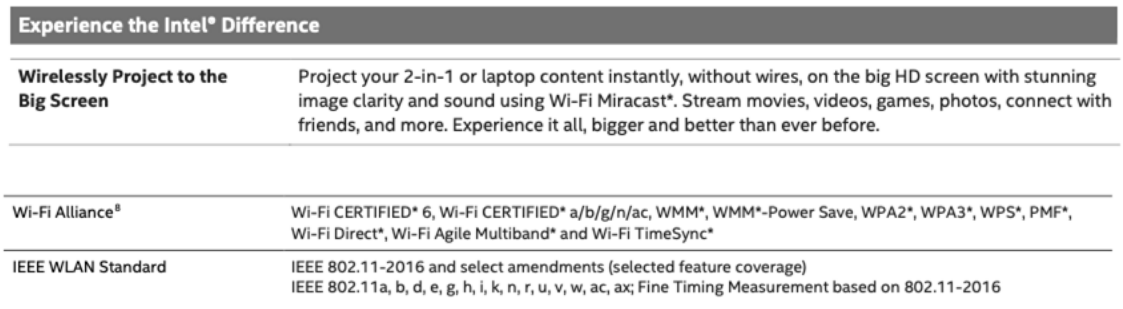
— the deauthentication procedure in Section 10.3.4.4 of IEEE 802.11-2012 [1] to send a Deauthentication frame to the P2P Group Owner if the P2P Group was established outside DMG, or

— the STA disassociation procedure in Section 10.3.5.6 of IEEE 802.11-2012 [1] to send a Disassociation frame to the P2P Group Owner if operating outside DMG, or the STA disassociation procedure in Section 11.3.5.6 of IEEE 802.11-REVmc [11] to send a Disassociation frame to the P2P Group Owner when operating within DMG.

The P2P Client acquires the Group Credentials through static configuration or through Wi-Fi Simple Configuration [2]. When using Wi-Fi Simple Configuration [2], the P2P Group Owner shall serve as the WSC Registrar and the P2P Client shall serve as the WSC Enrollee. In order to connect to a P2P Group, the P2P Client operating outside DMG, using the Credentials, shall engage in the authentication procedure in Section 10.3.4.2 of IEEE 802.11-2012 [1] and the association procedure in Section 10.3.5.2 of IEEE 802.11-2012 [1] with the P2P Group Owner. In order to connect to a P2P Group, the P2P Client operating within DMG, using the Credentials, shall engage in the association procedure in Section 11.3.5.2 of IEEE 802.11-REVmc [11] with the P2P Group Owner.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.2.2, 3.2.3 & 3.2.7.

124. The XPS 13 Laptop includes logic for maintaining at least a first wireless network connection using a first wireless network protocol and a second wireless network connection using a second wireless network protocol, that can be maintained, at times, simultaneously with each other in a common wireless space. For example, the XPS 13 Laptop includes logic to connect to an access point using 802.11x Wi-Fi (first wireless network connection using a first wireless network protocol) and to a receiver display screen (second wireless network connection) using Wi-Fi Direct (second wireless network protocol) that can be maintained, at times, simultaneously with each other in a common wireless space:



Experience the Intel® Difference	
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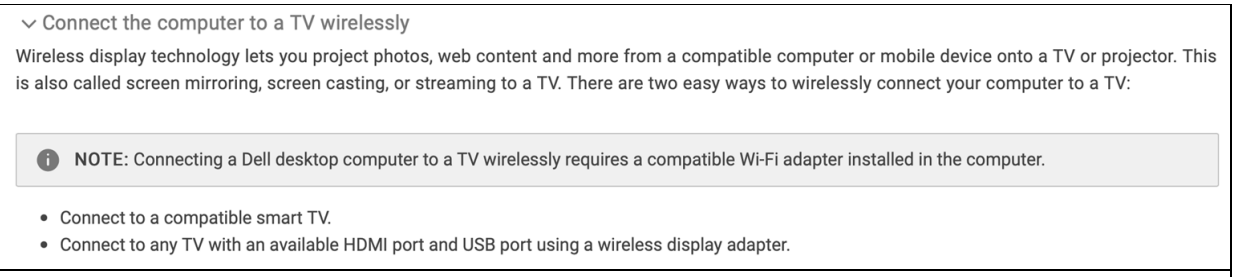
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html to embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf



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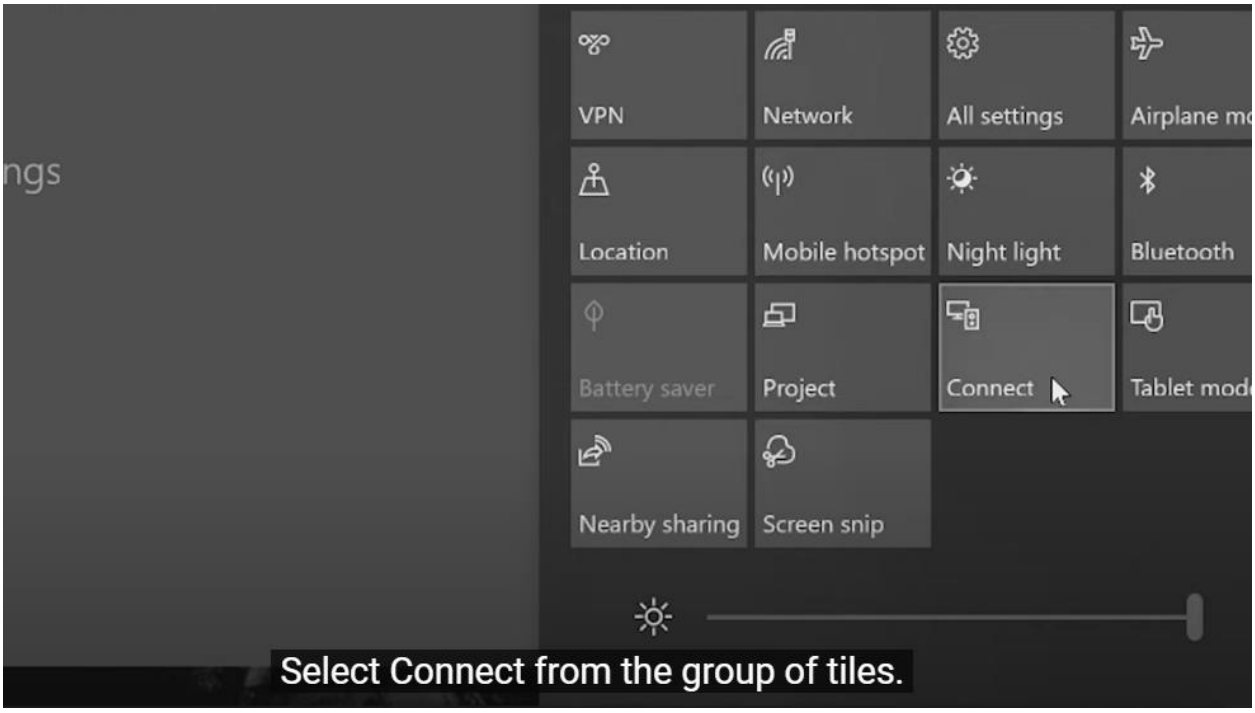
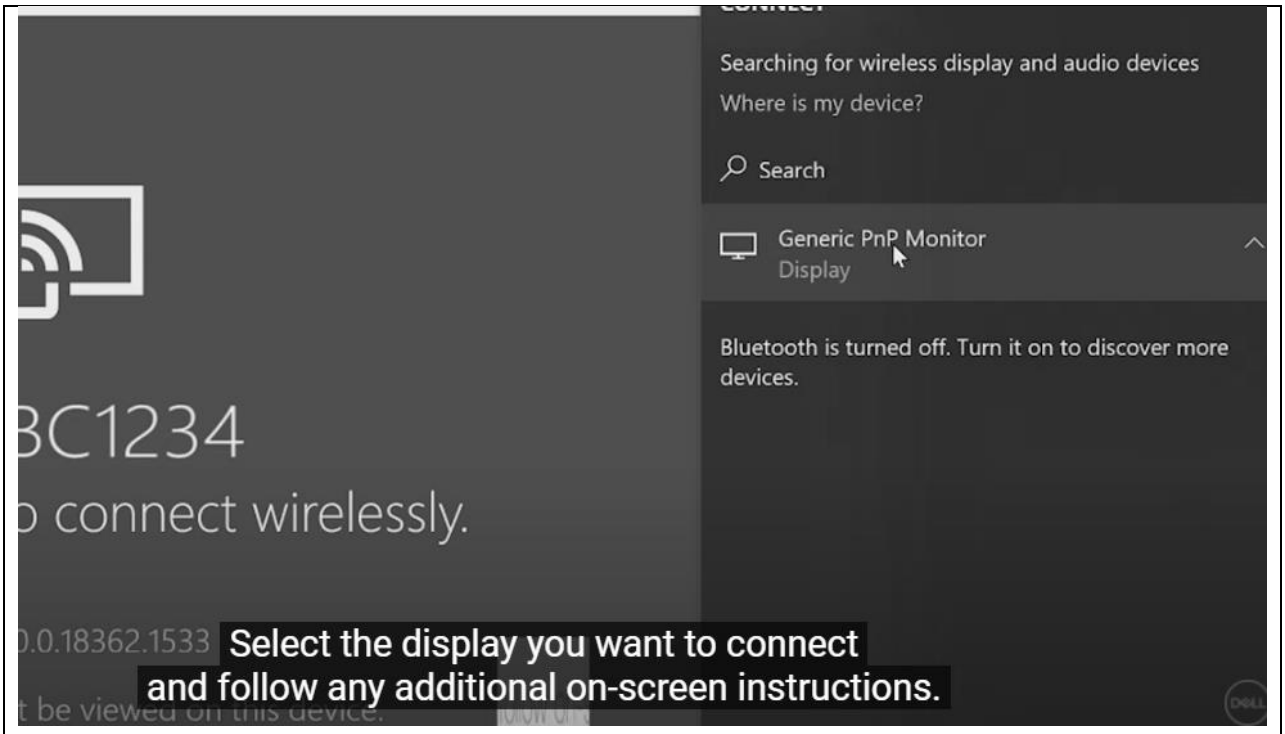
Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778


DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
In this video, we show you how to connect your Miracast display to your Windows 10 device.
Best match
Connect
App
Settings
Connect to a wireless display
Access work or school
View network connections
Add a VPN connection
Duplicate or extend to a connected display
Manage your account
Projection settings
Allow remote connections to this computer
Search work and web
connect - See work and web results
Documents - This
Connect
App
Open
Pin to Start
Pin to taskbar
App settings
Using Windows search, type Connect and click the Connect App.


W10ABC1234
is ready for you to connect wirelessly.
Version: 10.0.18362.1533
Protected content can't be viewed on this device.
Press Ctrl + S to open Settings
Connect will open indicating that your Windows 10 Dell PC supports Miracast


VPN
Network
All settings
Airplane mo
Location
Mobile hotspot
Night light
Bluetooth
Battery saver
Project
Connect
Tablet mod
Nearby sharing
Screen snip
Select Connect from the group of tiles.



Source: https://www.youtube.com/watch?v=kXBwdWp7sFM ("How to Connect a Wireless Monitor DELL (Official Dell Tech Support)"

Figure 2. Wi-Fi Direct Concurrent Mode

Source: https://arxiv.org/ftp/arxiv/papers/1810/1810.06964.pdf

2.3 Concurrent operation

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

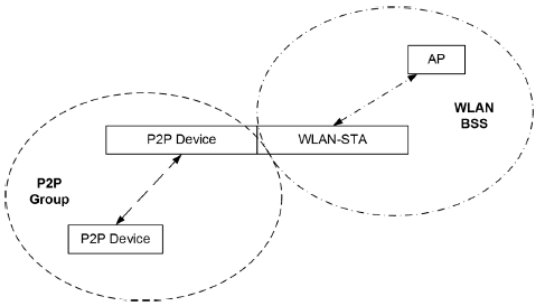


Figure 4—P2P Concurrent device

As an example, Figure 4 shows a P2P Concurrent Device that has one MAC entity operating as a WLAN-STA and the second MAC entity operating as a P2P Device. The dual MAC functionality can be provided via two separate physical MAC entities each associated with its own PHY entity, two virtual MAC entities over one PHY entity, or any other approach. Implementation of multiple MAC functionality is out of scope of this specification.

A P2P Group may operate in the same or different operating class and channel as a concurrently operating WLAN BSS. For example, a WLAN BSS may

Source: Wi-Fi Direct Standard, v. 1.7, Section 2.3

125. In further detail, the XPS 13 Laptop, in supporting Wi-Fi, includes logic to maintain at least a first wireless network connection using a first wireless network protocol (i.e., Wi-Fi). For example, the XPS 13 Laptop provides connections compliant with IEEE 802.11x:

Wireless module

The following table lists the Wireless Local Area Network (WLAN) module specifications of your XPS 13 9310.

NOTE: The wireless module is integrated on the system board.

Table 9. Wireless module specifications

Description	Option one
Model number	Intel AX1650
Transfer rate	Up to 2400 Mbps
Frequency bands supported	2.4 GHz/5 GHz
Wireless standards	• WiFi 802.11a/b/g • Wi-Fi 4 (WiFi 802.11n) • Wi-Fi 5 (WiFi 802.11ac) • Wi-Fi 6 (WiFi 802.11ax)
Encryption	• 64-bit/128-bit WEP • AES-CCMP • TKIP
Bluetooth	Bluetooth 5.1

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

TX/RX Streams	2x2
Bands	2.4Ghz, 5Ghz (160Mhz)
Max Speed	2.4Gbps
Wi-Fi CERTIFIED*	WiFi 6 (802.11ax)

Wi-Fi Alliance®	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)

10.1.3 Maintaining synchronization

10.1.3.1 General

Each STA shall maintain a TSF timer with modulus 2^{64} counting in increments of microseconds. STAs expect to receive Beacon frames at a nominal rate. The interval between Beacon frames is defined by the dot11BeaconPeriod parameter of the STA. A STA sending a Beacon frame shall set the value of the Beacon frame's timestamp so that it equals the value of the STA's TSF timer at the time that the data symbol containing the first bit of the timestamp is transmitted to the PHY plus the transmitting STA's delays through its local PHY from the MAC-PHY interface to its interface with the WM [e.g., antenna, light-emitting diode (LED) emission surface].

Source: IEEE 802.11-2012, Section 10.1.3.1

10.3.5 Association, reassociation, and disassociation

10.3.5.1 General

Subclause 10.3.5 describes the procedures used for IEEE 802.11 association, reassociation and disassociation.

The states used in this description are defined in 10.3.1.

Successful association enables a STA to exchange Class 3 frames. Successful association sets the STA's state to State 3 or State 4.

Successful reassociation enables a STA to exchange Class 3 frames. Unsuccessful reassociation when not in State 1 leaves the STA's state unchanged (with respect to the AP that was sent the Reassociation Request (which may be the current STA)). Successful reassociation sets the STA's state to State 3 or State 4 (with respect to the AP that was sent the Reassociation Request). Successful reassociation when not in State 1 sets the STA's state to State 2 (with respect to the current AP, if this is not the AP that was sent the Reassociation Request). Reassociation shall be performed only if the originating STA is already associated in the same ESS.

Disassociation notification when not in State 1 sets the STA's state to State 2. The STA shall become associated again prior to sending Class 3 frames. A STA may disassociate a peer STA at any time, for any reason.

Source: IEEE 802.11-2012, Section 10.3.5.1

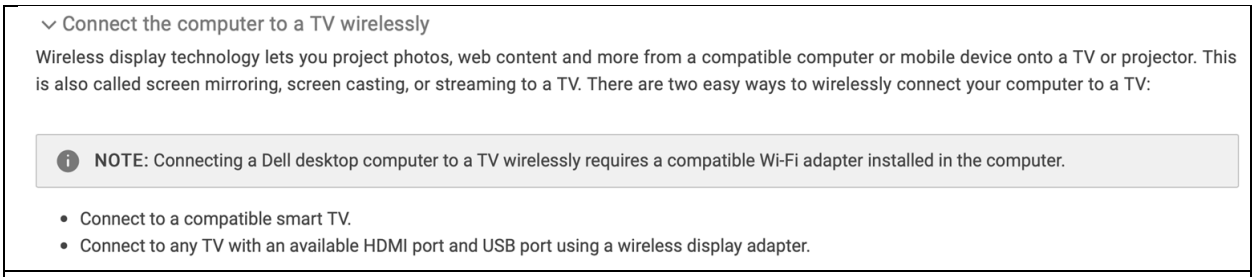
126. In further detail, the XPS 13 Laptop, in supporting Wi-Fi Direct, includes logic to maintain a second wireless network connection using a second wireless network protocol (e.g., Wi-Fi Direct). For example, the XPS 13 Laptop, which supports Wi-Fi Direct connections, provides connections using the Wi-Fi Direct Standard:

Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

Experience the Intel® Difference	
Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)



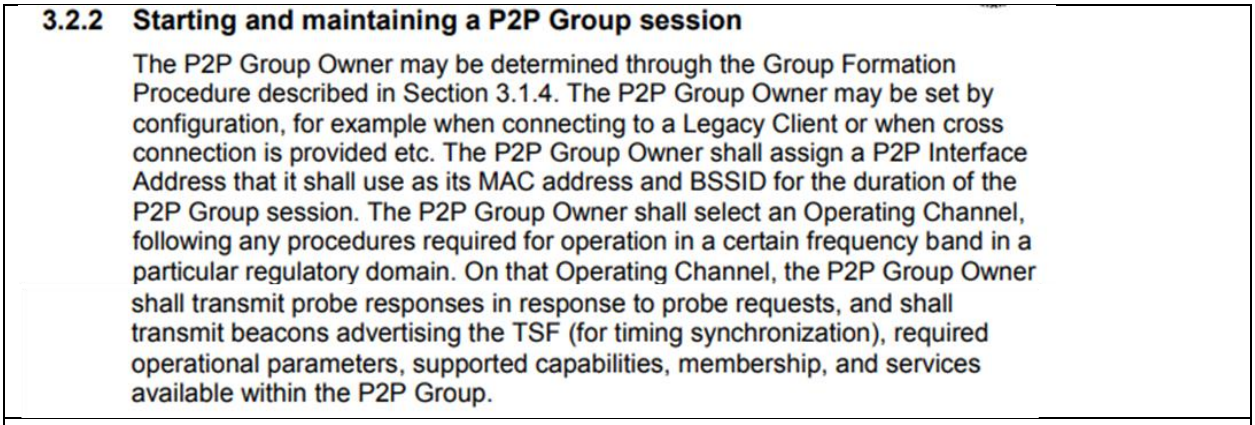
Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

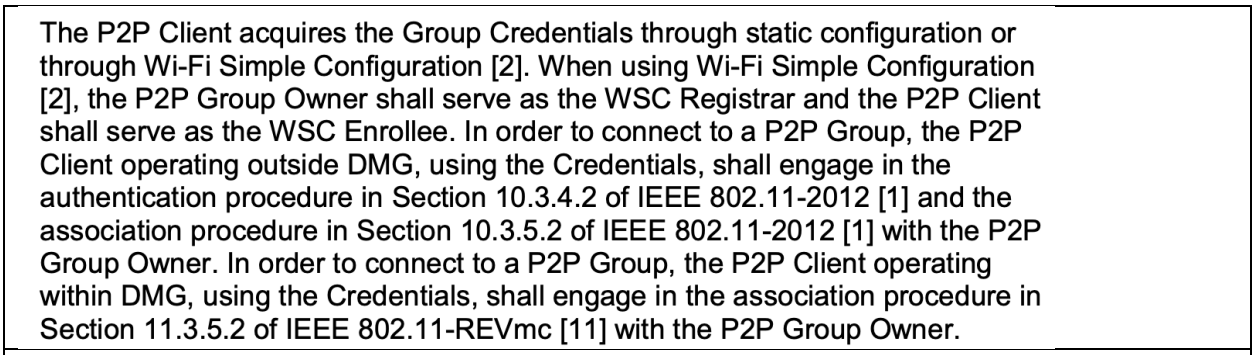
Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778



3.2.2 Starting and maintaining a P2P Group session

The P2P Group Owner may be determined through the Group Formation Procedure described in Section 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.

Source: Wi-Fi Direct Standard, v. 1.7, Section 3.2.2



The P2P Client acquires the Group Credentials through static configuration or through Wi-Fi Simple Configuration [2]. When using Wi-Fi Simple Configuration [2], the P2P Group Owner shall serve as the WSC Registrar and the P2P Client shall serve as the WSC Enrollee. In order to connect to a P2P Group, the P2P Client operating outside DMG, using the Credentials, shall engage in the authentication procedure in Section 10.3.4.2 of IEEE 802.11-2012 [1] and the association procedure in Section 10.3.5.2 of IEEE 802.11-2012 [1] with the P2P Group Owner. In order to connect to a P2P Group, the P2P Client operating within DMG, using the Credentials, shall engage in the association procedure in Section 11.3.5.2 of IEEE 802.11-REVmc [11] with the P2P Group Owner.

Source: Wi-Fi Direct Standard, v. 1.7, Section 3.2.3

127. In further detail, the XPS 13 Laptop can maintain the first wireless network connection and the second wireless network connection simultaneously with each other in a common wireless space. For example, the XPS 13 Laptop can maintain its connection to an access point via 802.11x Wi-Fi (first wireless network connection using a first wireless network protocol) and to a wireless receiver display screen (second wireless network connection) using Wi-Fi Direct

(second wireless network protocol), at times, simultaneously with each other in a common wireless space via concurrent operation, as explained herein and in the Wi-Fi Direct Standard:

Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778

All devices certified under the Wi-Fi Direct program allow the user to connect to an infrastructure or a Wi-Fi Direct-certified network. Some devices certified under the Wi-Fi Direct program support connections to both an infrastructure network and Wi-Fi Direct-certified group at the same time (e.g. a laptop may support an infrastructure connection while also belonging to a Wi-Fi Direct-certified group). Simultaneous connection to a Wi-Fi Direct-certified group and an infrastructure network is an optional feature.

Source: https://www.wi-fi.org/knowledge-center/faq/can-a-device-simultaneously-connect-to-a-regular-wi-fi-network-and-a-group-of

Figure 2. Wi-Fi Direct Concurrent Mode

Source: https://arxiv.org/ftp/arxiv/papers/1810/1810.06964.pdf

128. In the XPS 13 Laptop, the second wireless network protocol (Wi-Fi Direct) is an overlay protocol with respect to the first wireless network protocol (Wi-Fi). Wi-Fi Direct frames are based on 802.11x frames and use the vendor specific field of an 802.11x management frame. The Wi-Fi Direct protocol processes the data in the vendor-specific field that is overlaid on a Wi-Fi management frame.

2.4.1 Basic functions and services

For P2P operation outside the DMG, this specification assumes that the following STA functions and services are implemented in P2P Devices:

- IEEE 802.11g or newer 2.4 GHz PHY [1]
- IEEE 802.11i (AES-CCMP) [1]
- Wi-Fi Simple Configuration [2]
- Wi-Fi Multimedia [3]

Any required 'AP-like' functions and services required for P2P Group Owner operation outside DMG are described within this specification. A P2P Group Owner operating within DMG is required to support PCP functions and services.

3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.

* * *

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 802.11-2012 [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.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.1, 3.2 & 4

8.3.3 Management frames

8.3.3.1 Format of management frames

The format of a management frame is defined in Figure 8-34. The Frame Control, Duration, Address 1, Address 2, Address 3, and Sequence Control fields are present in all management frame subtypes. The maximum unencrypted MMPDU size, excluding the MAC header and FCS, is 2304 octets.

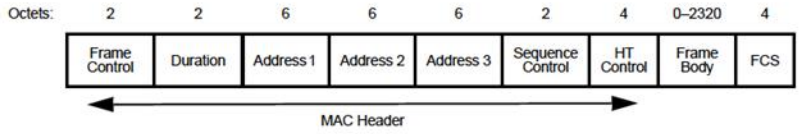


Figure 8-34—Management frame format

The HT Control field is defined in 8.2.4.6. The presence of the HT Control field is determined by the Order subfield of the Frame Control field, as specified in 8.2.4.1.10.

The frame body consists of the fields followed by the elements defined for each management frame subtype. All fields and elements are mandatory unless stated otherwise and appear in the specified, relative order. STAs that encounter an element ID they do not recognize in the frame body of a received management frame ignore that element and continue to parse the remainder of the management frame body (if any) for additional elements with recognizable element IDs. See 9.24.7. Unused element ID codes are reserved.

Gaps may exist in the ordering of fields and elements within frames. The order that remains is ascending.

8.4 Management frame body components

8.4.1 Fields that are not information elements

8.4.2 Information elements

8.4.2.1 General

Elements are defined to have a common general format consisting of a 1 octet Element ID field, a 1 octet Length field, and a variable-length element-specific Information field. Each element is assigned a unique Element ID as defined in this standard. The Length field specifies the number of octets in the Information field. See Figure 8-81.

	Element ID	Length	Information
Octets:	1	1	variable

Figure 8-81—Element format

The set of valid elements is defined in Table 8-54.

Table 8-54—Element IDs

Element	Element ID	Length of indicated element (in octets)	Extensible
SSID (see 8.4.2.2)	0	2 to 34	
Supported rates (see 8.4.2.3)	1	3 to 10	

Table 8-54—Element IDs *(continued)*

Element	Element ID	Length of indicated element (in octets)	Extensible
U-APSD Coexistence (see 8.4.2.93)	142	14 to 257	Subelements
Reserved	143–173		
MCCAOP Advertisement Overview (see 8.4.2.110)	174	8	Yes
Reserved	175–220		
Vendor Specific (see 8.4.2.28)	221	3 to 257	
Reserved	222–255		

8.5.6 Vendor-specific action details

The Vendor Specific Action frame is defined for vendor-specific signaling. The format of the Action field of the Vendor Specific Action frame is shown in Figure 8-437. An Organization Identifier, in the octet field immediately after the Category field, differentiates the vendors (see 8.4.1.31).

NOTE—If management frame protection is negotiated, then Vendor Specific Protected Action frames (see Table 8-38) are protected; otherwise they are unprotected.

	Category	Organization Identifier	Vendor Specific Content
Octets:	1	*j*	Variable

Figure 8-437—Vendor Specific Action frame Action field format

The Category field is set to the value indicating the vendor-specific category, as specified in Table 8-38.

The Organization Identifier contains a public organizationally unique identifier assigned by the IEEE and is specified in 8.4.1.31. The order of the Organization Identifier field is described in 8.2.2.

The Vendor Specific Content contains vendor-specific field(s). The length of the Vendor Specific Content in a Vendor Specific Action frame is limited by the maximum allowed MMPDU size.

Source: IEEE 802.11-2012, Sections 8.3.3.1, 8.4.2.1 & 8.5.6

129. In the XPS 13 Laptop, the WPAN protocol (second wireless network protocol) is an overlay protocol with respect to the WLAN protocol (first wireless network protocol). For example, the WPAN protocol uses a WLAN protocol frame adapted to support a WPAN protocol power-saving procedure that is different as compared to a power-saving protocol supported by the WLAN protocol. For example, in Wi-Fi Direct (the WPAN protocol) the WPAN-adapted frame may utilize the Vendor Specific Information Element (IE) field of an 802.11x protocol frame (a

WLAN protocol frame) to carry information not defined by the IEEE 802.11x Standard so that interoperability operations that are not part of the 802.11x standard can be implemented, such as those required by the power save features defined by the Wi-Fi Direct Standard. For example, in Wi-Fi Direct, two of the P2P Group Owner's adapted power saving protocol schemes are Notice of Absence and Opportunistic Power Save:

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 802.11-2012 [1] for operation outside DMG and in IEEE 802.11-REVmc [11] for operation within DMG, with the Wi-Fi Alliance OUI and an OUI Type indicating P2P. A number of P2P attributes are defined; a single P2P IE carries one or more P2P attributes.

* * *

3.3 P2P Power Management

The P2P power management approach for operation outside DMG 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.

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.

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

4.1.14 Notice of Absence attribute

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

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.
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.

The Notice of Absence attribute shall be present in the P2P IE in the Beacon frames and Probe Response frames transmitted by a P2P Group Owner when a Notice of Absence schedule is being advertised or when the CTWindow is non-zero, as described in Section 4.2.1 and Section 4.2.3. If there is neither a Notice of Absence schedule nor a CTWindow, the GO may omit the Notice of Absence attribute from Beacon and Probe Response frames. The Notice of Absence shall be also present in Notice of Absence frames, as described in Section 4.2.10.2, P2P Presence Request frames, as described in Section 4.2.10.3, and P2P Presence Response frames, as described in Section 4.2.10.4.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 4, 3.3.1, 3.3.2, & 4.1.14

130. In the XPS 13 Laptop, the second wireless network protocol (Wi-Fi Direct) is an overlay protocol with respect to the first wireless network protocol (Wi-Fi) in that communications using the second wireless network protocol are partially consistent with the first wireless network protocol. Aspects of communications using the overlay protocol (Wi-Fi Direct) which are consistent with the first network protocol (Wi-Fi) include, for example, how P2P device communications utilize and access the physical medium. For example, the XPS 13 Laptop, in supporting Wi-Fi Direct, is required to implement the underlying IEEE 802.11g (or newer) Standard at the PHY level, as shown below. By implementing the underlying PHY protocol, P2P device communications (communications in the second wireless network) use and access the physical medium in a manner that is coordinated with 802.11x communications occurring outside of the second wireless network, yet in a common wireless space, such that the problems of device interference are reduced.

2.4.1 Basic functions and services

For P2P operation outside the DMG, this specification assumes that the following STA functions and services are implemented in P2P Devices:

- IEEE 802.11g or newer 2.4 GHz PHY [1]
- IEEE 802.11i (AES-CCMP) [1]
- Wi-Fi Simple Configuration [2]
- Wi-Fi Multimedia [3]

3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.1 & 3.2

131. In the XPS 13 Laptop, the second wireless network protocol (Wi-Fi Direct) is an overlay protocol with respect to the first network protocol (Wi-Fi) in that communications using the Wi-Fi Direct protocol are partially consistent with the Wi-Fi protocol. Aspects of communications using the Wi-Fi Direct protocol which are not consistent with the Wi-Fi protocol include, for example, aspects of P2P Discovery, P2P Power Management, and Managed P2P Device Operation as set out below:

2.4.2 P2P specific functions and services

In addition to the assumed functions listed in Section 2.4.1, a P2P Device supports the 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 802.11-2012 [1] when operating outside DMG and PBSS operation as defined in IEEE 802.11-REVmc [11] when operating within DMG, and provides additions for a P2P Group operation.
- **P2P Power Management** provides a set of functions to reduce power consumption of P2P Devices that operate outside DMG.
- **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.

* * *

A P2P Group Owner shall respond to Probe Request frames following the rules in IEEE 802.11-2012 [1] for operation outside DMG and the rules in IEEE 802.11-REVmc [11] for operation within DMG, 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 802.11-2012 [1], Clause Section 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.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.2 & 3.2.2

132. For example, the Wi-Fi Direct protocol is not consistent with the 802.11x protocol for aspects of P2P Group Operation, such as when a P2P Group Owner shall respond to Probe Request frames. As shown below, there is an 802.11x protocol rule that applies to STAs, in an infrastructure BSS, receiving Probe Request frames which require those STAs to respond with a probe response when one the following are true: (1) the SSID in the probe request frame is the wildcard SSID; (2) the SSID in the probe request frame is the specific SSID of the STA; or (3) the specific SSID of the STA is included in the SSID List element. However, as can be seen in the below Wi-Fi Direct protocol excerpt, there are different rules for setting this same SSID field of a Probe Request frame that include, for example, the use of a P2P wildcard SSID. Thus, when the

XPS 13 Laptop communicates using the Wi-Fi Direct protocol to, for example, respond to Probe Request frames, it disobeys the analogous 802.11x protocol rule.

10.1.4.3.2 Sending a probe response

STAs, subject to the criteria below, receiving Probe Request frames shall respond with a probe response only if:

a) The Address 1 field in the probe request is the broadcast address or the specific MAC address of the STA, and either item b) or item c) below.

b) The STA is a mesh STA and the Mesh ID in the probe request is the wildcard Mesh ID or the specific Mesh ID of the STA.

c) The STA is not a mesh STA and

1) The SSID in the probe request is the wildcard SSID, the SSID in the probe request is the specific SSID of the STA, or the specific SSID of the STA is included in the SSID List element, and

2) The Address 3 field in the probe request is the wildcard BSSID or the BSSID of the STA.

In an infrastructure BSS or in an IBSS, STAs receiving Probe Request frames shall respond with a probe response when the SSID in the probe request is the wildcard SSID or matches the specific SSID of the STA or when the specific SSID of the STA is included in the SSID List element. Furthermore, a STA with dot11RadioMeasurementActivated true receiving a probe request with a DSSS Parameter Set element containing a Current Channel field value that is not the same as the value of dot11CurrentChannel shall not respond with a probe response. An AP shall respond to all probe requests meeting the above criteria. In an IBSS a STA that transmitted a Beacon frame since the last TBTT shall respond to group addressed Probe Request frames. A STA in an IBSS shall respond to Probe Request frames sent to the individual address of the STA.

Source: IEEE 802.11-2012 Standard, Section 10.1.4.3.2

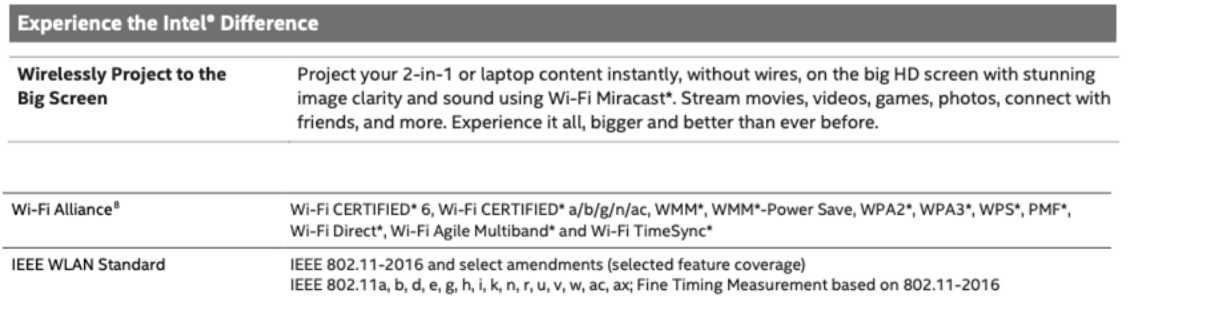
A P2P Group Owner shall respond to Probe Request frames following the rules in IEEE 802.11-2012 [1] for operation outside DMG and the rules in IEEE 802.11-REVmc [11] for operation within DMG, with the following modifications:

— 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 802.11-2012 [1], Clause Section 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,”)

Source: Wi-Fi Direct Standard, v. 1.7, Section 3.2.2

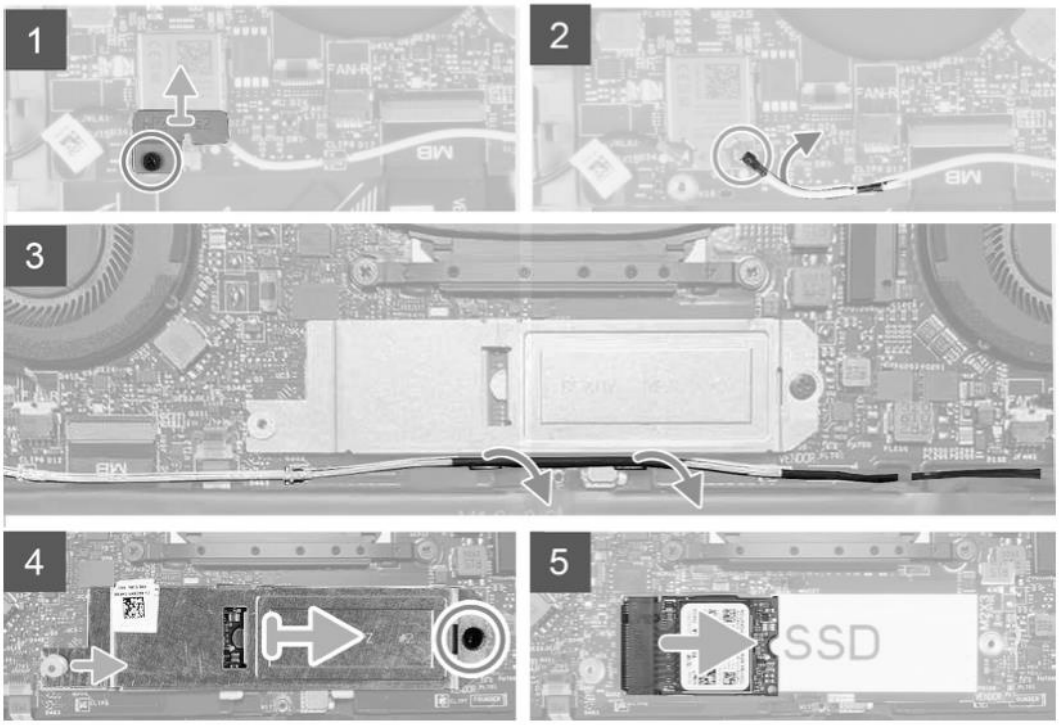
133. In the XPS 13 Laptop, at least some of the communications using the second wireless network protocol (Wi-Fi Direct) impinge on at least some antennae used for communications using the first wireless network protocol (802.11x Wi-Fi). For example, the XPS 13 Laptop contains a wireless radio circuit (Intel Killer AX1650 wireless module) and one or more

associated drivers, which include support for communications using an 802.11x protocol and the Wi-Fi Direct protocol, and which uses the same antennae for both Wi-Fi Direct and 802.11x Wi-Fi communications.



Experience the Intel® Difference	
Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html to embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf



Steps

1. Loosen the captive screw that secures the wireless-card bracket to the system board.
2. Lift the wireless-card bracket off the system board.
3. Using a plastic scribe, disconnect the left antenna cable from the wireless card.
4. Note the routing of the left antenna cable.
5. Starting from the wireless card, remove each antenna cable from the routing guides, toward the respective antennas.

Source: https://dl.dell.com/topicspdf/xps-13-9300-laptop_service-manual_en-us.pdf

134. The processor in the XPS 13 Laptop is configured to implement data forwarding logic, implemented in a network-enabled hub using hardware and/or software, that forwards data between an originating node and a destination node, wherein the originating node is a node in one of the first and second wireless networks and the destination node is a node in the other of the first and second wireless networks. For example, the XPS 13 Laptop (a network-enabled hub) includes Wi-Fi Direct circuitry and drivers, which enable applications that involve forwarding data, including, for example, Miracast (also known as "screen mirroring"). The XPS 13 Laptop forwards data, for example, from a Wi-Fi access point (originating node in the first (802.11x)

wireless network) to a wireless screen or television (destination node in the second (Wi-Fi Direct) wireless network):

Processor

The following table lists the details of the processors supported by your XPS 13 9310.

Table 4. Processor

Description	Option one
Processor type	11th Generation Intel Core i3-1115G4 processor
Processor wattage	15 W
Processor core count	2
Processor thread count	4
Processor speed	Up to 4.10 GHz
Processor cache	6 MB
Integrated graphics	Intel UHD Graphics

Wireless module

The following table lists the Wireless Local Area Network (WLAN) module specifications of your XPS 13 9310.

NOTE: The wireless module is integrated on the system board.

Table 9. Wireless module specifications

Description	Option one
Model number	Intel AX1650
Transfer rate	Up to 2400 Mbps
Frequency bands supported	2.4 GHz/5 GHz
Wireless standards	• WiFi 802.11a/b/g • Wi-Fi 4 (WiFi 802.11n) • Wi-Fi 5 (WiFi 802.11ac) • Wi-Fi 6 (WiFi 802.11ax)
Encryption	• 64-bit/128-bit WEP • AES-CCMP • TKIP
Bluetooth	Bluetooth 5.1

Chipset

The following table lists the details of the chipset supported by your XPS 13 9310.

Table 5. Chipset

Description	Values
Chipset	Integrated in the processor
Processor	11th Generation Intel Core i3/i5/i7
DRAM bus width	128 bit
Flash EPROM	32 MB (BIOS)
PCIe bus	Up to PCIe Gen 4.0 (Storage)

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

Experience the Intel® Difference	
Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.
Operating Systems	Microsoft Windows* 10, Linux*, Chrome OS*
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016
Bluetooth®	Bluetooth® 5.2

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)

Me and My Dell

For Inspiron, G-Series, XPS, and Alienware computers

Display

Displays are classified according to their screen size, resolution, color gamut, and so on. Generally, a screen with higher resolution and better color support provides better image quality. Some external displays also have USB ports, media-card readers, and so on. Displays may also support features such as, touch screen, 3D, and wireless connection.

Wireless display

The wireless display feature enables you to share your computer display with a compatible TV without the use of cables. To check if your TV supports this feature, see the documentation of the TV.

NOTE: Wireless display may not be supported on all computers. For more information, see www.intel.com.

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_reference-guide_en-us.pdf

Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778

Figure 2. Wi-Fi Direct Concurrent Mode

Source: https://arxiv.org/ftp/arxiv/papers/1810/1810.06964.pdf

With ***Miracast on Windows 10,*** you can conveniently mirror the content from your computer to any other display, be it a TV, a projector or a set-top box. The best part of the Miracast is that it does not need your home network to work since it creates its own network.

Source: https://www.technorms.com/68339/miracast-windows-10

135. As set forth above, Dell has directly infringed at least claim 1 of the '814 patent by making, importing, using, offering for sale and/or selling the Hub Accused Products into or in the United States.

136. Dell intentionally designed and incorporated the IEEE 802.11x and the Wi-Fi Direct features and functionalities described above into the Accused Products.

137. Dell provides instructions (in the form of at least user interface prompts and customer support instructional videos) to its customers, advertising, encouraging and directing the customers to use the Accused Products in an infringing manner as described above to implement, as Dell intends, the IEEE 802.11x/Wi-Fi Direct functionality. For further example, Dell provides operating instructions and the like for the Accused Products, including, but not limited to, the citations above and the following:

- https://www.youtube.com/watch?v=kXBwdWp7sFM
- https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778
- https://www.dell.com/support/kbdoc/en-us/000136674/miracast-to-replace-wi-di

- https://www.dell.com/support/kbdoc/en-us/000129880/miracast-users-may-encounter-various-issues-in-the-windows-10-operating-system
- https://www.dell.com/support/kbdoc/en-us/000130716/guide-to-dell-wireless-monitors
- https://www.dell.com/support/kbdoc/en-us/000152972/how-do-i-enable-widi-miracast-on-my-venue-7-3740-or-venue-8-3840?lang=en
- https://www.dell.com/support/kbdoc/en-us/000129818/a-guide-to-miracast-on-the-latitude-13-7350-tablet-pc?lang=en
- https://www.dell.com/support/kbdoc/en-us/000141601/xps-13-9350-touch-cursor-and-sound-may-have-a-lag-when-system-connected-wifi-miracast-and-bluetooth-audio?lang=en
- https://www.dell.com/support/manuals/en-us/latitude-13-7390-laptop/latitude_7290_7390_7490_tgb/wlan-—-miracast-support-matrix?guid=guid-76975785-70c3-4039-b5bb-eb0b83e669b3&lang=en-us
- https://www.dell.com/support/manuals/en-us/inspiron-11-3179-2-in-1-laptop/inspiron_11_3179_setupandspecs/communications?guid=guid-5fea805b-7f8a-420f-b984-b0e93e13048e&lang=en-us
- https://www.dell.com/support/manuals/en-us/alienware-15-laptop/alienware-15-r3-setupandspecifications/communications?guid=guid-935baab6-b4b4-4960-9783-971e87de151c&lang=en-us

138. By its instructions, including those set forth above, and with intent that they use the IEEE 802.11x/Wi-Fi Direct features described above, Dell has induced its customers to infringe the ’814 patent. Dell’s customers who use the Accused Products as described above directly

infringe the ’814 patent. Upon information and belief, as a result of attempts by the inventors to sell or license their patents to the PC industry, of which Dell is a member, Dell has had knowledge of (or has been willfully blind to) the ’814 patent. Further, Dell has had knowledge of (or has been willfully blind to) the ’814 patent since at least September 9, 2020, as a result of a letter from Christian Dubuc, Chief Executive Officer of Ozmo Licensing, to Richard Rothberg, General Counsel for Dell, regarding Ozmo Licensing’s patent portfolio and the Accused Dell Products, informing Dell that it required a license. On September 9, 2020, Ozmo Licensing had only eight patents and patent applications that embodied the inventions of Vleugels and Peeters. In addition, upon information and belief, Dell would have gained knowledge of the ’814 patent by virtue of the litigation filed against HP Inc. (Docket No: 6:21-cv-00383-ADA) and against Acer Inc. (Docket No. 6:21-cv-01225-ADA). Dell also induces such direct infringement by its customers by failing to remove the infringing features from the Accused Products.

139. By its instructions, including those set forth above, as well as by offering for sale, selling, commercially distributing and importing the Accused Products, Dell has also contributed to its customers’ infringement of the ’814 patent. The Accused Products are used by Dell’s customers to practice the inventions claimed in the ’814 patent. The IEEE 802.11x/Wi-Fi Direct features as performed by the Accused Products as described above constitute material parts of the claimed inventions of the ’814 patent. Dell knows or was willfully blind that portions of the hardware and software in the Accused Products were specifically made or adapted by Dell solely to provide such functionality and that such features are not staple articles or commodities of commerce suitable for substantial non-infringing use. Dell also knows or was willfully blind that such combinations of hardware and software have no use other than to provide such functionality

as intentionally designed into the Accused Products by Dell. Dell has had knowledge since, at the latest, September 2020 that its customers were infringing the '814 patent.

140. By the time of trial, Dell will have known and intended that its continued actions would directly infringe, and would induce and contribute to the infringement by its customers of, at least claim 1 of the '814 patent.

141. Ozmo Licensing has been damaged by Dell's past and ongoing direct and indirect infringement of the '814 patent.

142. With knowledge of the allegations set forth herein, Dell continues to incorporate the infringing functionalities in the Accused Products, and has failed to compensate Ozmo Licensing for the use of such features. Dell's unlawful activities described above have continued despite Dell's receipt of the correspondence described above. Dell's infringement will continue unabated unless and until Dell is enjoined or ordered to pay a reasonable royalty for a license to the '814 patent.

COUNT IV
(Dell's Infringement of U.S. Patent No. 11,012,934)

143. Paragraphs 1-142 are incorporated by reference as if fully set forth herein.

144. The invention of the '934 patent represented a technical solution to an unsolved technological problem. The written description of the '934 patent describes in technical detail each of the limitations of the claims, allowing a person of ordinary skill in the art to understand what the limitations cover and how the combination of claim elements differed markedly from and improved upon what may have been considered conventional or generic. For example, the specification and incorporated references detail the inventors' novel approach to seamlessly integrating a WPAN into a WLAN infrastructure.

145. The elements claimed by the ’934 patent, taken alone or in combination, were not well-understood, routine or conventional to one of ordinary skill in the art at the time of the invention. Rather, the ’934 patent claims and teaches, *inter alia*, an improved wireless device for connecting to or coordinating a WPAN, and for coordinating usage of a wireless medium where a WPAN is integrated into a WLAN infrastructure. The invention improved upon existing wireless communications, which were unable to integrate a WPAN into a common wireless space with a WLAN infrastructure without suffering from one or more of the aforementioned problems, by allowing the wireless device to associate with another wireless device over a wireless connection using a WPAN protocol, wherein the WPAN protocol is an overlay protocol with respect to a WLAN protocol, and such that communications using the WPAN protocol are partially compliant with respect to the WLAN protocol.

146. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN is also more cost effective, since communications using the second network WPAN protocol impinge on at least some of the antennae used for communications using a WLAN protocol.

147. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN allows the two to operate in the same frequency spectrum without causing excessive interference with each other.

148. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN is also more energy efficient, which can extend the battery life of WPAN devices that are battery powered or otherwise enable power-hungry WPAN devices to enter power-save modes more readily.

149. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN is also more seamless, insofar as it facilitates association and synchronization across multiple devices, without the need to repeatedly engage in the time- and power-consuming processes of re-associating and re-resynchronizing the devices.

150. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN also enables lower latency communication involving WPAN devices, which enables a device serving as a hub between a WPAN and a WLAN to more effectively forward video streams between the two.

151. Participants in the communications industry chose to incorporate a subset of the claimed apparatus into the Wi-Fi Direct Standard to enjoy at least some of their aforementioned advantages.

152. Dell has infringed, and continues to infringe, the ’934 patent by making, importing, using, offering for sale and selling in the United States numerous wireless devices, including laptop computers, desktop computers, tablets, and wireless monitors that implement the Wi-Fi Direct protocol (i.e., the “Accused Products”).

153. Examples of the Accused Products are Dell’s laptop computers (including, but not limited to, XPS Laptops, Inspiron Laptops, Alienware Gaming Laptops, Vostro Laptops, and Latitude Laptops); desktop computers (including, but not limited to, XPS Desktops, Inspiron Desktops, Alienware Gaming Desktops, OptiPlex Desktops, Vostro Desktops, and New Precision Workstations); tablets (including, but not limited to, Latitude 2-in-1 devices and Latitude Rugged Extreme tablets); monitors (including, but not limited to, Dell Wireless Monitors), and all other Dell products that include Wi-Fi Direct circuitry and drivers.

154. Claim 4 of the ’934 patent is reproduced below:

4. A first wireless device for connecting to a wireless personal area network (WPAN), comprising:

a wireless radio circuit configured to communicate over a wireless medium of a wireless local area network (WLAN) using a WLAN protocol;

a memory; and

at least one processor coupled to the wireless radio circuit and the memory, the at least one processor configured to:

discover, via the wireless radio circuit, a second wireless device using a WPAN protocol;

establish an association and synchronization, via the wireless radio circuit, with the second wireless device to establish a wireless connection, the wireless connection using the WPAN protocol, wherein upon establishing such association and synchronization, the first wireless device is configured to become a member of the WPAN;

maintain, via the wireless radio circuit, such association and the synchronization with the second wireless device over the wireless connection using the WPAN protocol; and

participate in a coordination of usage of the wireless medium by the wireless connection using the WPAN protocol;

wherein the WPAN protocol is an overlay protocol that is partially compliant with respect to the WLAN protocol such that said usage occurs without interference from the WLAN, and such that the WPAN protocol uses a WLAN protocol frame adapted to support a WPAN power-saving protocol that is different as compared to a power-saving protocol supported by the WLAN protocol;

wherein the wireless radio circuit is configured to operate in at least one of a 2.4 GHz or 5 GHz frequency band;

wherein the WLAN protocol is an 802.11x protocol that uses a frame defined by the 802.11x protocol, and the WPAN protocol uses a WPAN-adapted frame in which at least one field of the frame defined by the 802.11x protocol is adapted to support the WPAN power-saving protocol;

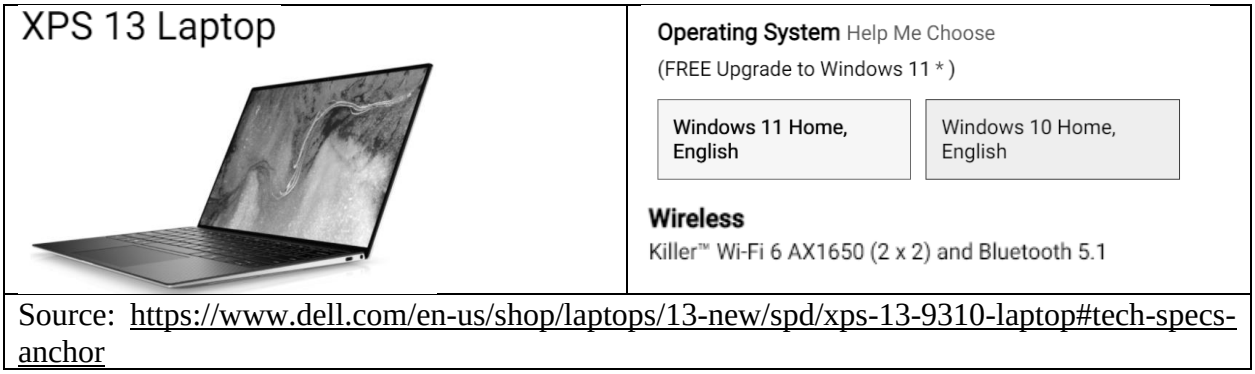
wherein the WPAN-adapted frame is adapted from a WLAN protocol management frame;

wherein the WPAN protocol provides for an inactivity time during which the first and second wireless devices can agree to at least partially disable the wireless connection;

wherein the WPAN protocol provides for the first wireless device and the second wireless device to agree on the inactivity time; and,

wherein the WPAN protocol provides for the first wireless device to disable at least a part of said coordination following a start of the inactivity time.

155. The Accused Products that infringe the ’934 patent include, *inter alia*, a first wireless device for connecting to a wireless personal area network (WPAN). For example, the Dell XPS 13 9310 Laptop (“XPS 13 Laptop”) is an Accused Product comprising a first wireless device that implements the Wi-Fi Direct standard to connect to a WPAN. The XPS 13 Laptop infringes the ’934 patent because it comprises Wi-Fi Direct circuitry and drivers, and applications, such as Miracast, that enable the XPS 13 Laptop to connect to and/or coordinate a WPAN:



Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

TX/RX Streams	2x2
Bands	2.4Ghz, 5Ghz (160Mhz)
Max Speed	2.4Gbps
Wi-Fi CERTIFIED*	WiFi 6 (802.11ax)

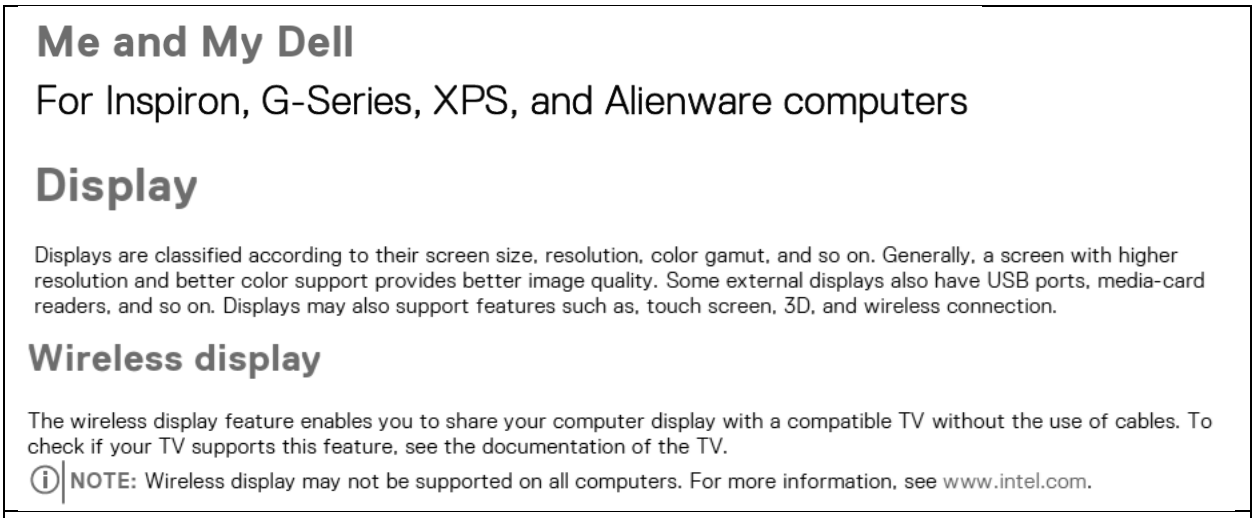
Experience the Intel® Difference

Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.

GENERAL

Dimensions (H x W x D)	M.2 2230: 22mm x 30mm x 2.4mm [1.5mm Max (Top Side)/ 0.1mm Max (Bottom Side)] M.2 1216: 12mm x 16mm x 1.67 (+-0.08) mm
Weight	M.2 2230: 2.83 +/– 0.3 g M.2 1216: 0.67 +/– 0.1 g
Radio ON/OFF Control	Supported
Connector Interface	M.2: PCIe*, USB
Operating Temperature (Adapter Shield)	0°C to +80°C
Humidity Non-Operating	50% to 90% RH non-condensing (at temperatures of 25°C to 35°C)
Operating Systems	Microsoft Windows* 10, Linux*, Chrome OS*
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016
Bluetooth®	Bluetooth® 5.2

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)



Me and My Dell

For Inspiron, G-Series, XPS, and Alienware computers

Display

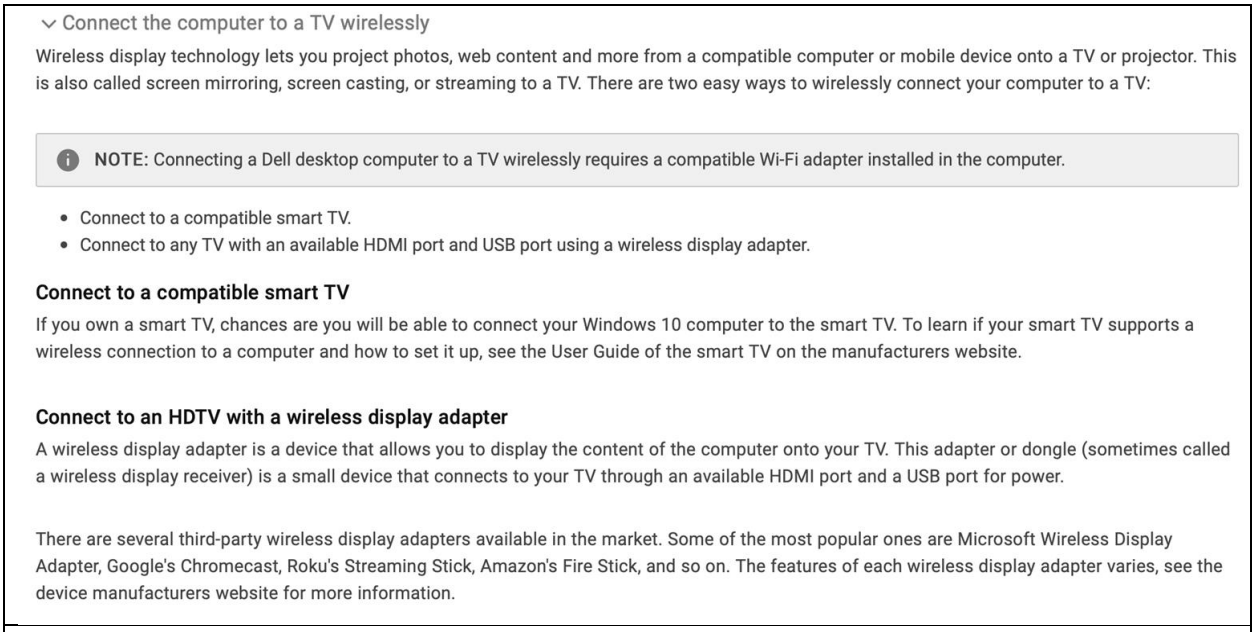
Displays are classified according to their screen size, resolution, color gamut, and so on. Generally, a screen with higher resolution and better color support provides better image quality. Some external displays also have USB ports, media-card readers, and so on. Displays may also support features such as, touch screen, 3D, and wireless connection.

Wireless display

The wireless display feature enables you to share your computer display with a compatible TV without the use of cables. To check if your TV supports this feature, see the documentation of the TV.

NOTE: Wireless display may not be supported on all computers. For more information, see www.intel.com.

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_reference-guide_en-us.pdf



Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Connect to a compatible smart TV

If you own a smart TV, chances are you will be able to connect your Windows 10 computer to the smart TV. To learn if your smart TV supports a wireless connection to a computer and how to set it up, see the User Guide of the smart TV on the manufacturers website.

Connect to an HDTV with a wireless display adapter

A wireless display adapter is a device that allows you to display the content of the computer onto your TV. This adapter or dongle (sometimes called a wireless display receiver) is a small device that connects to your TV through an available HDMI port and a USB port for power.

There are several third-party wireless display adapters available in the market. Some of the most popular ones are Microsoft Wireless Display Adapter, Google's Chromecast, Roku's Streaming Stick, Amazon's Fire Stick, and so on. The features of each wireless display adapter varies, see the device manufacturers website for more information.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778

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.

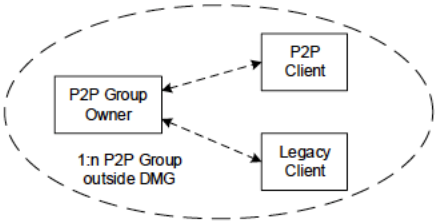


Figure 1—P2P components and topology when operating outside DMG

Source: Wi-Fi Direct Standard, v. 1.7, Section 2.1, Fig. 1

156. The Accused Products are first wireless devices comprising a wireless radio circuit configured to communicate over a wireless medium of a wireless local area network (WLAN) using a WLAN protocol. For example, the XPS 13 Laptop (first wireless device) includes the Intel Killer AX1650 wireless module (wireless radio circuit configured to communicate over a wireless medium), which is a wireless radio circuit with 802.11x capabilities (802.11x WLAN protocol), as seen below:

XPS 13 Laptop

Operating System Help Me Choose

(FREE Upgrade to Windows 11 *)

Windows 11 Home, English | Windows 10 Home, English

Wireless

Killer™ Wi-Fi 6 AX1650 (2 x 2) and Bluetooth 5.1

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Wireless module

The following table lists the Wireless Local Area Network (WLAN) module specifications of your XPS 13 9310.

NOTE: The wireless module is integrated on the system board.

Table 9. Wireless module specifications

Description	Option one
Model number	Intel AX1650
Transfer rate	Up to 2400 Mbps
Frequency bands supported	2.4 GHz/5 GHz
Wireless standards	• WiFi 802.11a/b/g • Wi-Fi 4 (WiFi 802.11n) • Wi-Fi 5 (WiFi 802.11ac) • Wi-Fi 6 (WiFi 802.11ax)
Encryption	• 64-bit/128-bit WEP • AES-CCMP • TKIP
Bluetooth	Bluetooth 5.1

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

TX/RX Streams	2x2
Bands	2.4Ghz, 5Ghz (160Mhz)
Max Speed	2.4Gbps
Wi-Fi CERTIFIED*	WiFi 6 (802.11ax)

Experience the Intel® Difference

Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.

GENERAL

Dimensions (H x W x D)	M.2 2230: 22mm x 30mm x 2.4mm [1.5mm Max (Top Side)/ 0.1mm Max (Bottom Side)] M.2 1216: 12mm x 16mm x 1.67 (+-0.08) mm
Weight	M.2 2230: 2.83 +/– 0.3 g M.2 1216: 0.67 +/– 0.1 g
Radio ON/OFF Control	Supported
Connector Interface	M.2: PCIe*, USB
Operating Temperature (Adapter Shield)	0°C to +80°C
Humidity Non-Operating	50% to 90% RH non-condensing (at temperatures of 25°C to 35°C)
Operating Systems	Microsoft Windows* 10, Linux*, Chrome OS*
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016
Bluetooth®	Bluetooth® 5.2

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)

157. The Accused Products are first wireless devices comprising a memory. For example, the XPS 13 Laptop includes system memory as seen below:

XPS 13 Laptop

Memory ⓘ

8GB 4267MHz LPDDR4x Memory Onboard

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Memory

The following table lists the memory specifications of your XPS 13 9310.

Table 6. Memory specifications

Description	Values
Memory slots	No memory slots ⓘ NOTE: The memory module is integrated on the system board.
Memory type	LPDDR4x
Memory speed	4267 MHz
Maximum memory configuration	32 GB
Minimum memory configuration	8 GB
Memory configurations supported	• 8 GB (4 x 2 GB) LPDDR4x at 4267 MHz • 16 GB (4 x 4 GB) LPDDR4x at 4267 MHz • 32 GB (4 x 8 GB) LPDDR4x at 4267 MHz

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

158. The Accused Products are first wireless devices comprising at least one processor coupled to the wireless radio circuit and the memory. For example, the XPS 13 Laptop includes the Intel Core i3-1115G4 system processor coupled to wireless radio circuit and the memory, as seen below:

XPS 13 Laptop

Tech Specs

Processor
11th Generation Intel® Core™ i3-1115G4 Processor (6MB Cache, up to 4.1 GHz)

Operating System
(FREE Upgrade to Windows 11)
Windows 11 Home, English

Graphics Card ⓘ
Intel® UHD Graphics with shared graphics memory

Display
13.4" UHD+ (3840 x 2400) InfinityEdge Touch Anti-Reflective 500-Nit Display

Memory ⓘ
8GB 4267MHz LPDDR4x Memory Onboard

Hard Drive
256GB M.2 PCIe NVMe Solid State Drive

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Processor

The following table lists the details of the processors supported by your XPS 13 9310.

Table 4. Processor

Description	Option one
Processor type	11th Generation Intel Core i3-1115G4 processor
Processor wattage	15 W
Processor core count	2
Processor thread count	4
Processor speed	Up to 4.10 GHz
Processor cache	6 MB
Integrated graphics	Intel UHD Graphics

Wireless module

The following table lists the Wireless Local Area Network (WLAN) module specifications of your XPS 13 9310.

NOTE: The wireless module is integrated on the system board.

Table 9. Wireless module specifications

Description	Option one
Model number	Intel AX1650
Transfer rate	Up to 2400 Mbps
Frequency bands supported	2.4 GHz/5 GHz
Wireless standards	• WiFi 802.11a/b/g • Wi-Fi 4 (WiFi 802.11n) • Wi-Fi 5 (WiFi 802.11ac) • Wi-Fi 6 (WiFi 802.11ax)
Encryption	• 64-bit/128-bit WEP • AES-CCMP • TKIP
Bluetooth	Bluetooth 5.1

Chipset

The following table lists the details of the chipset supported by your XPS 13 9310.

Table 5. Chipset

Description	Values
Chipset	Integrated in the processor
Processor	11th Generation Intel Core i3/i5/i7
DRAM bus width	128 bit
Flash EPROM	32 MB (BIOS)
PCIe bus	Up to PCIe Gen 4.0 (Storage)

Memory

The following table lists the memory specifications of your XPS 13 9310.

Table 6. Memory specifications

Description	Values
Memory slots	No memory slots NOTE: The memory module is integrated on the system board.
Memory type	LPDDR4x
Memory speed	4267 MHz
Maximum memory configuration	32 GB
Minimum memory configuration	8 GB
Memory configurations supported	• 8 GB (4 x 2 GB) LPDDR4x at 4267 MHz • 16 GB (4 x 4 GB) LPDDR4x at 4267 MHz • 32 GB (4 x 8 GB) LPDDR4x at 4267 MHz

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

159. The Accused Products are first wireless devices comprising at least one processor configured to discover, via the wireless radio circuit, a second wireless device using a WPAN

protocol. For example, the XPS 13 Laptop (a first wireless device) includes the Intel Core i3-1115G4 system processor configured to support the Wi-Fi Direct protocol (as shown above) by, for example, discovering a second wireless device, such as a wireless monitor or other peripheral (including, but not limited to, other Accused Products), using Wi-Fi Direct (a WPAN protocol):

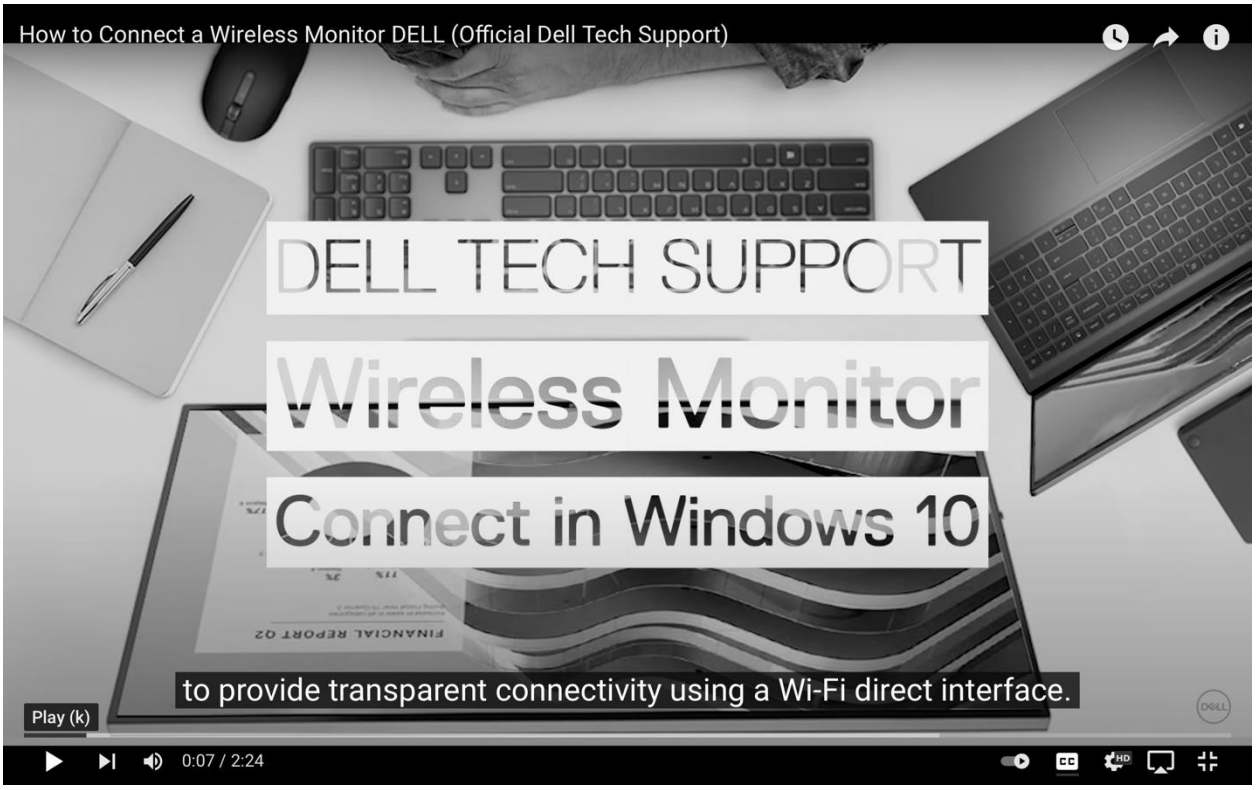
Standards-based Miracast advances life without wires

Miracast is an industry-wide solution, allowing technology to work across device types and vendors. Connections are easy to set up and use since Miracast devices choose the appropriate settings automatically. Miracast can connect two devices using network infrastructure or **Wi-Fi Direct®**. When content to be shared is stored on a Miracast-certified device, such as a smartphone to an automobile infotainment display, a Wi-Fi network connection is not required.

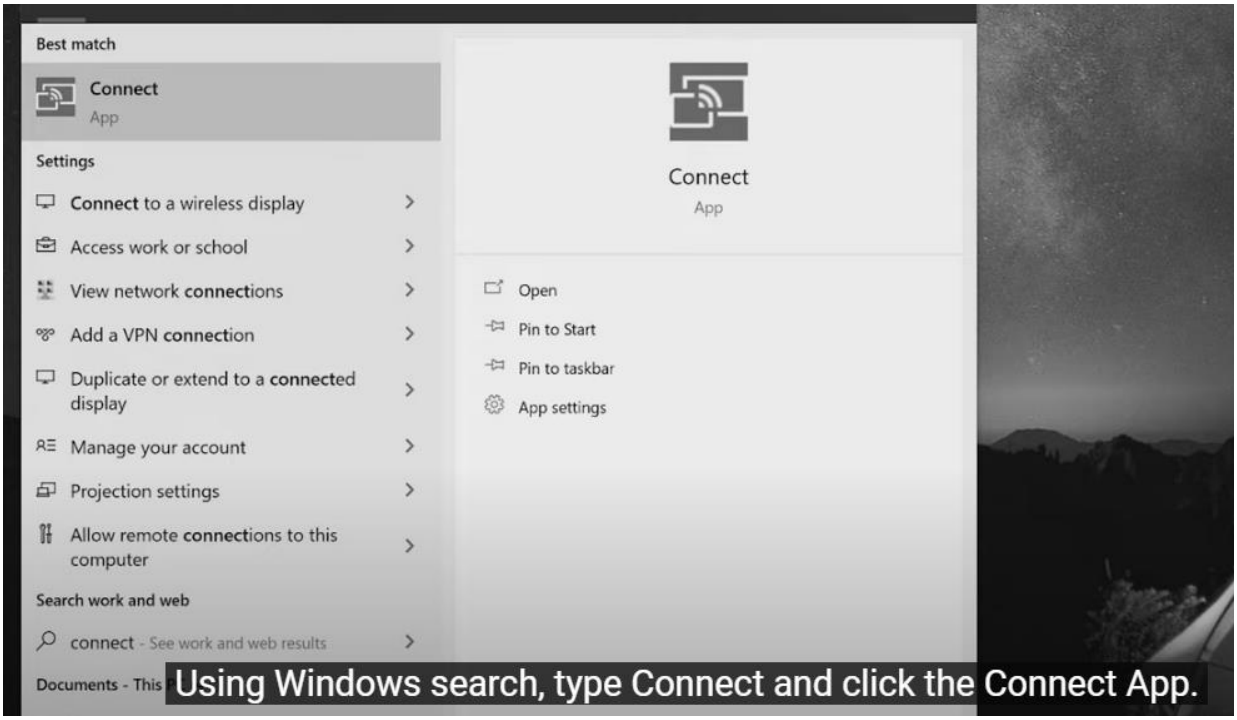
Only devices marked Wi-Fi CERTIFIED Miracast have been certified by Wi-Fi Alliance® to work well with other Wi-Fi CERTIFIED™ devices, employ the latest security protections, and deliver a high-quality user experience.

Source: https://www.wi-fi.org/discover-wi-fi/miracast

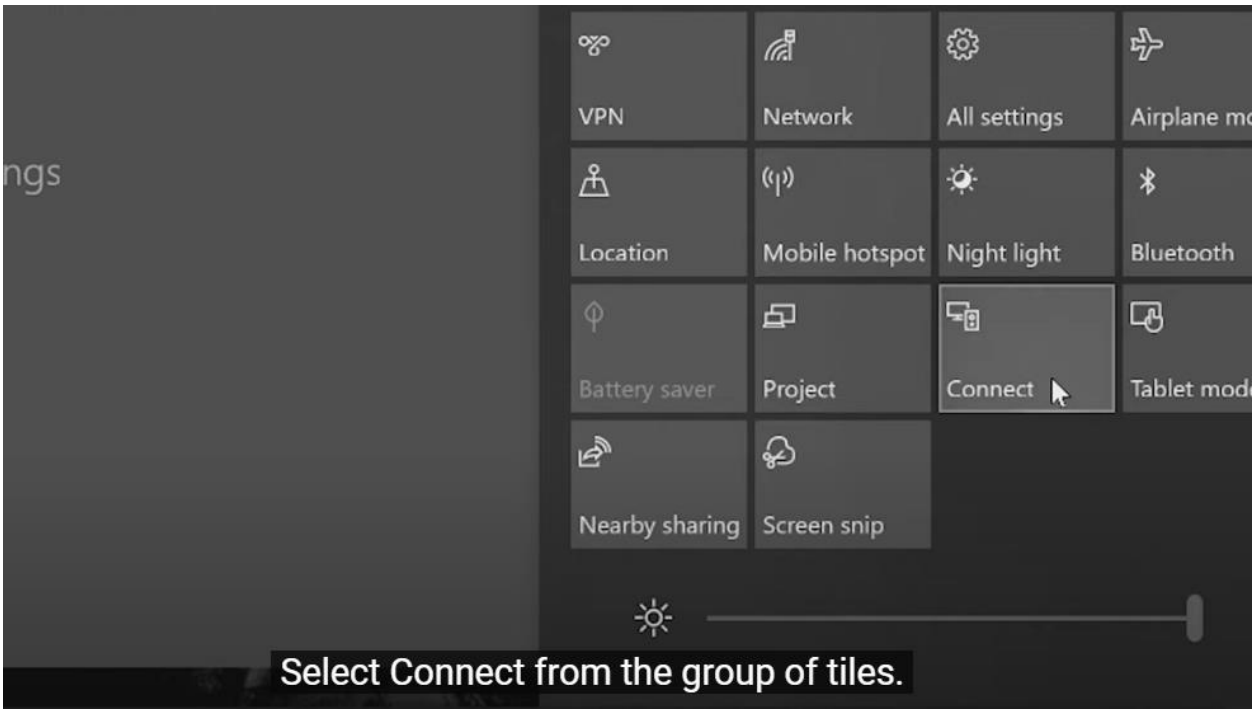

How to Connect a Wireless Monitor DELL (Official Dell Tech Support)
DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
Dell PCs and wireless monitors use Windows and Miracast technology
0:04 / 2:24

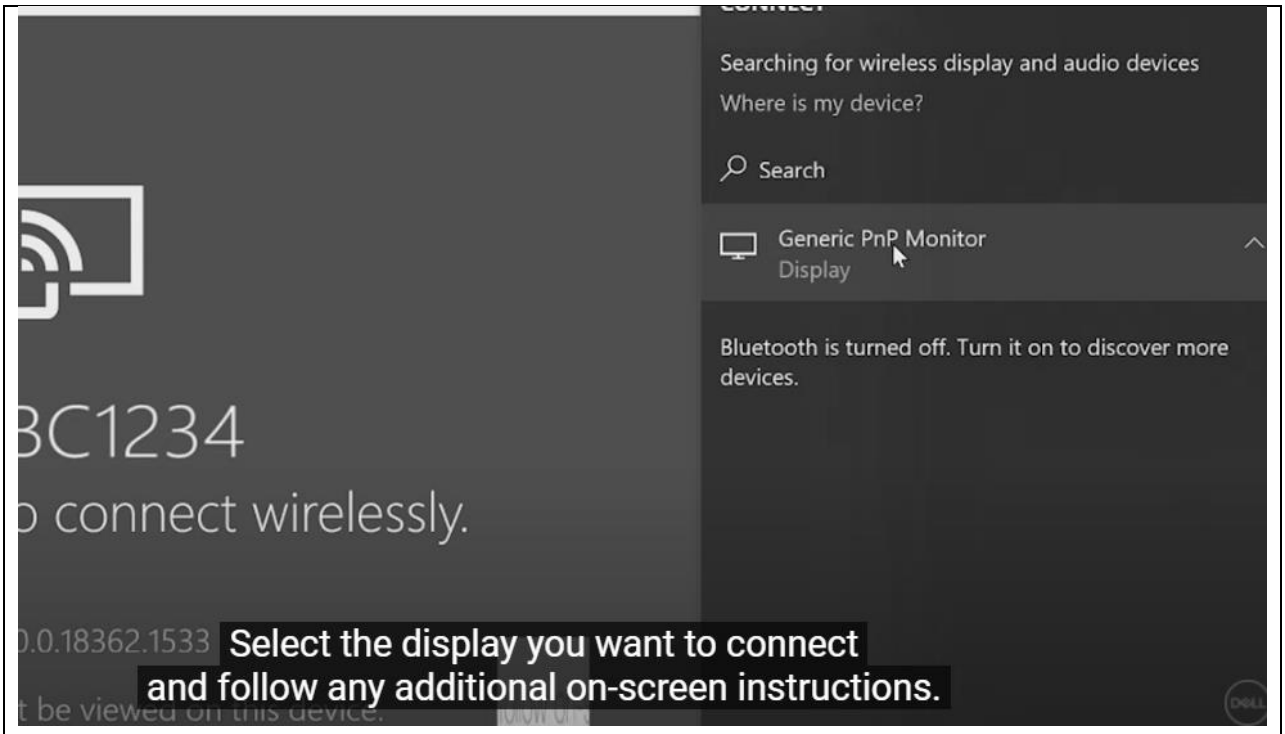

How to Connect a Wireless Monitor DELL (Official Dell Tech Support)
DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
to provide transparent connectivity using a Wi-Fi direct interface.
Play (k)
0:07 / 2:24


DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
In this video, we show you how to connect
your Miracast display to your Windows 10 device.


Best match
Connect
App
Settings
Connect to a wireless display
Access work or school
View network connections
Add a VPN connection
Duplicate or extend to a connected display
Manage your account
Projection settings
Allow remote connections to this computer
Search work and web
connect - See work and web results
Connect
App
Open
Pin to Start
Pin to taskbar
App settings
Using Windows search, type Connect and click the Connect App.


W10ABC1234
is ready for you to connect wirelessly.
Version: 10.0.18362.1533
Protected content can't be viewed on this device.
Press Ctrl + S to open Settings
Connect will open indicating that your Windows 10 Dell PC supports Miracast


VPN
Network
All settings
Airplane mo
Location
Mobile hotspot
Night light
Bluetooth
Battery saver
Project
Connect
Tablet mod
Nearby sharing
Screen snip
Select Connect from the group of tiles.



Source: https://www.youtube.com/watch?v=kXBwdWp7sFM ("How to Connect a Wireless Monitor DELL (Official Dell Tech Support)"

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.

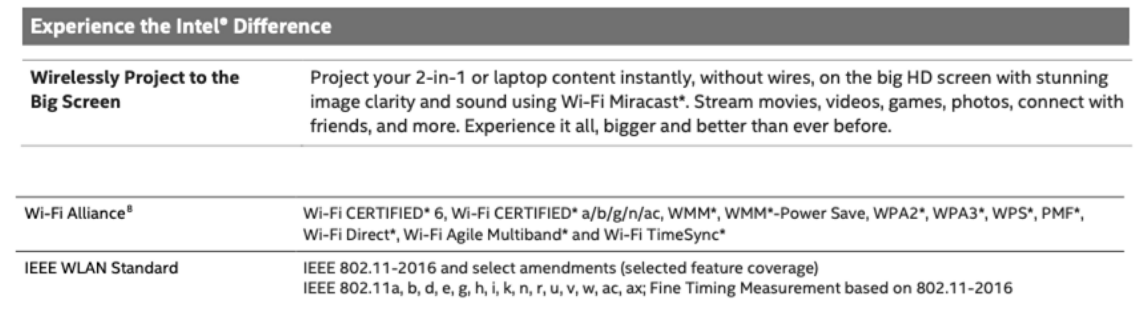
3.1.2.2 P2P Device discovering a P2P Device that is in a P2P Group

A searching P2P Device discovers a P2P Group Owner in the Scan Phase through received Beacon, DMG Beacon, SSW, or Probe Response frames. The searching P2P Device will also discover other P2P Devices that are associated to that P2P Group Owner from Group Information Advertisement (see Section 3.2.4) or, when operating within DMG, through a STA Availability element or Information Response frame (see Section 11.30.1 of IEEE 802.11-REVmc [11]).

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.1.1 & 3.1.2.2

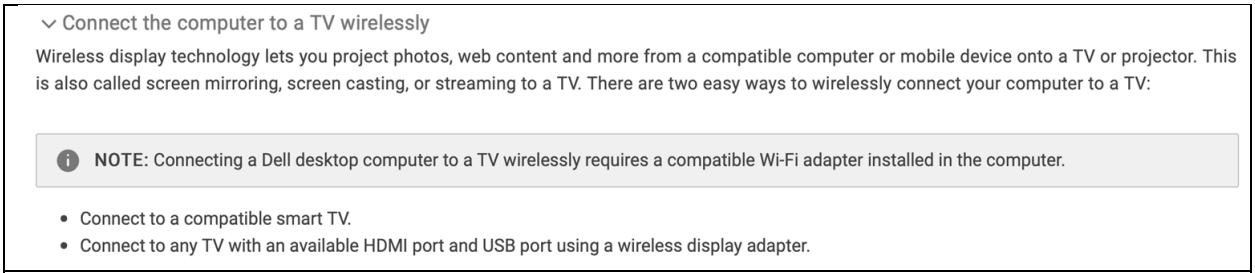
160. The Accused Products are first wireless devices comprising at least one processor configured to establish an association and synchronization, via the wireless radio circuit, with the

second wireless device to establish a wireless connection, the wireless connection using the WPAN protocol, wherein, upon establishing such association and synchronization, the first wireless device is configured to become a member of the WPAN. For example, the XPS 13 Laptop (a first wireless device) includes the Intel Core i3-1115G4 system processor (a processor) configured to support the Wi-Fi Direct protocol (as shown above) by, for example, establishing a Wi-Fi Direct connection (a wireless connection using a WPAN protocol) with a second wireless device, such as a wireless monitor or other peripheral (including, but not limited to, other Accused Products), wherein, upon establishing such association and synchronization, the XPS 13 Laptop is configured to become a member of the Wi-Fi Direct network (the WPAN network):



Experience the Intel® Difference	
Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html to embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf



Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

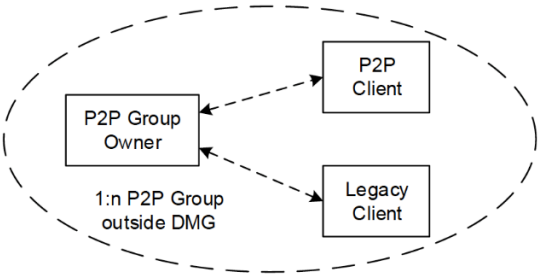
NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778

3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.



3.2.2 Starting and maintaining a P2P Group session

The P2P Group Owner may be determined through the Group Formation Procedure described in Section 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.

3.2.3 Connecting to a P2P Group

The P2P Client acquires the Group Credentials through static configuration or through Wi-Fi Simple Configuration [2]. When using Wi-Fi Simple Configuration [2], the P2P Group Owner shall serve as the WSC Registrar and the P2P Client shall serve as the WSC Enrollee. In order to connect to a P2P Group, the P2P Client operating outside DMG, using the Credentials, shall engage in the authentication procedure in Section 10.3.4.2 of IEEE 802.11-2012 [1] and the association procedure in Section 10.3.5.2 of IEEE 802.11-2012 [1] with the P2P Group Owner. In order to connect to a P2P Group, the P2P Client operating within DMG, using the Credentials, shall engage in the association procedure in Section 11.3.5.2 of IEEE 802.11-REVmc [11] with the P2P Group Owner.

When a P2P Client associates with a P2P Group Owner, it provides its Device Name, Primary Device Type, and optionally Secondary Device Type List information to the P2P Group Owner by including the P2P Device Info attribute (see Section 4.1.15) and the P2P Capability attribute (see Section 4.1.4) in the P2P IE in the Association Request frame. This information shall be used by the

Source: Wi-Fi Direct Standard, v. 1.7, Figure 1, Sections 3.2, 3.2.2 & 3.2.3

10.1 Synchronization

10.1.2.1 TSF for infrastructure networks

In an infrastructure BSS, the AP shall be the timing master for the TSF. The AP shall initialize its TSF timer independently of any simultaneously started APs in an effort to minimize the synchronization of the TSF timers of multiple APs. The AP shall periodically transmit special frames called *Beacon frames* that contain the value of its TSF timer in order to synchronize the TSF timers of other STAs in a BSS. A receiving STA shall accept the timing information in Beacon frames sent from the AP servicing its BSS. If a STA's TSF timer is different from the timestamp in the received Beacon frame, the receiving STA shall set its local TSF timer to the received timestamp value.

10.1.3 Maintaining synchronization

10.1.3.1 General

Each STA shall maintain a TSF timer with modulus 2^{64} counting in increments of microseconds. STAs expect to receive Beacon frames at a nominal rate. The interval between Beacon frames is defined by the dot11BeaconPeriod parameter of the STA. A STA sending a Beacon frame shall set the value of the Beacon frame's timestamp so that it equals the value of the STA's TSF timer at the time that the data symbol containing the first bit of the timestamp is transmitted to the PHY plus the transmitting STA's delays through its local PHY from the MAC-PHY interface to its interface with the WM [e.g., antenna, light-emitting diode (LED) emission surface].

Source: IEEE 802.11-2012, Sections 10.1.2.1, 10.1.3.1 and 10.3.5.2

Source: https://www.youtube.com/watch?v=kXBwdWp7sFM ("How to Connect a Wireless Monitor DELL (Official Dell Tech Support)"

161. The Accused Products are first wireless devices comprising at least one processor configured to maintain, via the wireless radio circuit, such association and synchronization with the second wireless device over the wireless connection using the WPAN protocol. For example, the XPS 13 Laptop (a first wireless device) includes the Intel Core i3-1115G4 system processor (a processor) configured to support the Wi-Fi Direct protocol (as shown above) by, for example, maintaining the association and synchronization with the second wireless device, such as a wireless monitor or other peripheral (including, but not limited to, other Accused Products), in providing connections compliant with the Wi-Fi Direct Standard (a WPAN protocol):

3.2.2 Starting and maintaining a P2P Group session

The P2P Group Owner may be determined through the Group Formation Procedure described in Section 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.

3.2.3 Connecting to a P2P Group

The P2P Client acquires the Group Credentials through static configuration or through Wi-Fi Simple Configuration [2]. When using Wi-Fi Simple Configuration [2], the P2P Group Owner shall serve as the WSC Registrar and the P2P Client shall serve as the WSC Enrollee. In order to connect to a P2P Group, the P2P Client operating outside DMG, using the Credentials, shall engage in the authentication procedure in Section 10.3.4.2 of IEEE 802.11-2012 [1] and the association procedure in Section 10.3.5.2 of IEEE 802.11-2012 [1] with the P2P Group Owner. In order to connect to a P2P Group, the P2P Client operating within DMG, using the Credentials, shall engage in the association procedure in Section 11.3.5.2 of IEEE 802.11-REVmc [11] with the P2P Group Owner.

When a P2P Client associates with a P2P Group Owner, it provides its Device Name, Primary Device Type, and optionally Secondary Device Type List information to the P2P Group Owner by including the P2P Device Info attribute (see Section 4.1.15) and the P2P Capability attribute (see Section 4.1.4) in the P2P IE in the Association Request frame. This information shall be used by the

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.2.2 & 3.2.3

Source: https://www.youtube.com/watch?v=kXBwdWp7sFM ("How to Connect a Wireless Monitor DELL (Official Dell Tech Support)"

162. The Accused Products are first wireless devices comprising at least one processor configured to participate in a coordination of usage of the wireless medium by the wireless connection using the WPAN protocol. For example, the XPS 13 Laptop (a first wireless device) includes the Intel Core i3-1115G4 system process (a processor) configured to support the Wi-Fi Direct protocol (as shown above) by, for example, participating in a coordination of usage of the wireless medium by the wireless connection using Wi-Fi Direct (a WPAN protocol):

2.4 Functions and services

2.4.1 Basic functions and services

For P2P operation outside the DMG, this specification assumes that the following STA functions and services are implemented in P2P Devices:

- IEEE 802.11g or newer 2.4 GHz PHY [1]
- IEEE 802.11i (AES-CCMP) [1]
- Wi-Fi Simple Configuration [2]
- Wi-Fi Multimedia [3]

3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.1 and 3.2

9.2 MAC architecture

9.2.1 General

A representation of the MAC architecture is shown in Figure 9-1 in which the PCF and HCF services are provided using the services of the DCF. Note that in a non-QoS STA, HCF is not present. In a QoS STA implementation, both DCF and HCF are present. PCF is optional in all STAs.

Due to the distributed nature of the MBSS, only the MCF is present in a mesh STA.

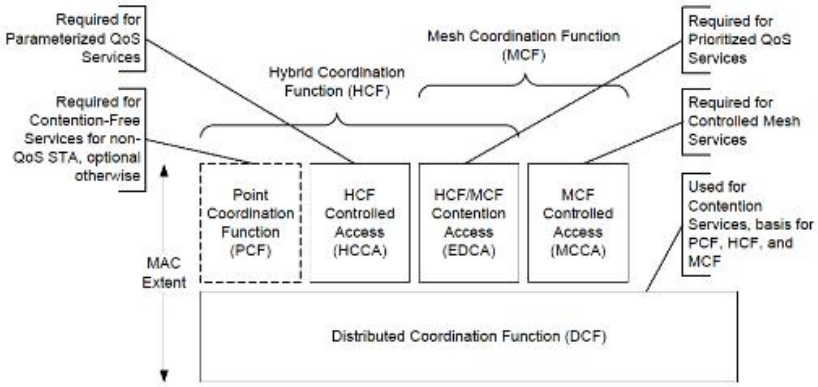


Figure 9-1—MAC architecture

9.2.2 DCF

The fundamental access method of the IEEE 802.11 MAC is a DCF known as *carrier sense multiple access with collision avoidance* (CSMA/CA). The DCF shall be implemented in all STAs.

9.3 DCF

9.3.1 General

The basic medium access protocol is a DCF that allows for automatic medium sharing between compatible PHYs through the use of CSMA/CA and a random backoff time following a busy medium condition. In addition, all individually addressed traffic uses immediate positive acknowledgment (ACK frame) where retransmission is scheduled by the sender if no ACK is received.

The CSMA/CA protocol is designed to reduce the collision probability between multiple STAs accessing a medium, at the point where collisions would most likely occur. Just after the medium becomes idle following a busy medium (as indicated by the CS function) is when the highest probability of a collision exists. This is because multiple STAs could have been waiting for the medium to become available again. This is the situation that necessitates a random backoff procedure to resolve medium contention conflicts.

Source: IEEE 802.11-2012, Sections 9.2.1, 9.2.2 & 9.3.1

163. In the Accused Products, the WPAN protocol (Wi-Fi Direct) is an overlay protocol with respect to the WLAN protocol (802.11x Wi-Fi). For example, Wi-Fi Direct frames are based on 802.11x frames and use the vendor specific field of an 802.11x management frame. The Wi-Fi Direct protocol processes the data in the vendor-specific field that is overlaid on a Wi-Fi management frame.

2.4.1 Basic functions and services

For P2P operation outside the DMG, this specification assumes that the following STA functions and services are implemented in P2P Devices:

- IEEE 802.11g or newer 2.4 GHz PHY [1]
- IEEE 802.11i (AES-CCMP) [1]
- Wi-Fi Simple Configuration [2]
- Wi-Fi Multimedia [3]

Any required 'AP-like' functions and services required for P2P Group Owner operation outside DMG are described within this specification. A P2P Group Owner operating within DMG is required to support PCP functions and services.

3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.

* * *

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 802.11-2012 [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.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.1, 3.2 & 4

8.3.3 Management frames

8.3.3.1 Format of management frames

The format of a management frame is defined in Figure 8-34. The Frame Control, Duration, Address 1, Address 2, Address 3, and Sequence Control fields are present in all management frame subtypes. The maximum unencrypted MMPDU size, excluding the MAC header and FCS, is 2304 octets.

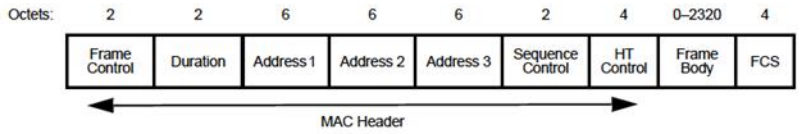


Figure 8-34—Management frame format

The HT Control field is defined in 8.2.4.6. The presence of the HT Control field is determined by the Order subfield of the Frame Control field, as specified in 8.2.4.1.10.

The frame body consists of the fields followed by the elements defined for each management frame subtype. All fields and elements are mandatory unless stated otherwise and appear in the specified, relative order. STAs that encounter an element ID they do not recognize in the frame body of a received management frame ignore that element and continue to parse the remainder of the management frame body (if any) for additional elements with recognizable element IDs. See 9.24.7. Unused element ID codes are reserved.

Gaps may exist in the ordering of fields and elements within frames. The order that remains is ascending.

8.4 Management frame body components

8.4.1 Fields that are not information elements

8.4.2 Information elements

8.4.2.1 General

Elements are defined to have a common general format consisting of a 1 octet Element ID field, a 1 octet Length field, and a variable-length element-specific Information field. Each element is assigned a unique Element ID as defined in this standard. The Length field specifies the number of octets in the Information field. See Figure 8-81.

	Element ID	Length	Information
Octets:	1	1	variable

Figure 8-81—Element format

The set of valid elements is defined in Table 8-54.

Table 8-54—Element IDs

Element	Element ID	Length of indicated element (in octets)	Extensible
SSID (see 8.4.2.2)	0	2 to 34	
Supported rates (see 8.4.2.3)	1	3 to 10	

Table 8-54—Element IDs *(continued)*

Element	Element ID	Length of indicated element (in octets)	Extensible
U-APSD Coexistence (see 8.4.2.93)	142	14 to 257	Subelements
Reserved	143–173		
MCCAOP Advertisement Overview (see 8.4.2.110)	174	8	Yes
Reserved	175–220		
Vendor Specific (see 8.4.2.28)	221	3 to 257	
Reserved	222–255		

8.5.6 Vendor-specific action details

The Vendor Specific Action frame is defined for vendor-specific signaling. The format of the Action field of the Vendor Specific Action frame is shown in Figure 8-437. An Organization Identifier, in the octet field immediately after the Category field, differentiates the vendors (see 8.4.1.31).

NOTE—If management frame protection is negotiated, then Vendor Specific Protected Action frames (see Table 8-38) are protected; otherwise they are unprotected.

	Category	Organization Identifier	Vendor Specific Content
Octets:	1	*j*	Variable

Figure 8-437—Vendor Specific Action frame Action field format

The Category field is set to the value indicating the vendor-specific category, as specified in Table 8-38.

The Organization Identifier contains a public organizationally unique identifier assigned by the IEEE and is specified in 8.4.1.31. The order of the Organization Identifier field is described in 8.2.2.

The Vendor Specific Content contains vendor-specific field(s). The length of the Vendor Specific Content in a Vendor Specific Action frame is limited by the maximum allowed MMPDU size.

Source: IEEE 802.11-2012, Sections 8.3.3.1, 8.4.2.1 & 8.5.6

164. In the Accused Products, the WPAN protocol is an overlay protocol with respect to the WLAN protocol, such that the WPAN protocol uses a WLAN protocol frame adapted to support a WPAN power-saving protocol that is different as compared to a power-saving protocol supported by the WLAN protocol. For example, in Wi-Fi Direct (the WPAN protocol) the WPAN-adapted frame may utilize the Vendor Specific Information Element (IE) field of an 802.11x protocol frame (a WLAN protocol frame) to carry information not defined by the IEEE 802.11x

Standard so that interoperability operations that are not part of the 802.11x standard can be implemented, such as those required by the power save features defined by the Wi-Fi Direct Standard. For example, in Wi-Fi Direct, two of the P2P Group Owner's adapted power saving protocol schemes are Notice of Absence and Opportunistic Power Save:

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 802.11-2012 [1] for operation outside DMG and in IEEE 802.11-REVmc [11] for operation within DMG, with the Wi-Fi Alliance OUI and an OUI Type indicating P2P. A number of P2P attributes are defined; a single P2P IE carries one or more P2P attributes.

* * *

3.3 P2P Power Management

The P2P power management approach for operation outside DMG 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.

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.

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

4.1.14 Notice of Absence attribute

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

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.
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.

The Notice of Absence attribute shall be present in the P2P IE in the Beacon frames and Probe Response frames transmitted by a P2P Group Owner when a Notice of Absence schedule is being advertised or when the CTWindow is non-zero, as described in Section 4.2.1 and Section 4.2.3. If there is neither a Notice of Absence schedule nor a CTWindow, the GO may omit the Notice of Absence attribute from Beacon and Probe Response frames. The Notice of Absence shall be also present in Notice of Absence frames, as described in Section 4.2.10.2, P2P Presence Request frames, as described in Section 4.2.10.3, and P2P Presence Response frames, as described in Section 4.2.10.4.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 4, 3.3.1, 3.3.2, & 4.1.14

165. In the Accused Products, the WPAN protocol is an overlay protocol that is partially compliant with respect to the WLAN protocol such that said usage occurs without interference from the WLAN. Aspects of the overlay protocol (Wi-Fi Direct) which are compliant with the WLAN protocol (Wi-Fi) include, for example, how P2P devices utilize and access the wireless medium. For example, the XPS 13 Laptop, in supporting Wi-Fi Direct, is required to implement the underlying IEEE 802.11g (or newer) Standard at the PHY level, as shown below. By implementing the underlying PHY protocol, WPAN devices use and access the wireless medium in a manner that is coordinated with 802.11x communications occurring outside of the WPAN, yet in a common wireless space, such that the problems of device interference are reduced:

2.4.1 Basic functions and services

For P2P operation outside the DMG, this specification assumes that the following STA functions and services are implemented in P2P Devices:

- IEEE 802.11g or newer 2.4 GHz PHY [1]
- IEEE 802.11i (AES-CCMP) [1]
- Wi-Fi Simple Configuration [2]
- Wi-Fi Multimedia [3]

3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.1 & 3.2

166. In the Accused Products, the WPAN protocol is an overlay protocol that is partially compliant with respect to the WLAN protocol. Aspects of the overlay protocol (Wi-Fi Direct) which are not compliant with the WLAN protocol (Wi-Fi) include, for example, aspects of P2P Discovery, P2P Power Management, and Managed P2P Device Operation as set out below:

2.4.2 P2P specific functions and services

In addition to the assumed functions listed in Section 2.4.1, a P2P Device supports the 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 802.11-2012 [1] when operating outside DMG and PBSS operation as defined in IEEE 802.11-REVmc [11] when operating within DMG, and provides additions for a P2P Group operation.
- **P2P Power Management** provides a set of functions to reduce power consumption of P2P Devices that operate outside DMG.
- **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.

* * *

A P2P Group Owner shall respond to Probe Request frames following the rules in IEEE 802.11-2012 [1] for operation outside DMG and the rules in IEEE 802.11-REVmc [11] for operation within DMG, 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 802.11-2012 [1], Clause Section 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.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.2 & 3.2.2

167. In the Accused Products, the WPAN protocol is partially compliant with respect to the WLAN protocol such that the WPAN protocol uses a WLAN protocol frame adapted to support

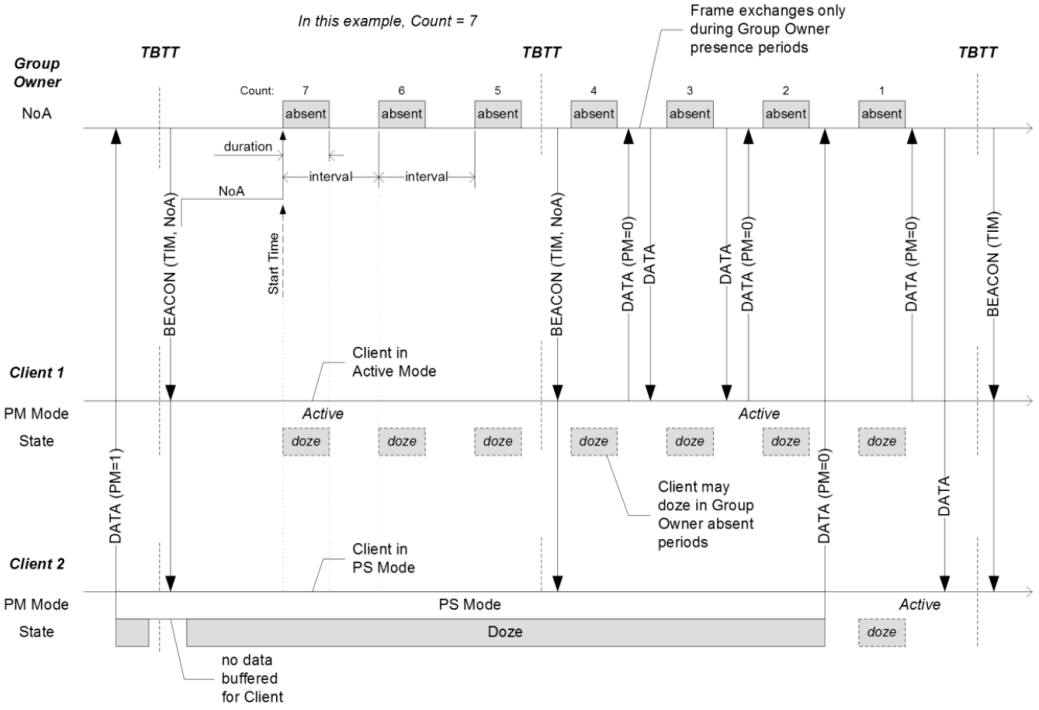
a WPAN power-saving protocol that is different as compared to a power-saving protocol supported by the WLAN protocol. For example, the Wi-Fi Direct protocol is not compliant with the 802.11x protocol for aspects of P2P Power Management including, for example, the Wi-Fi Direct rules that modify 802.11x protocol rules to permit the Accused Products to be absent for defined periods. For example, the 802.11x protocol rule requiring an AP to "remain in the Awake state and always respond to probe requests" is not followed when the second wireless device (a P2P Group Owner which, per the Wi-Fi Direct protocol, assumes the role of an 802.11x AP) is "Absent."

3.3 P2P Power Management

3.3.1 Introduction

P2P power management supports power save mechanisms for P2P Group Owners and P2P Clients when the P2P Group operates outside DMG. If the

The P2P power management approach for operation outside DMG 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.



Source: Wi-Fi Direct Standard, v. 1.7, Section 3.3.1 & Fig. 15

Only APs and STAs in an IBSS or in an MBSS respond to probe requests. A result of the procedures defined in this subclause is that in each infrastructure BSS and IBSS there is at least one STA that is awake at any given time to receive and respond to probe requests. In an MBSS, STAs might not be awake at any given time to respond to probe requests. In an infrastructure BSS or in an IBSS, a STA that sent a Beacon frame shall remain in the Awake state and shall respond to probe requests, subject to criteria in the next paragraph, until a Beacon frame with the current BSSID is received. If the STA is contained within an AP, it shall remain in the Awake state and always respond to probe requests, subject to criteria in the next paragraph. There may be more than one STA in an IBSS that responds to any given probe request, particularly in cases where more than one STA transmitted a Beacon frame following the most recent TBTT, either due to not receiving successfully a previous Beacon frame or due to collisions between beacon transmissions.

Source: IEEE 802.11-2012 Standard, Section 10.1.4.3.2

168. As another example, the 802.11x protocol rule requiring there "is at least one STA awake at any given time" is not followed when the first wireless device (a P2P Client which, per the Wi-Fi Direct protocol, assumes the role of an 802.11x STA) enters a "Doze" state.

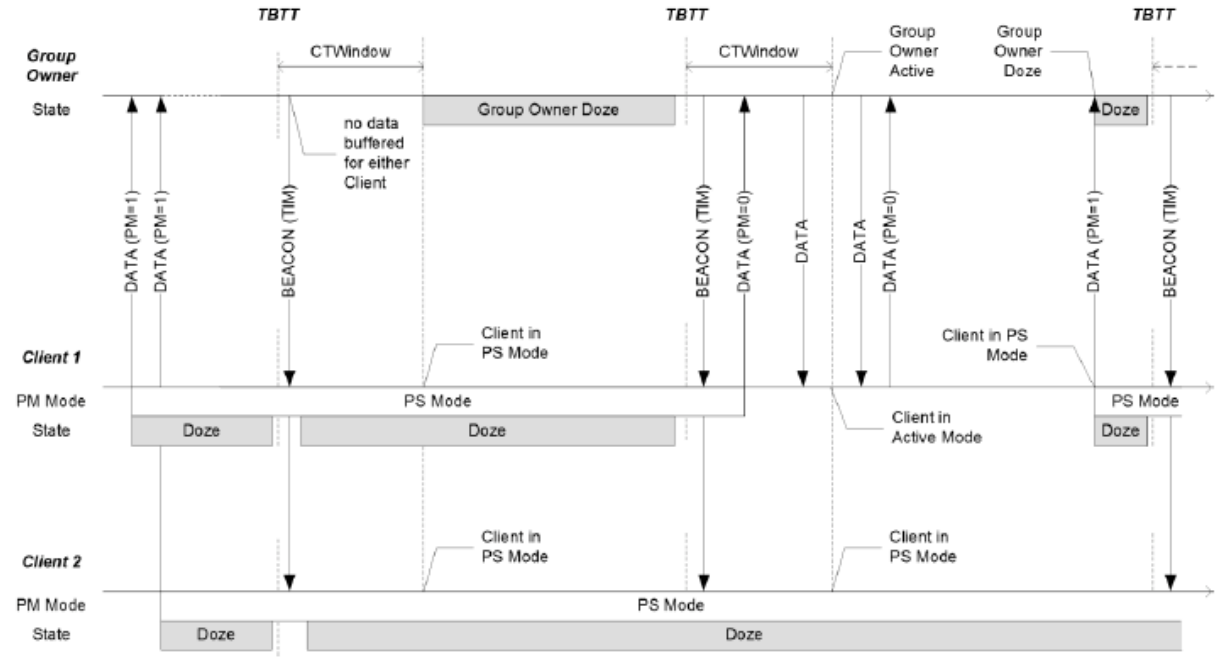


Figure 14—Example of P2P Group Owner Opportunistic Power Save

Source: Wi-Fi Direct Standard, v. 1.7, Fig. 14

Only APs and STAs in an IBSS or in an MBSS respond to probe requests. A result of the procedures defined in this subclause is that in each infrastructure BSS and IBSS there is at least one STA that is awake at any given time to receive and respond to probe requests. In an MBSS, STAs might not be awake at any given time to respond to probe requests. In an infrastructure BSS or in an IBSS, a STA that sent a Beacon frame shall remain in the Awake state and shall respond to probe requests, subject to criteria in the next paragraph, until a Beacon frame with the current BSSID is received. If the STA is contained within an AP, it shall remain in the Awake state and always respond to probe requests, subject to criteria in the next paragraph. There may be more than one STA in an IBSS that responds to any given probe request, particularly in cases where more than one STA transmitted a Beacon frame following the most recent TBTT, either due to not receiving successfully a previous Beacon frame or due to collisions between beacon transmissions.

Source: IEEE 802.11-2012 Standard, Section 10.1.4.3.2

169. In the Accused Products, the wireless radio circuit is configured to operate in at least one of a 2.4 GHz or 5 GHz frequency band. For example, the XPS 13 Laptop (a first wireless device) includes the Intel Killer AX1650 wireless module (a wireless radio circuit) that operates in both the 2.4 GHz and 5 GHz frequency bands:

XPS 13 Laptop

Wireless
Killer™ Wi-Fi 6 AX1650 (2 x 2) and Bluetooth 5.1

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

TX/RX Streams	2x2
Bands	2.4Ghz, 5Ghz (160Mhz)
Max Speed	2.4Gbps
Wi-Fi CERTIFIED*	WiFi 6 (802.11ax)

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html

In-band: Data transfer using the WLAN communication channel, including WLAN multiband devices (e.g. 2.4GHz, 5GHz, and 60GHz).

Source: Wi-Fi Direct Standard, v. 1.7, Section 1.4

In-band Device Discovery uses Probe Request and Probe Response frames to exchange device information. When operating outside DMG, the P2P Devices in a P2P Group are discovered via a Probe Response frame from the P2P Group Owner. When operating within DMG, P2P Devices in a P2P Group are
Source: Wi-Fi Direct Standard, v. 1.7, Section 3.1.2.1

170. In the Accused Products, the WLAN protocol is an 802.11x protocol that uses a frame defined by the 802.11x protocol, and the WPAN protocol uses a WPAN-adapted frame in which at least one field of the frame defined by the 802.11x protocol is adapted to support the WPAN power-saving protocol. For example, in Wi-Fi Direct (the WPAN protocol) the WPAN-adapted frame may utilize the Vendor Specific Information Element (IE) of an 802.11x protocol frame to specify the organizationally unique identifier (OUI) as the Wi-Fi Alliance OUI and the type indicating P2P (an 802.11x protocol that uses a frame defined by the 802.11x protocol). The modified frame is used to carry information not defined by the IEEE 802.11x Standard when implementing operations that are not part of the 802.11x standard, such as those required by the power save features defined by the Wi-Fi Direct Standard. P2P attributes used in this manner may, for example, enable a power-saving protocol that allows the P2P Group Owner (the second wireless device) to take on a role similar to that of an AP in an IEEE 802.11x network, while also implementing power management for a P2P Group, by for example allowing the P2P Group Owner to be absent for certain periods of time (using a WPAN-adapted frame in which at least one field of the frame defined by the 802.11x protocol, namely the aforementioned vendor-specific field, is adapted to support the WPAN power-saving protocol). In the Wi-Fi Direct protocol, two of the P2P Group Owner's adapted power saving protocol schemes are Notice of Absence and Opportunistic Power Save:

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 802.11-2012 [1] for operation outside DMG and in IEEE 802.11-REVmc [11] for operation within DMG, with the Wi-Fi Alliance OUI and an OUI Type indicating P2P. A number of P2P attributes are defined; a single P2P IE carries one or more P2P attributes.

Source: Wi-Fi Direct Standard, v. 1.7, Section 4

P2P PS	IEEE802.11 Power Save adapted for P2P operation
P2P WMM-PS	WMM-PS adapted for P2P operation

Source: Wi-Fi Direct Standard, v. 1.7, Section 1.4

4.1.14 Notice of Absence attribute

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

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.
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.

The Notice of Absence attribute shall be present in the P2P IE in the Beacon frames and Probe Response frames transmitted by a P2P Group Owner when a Notice of Absence schedule is being advertised or when the CTWindow is non-zero, as described in Section 4.2.1 and Section 4.2.3. If there is neither a Notice of Absence schedule nor a CTWindow, the GO may omit the Notice of Absence attribute from Beacon and Probe Response frames. The Notice of Absence shall be also present in Notice of Absence frames, as described in Section 4.2.10.2, P2P Presence Request frames, as described in Section 4.2.10.3, and P2P Presence Response frames, as described in Section 4.2.10.4.

Source: Wi-Fi Direct Standard, v. 1.7, Section 4.1.14

171. In the Accused Products, the WPAN-adapted frame is adapted from a WLAN protocol management frame; *i.e.*, a WPAN-adapted MAC frame of type management (as defined by IEEE 802.11-2012 at Section 8.2.4.1). For example, per IEEE 802.11x, management frames are used by stations (STAs) to join and leave a Basic Service Set (BSS). By adapting a WLAN protocol management frame to specify the Wi-Fi Alliance OUI and an OUI type indicating P2P, all devices in the P2P Group may communicate according to the Wi-Fi Direct Standard, however with reduced interference with Wi-Fi STA devices, and potentially at reduced power dissipation:

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 802.11-2012 [1] for operation outside DMG and in IEEE 802.11-REVmc [11] for operation within DMG, with the Wi-Fi Alliance OUI and an OUI Type indicating P2P. A number of P2P attributes are defined; a single P2P IE carries one or more P2P attributes.

Source: Wi-Fi Direct Standard, v. 1.7, Section 4

8.4 Management frame body components

8.4.1 Fields that are not information elements

8.4.2 Information elements

8.4.2.1 General

Elements are defined to have a common general format consisting of a 1 octet Element ID field, a 1 octet Length field, and a variable-length element-specific Information field. Each element is assigned a unique Element ID as defined in this standard. The Length field specifies the number of octets in the Information field. See Figure 8-81.

	Element ID	Length	Information
Octets:	1	1	variable

Figure 8-81—Element format

The set of valid elements is defined in Table 8-54.

Table 8-54—Element IDs

Element	Element ID	Length of indicated element (in octets)	Extensible
SSID (see 8.4.2.2)	0	2 to 34	
Supported rates (see 8.4.2.3)	1	3 to 10	

Table 8-54—Element IDs *(continued)*

Element	Element ID	Length of indicated element (in octets)	Extensible
U-APSD Coexistence (see 8.4.2.93)	142	14 to 257	Subelements
Reserved	143–173		
MCCAOP Advertisement Overview (see 8.4.2.110)	174	8	Yes
Reserved	175–220		
Vendor Specific (see 8.4.2.28)	221	3 to 257	
Reserved	222–255		

Source: IEEE 802.11-2012, Section 8.4

172. In the Accused Products, the WPAN protocol provides for an inactivity time during which the first and second wireless devices can agree to at least partially disable the wireless connection. For example, a P2P Group Owner (the second wireless device) utilizing the Notice of Absence procedure shall not send frames within the P2P Group during periods it has indicated it

will be absent, and a P2P Client (the first wireless device) that received the Notice of Absence and that does not try modifying any of the periods using P2P Presence procedures, shall not send frames to a P2P Group Owner during the specified absence. According to the Wi-Fi Direct Standard, for example, during a P2P Group Owner's absence, the P2P Client shall buffer frames until frame delivery may be attempted in a presence period, such that during the absence, the wireless connection between the P2P Group Owner and the P2P Client is partially disabled (an inactivity time during which the first and second wireless devices can agree to at least partially disable the wireless connection):

3.3.3.2 P2P Group Owner Notice of Absence procedure

Notice of Absence timing is specified by the values of the combination of Start Time, Interval, Duration and Count fields in the Notice of Absence attribute — 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.

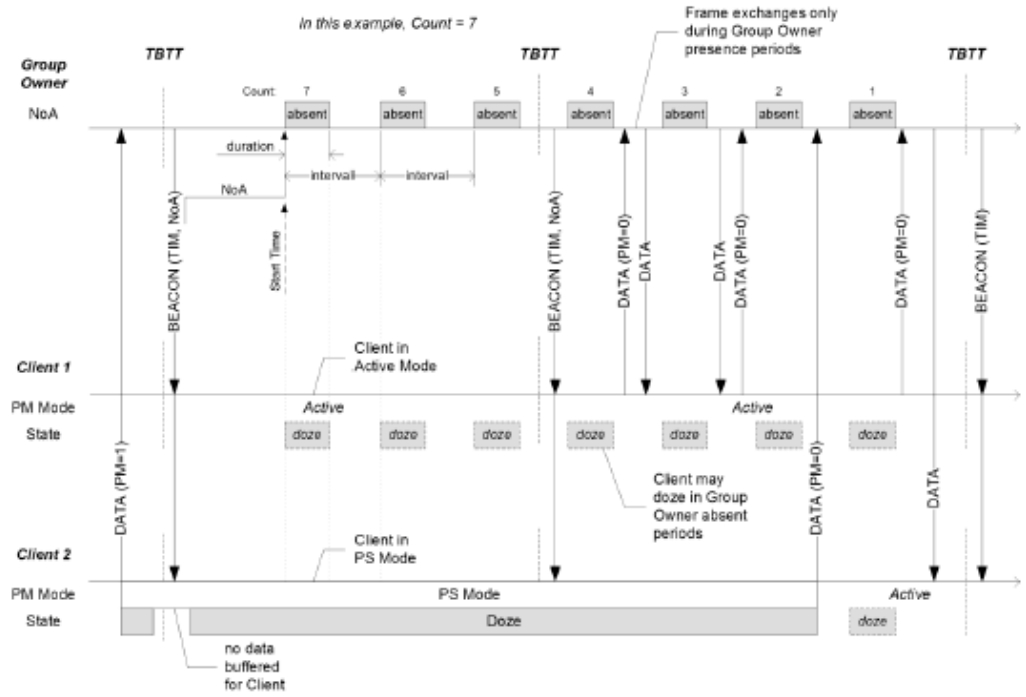


Figure 15—P2P Group Owner Notice of Absence

P2P Clients 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 interval between and/or duration of P2P Group Owner presence periods, e.g. where the P2P Client has WMM Traffic Stream (TS), or latency sensitive traffic.

On receipt of a P2P Presence Request, the P2P Group Owner shall determine whether to accept the request. If the P2P Group Owner accepts the P2P Presence Request, it shall respond with a P2P Presence Response action frame containing a Status attribute indicating success and a Notice of Absence attribute describing the Notice of Absence timing that it will use in response to the request. The P2P Group Owner may adopt revised Notice of Absence

3.3.4.4 Signaling of Client service requirements

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

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

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

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 Section 10.2.1.6 of IEEE 802.11-2012 [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 Section 3.3.4.2.

3.3.4 Power Management at a P2P Client

3.3.4.1 P2P Client operation with P2P Group Owner Power Management

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

The P2P Client shall not send frames to a P2P Group Owner during periods that the P2P Group Owner has indicated it will be absent, subject to the power save state precedence rules above. P2P Clients shall buffer frames until frame delivery can be attempted in a presence period. 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.

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

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

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

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.3.3.2, 3.3.4.4, 3.3.3.3, & 3.3.4.1

173. As another example, the Wi-Fi Direct protocol provides for an inactivity time during which the first and second wireless devices can agree to at least partially disable the wireless connection using the Opportunistic Power Save procedure:

3.3.3.1 P2P Group Owner Opportunistic Power Save procedure

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

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

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

As long as any Client is determined to be in Awake state, the P2P Group Owner shall remain in Awake state subject to any advertised Notice of Absence schedule. A P2P Group Owner shall determine that a P2P Client is in the Awake state if it is in the Active mode or if it is in the Power Save mode and has a WMM Unscheduled Service Period (USP) in progress or an unanswered PS-Poll. Figure 14 illustrates an example of P2P Group Owner Opportunistic Power Save with two connected P2P Clients, both using P2P PS.

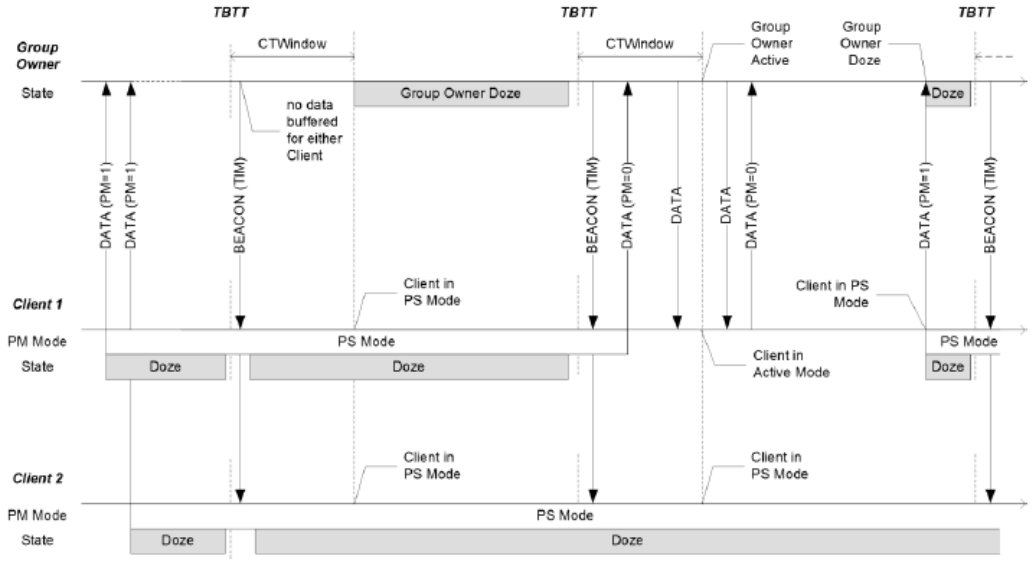


Figure 14—Example of P2P Group Owner Opportunistic Power Save

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.

3.3.4.4 Signaling of Client service requirements

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

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

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

3.3.4 Power Management at a P2P Client

3.3.4.1 P2P Client operation with P2P Group Owner Power Management

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

The P2P Client shall not send frames to a P2P Group Owner during periods that the P2P Group Owner has indicated it will be absent, subject to the power save state precedence rules above. P2P Clients shall buffer frames until frame delivery can be attempted in a presence period. 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.

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

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

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

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.3.3.1, Fig. 14, 3.3.2, 3.3.4.4, & 3.3.4.1

174. In the Accused Products, the first wireless device and the second wireless device are configured to agree on the inactivity time in accordance with the WPAN protocol as described above and reiterated below when utilizing, for example, the Notice of Absence procedure:

3.3.3.2 P2P Group Owner Notice of Absence procedure

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

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

P2P Clients 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 interval between and/or duration of P2P Group Owner presence periods, e.g. where the P2P Client has WMM Traffic Stream (TS), or latency sensitive traffic.

On receipt of a P2P Presence Request, the P2P Group Owner shall determine whether to accept the request. If the P2P Group Owner accepts the P2P Presence Request, it shall respond with a P2P Presence Response action frame containing a Status attribute indicating success and a Notice of Absence attribute describing the Notice of Absence timing that it will use in response to the request. The P2P Group Owner may adopt revised Notice of Absence

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.

3.3.4.4 Signaling of Client service requirements

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

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

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

4.2.10.2 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.

4.2.10.3 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 Section 3.3.4.4.

4.1.14 Notice of Absence attribute

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

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.
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.

4.2.1 Beacon frame format

One or more P2P IEs and the WSC IE shall be inserted after other information elements in the Beacon frames transmitted by a P2P Group Owner. P2P attributes for a P2P IE that is included in the Beacon frame are shown in Table 48.

Table 48—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.

Attributes	Attribute ID	Note
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 Section 3.3.3.2), or when the CTWindow is non-zero (see Section 3.3.2).

4.2.3 Probe Response frame format

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

One or more P2P IEs and the WSC IE shall be inserted after other information elements in Probe Response frames transmitted by a P2P Device. P2P attributes for a P2P IE that is included in the Probe Response frame are shown in Table 52.

Table 52—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 Section 3.3.3.2) or non-zero CTWindow (see Section 3.3.2) is being advertised in the Beacon frames (see Section 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.
Advertised Service Info	25	The Service Instance attribute may be present in the P2P IE if P2Ps is supported. The usage of this attribute is defined in the Wi-Fi Peer-to-Peer Services specification [10].

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 Section 10.2.1.6 of IEEE 802.11-2012 [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 Section 3.3.4.2.

3.3.4 Power Management at a P2P Client

3.3.4.1 P2P Client operation with P2P Group Owner Power Management

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

The P2P Client shall not send frames to a P2P Group Owner during periods that the P2P Group Owner has indicated it will be absent, subject to the power save state precedence rules above. P2P Clients shall buffer frames until frame delivery can be attempted in a presence period. 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.

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

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

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

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.3.3.2, Table 28, 3.3.4.4, 4.2.10.2, 4.2.10.3, 4.1.14, Table 26, 4.2.1, 4.2.3, 3.3.3.3, & 3.3.4.1

175. Alternatively, in the Accused Products, the first and second wireless devices are configured to agree on the inactivity time in accordance with the WPAN protocol as described above and reiterated below when utilizing, for example, the Opportunistic Power Save procedure:

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.

3.3.3.1 P2P Group Owner Opportunistic Power Save procedure

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

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

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

As long as any Client is determined to be in Awake state, the P2P Group Owner shall remain in Awake state subject to any advertised Notice of Absence schedule. A P2P Group Owner shall determine that a P2P Client is in the Awake state if it is in the Active mode or if it is in the Power Save mode and has a WMM Unscheduled Service Period (USP) in progress or an unanswered PS-Poll. Figure 14 illustrates an example of P2P Group Owner Opportunistic Power Save with two connected P2P Clients, both using P2P PS.

3.3.4 Power Management at a P2P Client

3.3.4.1 P2P Client operation with P2P Group Owner Power Management

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

The P2P Client shall not send frames to a P2P Group Owner during periods that the P2P Group Owner has indicated it will be absent, subject to the power save state precedence rules above. P2P Clients shall buffer frames until frame delivery can be attempted in a presence period. 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.

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

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

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

4.1.14 Notice of Absence attribute

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

The Notice of Absence attribute shall be present in the P2P IE in the Beacon frames and Probe Response frames transmitted by a P2P Group Owner when a Notice of Absence schedule is being advertised or when the CTWindow is non-zero, as described in Section 4.2.1 and Section 4.2.3. If there is neither a Notice of Absence schedule nor a CTWindow, the GO may omit the Notice of Absence attribute from Beacon and Probe Response frames. The Notice of Absence shall be also present in Notice of Absence frames, as described in Section 4.2.10.2, P2P Presence Request frames, as described in Section 4.2.10.3, and P2P Presence Response frames, as described in Section 4.2.10.4.

4.2.10.2 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.

4.2.10.3 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 Section 3.3.4.4.

3.3.4.4 Signaling of Client service requirements

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

— send a new P2P Presence Request with revised timing,

— use the timing indicated in the returned Notice of Absence attribute, or

— disconnect from the P2P Group.

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

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.
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.

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.

4.2.1 Beacon frame format

One or more P2P IEs and the WSC IE shall be inserted after other information elements in the Beacon frames transmitted by a P2P Group Owner. P2P attributes for a P2P IE that is included in the Beacon frame are shown in Table 48.

Table 48—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.

Attributes	Attribute ID	Note
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 Section 3.3.3.2), or when the CTWindow is non-zero (see Section 3.3.2).

4.2.3 Probe Response frame format

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

One or more P2P IEs and the WSC IE shall be inserted after other information elements in Probe Response frames transmitted by a P2P Device. P2P attributes for a P2P IE that is included in the Probe Response frame are shown in Table 52.

Table 52—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 Section 3.3.3.2) or non-zero CTWindow (see Section 3.3.2) is being advertised in the Beacon frames (see Section 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.
Advertised Service Info	25	The Service Instance attribute may be present in the P2P IE if P2Ps is supported. The usage of this attribute is defined in the Wi-Fi Peer-to-Peer Services specification [10].

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.3.2, 3.3.3.1, 3.3.4.1, 4.1.14, 4.2.10.2, 4.2.10.3, 3.3.4.4, Table 26, Table 27, 4.2.1, & 4.2.3

176. In the Accused Products, the WPAN protocol provides for the first wireless device to disable at least a part of the coordination following a start of the inactivity time, such as can be seen in the following:

3.3.4.1 P2P Client operation with P2P Group Owner Power Management

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

The P2P Client shall not send frames to a P2P Group Owner during periods that the P2P Group Owner has indicated it will be absent, subject to the power save state precedence rules above. P2P Clients shall buffer frames until frame delivery can be attempted in a presence period. 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.

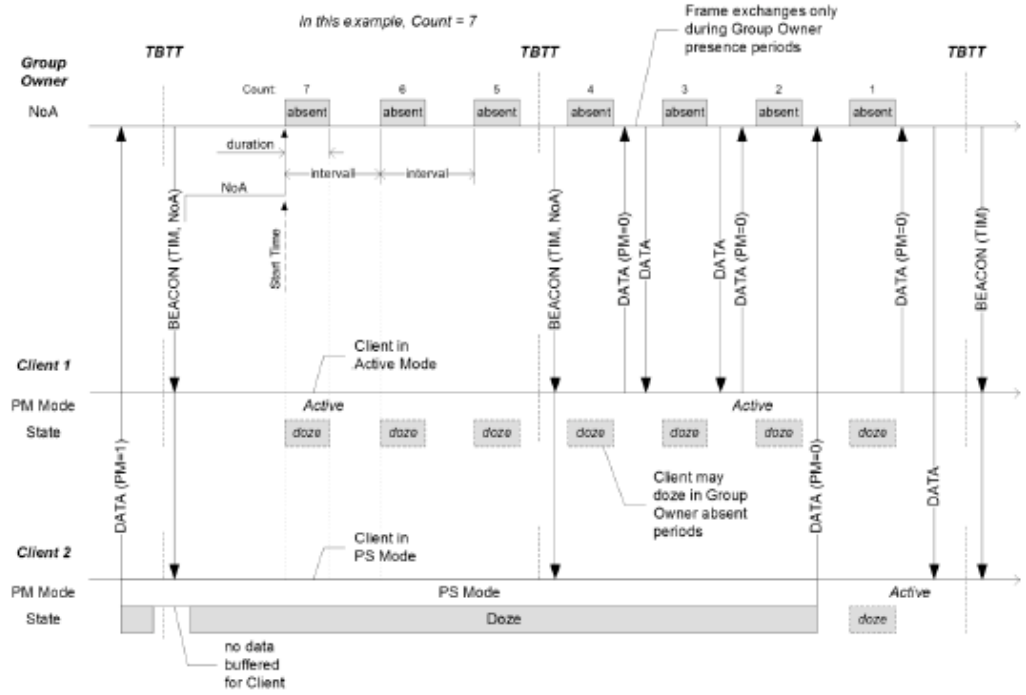


Figure 15—P2P Group Owner Notice of Absence

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.3.4.1 & Figure 15

177. As set forth above, Dell has directly infringed at least claim 4 of the ’934 patent by making, importing, using, offering for sale and/or selling the Accused Products into or in the United States.

178. Dell intentionally designed and incorporated the IEEE 802.11x and the Wi-Fi Direct features and functionalities described above into the Accused Products.

179. Dell provides instructions (in the form of at least user interface prompts and customer support instructional videos) to its customers, advertising, encouraging and directing the customers to use the Accused Products in an infringing manner as described above to implement the IEEE 802.11x/Wi-Fi Direct functionality, as intended by Dell. For example, Dell provides operating instructions and the like for the Accused Products, including, but not limited to, the citations above and the following:

- https://www.youtube.com/watch?v=kXBwdWp7sFM
- https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778
- https://www.dell.com/support/kbdoc/en-us/000136674/miracast-to-replace-wi-di
- https://www.dell.com/support/kbdoc/en-us/000129880/miracast-users-may-encounter-various-issues-in-the-windows-10-operating-system
- https://www.dell.com/support/kbdoc/en-us/000130716/guide-to-dell-wireless-monitors
- https://www.dell.com/support/kbdoc/en-us/000152972/how-do-i-enable-widi-miracast-on-my-venue-7-3740-or-venue-8-3840?lang=en
- https://www.dell.com/support/kbdoc/en-us/000129818/a-guide-to-miracast-on-the-latitude-13-7350-tablet-pc?lang=en

- https://www.dell.com/support/kbdoc/en-us/000141601/xps-13-9350-touch-cursor-and-sound-may-have-a-lag-when-system-connected-wifi-miracast-and-bluetooth-audio?lang=en
- https://www.dell.com/support/manuals/en-us/latitude-13-7390-laptop/latitude_7290_7390_7490_tgb/wlan-—-miracast-support-matrix?guid=guid-76975785-70c3-4039-b5bb-eb0b83e669b3&lang=en-us
- https://www.dell.com/support/manuals/en-us/inspiron-11-3179-2-in-1-laptop/inspiron_11_3179_setupandspecs/communications?guid=guid-5fea805b-7f8a-420f-b984-b0e93e13048e&lang=en-us
- https://www.dell.com/support/manuals/en-us/alienware-15-laptop/alienware-15-r3-setupandspecifications/communications?guid=guid-935baab6-b4b4-4960-9783-971e87de151c&lang=en-us

180. By its instructions, including those set forth above, and with intent that they use the IEEE 802.11x/Wi-Fi Direct features described above, Dell has induced its customers to infringe the ’934 patent. Dell’s customers who use the Accused Products as described above directly infringe the ’934 patent. Upon information and belief, as a result of attempts by the inventors to sell or license their patents to the PC industry, of which Dell is a member, Dell has had knowledge of (or has been willfully blind to) the ’934 patent, a child of the ’991 patent. Further, Dell has had knowledge of (or has been willfully blind to) the ’934 patent since at least September 9, 2020, as a result of a letter from Christian Dubuc, Chief Executive Officer of Ozmo Licensing, to Richard Rothberg, General Counsel for Dell, regarding Ozmo Licensing’s patent portfolio and the Accused Dell Products, informing Dell that it required a license. On September 9, 2020, Ozmo Licensing had only eight patents and patent applications that embodied the inventions of Vleugels and

Peeters. In addition, upon information and belief, Dell would have gained knowledge of the '934 patent by virtue of the litigation filed against HP Inc. (Docket No: 6:21-cv-00383-ADA) and against Acer Inc. (Docket No. 6:21-cv-01225-ADA). Dell also induces such direct infringement by its customers by failing to remove the infringing features from the Accused Products.

181. By its instructions, including those set forth above, as well as by offering for sale, selling, commercially distributing and importing the Accused Products, Dell has also contributed to its customers' infringement of the '934 patent. The Accused Products are used by Dell's customers to practice the inventions claimed in the '934 patent. The IEEE 802.11x/Wi-Fi Direct features as performed by the Accused Products as described above constitute material parts of the claimed inventions of the '934 patent. Dell knows or is willfully blind that portions of the hardware and software in the Accused Products were specifically made or adapted by Dell solely to provide such functionality and that such features are not staple articles or commodities of commerce suitable for substantial non-infringing use. Dell also knows or is willfully blind that such combinations of hardware and software have no use other than to provide such functionality as intentionally designed into the Accused Products by Dell.

182. By the time of trial, Dell will have known and intended that its continued actions would directly infringe, and would induce and contribute to the infringement by its customers of, at least claim 4 of the '934 patent.

183. Ozmo Licensing has been damaged by Dell's past and ongoing direct and indirect infringement of the '934 patent.

184. With knowledge of the allegations set forth herein, Dell nonetheless refuses to remove the infringing functionalities from the Accused Products or to compensate Ozmo Licensing for the use of such features. Dell's infringement described above will continue unabated

unless and until Dell is enjoined or ordered to pay a reasonable royalty for a license to the '934 patent.

COUNT V
(Dell's Infringement of U.S. Patent No. 11,122,504)

185. Paragraphs 1-184 are incorporated by reference as if fully set forth herein.

186. The invention of the '504 patent represented a technical solution to an unsolved technological problem. The written description of the '504 patent describes in technical detail each of the limitations of the claims, allowing a person of ordinary skill in the art to understand what the limitations cover and how the combination of claim elements differed markedly from and improved upon what may have been considered conventional or generic. For example, the specification and incorporated references detail the inventors' novel approach to seamlessly integrating a WPAN into a WLAN wherein the WPAN protocol is an overlay protocol that is only partially compliant with the WLAN protocol, and wherein a wireless device can establish and maintain association and synchronization with a WPAN.

187. The elements claimed by the '504 patent, taken alone or in combination, were not well-understood, routine or conventional to one of ordinary skill in the art at the time of the invention. Rather, the '504 patent claims and teaches, *inter alia*, an improved way to associate and synchronize a wireless device with a WPAN, wherein a wireless device participates in a coordination of usage of the wireless medium using the WPAN protocol, which WPAN protocol is partially compliant with a WLAN protocol, and includes frames adapted to support WPAN power-savings. A wireless circuit of the device operates in either the 2.4 or 5 GHz frequency band, and can also communicate using another protocol that is a WLAN protocol using WLAN protocol frames. The WPAN protocol uses a WPAN-adapted frame in which at least one field of a WLAN frame is adapted to support a WPAN power-saving protocol, and the WPAN-adapted frame is

adapted from a WLAN protocol management frame. The WPAN protocol provides for an inactivity time, during which the wireless device agrees with a second wireless device to at least partially disable a wireless connection between them during an agreed upon inactivity time, in accordance with the WPAN protocol. The WPAN protocol provides for the wireless devices to disable at least a part of the coordination function following the start of the inactivity time.

188. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN is also more cost effective, since communications using the WPAN protocol rely upon the same hardware used for communications using a WLAN protocol.

189. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN allows the two to operate in the same frequency spectrum without causing exc essive interference with each other.

190. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN is also more energy efficient, thereby extending the battery life of the devices or otherwise enable power-hungry WPAN devices to enter power-save modes more readily.

191. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN is also more seamless, insofar as it facilitates association and synchronization across multiple devices, without the need to repeatedly engage in the time- and power-consuming processes of re-associating and re-synchronizing the devices.

192. Compared to the prior art, the claimed apparatus for integrating a WPAN into a WLAN also enables lower latency communication involved WPAN devices, which enables a device serving as a hub between a WPAN and a WLAN to more effectively forward video streams between the two.

193. Participants in the communications industry chose to incorporate a subset of the claimed apparatus into the Wi-Fi Direct Standard to enjoy at least some of their aforementioned advantages.

194. Dell has infringed, and continues to infringe, the ’504 patent by making, importing, using, offering for sale and selling in the United States numerous wireless devices, including laptop computers, desktop computers, tablets, and monitors, that implement the Wi-Fi Direct protocol (i.e., the “Accused Products”). A subset of these Accused Products comprise network-enabled hubs that can receive, for example, video from an IEEE 802.11x AP and forward such video to a Wi-Fi STA device using the Wi-Fi Direct protocol (i.e., the “Hub Accused Products”).

195. Examples of the Hub Accused Products are Dell’s laptop computers (including, but not limited to, XPS Laptops, Inspiron Laptops, Alienware Gaming Laptops, Vostro Laptops, and Latitude Laptops); desktop computers (including, but not limited to, XPS Desktops, Inspiron Desktops, Alienware Gaming Desktops, OptiPlex Desktops, Vostro Desktops, and New Precision Workstations); and tablets (including, but not limited to, Latitude 2-in-1 devices and Latitude Rugged Extreme tablets), and all other Dell products that include Wi-Fi Direct circuitry and drivers. Examples of the Accused Products are Dell’s aforementioned Hub Accused Products, as well as Dell’s monitors (including, but not limited to, Dell Wireless Monitors), and all other Dell products that include Wi-Fi Direct circuitry and drivers.

196. Claim 7 of the ’504 patent is reproduced below:

> 7. A first wireless device for coordinating usage of a wireless medium comprising:
>
> a wireless radio circuit;
>
> a memory; and

at least one processor coupled to the wireless radio circuit and the memory, said at least one processor configured to:

maintain a first association and a first synchronization over the wireless medium with an access point of a wireless local area network (WLAN) over a first wireless connection via the wireless radio circuit, using a WLAN protocol;

determine, via the wireless radio circuit, that a second wireless device corresponds to a wireless personal area network (WPAN) protocol;

maintain, via the wireless radio circuit, a second association and a second synchronization over the wireless medium with the second wireless device over a second wireless connection via the wireless radio circuit using the WPAN protocol, while maintaining said first association and said first synchronization with the access point over the first wireless connection using the WLAN protocol;

participate in a first coordination of a first usage of the wireless medium over the first wireless connection using the WLAN protocol; and

participate in a second coordination of a second usage of the wireless medium over the second wireless connection using the WPAN protocol;

wherein the WPAN protocol is an overlay protocol with respect to the WLAN protocol, such that the WPAN protocol uses a first WPAN protocol frame adapted to support a WPAN protocol power-saving procedure; and

wherein the WPAN protocol is partially compliant with respect to the WLAN protocol, such that said second usage occurs without interference from the WLAN, and such that the WPAN protocol uses a second WPAN protocol frame comprising a WLAN probe request protocol frame adapted to determine that the second wireless device corresponds to the WPAN protocol, and the second WPAN protocol frame comprises an SSID adapted to identify the WPAN protocol.

197. The Hub Accused Products that infringe the ’504 patent’s claim 7 include, *inter alia*, a first wireless device, usable for coordinating usage of a wireless medium and capable of concurrent operations when associated and synchronized with an AP of a WLAN and also associated and synchronized with a second wireless device of a WPAN (a “hub”). For example,

the Dell XPS 13 9310 Laptop ("XPS 13 Laptop") is a Hub Accused Product comprising a wireless device that implements the Wi-Fi and Wi-Fi Direct standards. It also supports applications such as Miracast, which is a standard that allows a user to "mirror" a video image being displayed at one STA onto the display of another STA, by having it communicated over a Wi-Fi Direct connection between the two STAs. The XPS 13 Laptop infringes the '504 patent because it comprises Wi-Fi and Wi-Fi Direct circuitry and drivers, and applications, such as Miracast, that enable it to act as a hub that concurrently receives data from a node in a WLAN over an 802.11x connection (e.g., streamed video), and concurrently forward that data to a node in a WPAN over a Wi-Fi Direct connection:

<table>
<tr>
<td>XPS 13 Laptop
  </td>
<td>Operating System Help Me Choose
(FREE Upgrade to Windows 11 *)
Windows 11 Home, English
Windows 10 Home, English
Wireless
Killer™ Wi-Fi 6 AX1650 (2 x 2) and Bluetooth 5.1</td>
</tr>
<tr>
<td colspan="2">Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor</td>
</tr>
</table>

Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

TX/RX Streams	2x2
Bands	2.4Ghz, 5Ghz (160Mhz)
Max Speed	2.4Gbps
Wi-Fi CERTIFIED*	WiFi 6 (802.11ax)

Experience the Intel® Difference

Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)

Me and My Dell

For Inspiron, G-Series, XPS, and Alienware computers

Display

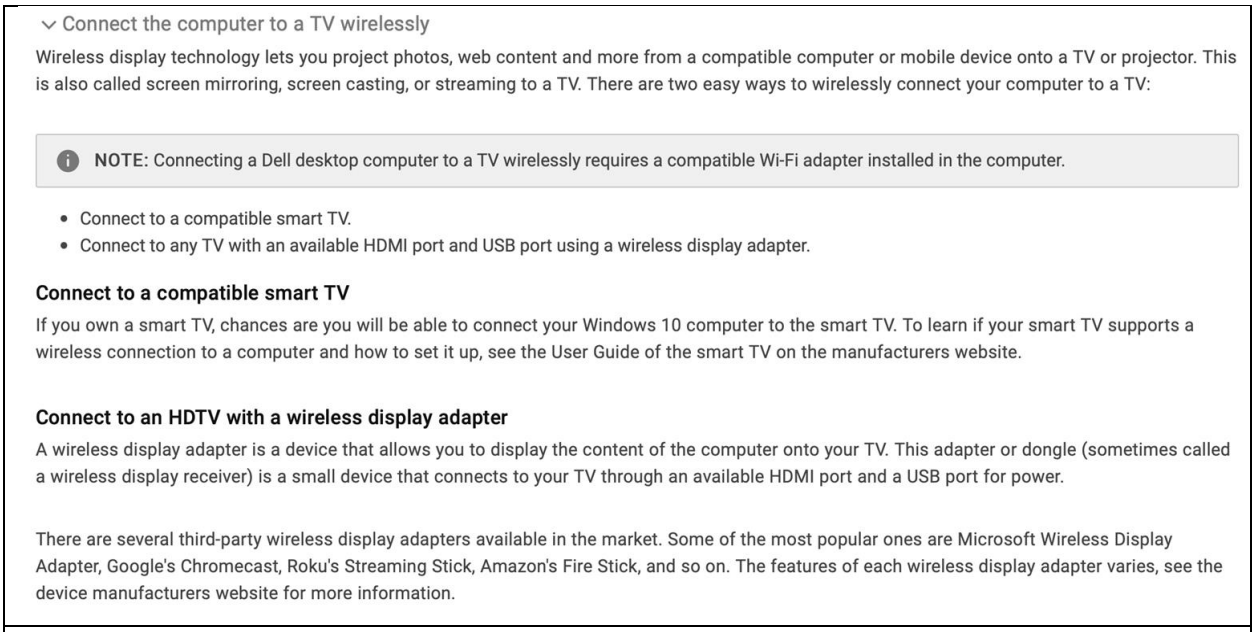
Displays are classified according to their screen size, resolution, color gamut, and so on. Generally, a screen with higher resolution and better color support provides better image quality. Some external displays also have USB ports, media-card readers, and so on. Displays may also support features such as, touch screen, 3D, and wireless connection.

Wireless display

The wireless display feature enables you to share your computer display with a compatible TV without the use of cables. To check if your TV supports this feature, see the documentation of the TV.

NOTE: Wireless display may not be supported on all computers. For more information, see www.intel.com.

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_reference-guide_en-us.pdf



Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Connect to a compatible smart TV

If you own a smart TV, chances are you will be able to connect your Windows 10 computer to the smart TV. To learn if your smart TV supports a wireless connection to a computer and how to set it up, see the User Guide of the smart TV on the manufacturers website.

Connect to an HDTV with a wireless display adapter

A wireless display adapter is a device that allows you to display the content of the computer onto your TV. This adapter or dongle (sometimes called a wireless display receiver) is a small device that connects to your TV through an available HDMI port and a USB port for power.

There are several third-party wireless display adapters available in the market. Some of the most popular ones are Microsoft Wireless Display Adapter, Google's Chromecast, Roku's Streaming Stick, Amazon's Fire Stick, and so on. The features of each wireless display adapter varies, see the device manufacturers website for more information.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778

2.1 P2P components

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

P2P Device:

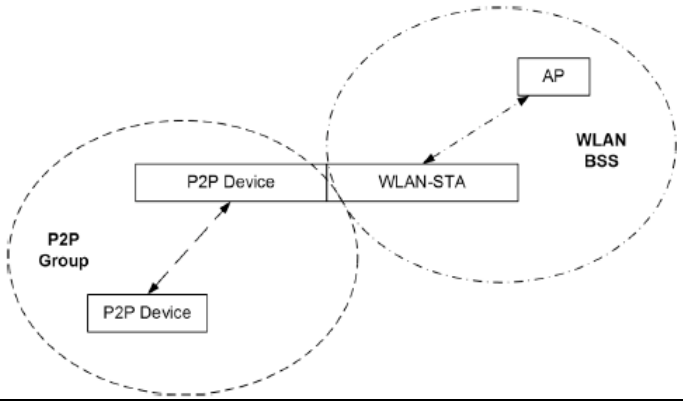
- Supports both P2P Group Owner and P2P Client roles.
- Negotiates P2P Group Owner or P2P Client role.
- Supports WSC and P2P Discovery mechanism.
- May support WLAN and P2P concurrent operation.

P2P Group Owner role:

- "AP-like" entity that provides BSS functionality and services for associated Clients (P2P Clients or Legacy Clients) when not operating within DMG, or a PCP that provides PBSS functionality and services for Clients (P2P Clients) when operating within DMG.
- Provides WSC Internal Registrar functionality.
- May provide communication between associated Clients.
- May provide access to a simultaneous WLAN connection for its associated Clients.

2.3 Concurrent operation

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



Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.1, 2.3, Fig. 4

198. The XPS 13 Laptop includes a wireless radio circuit configured to communicate over a wireless medium of a wireless local area network (WLAN) using a WLAN protocol. For example, the XPS 13 Laptop includes the Intel Killer AX1650 wireless module, which is a wireless radio circuit with 802.11x capabilities (a WLAN protocol), as seen below:

XPS 13 Laptop

Operating System Help Me Choose

(FREE Upgrade to Windows 11 *)

Windows 11 Home, English	Windows 10 Home, English

Wireless

Killer™ Wi-Fi 6 AX1650 (2 x 2) and Bluetooth 5.1

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Wireless module

The following table lists the Wireless Local Area Network (WLAN) module specifications of your XPS 13 9310.

NOTE: The wireless module is integrated on the system board.

Table 9. Wireless module specifications

Description	Option one
Model number	Intel AX1650
Transfer rate	Up to 2400 Mbps
Frequency bands supported	2.4 GHz/5 GHz
Wireless standards	• WiFi 802.11a/b/g • Wi-Fi 4 (WiFi 802.11n) • Wi-Fi 5 (WiFi 802.11ac) • Wi-Fi 6 (WiFi 802.11ax)
Encryption	• 64-bit/128-bit WEP • AES-CCMP • TKIP
Bluetooth	Bluetooth 5.1

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

TX/RX Streams	2x2
Bands	2.4Ghz, 5Ghz (160Mhz)
Max Speed	2.4Gbps
Wi-Fi CERTIFIED*	WiFi 6 (802.11ax)

Experience the Intel® Difference

Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.

GENERAL

Dimensions (H x W x D)	M.2 2230: 22mm x 30mm x 2.4mm [1.5mm Max (Top Side)/ 0.1mm Max (Bottom Side)] M.2 1216: 12mm x 16mm x 1.67 (+-0.08) mm
Weight	M.2 2230: 2.83 +/– 0.3 g M.2 1216: 0.67 +/– 0.1 g
Radio ON/OFF Control	Supported
Connector Interface	M.2: PCIe*, USB
Operating Temperature (Adapter Shield)	0°C to +80°C
Humidity Non-Operating	50% to 90% RH non-condensing (at temperatures of 25°C to 35°C)
Operating Systems	Microsoft Windows* 10, Linux*, Chrome OS*
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016
Bluetooth®	Bluetooth® 5.2

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)

199. The XPS 13 Laptop includes a memory. For example, the XPS 13 Laptop includes system memory as seen below:

XPS 13 Laptop

Memory ⓘ

8GB 4267MHz LPDDR4x Memory Onboard

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Memory

The following table lists the memory specifications of your XPS 13 9310.

Table 6. Memory specifications

Description	Values
Memory slots	No memory slots ⓘ NOTE: The memory module is integrated on the system board.
Memory type	LPDDR4x
Memory speed	4267 MHz
Maximum memory configuration	32 GB
Minimum memory configuration	8 GB
Memory configurations supported	• 8 GB (4 x 2 GB) LPDDR4x at 4267 MHz • 16 GB (4 x 4 GB) LPDDR4x at 4267 MHz • 32 GB (4 x 8 GB) LPDDR4x at 4267 MHz

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

200. The XPS 13 Laptop includes at least one processor coupled to the wireless radio circuit and the memory. For example, the XPS 13 Laptop includes the Intel Core i3-1115G4 system processor (a processor) coupled to the wireless radio circuit and the memory, as seen below:

XPS 13 Laptop

Tech Specs

Processor
11th Generation Intel® Core™ i3-1115G4 Processor (6MB Cache, up to 4.1 GHz)

Operating System
(FREE Upgrade to Windows 11)
Windows 11 Home, English

Graphics Card ⓘ
Intel® UHD Graphics with shared graphics memory

Display
13.4" UHD+ (3840 x 2400) InfinityEdge Touch Anti-Reflective 500-Nit Display

Memory ⓘ
8GB 4267MHz LPDDR4x Memory Onboard

Hard Drive
256GB M.2 PCIe NVMe Solid State Drive

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Processor

The following table lists the details of the processors supported by your XPS 13 9310.

Table 4. Processor

Description	Option one
Processor type	11th Generation Intel Core i3-1115G4 processor
Processor wattage	15 W
Processor core count	2
Processor thread count	4
Processor speed	Up to 4.10 GHz
Processor cache	6 MB
Integrated graphics	Intel UHD Graphics

Wireless module

The following table lists the Wireless Local Area Network (WLAN) module specifications of your XPS 13 9310.

NOTE: The wireless module is integrated on the system board.

Table 9. Wireless module specifications

Description	Option one
Model number	Intel AX1650
Transfer rate	Up to 2400 Mbps
Frequency bands supported	2.4 GHz/5 GHz
Wireless standards	• WiFi 802.11a/b/g • Wi-Fi 4 (WiFi 802.11n) • Wi-Fi 5 (WiFi 802.11ac) • Wi-Fi 6 (WiFi 802.11ax)
Encryption	• 64-bit/128-bit WEP • AES-CCMP • TKIP
Bluetooth	Bluetooth 5.1

Chipset

The following table lists the details of the chipset supported by your XPS 13 9310.

Table 5. Chipset

Description	Values
Chipset	Integrated in the processor
Processor	11th Generation Intel Core i3/i5/i7
DRAM bus width	128 bit
Flash EPROM	32 MB (BIOS)
PCIe bus	Up to PCIe Gen 4.0 (Storage)

Memory

The following table lists the memory specifications of your XPS 13 9310.

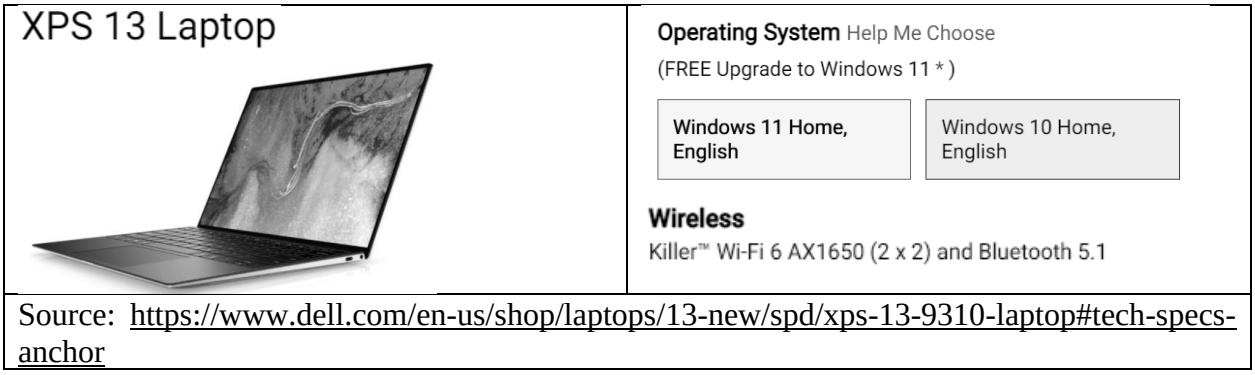
Table 6. Memory specifications

Description	Values
Memory slots	No memory slots NOTE: The memory module is integrated on the system board.
Memory type	LPDDR4x
Memory speed	4267 MHz
Maximum memory configuration	32 GB
Minimum memory configuration	8 GB
Memory configurations supported	• 8 GB (4 x 2 GB) LPDDR4x at 4267 MHz • 16 GB (4 x 4 GB) LPDDR4x at 4267 MHz • 32 GB (4 x 8 GB) LPDDR4x at 4267 MHz

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

201. The XPS 13 Laptop is configured to maintain a first association and a first synchronization over the wireless medium with an access point of a wireless local area network

(WLAN) over a first wireless connection via the wireless radio circuit, using a WLAN protocol. For example, the XPS 13 Laptop (a first wireless device) includes the Intel Core i3-1115G4 system processor, as shown above, configured to maintain an association and a synchronization with an access point (AP) of an 802.11x network (a WLAN) over a wireless connection, via its wireless radio circuit, using an 802.11x protocol:



Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

TX/RX Streams	2x2
Bands	2.4Ghz, 5Ghz (160Mhz)
Max Speed	2.4Gbps
Wi-Fi CERTIFIED*	WiFi 6 (802.11ax)

Experience the Intel® Difference	
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Weight	M.2 2230: 2.83 +/– 0.3 g M.2 1216: 0.67 +/– 0.1 g
Radio ON/OFF Control	Supported
Connector Interface	M.2: PCIe*, USB
Operating Temperature (Adapter Shield)	0°C to +80°C
Humidity Non-Operating	50% to 90% RH non-condensing (at temperatures of 25°C to 35°C)
Operating Systems	Microsoft Windows* 10, Linux*, Chrome OS*
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016
Bluetooth®	Bluetooth® 5.2

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)

Standards-based Miracast advances life without wires

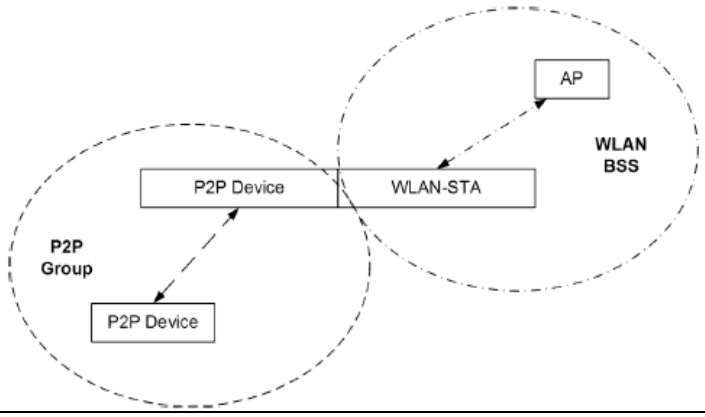
Miracast is an industry-wide solution, allowing technology to work across device types and vendors. Connections are easy to set up and use since Miracast devices choose the appropriate settings automatically. Miracast can connect two devices using network infrastructure or **Wi-Fi Direct®**. When content to be shared is stored on a Miracast-certified device, such as a smartphone to an automobile infotainment display, a Wi-Fi network connection is not required.

Only devices marked Wi-Fi CERTIFIED Miracast have been certified by Wi-Fi Alliance® to work well with other Wi-Fi CERTIFIED™ devices, employ the latest security protections, and deliver a high-quality user experience.

Source: https://www.wi-fi.org/discover-wi-fi/miracast

2.3 Concurrent operation

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



Source: Wi-Fi Direct Standard, v. 1.7, Section 2.3, Fig. 4

10.3.5 Association, reassociation, and disassociation

10.3.5.1 General

Subclause 10.3.5 describes the procedures used for IEEE 802.11 association,

10.1.2.1 TSF for infrastructure networks

In an infrastructure BSS, the AP shall be the timing master for the TSF. The AP shall initialize its TSF timer independently of any simultaneously started APs in an effort to minimize the synchronization of the TSF timers of multiple APs. The AP shall periodically transmit special frames called *Beacon frames* that contain the value of its TSF timer in order to synchronize the TSF timers of other STAs in a BSS. A receiving STA shall accept the timing information in Beacon frames sent from the AP servicing its BSS. If a STA's TSF timer is different from the timestamp in the received Beacon frame, the receiving STA shall set its local TSF timer to the received timestamp value.

10.1.3 Maintaining synchronization

10.1.3.1 General

Each STA shall maintain a TSF timer with modulus 2^{64} counting in increments of microseconds. STAs expect to receive Beacon frames at a nominal rate. The interval between Beacon frames is defined by the dot11BeaconPeriod parameter of the STA. A STA sending a Beacon frame shall set the value of the Beacon frame's timestamp so that it equals the value of the STA's TSF timer at the time that the data symbol containing the first bit of the timestamp is transmitted to the PHY plus the transmitting STA's delays through its local PHY from the MAC-PHY interface to its interface with the WM [e.g., antenna, light-emitting diode (LED) emission surface].

Source: IEEE 802.11-2012, Sections 10.1.2.1, 10.1.3, 10.1.3.1, 10.3.5 & 10.3.5.1

202. The XPS 13 Laptop is a first wireless devices comprising at least one processor configured to determine, via the wireless radio circuit, that a second wireless device corresponds to a wireless personal area network (WPAN) protocol. For example, the XPS 13 Laptop (a first

wireless device) includes the Intel Core i3-1115G4 system processor (a processor) configured to support the Wi-Fi Direct protocol (as shown above) by, for example, determining that a second wireless device, such as a television or other peripheral device (including, but not limited to, other Accused Products), corresponds to a Wi-Fi Direct Network (WPAN) using Wi-Fi Direct (a WPAN protocol):

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.

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

A searching P2P Device discovers a P2P Group Owner in the Scan Phase through received Beacon, DMG Beacon, SSW, or Probe Response frames. The searching P2P Device will also discover other P2P Devices that are associated to that P2P Group Owner from Group Information Advertisement (see Section 3.2.4) or, when operating within DMG, through a STA Availability element or Information Response frame (see Section 11.30.1 of IEEE 802.11-REVmc [11]).

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.1.1 & 3.1.2.2

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.

4 Frame formats

This section describes the information elements (see Section 4.1) and frame formats (see Section 4.2) in support of the capabilities described in clause P2P specific functions and services (see Section 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 802.11-2012 [1] for operation outside DMG and in IEEE 802.11-REVmc [11] for operation within DMG, with the Wi-Fi Alliance OUI and an OUI Type indicating P2P. A number of P2P attributes are defined; a single P2P IE carries one or more P2P attributes.

P2P Devices in the Search State shall transmit one or more Probe Request or Discovery DMG Beacon frames on each of the Social Channels supported by the P2P Device. 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.

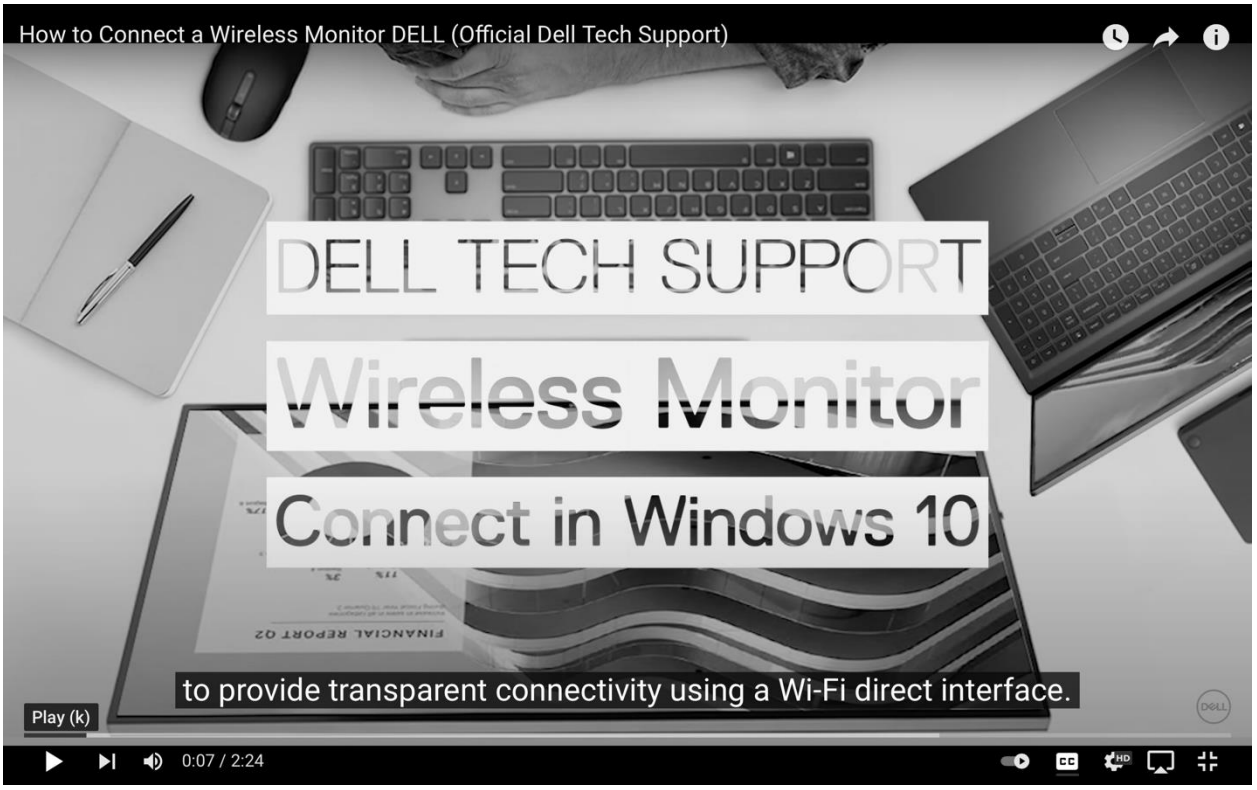
Probe Request frames sent by P2P devices in the Search State may include either one of the following:

— Requested Device Type attribute in the WSC IE. This attribute has the same format as the Primary Device Type attribute in the WSC specification.

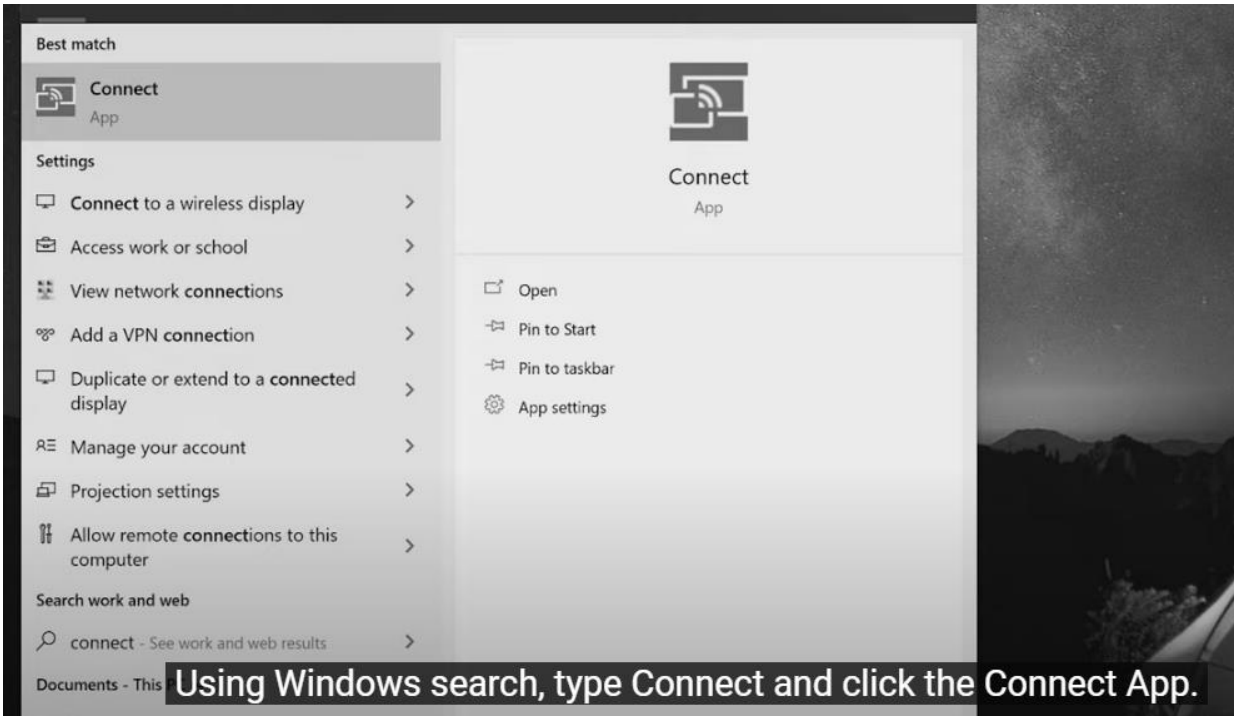
— P2P Device ID attribute in the P2P IE.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.1, 4 & 3.1.2.1.3

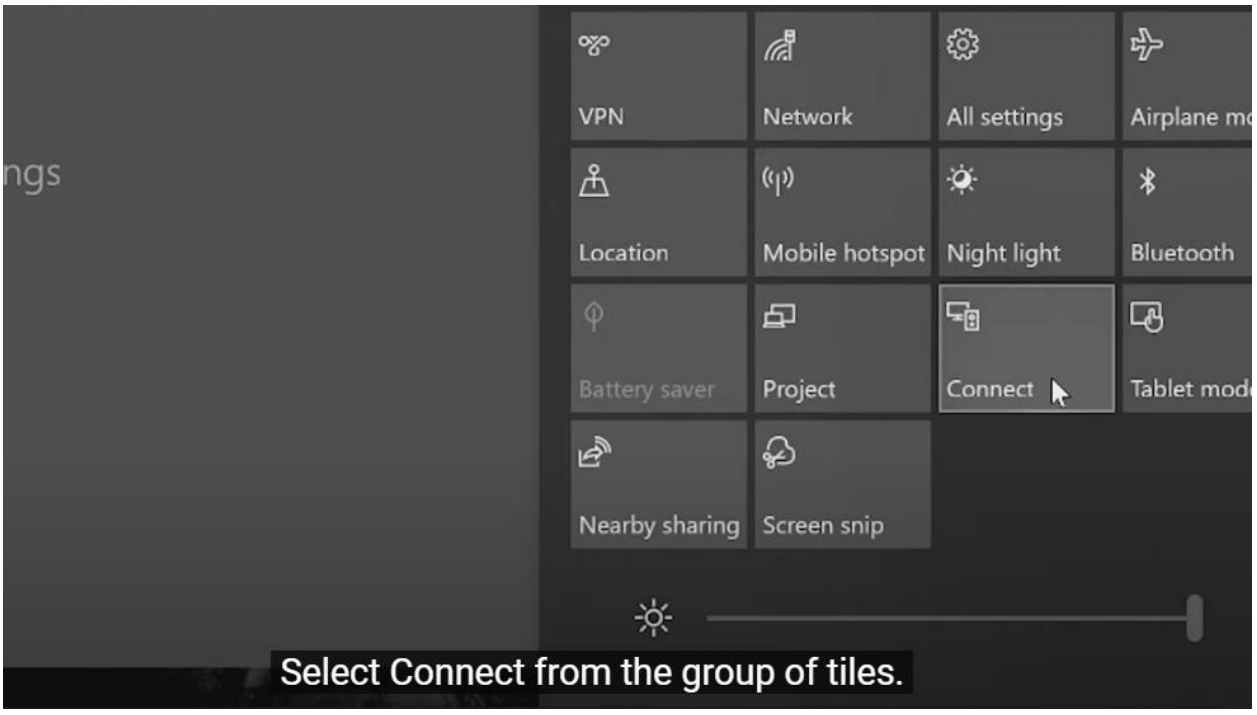

How to Connect a Wireless Monitor DELL (Official Dell Tech Support)
DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
Dell PCs and wireless monitors use Windows and Miracast technology
0:04 / 2:24

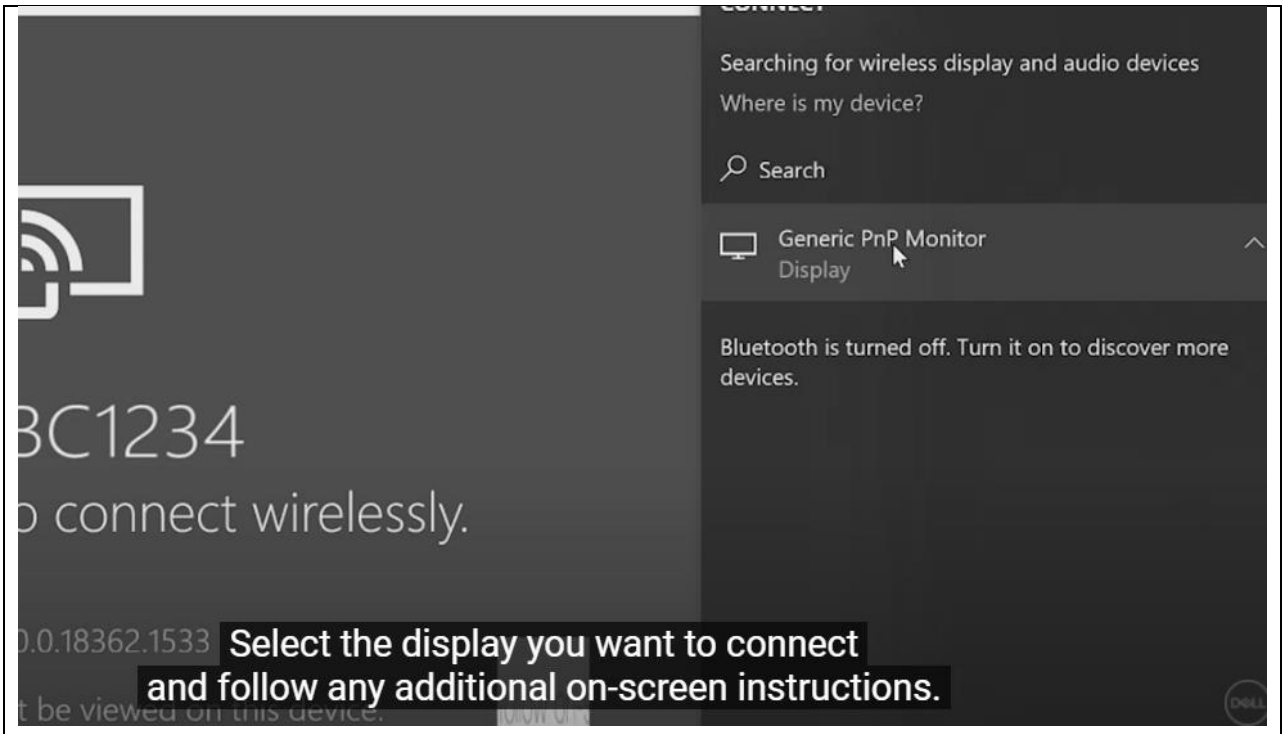

How to Connect a Wireless Monitor DELL (Official Dell Tech Support)
DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
to provide transparent connectivity using a Wi-Fi direct interface.
Play (k)
0:07 / 2:24


DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
In this video, we show you how to connect
your Miracast display to your Windows 10 device.


Best match
Connect
App
Settings
Connect to a wireless display
Access work or school
View network connections
Add a VPN connection
Duplicate or extend to a connected display
Manage your account
Projection settings
Allow remote connections to this computer
Search work and web
connect - See work and web results
Documents - This
Connect
App
Open
Pin to Start
Pin to taskbar
App settings
Using Windows search, type Connect and click the Connect App.


W10ABC1234
is ready for you to connect wirelessly.
Version: 10.0.18362.1533
Protected content can't be viewed on this device.
Press Ctrl + S to open Settings
Connect will open indicating that your Windows 10 Dell PC supports Miracast

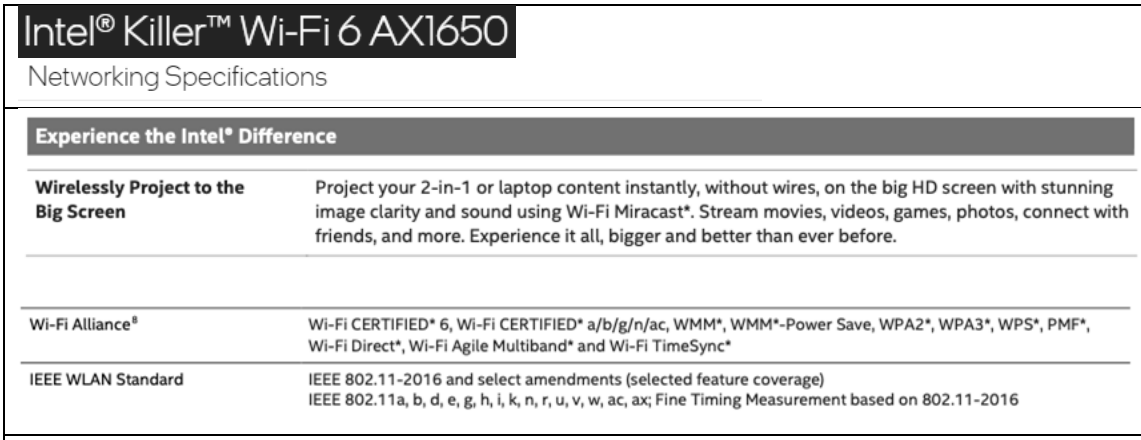

VPN
Network
All settings
Airplane mo
Location
Mobile hotspot
Night light
Bluetooth
Battery saver
Project
Connect
Tablet mod
Nearby sharing
Screen snip
Select Connect from the group of tiles.



Source: https://www.youtube.com/watch?v=kXBwdWp7sFM ("How to Connect a Wireless Monitor DELL (Official Dell Tech Support)"

203. The XPS 13 Laptop is a first wireless device comprising at least one processor configured to maintain, via the wireless radio circuit, a second association and a second synchronization over the wireless medium with the second wireless device over a second wireless connection using the WPAN protocol. For example, the XPS 13 Laptop (a first wireless device) includes the Intel Core i3-1115G4 system processor (a processor) configured to support the Wi-Fi Direct protocol (as shown above) by, for example, maintaining a second association and a second synchronization over the wireless medium to a second wireless device, such as a wireless monitor or other peripheral device (including, but not limited to, other Accused Products), over a second wireless connection between the XPS 13 Laptop and the second wireless device, using the Wi-Fi Direct protocol (a WPAN protocol). Furthermore, in accordance with the Wi-Fi Direct protocol, the XPS 13 Laptop, and other "hub" devices, are configured to maintain this second association and second synchronization with a second wireless device over a second wireless connection while

maintaining the first association and first synchronization with an AP of a WLAN over the first wireless connection using an 802.11x protocol (a WLAN protocol):

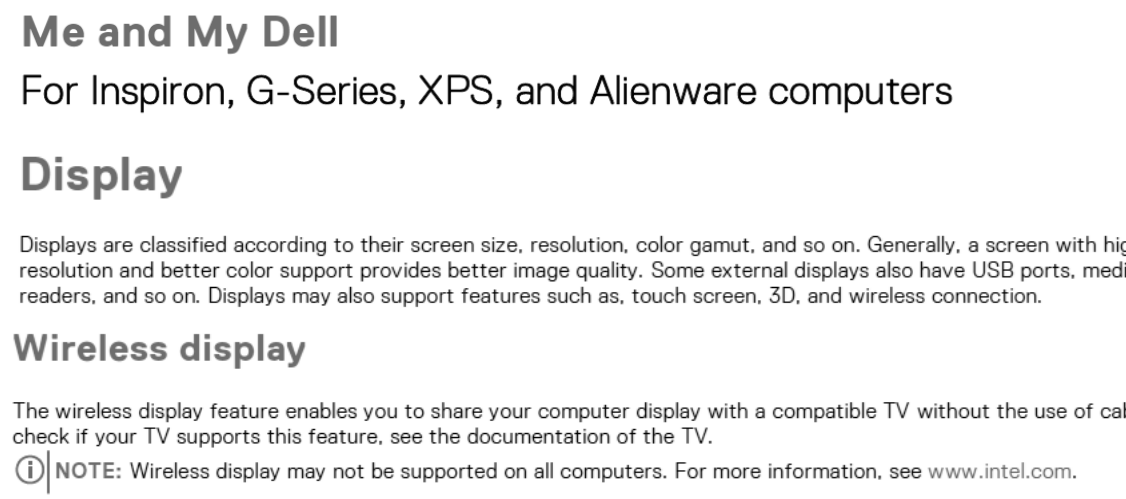


Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

Experience the Intel® Difference	
Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)



Me and My Dell

For Inspiron, G-Series, XPS, and Alienware computers

Display

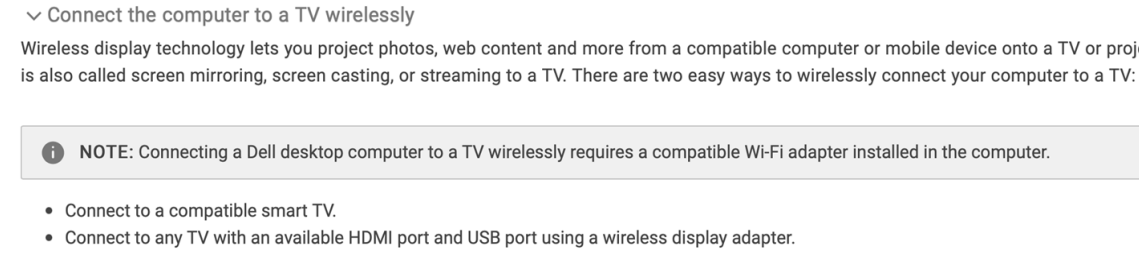
Displays are classified according to their screen size, resolution, color gamut, and so on. Generally, a screen with higher resolution and better color support provides better image quality. Some external displays also have USB ports, media-card readers, and so on. Displays may also support features such as, touch screen, 3D, and wireless connection.

Wireless display

The wireless display feature enables you to share your computer display with a compatible TV without the use of cables. To check if your TV supports this feature, see the documentation of the TV.

NOTE: Wireless display may not be supported on all computers. For more information, see www.intel.com.

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_reference-guide_en-us.pdf



Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

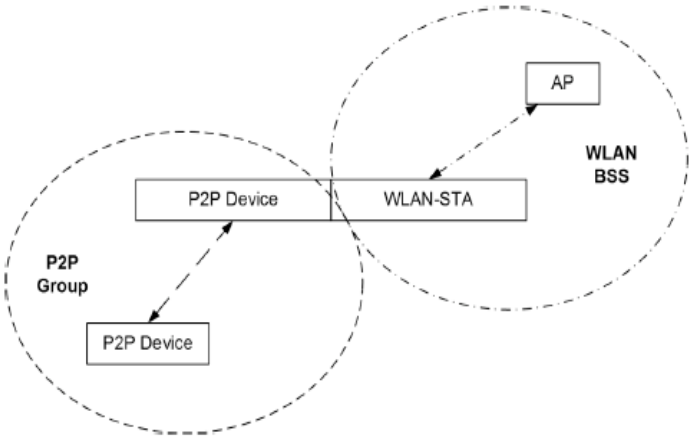
NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778

2.3 Concurrent operation

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



3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.

3.2.2 Starting and maintaining a P2P Group session

The P2P Group Owner may be determined through the Group Formation Procedure described in Section 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.

3.2.3 Connecting to a P2P Group

The P2P Client acquires the Group Credentials through static configuration or through Wi-Fi Simple Configuration [2]. When using Wi-Fi Simple Configuration [2], the P2P Group Owner shall serve as the WSC Registrar and the P2P Client shall serve as the WSC Enrollee. In order to connect to a P2P Group, the P2P Client operating outside DMG, using the Credentials, shall engage in the authentication procedure in Section 10.3.4.2 of IEEE 802.11-2012 [1] and the association procedure in Section 10.3.5.2 of IEEE 802.11-2012 [1] with the P2P Group Owner. In order to connect to a P2P Group, the P2P Client operating within DMG, using the Credentials, shall engage in the association procedure in Section 11.3.5.2 of IEEE 802.11-REVmc [11] with the P2P Group Owner.

When a P2P Client associates with a P2P Group Owner, it provides its Device Name, Primary Device Type, and optionally Secondary Device Type List information to the P2P Group Owner by including the P2P Device Info attribute (see Section 4.1.15) and the P2P Capability attribute (see Section 4.1.4) in the P2P IE in the Association Request frame. This information shall be used by the

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.3, Fig. 4, 3.2, 3.2.2 & 3.2.3

10.1.2.1 TSF for infrastructure networks

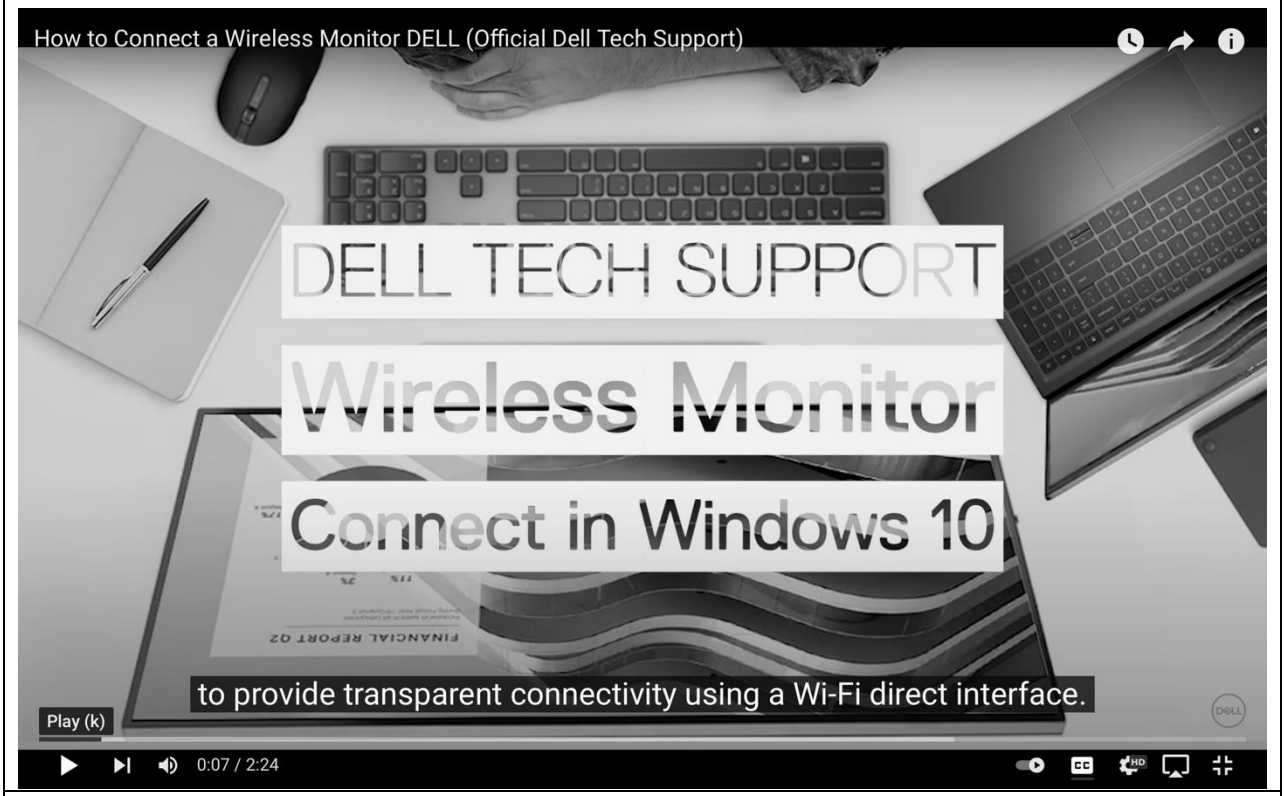
In an infrastructure BSS, the AP shall be the timing master for the TSF. The AP shall initialize its TSF timer independently of any simultaneously started APs in an effort to minimize the synchronization of the TSF timers of multiple APs. The AP shall periodically transmit special frames called *Beacon frames* that contain the value of its TSF timer in order to synchronize the TSF timers of other STAs in a BSS. A receiving STA shall accept the timing information in Beacon frames sent from the AP servicing its BSS. If a STA's TSF timer is different from the timestamp in the received Beacon frame, the receiving STA shall set its local TSF timer to the received timestamp value.

10.1.3 Maintaining synchronization

10.1.3.1 General

Each STA shall maintain a TSF timer with modulus 2^{64} counting in increments of microseconds. STAs expect to receive Beacon frames at a nominal rate. The interval between Beacon frames is defined by the dot11BeaconPeriod parameter of the STA. A STA sending a Beacon frame shall set the value of the Beacon frame's timestamp so that it equals the value of the STA's TSF timer at the time that the data symbol containing the first bit of the timestamp is transmitted to the PHY plus the transmitting STA's delays through its local PHY from the MAC-PHY interface to its interface with the WM [e.g., antenna, light-emitting diode (LED) emission surface].

Source: IEEE 802.11-2012, Sections 10.1.2.1 & 10.1.3.1



Source: https://www.youtube.com/watch?v=kXBwdWp7sFM ("How to Connect a Wireless Monitor DELL (Official Dell Tech Support)"

204. The XPS 13 Laptop is a first wireless device comprising at least one processor configured to participate in a first coordination of a first usage of the wireless medium over the first wireless connection using the WLAN protocol. For example, the XPS 13 Laptop (a first wireless device) includes the Intel Core i3-1115G4 system processor (a processor) configured to support the 802.11x WLAN protocol and the Wi-Fi Direct protocol (as shown above) by, for example, participating in a first coordination of a first usage of the wireless medium over the first wireless connection to an AP of a WLAN using an 802.11x protocol (a WLAN protocol):

9.2 MAC architecture

9.2.1 General

A representation of the MAC architecture is shown in Figure 9-1 in which the PCF and HCF services are provided using the services of the DCF. Note that in a non-QoS STA, HCF is not present. In a QoS STA implementation, both DCF and HCF are present. PCF is optional in all STAs.

Due to the distributed nature of the MBSS, only the MCF is present in a mesh STA.

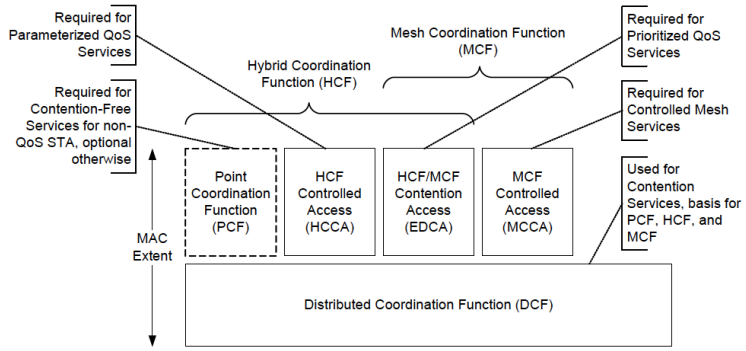


Figure 9-1—MAC architecture

9.2.2 DCF

The fundamental access method of the IEEE 802.11 MAC is a DCF known as *carrier sense multiple access with collision avoidance* (CSMA/CA). The DCF shall be implemented in all STAs.

9.3 DCF

9.3.1 General

The basic medium access protocol is a DCF that allows for automatic medium sharing between compatible PHYs through the use of CSMA/CA and a random backoff time following a busy medium condition. In addition, all individually addressed traffic uses immediate positive acknowledgment (ACK frame) where retransmission is scheduled by the sender if no ACK is received.

The CSMA/CA protocol is designed to reduce the collision probability between multiple STAs accessing a medium, at the point where collisions would most likely occur. Just after the medium becomes idle following a busy medium (as indicated by the CS function) is when the highest probability of a collision exists. This is because multiple STAs could have been waiting for the medium to become available again. This is the situation that necessitates a random backoff procedure to resolve medium contention conflicts.

Source: IEEE 802.11-2012, Sections 9.2, 9.2.1, 9.2.2 & 9.2.3

205. The XPS 13 Laptop is a first wireless device comprising at least one processor configured to participate in a second coordination of a second usage of the wireless medium over the second wireless connection using the WPAN protocol. For example, the XPS 13 Laptop (a first wireless device) includes the Intel Core i3-1115G4 system processor (a processor) configured to support the Wi-Fi Direct protocol (as shown above) by, for example, participating in a second coordination of a second usage of the wireless medium over the second wireless connection using the Wi-Fi Direct protocol (a WPAN protocol):

2.4 Functions and services

2.4.1 Basic functions and services

For P2P operation outside the DMG, this specification assumes that the following STA functions and services are implemented in P2P Devices:

- IEEE 802.11g or newer 2.4 GHz PHY [1]
- IEEE 802.11i (AES-CCMP) [1]
- Wi-Fi Simple Configuration [2]
- Wi-Fi Multimedia [3]

3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.1 and 3.2

9.2 MAC architecture

9.2.1 General

A representation of the MAC architecture is shown in Figure 9-1 in which the PCF and HCF services are provided using the services of the DCF. Note that in a non-QoS STA, HCF is not present. In a QoS STA implementation, both DCF and HCF are present. PCF is optional in all STAs.

Due to the distributed nature of the MBSS, only the MCF is present in a mesh STA.

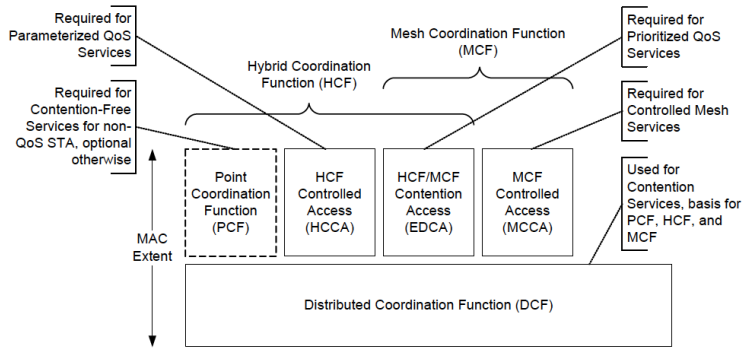


Figure 9-1—MAC architecture

9.2.2 DCF

The fundamental access method of the IEEE 802.11 MAC is a DCF known as *carrier sense multiple access with collision avoidance* (CSMA/CA). The DCF shall be implemented in all STAs.

9.3 DCF

9.3.1 General

The basic medium access protocol is a DCF that allows for automatic medium sharing between compatible PHYs through the use of CSMA/CA and a random backoff time following a busy medium condition. In addition, all individually addressed traffic uses immediate positive acknowledgment (ACK frame) where retransmission is scheduled by the sender if no ACK is received.

The CSMA/CA protocol is designed to reduce the collision probability between multiple STAs accessing a medium, at the point where collisions would most likely occur. Just after the medium becomes idle following a busy medium (as indicated by the CS function) is when the highest probability of a collision exists. This is because multiple STAs could have been waiting for the medium to become available again. This is the situation that necessitates a random backoff procedure to resolve medium contention conflicts.

Source: IEEE 802.11-2012, Sections 9.2, 9.2.1, 9.2.2 & 9.2.3

206. In the XPS 13 Laptop, the WPAN protocol (Wi-Fi Direct) is an overlay protocol with respect to the WLAN protocol (802.11x Wi-Fi). For example, Wi-Fi Direct frames are based on 802.11x frames and use the vendor specific field of an 802.11x management frame. The Wi-Fi Direct protocol processes the data in the vendor-specific field that is overlaid on a Wi-Fi management frame.

2.4.1 Basic functions and services

For P2P operation outside the DMG, this specification assumes that the following STA functions and services are implemented in P2P Devices:

- IEEE 802.11g or newer 2.4 GHz PHY [1]
- IEEE 802.11i (AES-CCMP) [1]
- Wi-Fi Simple Configuration [2]
- Wi-Fi Multimedia [3]

Any required 'AP-like' functions and services required for P2P Group Owner operation outside DMG are described within this specification. A P2P Group Owner operating within DMG is required to support PCP functions and services.

3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.

* * *

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 802.11-2012 [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.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.1, 3.2 & 4

8.3.3 Management frames

8.3.3.1 Format of management frames

The format of a management frame is defined in Figure 8-34. The Frame Control, Duration, Address 1, Address 2, Address 3, and Sequence Control fields are present in all management frame subtypes. The maximum unencrypted MMPDU size, excluding the MAC header and FCS, is 2304 octets.

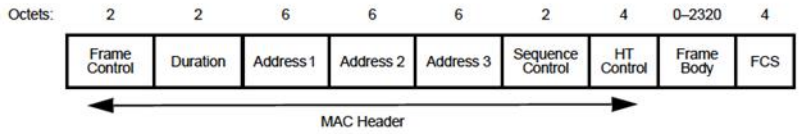


Figure 8-34—Management frame format

The HT Control field is defined in 8.2.4.6. The presence of the HT Control field is determined by the Order subfield of the Frame Control field, as specified in 8.2.4.1.10.

The frame body consists of the fields followed by the elements defined for each management frame subtype. All fields and elements are mandatory unless stated otherwise and appear in the specified, relative order. STAs that encounter an element ID they do not recognize in the frame body of a received management frame ignore that element and continue to parse the remainder of the management frame body (if any) for additional elements with recognizable element IDs. See 9.24.7. Unused element ID codes are reserved.

Gaps may exist in the ordering of fields and elements within frames. The order that remains is ascending.

8.4 Management frame body components

8.4.1 Fields that are not information elements

8.4.2 Information elements

8.4.2.1 General

Elements are defined to have a common general format consisting of a 1 octet Element ID field, a 1 octet Length field, and a variable-length element-specific Information field. Each element is assigned a unique Element ID as defined in this standard. The Length field specifies the number of octets in the Information field. See Figure 8-81.

	Element ID	Length	Information
Octets:	1	1	variable

Figure 8-81—Element format

The set of valid elements is defined in Table 8-54.

Table 8-54—Element IDs

Element	Element ID	Length of indicated element (in octets)	Extensible
SSID (see 8.4.2.2)	0	2 to 34	
Supported rates (see 8.4.2.3)	1	3 to 10	

Table 8-54—Element IDs *(continued)*

Element	Element ID	Length of indicated element (in octets)	Extensible
U-APSD Coexistence (see 8.4.2.93)	142	14 to 257	Subelements
Reserved	143–173		
MCCAOP Advertisement Overview (see 8.4.2.110)	174	8	Yes
Reserved	175–220		
Vendor Specific (see 8.4.2.28)	221	3 to 257	
Reserved	222–255		

8.5.6 Vendor-specific action details

The Vendor Specific Action frame is defined for vendor-specific signaling. The format of the Action field of the Vendor Specific Action frame is shown in Figure 8-437. An Organization Identifier, in the octet field immediately after the Category field, differentiates the vendors (see 8.4.1.31).

NOTE—If management frame protection is negotiated, then Vendor Specific Protected Action frames (see Table 8-38) are protected; otherwise they are unprotected.

	Category	Organization Identifier	Vendor Specific Content
Octets:	1	*j*	Variable

Figure 8-437—Vendor Specific Action frame Action field format

The Category field is set to the value indicating the vendor-specific category, as specified in Table 8-38.

The Organization Identifier contains a public organizationally unique identifier assigned by the IEEE and is specified in 8.4.1.31. The order of the Organization Identifier field is described in 8.2.2.

The Vendor Specific Content contains vendor-specific field(s). The length of the Vendor Specific Content in a Vendor Specific Action frame is limited by the maximum allowed MMPDU size.

Source: IEEE 802.11-2012, Sections 8.3.3.1, 8.4.2.1 & 8.5.6

207. In the XPS 13 Laptop, the WPAN protocol is an overlay protocol with respect to the WLAN protocol, such that the WPAN protocol uses a first WPAN protocol frame comprising a WLAN protocol frame adapted to support a WPAN protocol power-saving procedure. For example, in Wi-Fi Direct (the WPAN protocol) the WPAN-adapted frame may utilize the Vendor Specific Information Element (IE) field of an 802.11x protocol frame (a WLAN protocol frame) to carry information not defined by the IEEE 802.11x Standard so that interoperability operations

that are not part of the 802.11x standard can be implemented, such as those required by the power save features defined by the Wi-Fi Direct Standard. For example, in Wi-Fi Direct, two of the P2P Group Owner's adapted power saving protocol schemes are Notice of Absence and Opportunistic Power Save:

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 802.11-2012 [1] for operation outside DMG and in IEEE 802.11-REVmc [11] for operation within DMG, with the Wi-Fi Alliance OUI and an OUI Type indicating P2P. A number of P2P attributes are defined; a single P2P IE carries one or more P2P attributes.

* * *

3.3 P2P Power Management

The P2P power management approach for operation outside DMG 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.

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.

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

4.1.14 Notice of Absence attribute

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

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.
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.

The Notice of Absence attribute shall be present in the P2P IE in the Beacon frames and Probe Response frames transmitted by a P2P Group Owner when a Notice of Absence schedule is being advertised or when the CTWindow is non-zero, as described in Section 4.2.1 and Section 4.2.3. If there is neither a Notice of Absence schedule nor a CTWindow, the GO may omit the Notice of Absence attribute from Beacon and Probe Response frames. The Notice of Absence shall be also present in Notice of Absence frames, as described in Section 4.2.10.2, P2P Presence Request frames, as described in Section 4.2.10.3, and P2P Presence Response frames, as described in Section 4.2.10.4.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 4, 3.3.1, 3.3.2, & 4.1.14

208. In the XPS 13 Laptop, the WPAN protocol is partially compliant with respect to the WLAN protocol, such that said second usage occurs without interference from the WLAN. Aspects of the Wi-Fi Direct protocol which are compliant with the WLAN protocol (802.11x Wi-Fi) include, for example, how P2P devices utilize and access the wireless medium. For example, the XPS 13 Laptop, in supporting Wi-Fi Direct, is required to implement the underlying IEEE 802.11g (or newer) Standard at the PHY level, as shown below. By implementing the underlying PHY protocol, WPAN devices use and access the wireless medium in a manner that is coordinated with 802.11x communications occurring outside of the WPAN, yet in a common wireless space (such as the first wireless connection between the XPS 13 Laptop and an AP in the 802.11x WLAN), such that the problems of device interference are reduced.

2.4.1 Basic functions and services

For P2P operation outside the DMG, this specification assumes that the following STA functions and services are implemented in P2P Devices:

- IEEE 802.11g or newer 2.4 GHz PHY [1]
- IEEE 802.11i (AES-CCMP) [1]
- Wi-Fi Simple Configuration [2]
- Wi-Fi Multimedia [3]

In order to promote efficient wireless medium use when operating outside DMG:

- P2P Devices shall not use 11b rates (1, 2, 5.5, 11 Mbps) for data and management frames except:
  - Probe Request frames sent to both P2P Devices and non-P2P Devices.
- P2P Devices shall not respond to Probe Request frames that indicate support for 11b rates only.

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

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

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

* * *

3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.1 & 3.2

9.2 MAC architecture

9.2.1 General

A representation of the MAC architecture is shown in Figure 9-1 in which the PCF and HCF services are provided using the services of the DCF. Note that in a non-QoS STA, HCF is not present. In a QoS STA implementation, both DCF and HCF are present. PCF is optional in all STAs.

Due to the distributed nature of the MBSS, only the MCF is present in a mesh STA.

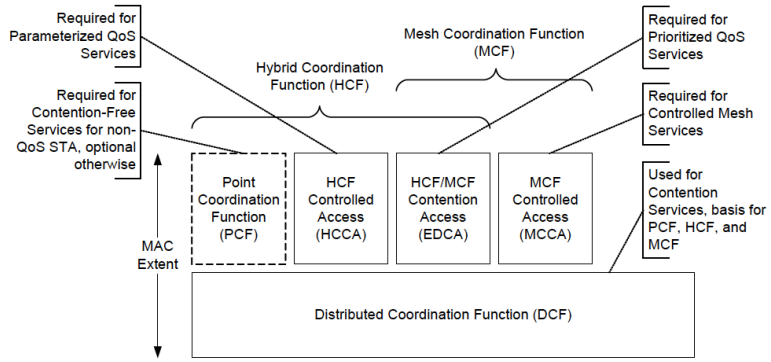


Figure 9-1—MAC architecture

9.2.2 DCF

The fundamental access method of the IEEE 802.11 MAC is a DCF known as *carrier sense multiple access with collision avoidance* (CSMA/CA). The DCF shall be implemented in all STAs.

9.3 DCF

9.3.1 General

The basic medium access protocol is a DCF that allows for automatic medium sharing between compatible PHYs through the use of CSMA/CA and a random backoff time following a busy medium condition. In addition, all individually addressed traffic uses immediate positive acknowledgment (ACK frame) where retransmission is scheduled by the sender if no ACK is received.

The CSMA/CA protocol is designed to reduce the collision probability between multiple STAs accessing a medium, at the point where collisions would most likely occur. Just after the medium becomes idle following a busy medium (as indicated by the CS function) is when the highest probability of a collision exists. This is because multiple STAs could have been waiting for the medium to become available again. This is the situation that necessitates a random backoff procedure to resolve medium contention conflicts.

* * *

are not already members of the BSSDescriptionSet. To actively scan, the STA shall transmit Probe request frames containing the desired SSID or one or more SSID List elements. When the SSID List element is pres-

8.3.3.9 Probe Request frame format

The frame body of a management frame of subtype Probe Request contains the information shown in Table 8-26.

Table 8-26—Probe Request frame body

Order	Information	Notes
1	SSID	If dot11MeshActivated is true, the SSID element is the wildcard value as described in 8.4.2.2.
2	Supported rates	
SupportedRates	Set of integers	2–127 inclusive (for each integer in the set)	The set of data rates (in units of 500 kb/s) that are supported by the STA that is requesting association.

Source: IEEE 802.11-2012 Standard, Sections 9.2, 9.2.1, 9.2.2, 9.3 & 8.3.3.9

209. Aspects of the Wi-Fi Direct protocol which are not compliant with the WLAN protocol (Wi-Fi) include, for example, aspects of P2P Discovery, P2P Power Management, and Managed P2P Device Operation as set out below:

2.4.2 P2P specific functions and services

In addition to the assumed functions listed in Section 2.4.1, a P2P Device supports the 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 802.11-2012 [1] when operating outside DMG and PBSS operation as defined in IEEE 802.11-REVmc [11] when operating within DMG, and provides additions for a P2P Group operation.
- **P2P Power Management** provides a set of functions to reduce power consumption of P2P Devices that operate outside DMG.
- **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.

A P2P Group Owner shall respond to Probe Request frames following the rules in IEEE 802.11-2012 [1] for operation outside DMG and the rules in IEEE 802.11-REVmc [11] for operation within DMG, 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 802.11-2012 [1], Clause Section 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.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.2 & 3.2.2

210. In the XPS 13 Laptop, the WPAN protocol is partially compliant with respect to the WLAN protocol such that the WPAN protocol uses a second WPAN protocol frame comprising a WLAN probe request frame adapted to determine that the second wireless device corresponds to the WPAN protocol. For example, in Wi-Fi Direct (the WPAN protocol) the second WPAN-adapted frame may utilize the Vendor Specific Information Element (IE) field of an 802.11x probe request protocol frame to specify one or more P2P IEs and/or WSC IEs (Wi-Fi Simple Configuration Information Elements; the WLAN protocol may alternatively be the WSC protocol, which leverages the 802.11x protocol). The WPAN-adapted probe request frame containing one or more P2P IEs, specifies P2P attributes including P2P Capability, P2P Device ID, Listen Channel, P2P Device Info, and other information such that, for example, an Accused Product (a first wireless device) could determine that a second wireless device corresponds to the Wi-Fi Direct protocol (a WPAN protocol):

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. In-band P2P Device Discovery consists of two major phases: Scan and Find, which are described in detail in the following sections. Alternatively, if two P2P Devices support NFC, the user may specify the target device by touching the P2P Device's NFC Interface to the corresponding device's NFC Interface. Such NFC Out-of-Band Device Discovery is defined in Section 3.1.2.7.

In-band Device Discovery uses Probe Request and Probe Response frames to exchange device information. When operating outside DMG, the P2P Devices in a P2P Group are discovered via a Probe Response frame from the P2P Group Owner. When operating within DMG, P2P Devices in a P2P Group are normally discovered via an SSW frame received in response to a DMG Beacon transmission as described in Section 11.1.4.3 of IEEE 802.11-REVmc [11]; Probe Request and Probe Response frames are subsequently used to exchange device information. Alternatively, Probe Request and Probe Response frames may be used instead of SSW frames for devices that do not use beamforming.

* * *

3.1.2.1.1 Listen State

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.

* * *

4.2.2 Probe Request frame format

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

One or more P2P IEs and the WSC IE shall be inserted after other information elements in the Probe Request frames transmitted by a P2P Device as shown in Table 49.

Table 49—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.

Additional attributes shall be inserted in the WSC IE that is included in the Probe Request frame as shown in Table 50.

Table 50—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.

P2P attributes for a P2P IE that is included in the Probe Request frame are shown in Table 51.

Table 51—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.
P2P Device Info	13	For operation within DMG, the P2P Device Info attribute shall be present in the P2P IE to indicate the P2P Device information.
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.
Service Hash	21	The Service Hash attribute may be present in the P2P IE if P2Ps is supported. The usage of this attribute is defined in the Wi-Fi Peer-to-Peer Services specification [10].

* * *

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.

WLAN	Wireless Local Area Network
WMM®	Wi-Fi Multimedia™
WPA2™	Wi-Fi Protected Access® 2
WMM-PS	Wireless Multimedia Power Save
WSC	Wi-Fi Simple Configuration

1.3 References

[1] IEEE 802.11-2012 IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local anc metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications

[2] Wi-Fi Simple Configuration Specification, Wi-Fi Alliance, http://www.wi-fi.org

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.1.1, 3.1.2.1, 3.1.2.1.1, 3.1.2.1.2, 4.2.2, Table 51, & 1.3, 1.4, 2.1

8.3.3.9 Probe Request frame format

The frame body of a management frame of subtype Probe Request contains the information shown in Table 8-26.

Table 8-26—Probe Request frame body

Order	Information	Notes
1	SSID	If dot11MeshActivated is true, the SSID element is the wildcard value as described in 8.4.2.2.
2	Supported rates	
3	Request information	The Request element is optionally present if dot11MultiDomainCapabilityActivated is true.
4	Extended Supported Rates	The Extended Supported Rates element is present if there are more than eight supported rates, and is optionally present otherwise.

Table 8-26—Probe Request frame body *(continued)*

Order	Information	Notes
5	DSSS Parameter Set	The DSSS Parameter Set element is present within Probe Request frames generated by STAs using Clause 16, Clause 17, or Clause 19 PHYs if dot11RadioMeasurementActivated is true. The DSSS Parameter Set element is present within Probe Request frames generated by STAs using a Clause 20 PHY in the 2.4 GHz band if dot11RadioMeasurementActivated is true. The DSSS Parameter Set element is optionally present within Probe Request frames generated by STAs using Clause 16, Clause 17, or Clause 19 PHYs if dot11RadioMeasurementActivated is false. The DSSS Parameter Set element is optionally present within Probe Request frames generated by STAs using a Clause 20 PHY in the 2.4 GHz band if dot11RadioMeasurementActivated is false.
6	Supported Operating Classes	The Supported Operating Classes element is present if dot11ExtendedChannelSwitchActivated is true.
7	HT Capabilities	The HT Capabilities element is present when dot11HighThroughputOptionImplemented attribute is true.
8	20/40 BSS Coexistence	The 20/40 BSS Coexistence element is optionally present when the dot112040BSSCoexistenceManagementSupport attribute is true.
9	Extended Capabilities	The Extended Capabilities element is optionally present if any of the fields in this element are nonzero.
10	SSID List	The SSID List element is optionally present if dot11MgmtOptionSSIDListActivated is true.
11	Channel Usage	The Channel Usage element is optionally present if dot11MgmtOptionChannelUsageActivated is true.
12	Interworking	The Interworking element is present if dot11InterworkingServiceActivated is true.
13	Mesh ID	The Mesh ID element is present if dot11MeshActivated is true.
Last	Vendor Specific	One or more vendor-specific elements are optionally present. These elements follow all other elements.

Source: IEEE 802.11-2012 Standard, Section 8.3.3.9

8.2.4 Probe Request (D-E or D-R)

If the station intends to use Wi-Fi Simple Configuration protocol, the Wi-Fi Simple Configuration Information Element shall be included in a probe request, and contain the following device attributes (Enrollee or Registrar):

Table 6 – Attributes in WSC IE in the Probe Request frame

Attribute	R/O/C	Notes
Version	R	Deprecated. Always set to 0x10 for backwards compatibility. See Version2 for current version negotiation mechanism.
Request Type	R	
Configuration Methods	R	
UUID-(E or R)	R	
Primary Device Type	R	
RF Bands	R	Specific RF band used for this message.
Association State	R	
Configuration Error	R	
Device Password ID	R	If the device is in PBC mode this value shall be 0x0004 (Pushbutton).
Manufacturer	C	Shall be included in protocol version 2.0 and higher.
Model Name	C	Shall be included in protocol version 2.0 and higher.
Model Number	C	Shall be included in protocol version 2.0 and higher.
Device Name	C	User-friendly description of device. Shall be included in protocol version 2.0 and higher.

Attribute	R/O/C	Notes
Version2 (inside WFA Vendor Extension)	C	0x20 = version 2.0, 0x21 = version 2.1, etc. Shall be included in protocol version 2.0 and higher.
Request to Enroll (inside WFA Vendor Extension)	O	Indicates the desire to enroll in the network. If the Registrar gets this attribute it can use this as a trigger that a device wants to enroll.
Requested Device Type	O	When a device receives a Probe Request containing a WSC IE with the Requested Device Type attribute it will only respond with a Probe Response if the devices Primary Device Type or Secondary Device Type matches the Requested Device Type contained in the Probe Request.
<other...>	O	Multiple attributes are permitted.

Source: WSC Specification, v.2.0.7, Section 8.2.4

211. In addition, the second WPAN protocol frame comprises an SSID adapted to identify the WPAN protocol. For example, in the XPS 13 Laptop, the second WPAN-adapted frame uses a modified 802.11x probe request frame (a WLAN protocol probe request frame). For example, besides Wi-Fi Direct calling for the use the of the Vendor Specific IE field of the 802.11x protocol probe request frame to indicate that a wireless device corresponds to the Wi-Fi Direct protocol, as discussed above, Wi-Fi Direct also calls for the SSID element in the 802.11x probe request frame be adapted to identify the Wi-Fi Direct protocol (the WPAN protocol) via setting the SSID element to the P2P Wildcard SSID:

3.1.2.1.2 Scan Phase

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 Section 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.

* * *

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 uniform 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 IEEE802.11-2012 [1] may be included after the string "DIRECT-xy" (including none).

Source: Wi-Fi Direct Standard, v. 1.7, Sections 3.1.2.1.2 & 3.2.1

8.3.3.9 Probe Request frame format

The frame body of a management frame of subtype Probe Request contains the information shown in Table 8-26.

Table 8-26—Probe Request frame body

Order	Information	Notes
1	SSID	If dot11MeshActivated is true, the SSID element is the wildcard value as described in 8.4.2.2.
2	Supported rates	
3	Request information	The Request element is optionally present if dot11MultiDomainCapabilityActivated is true.
4	Extended Supported Rates	The Extended Supported Rates element is present if there are more than eight supported rates, and is optionally present otherwise.

Source: IEEE 802.11-2012 Standard, Section 8.3.3.9

212. As set forth above, Dell has directly infringed at least claim 7 of the '504 patent by making, importing, using, offering for sale and/or selling the Hub Accused Products into or in the United States.

213. Dell intentionally designed and incorporated the IEEE 802.11x and the Wi-Fi Direct features and functionalities described above into the Accused Products.

214. Dell provides instructions (in the form of at least user interface prompts and customer support instructional videos) to its customers, advertising, encouraging and directing the customers to use the Accused Products in an infringing manner as described above to implement the IEEE 802.11x/Wi-Fi Direct functionality, as intended by Dell. For example, Dell provides operating instructions and the like for the Accused Products, including, but not limited to, the citations above and the following:

- https://www.youtube.com/watch?v=kXBwdWp7sFM
- https://www.dell.com/support/kbdoc/en-use/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778
- https://www.dell.com/support/kbdoc/en-us/000136674/miracast-to-replace-wi-di
- https://www.dell.com/support/kbdoc/en-us/000129880/miracast-users-may-encounter-various-issues-in-the-windows-10-operating-system
- https://www.dell.com/support/kbdoc/en-us/000130716/guide-to-dell-wireless-monitors
- https://www.dell.com/support/kbdoc/en-us/000152972/how-do-i-enable-widi-miracast-on-my-venue-7-3740-or-venue-8-3840?lang=en
- https://www.dell.com/support/kbdoc/en-us/000129818/a-guide-to-miracast-on-the-latitude-13-7350-tablet-pc?lang=en
- https://www.dell.com/support/kbdoc/en-us/000141601/xps-13-9350-touch-cursor-and-sound-may-have-a-lag-when-system-connected-wifi-miracast-and-bluetooth-audio?lang=en

- https://www.dell.com/support/manuals/en-us/latitude-13-7390-laptop/latitude_7290_7390_7490_tgb/wlan-—-miracast-support-matrix?guid=guid-76975785-70c3-4039-b5bb-eb0b83e669b3&lang=en-us
- https://www.dell.com/support/manuals/en-us/inspiron-11-3179-2-in-1-laptop/inspiron_11_3179_setupandspecs/communications?guid=guid-5fea805b-7f8a-420f-b984-b0e93e13048e&lang=en-us
- https://www.dell.com/support/manuals/en-us/alienware-15-laptop/alienware-15-r3-setupandspecifications/communications?guid=guid-935baab6-b4b4-4960-9783-971e87de151c&lang=en-us

215. By its instructions, including those set forth above, and with intent that they use the IEEE 802.11x/Wi-Fi Direct features described above, Dell has induced its customers to infringe the ’504 patent. Dell’s customers who use the Accused Products as described above directly infringe the ’504 patent. Upon information and belief, as a result of attempts by the inventors to sell or license their patents to the PC industry, of which Dell is a member, Dell has had knowledge of (or has been willfully blind to) the ’504 patent, a child of the ’991 patent, since its application was filed and its issuance was received. Further, Dell has had knowledge of (or has been willfully blind to) the ’504 patent since at least September 9, 2020, as a result of a letter from Christian Dubuc, Chief Executive Officer of Ozmo Licensing, to Richard Rothberg, General Counsel for Dell, regarding Ozmo Licensing’s patent portfolio and the Accused Dell Products, informing Dell that it required a license. On September 9, 2020, Ozmo Licensing had only eight patents and patent applications that embodied the inventions of Vleugels and Peeters. In addition, upon information and belief, Dell would have gained knowledge of the ’504 patent by virtue of the litigation filed against HP Inc. (Docket No: 6:21-cv-00383-ADA) and against Acer Inc. (Docket No. 6:21-cv-

01225-ADA). Dell also induces such direct infringement by its customers by failing to remove the infringing features from the Accused Products.

216. Upon information and belief, Dell has had knowledge or has been willfully blind of the '504 patent since at least as early as the day the '504 patent issued, September 14, 2021, but no later than the date of service upon it of this Complaint.

217. By its instructions, including those set forth above, and with intent that they use the IEEE 802.11x/Wi-Fi Direct features described above, Dell has also contributed to its customers' infringement of the '504 patent. The Accused Products are used by Dell's customers to practice the inventions claimed in the '504 patent. The IEEE 802.11x/Wi-Fi Direct features as performed by the Accused Products as described above constitute material parts of the claimed inventions of the '504 patent. Dell knows or is willfully blind that portions of the hardware and software in the Accused Products were specifically made or adapted by Dell solely to provide such functionality and that such features are not staple articles or commodities of commerce suitable for substantial non-infringing use. Dell also knows, via at least the aforementioned communications with Ozmo Licensing, or is willfully blind that such combinations of hardware and software have no use other than to provide such functionality as intentionally designed into the Accused Products by Dell.

218. By the time of trial, Dell will have known and intended that its continued actions would directly infringe, and would induce and contribute to the infringement by its customers of, at least claim 7 of the '504 patent.

219. Ozmo Licensing has been damaged by Dell's past and ongoing direct and indirect infringement of the '504 patent.

220. With knowledge of the allegations set forth herein, Dell nonetheless refuses to remove the infringing functionalities from the Accused Products or to compensate Ozmo

Licensing for the use of such features. Dell's infringement described above will continue unabated unless and until Dell is enjoined or ordered to pay a reasonable royalty for a license to the '504 patent.

COUNT VI
(Dell's Infringement of U.S. Patent No. 11,252,659)

221. Paragraphs 1-220 are incorporated by reference as if fully set forth herein.

222. The invention of the '659 patent represented a technical solution to an unsolved technological problem. The written description of the '659 patent describes in technical detail each of the limitations of the claims, allowing a person of ordinary skill in the art to understand what the limitations cover and how the combination of claim elements differed markedly from and improved upon what may have been considered conventional or generic. For example, the specification and incorporated references detail the inventors' novel approach to seamlessly integrating a WPAN into a WLAN infrastructure.

223. The elements claimed by the '659 patent, taken alone or in combination, were not well-understood, routine or conventional to one of ordinary skill in the art at the time of the invention. Rather, the '659 patent claims and teaches, *inter alia*, an improved method to facilitate data communications between WLAN and WPAN wireless devices. The invention improved upon existing wireless communications, which were unable to integrate a WPAN into a WLAN infrastructure without suffering from one or more of the aforementioned problems, by allowing a single wireless device to maintain a first association with a first wireless network over a first wireless network connection using a WLAN protocol operable to connect end stations via a WLAN AP, and a second association with a second wireless network over a second wireless network connection using a WPAN protocol operable to connect end stations without going

through a WLAN AP, wherein the second wireless network WPAN protocol is partially compliant with respect to the WLAN protocol.

224. Compared to the prior art, the claimed method for facilitating data communications between WLAN and WPAN wireless devices is also more cost effective, since communications using the second network WPAN protocol utilize the same wireless radio circuit used for communications using the first network WLAN protocol.

225. Compared to the prior art, the claimed method for facilitating data communications between a WLAN and WPAN allows the two networks to operate in the same frequency spectrum without causing excessive interference with each other.

226. Compared to the prior art, the claimed method for facilitating data communications between WLAN and WPAN wireless devices is also more energy efficient, which can extend the battery life of WPAN devices that are battery powered or otherwise enable power-hungry WPAN devices to enter power-save modes more readily.

227. Compared to the prior art, the claimed method for facilitating data communications between WLAN and WPAN wireless devices also enables lower latency communication involving WPAN devices, which enables a device capable of concurrently operating in both the WPAN and WLAN to more effectively forward video streams between the two.

228. Participants in the communications industry chose to incorporate a subset of the claimed methods into the Wi-Fi Direct Standard to enjoy at least some of their aforementioned advantages.

229. Dell has infringed, and continues to infringe, the ’659 patent by making, importing, using, offering for sale and selling in the United States numerous wireless devices, including laptop computers, desktop computers, tablets, and monitors, that implement the Wi-Fi Direct protocol

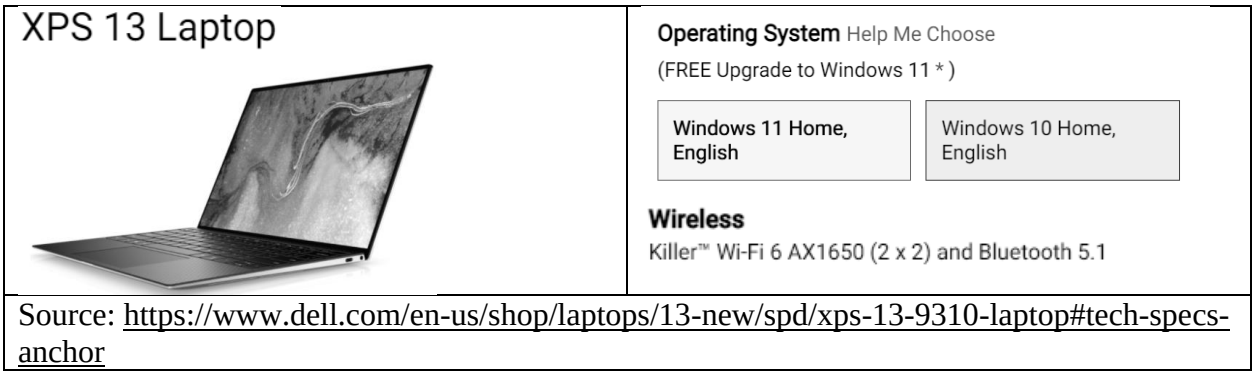
(i.e., the "Accused Products"). A subset of these Accused Products comprise "hubs" that can receive, for example, video from an IEEE 802.11x AP and forward such video to a Wi-Fi STA device using the Wi-Fi Direct protocol (i.e., the "Hub Accused Products").

230. Examples of the Hub Accused Products are Dell's laptop computers (including, but not limited to, XPS Laptops, Inspiron Laptops, Alienware Gaming Laptops, Vostro Laptops, and Latitude Laptops); desktop computers (including, but not limited to, XPS Desktops, Inspiron Desktops, Alienware Gaming Desktops, OptiPlex Desktops, Vostro Desktops, and New Precision Workstations); and tablets (including, but not limited to, Latitude 2-in-1 devices and Latitude Rugged Extreme tablets), and all other Dell products that include Wi-Fi Direct circuitry and drivers.

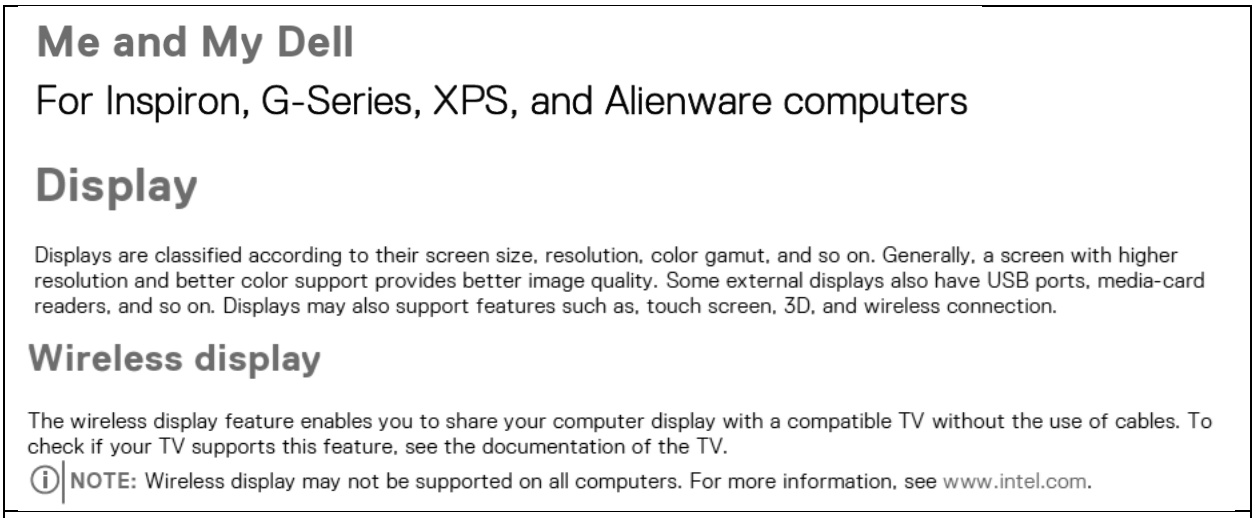
231. Claim 1 of the '659 patent is reproduced below:

> 1. A method for facilitating data communications with a first node in a first wireless network operating in a wireless medium, and with a second node in a second wireless network operating in the wireless medium, via a wireless radio circuit providing access to bi-directional wireless data communication capability with both the first and second wireless networks, comprising:
>
> maintaining, via the wireless radio circuit, a first association with the first wireless network over a first wireless network connection, the first wireless network connection using a WLAN protocol operable to connect end stations via a WLAN access point;
>
> maintaining, via the wireless radio circuit, a second association with the second wireless network over a second wireless network connection, the second wireless network connection using a WPAN protocol operable to connect end stations without going through a WLAN access point, wherein the WPAN protocol is partially compliant with respect to the WLAN protocol in that the WPAN protocol uses a WLAN protocol frame including a field adapted to support at least one feature of the WPAN protocol that is not part of the WLAN protocol; and
>
> coordinating data exchanges, via the wireless radio circuit, with a first node over the first wireless network connection using the WLAN protocol and with a second node over the second wireless network connection using the WPAN protocol, while maintaining both the first association with the first wireless network and the second association with the second wireless network.

232. The Hub Accused Products that infringe the '659 patent include, *inter alia*, a wireless device, usable for facilitating data communications between a first node in a first wireless network operating in a wireless medium, and with a second node in a second wireless network operating in the wireless medium, via a wireless radio circuit providing access to bi-directional wireless data communication capability with both the first and second wireless networks. For example, the Dell XPS 13 9310 Laptop ("XPS 13 Laptop") is a Hub Accused Product comprising a hub that implements the Wi-Fi and Wi-Fi Direct standards. It also supports applications such as Miracast, which is a standard that allows a user to "mirror" a video image being displayed at one STA onto the display of another STA, by having it communicated over a Wi-Fi Direct connection between the two STAs. The XPS 13 Laptop infringes the '659 patent because it comprises Wi-Fi and Wi-Fi Direct circuitry and drivers, and applications, such as Miracast, that enable the XPS 13 Laptop to act as a hub to coordinate data exchanges with a first node in a WLAN over an 802.11x connection (e.g., streamed video), and a second node in a WPAN over a Wi-Fi Direct connection:



Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor



Me and My Dell

For Inspiron, G-Series, XPS, and Alienware computers

Display

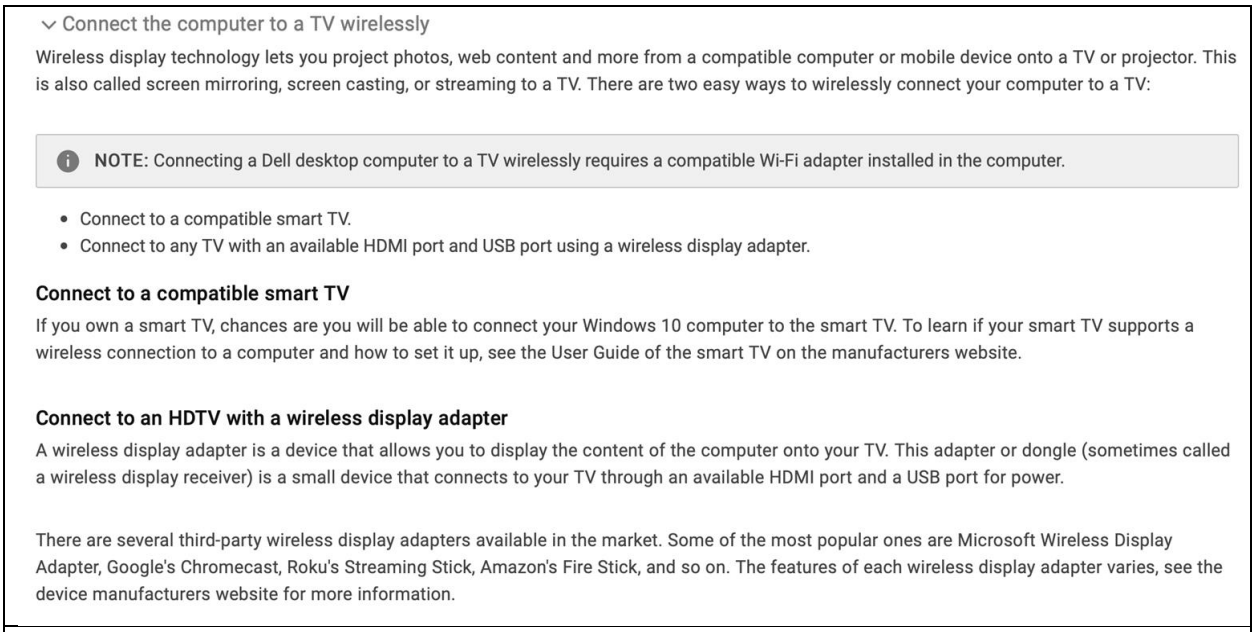
Displays are classified according to their screen size, resolution, color gamut, and so on. Generally, a screen with higher resolution and better color support provides better image quality. Some external displays also have USB ports, media-card readers, and so on. Displays may also support features such as, touch screen, 3D, and wireless connection.

Wireless display

The wireless display feature enables you to share your computer display with a compatible TV without the use of cables. To check if your TV supports this feature, see the documentation of the TV.

NOTE: Wireless display may not be supported on all computers. For more information, see www.intel.com.

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_reference-guide_en-us.pdf



Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Connect to a compatible smart TV

If you own a smart TV, chances are you will be able to connect your Windows 10 computer to the smart TV. To learn if your smart TV supports a wireless connection to a computer and how to set it up, see the User Guide of the smart TV on the manufacturers website.

Connect to an HDTV with a wireless display adapter

A wireless display adapter is a device that allows you to display the content of the computer onto your TV. This adapter or dongle (sometimes called a wireless display receiver) is a small device that connects to your TV through an available HDMI port and a USB port for power.

There are several third-party wireless display adapters available in the market. Some of the most popular ones are Microsoft Wireless Display Adapter, Google's Chromecast, Roku's Streaming Stick, Amazon's Fire Stick, and so on. The features of each wireless display adapter varies, see the device manufacturers website for more information.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778

Standards-based Miracast advances life without wires

Miracast is an industry-wide solution, allowing technology to work across device types and vendors. Connections are easy to set up and use since Miracast devices choose the appropriate settings automatically. Miracast can connect two devices using network infrastructure or **Wi-Fi Direct®**. When content to be shared is stored on a Miracast-certified device, such as a smartphone to an automobile infotainment display, a Wi-Fi network connection is not required.

Only devices marked Wi-Fi CERTIFIED Miracast have been certified by Wi-Fi Alliance® to work well with other Wi-Fi CERTIFIED™ devices, employ the latest security protections, and deliver a high-quality user experience.

Source: https://www.wi-fi.org/discover-wi-fi/miracast

2.1 P2P components

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

P2P Device:

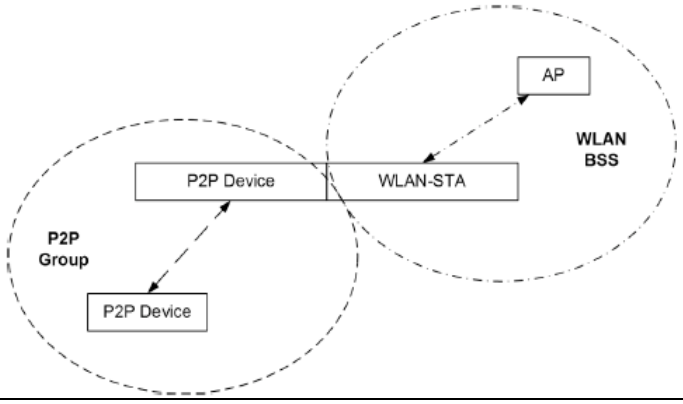
- Supports both P2P Group Owner and P2P Client roles.
- Negotiates P2P Group Owner or P2P Client role.
- Supports WSC and P2P Discovery mechanism.
- May support WLAN and P2P concurrent operation.

P2P Group Owner role:

- "AP-like" entity that provides BSS functionality and services for associated Clients (P2P Clients or Legacy Clients) when not operating within DMG, or a PCP that provides PBSS functionality and services for Clients (P2P Clients) when operating within DMG.
- Provides WSC Internal Registrar functionality.
- May provide communication between associated Clients.
- May provide access to a simultaneous WLAN connection for its associated Clients.

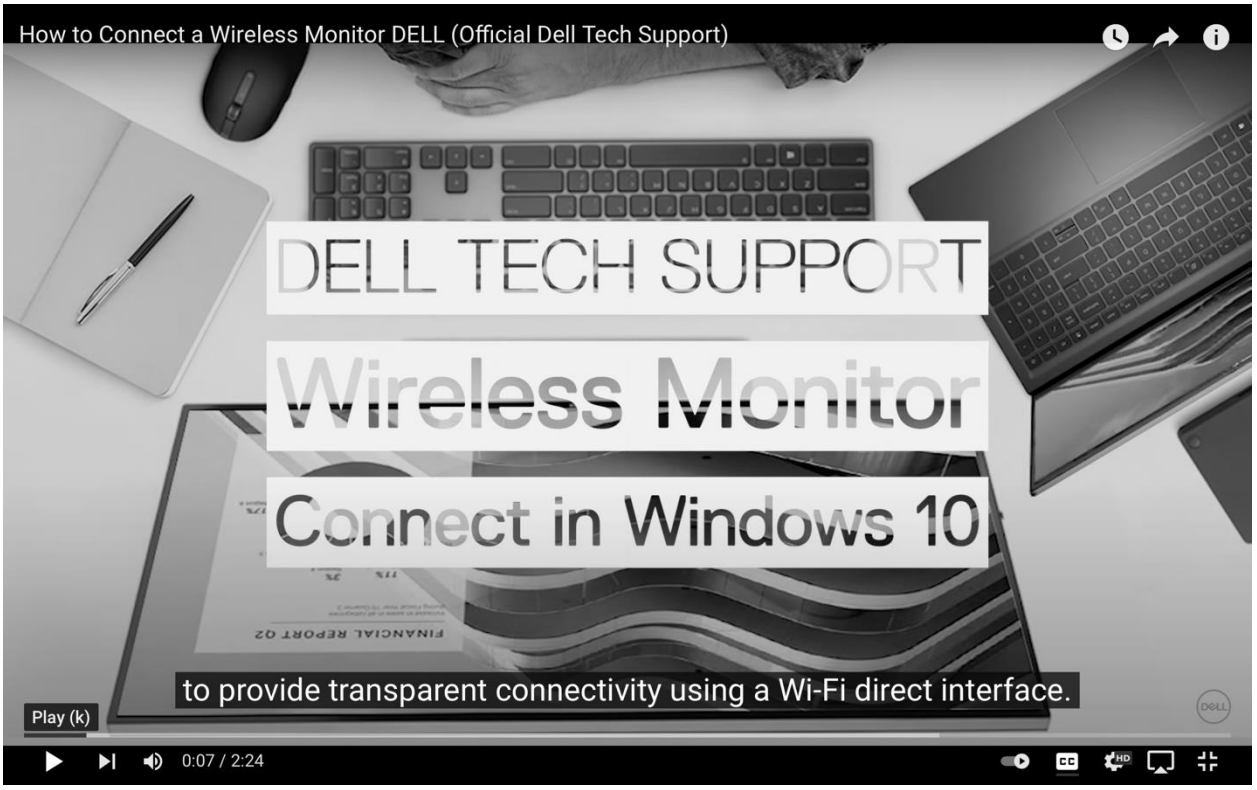
2.3 Concurrent operation

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



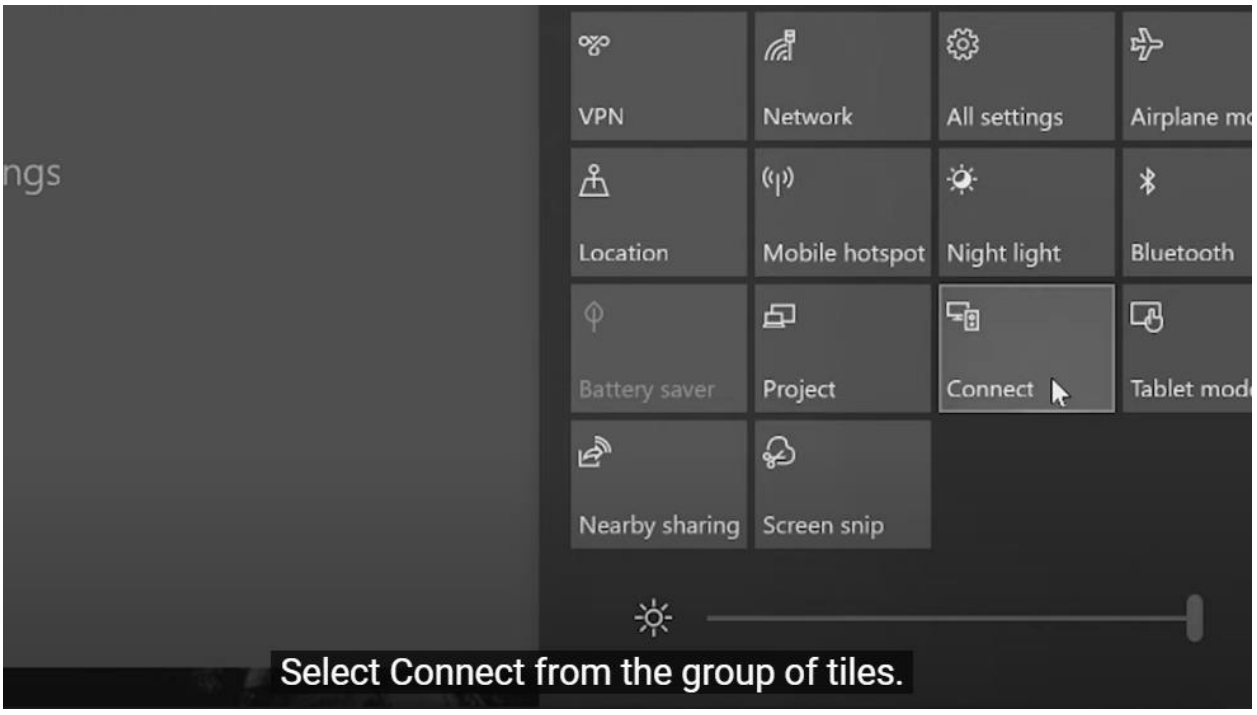
Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.1, 2.3, Fig. 4

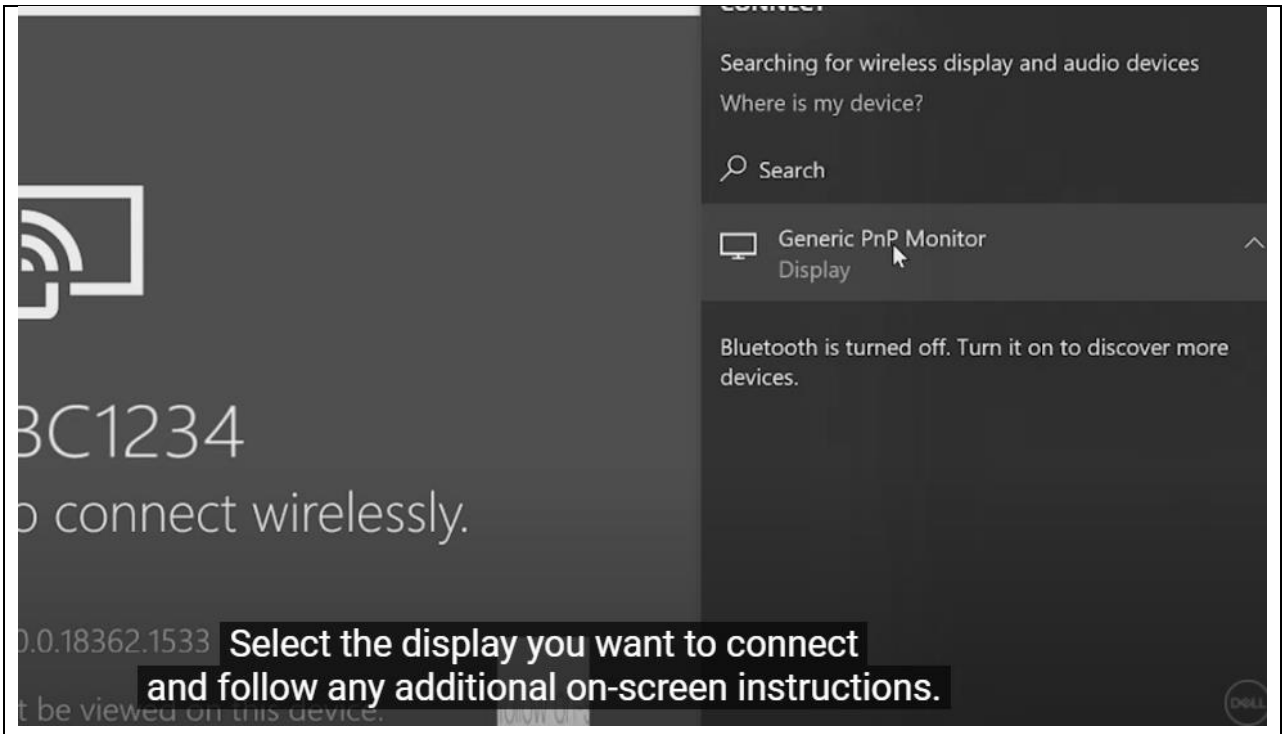

How to Connect a Wireless Monitor DELL (Official Dell Tech Support)
DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
Dell PCs and wireless monitors use Windows and Miracast technology
0:04 / 2:24


How to Connect a Wireless Monitor DELL (Official Dell Tech Support)
DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
to provide transparent connectivity using a Wi-Fi direct interface.
Play (k)
0:07 / 2:24


DELL TECH SUPPORT
Wireless Monitor
Connect in Windows 10
In this video, we show you how to connect your Miracast display to your Windows 10 device.
Best match
Connect
App
Settings
Connect to a wireless display
Access work or school
View network connections
Add a VPN connection
Duplicate or extend to a connected display
Manage your account
Projection settings
Allow remote connections to this computer
Search work and web
connect - See work and web results
Documents - This
Connect
App
Open
Pin to Start
Pin to taskbar
App settings
Using Windows search, type Connect and click the Connect App.


W10ABC1234
is ready for you to connect wirelessly.
Version: 10.0.18362.1533
Protected content can't be viewed on this device.
Press Ctrl + S to open Settings
Connect will open indicating that your Windows 10 Dell PC supports Miracast


VPN
Network
All settings
Airplane mo
Location
Mobile hotspot
Night light
Bluetooth
Battery saver
Project
Connect
Tablet mod
Nearby sharing
Screen snip
Select Connect from the group of tiles.



Source: https://www.youtube.com/watch?v=kXBwdWp7sFM ("How to Connect a Wireless Monitor DELL (Official Dell Tech Support)"

233. The XPS 13 Laptop is operable to facilitate data communications with a first node in a first wireless network operating in a wireless medium, and with a second node in a second wireless network operating in the wireless medium, via a wireless radio circuit providing access to bi-directional wireless data communication capability with both the first and second wireless networks. For example, the XPS 13 Laptop, designed and manufactured by Dell, includes the Intel Killer AX1650 wireless module (wireless radio circuit providing access to bi-directional wireless data communication capability), which includes Wi-Fi and Wi-Fi Direct functionality (wireless data communication capability with both the first and second wireless networks). The XPS 13 Laptop can serve to facilitate data communications providing communication capability in both the first and second wireless networks when, for example, a video is streamed over a Wi-Fi connection from the Internet to the XPS 13 Laptop, and the XPS 13 Laptop's Wi-Fi Direct-

circuitry and drivers are used (e.g., under control of, for example, its Miracast application) to mirror that Internet-sourced video to a second device, such as a wireless display or television:

XPS 13 Laptop

Operating System Help Me Choose

(FREE Upgrade to Windows 11 *)

Windows 11 Home, English	Windows 10 Home, English

Wireless

Killer™ Wi-Fi 6 AX1650 (2 x 2) and Bluetooth 5.1

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Wireless module

The following table lists the Wireless Local Area Network (WLAN) module specifications of your XPS 13 9310.

NOTE: The wireless module is integrated on the system board.

Table 9. Wireless module specifications

Description	Option one
Model number	Intel AX1650
Transfer rate	Up to 2400 Mbps
Frequency bands supported	2.4 GHz/5 GHz
Wireless standards	• WiFi 802.11a/b/g • Wi-Fi 4 (WiFi 802.11n) • Wi-Fi 5 (WiFi 802.11ac) • Wi-Fi 6 (WiFi 802.11ax)
Encryption	• 64-bit/128-bit WEP • AES-CCMP • TKIP
Bluetooth	Bluetooth 5.1

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

TX/RX Streams	2x2
Bands	2.4Ghz, 5Ghz (160Mhz)
Max Speed	2.4Gbps
Wi-Fi CERTIFIED*	WiFi 6 (802.11ax)

Experience the Intel® Difference	
Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.
GENERAL	
Dimensions (H x W x D)	M.2 2230: 22mm x 30mm x 2.4mm [1.5mm Max (Top Side)/ 0.1mm Max (Bottom Side)] M.2 1216: 12mm x 16mm x 1.67 (+-0.08) mm
Weight	M.2 2230: 2.83 +/– 0.3 g M.2 1216: 0.67 +/– 0.1 g
Radio ON/OFF Control	Supported
Connector Interface	M.2: PCIe*, USB
Operating Temperature (Adapter Shield)	0°C to +80°C
Humidity Non-Operating	50% to 90% RH non-condensing (at temperatures of 25°C to 35°C)
Operating Systems	Microsoft Windows* 10, Linux*, Chrome OS*
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016
Bluetooth®	Bluetooth® 5.2

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)

2.1 P2P components

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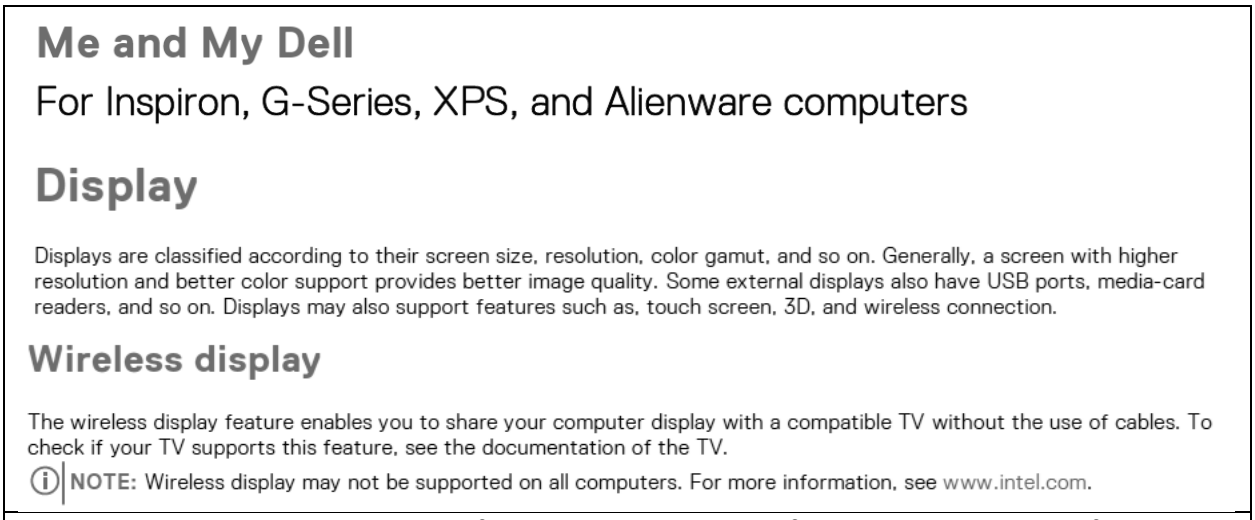
- Provides WSC Internal Registrar functionality.
- May provide communication between associated Clients.
- May provide access to a simultaneous WLAN connection for its associated Clients.

Source: Wi-Fi Direct Standard, v. 1.7, Section 2.1



Me and My Dell

For Inspiron, G-Series, XPS, and Alienware computers

Display

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Wireless display

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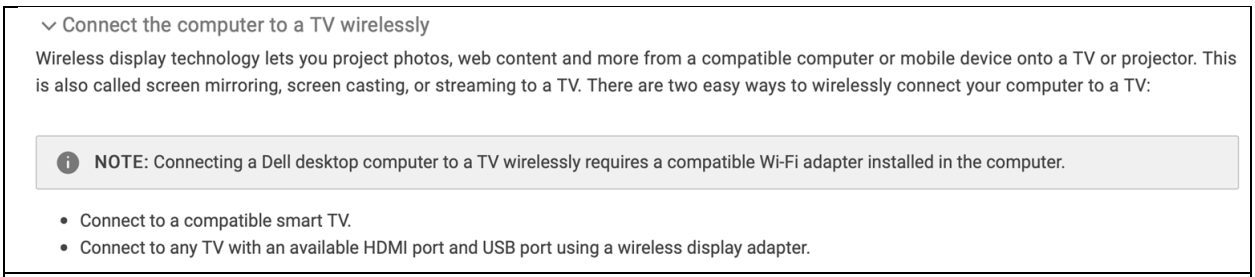
Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_reference-guide_en-us.pdf



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Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778

Source: https://www.youtube.com/watch?v=kXBwdWp7sFM ("How to Connect a Wireless Monitor DELL (Official Dell Tech Support)"

234. The XPS 13 Laptop is operable to maintain, via the wireless radio circuit, a first association with the first wireless network over a first wireless network connection, the first wireless network connection using a WLAN protocol operable to connect end stations via a WLAN access point. For example, the XPS 13 Laptop includes the Intel Killer AX1650 wireless

module, which is a wireless radio circuit with 802.11x capabilities (a WLAN protocol), as seen below:

XPS 13 Laptop

Operating System Help Me Choose

(FREE Upgrade to Windows 11 *)

Windows 11 Home, English | Windows 10 Home, English

Wireless

Killer™ Wi-Fi 6 AX1650 (2 x 2) and Bluetooth 5.1

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

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Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_setup-guide_en-us.pdf

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Operating Temperature (Adapter Shield)	0°C to +80°C
Humidity Non-Operating	50% to 90% RH non-condensing (at temperatures of 25°C to 35°C)
Operating Systems	Microsoft Windows* 10, Linux*, Chrome OS*
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016
Bluetooth®	Bluetooth® 5.2

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)

235. The XPS 13 Laptop is operable to maintain, via the wireless radio circuit, a first association with the first wireless network over a first wireless network connection, the first wireless network connection using a WLAN protocol operable to connect end stations via a WLAN access point. For example, the XPS 13 Laptop includes the Intel Killer AX 1650 wireless module (a wireless radio circuit), as shown above, configured to maintain an association with a WLAN over a first wireless network connection using an 802.11x protocol (WLAN protocol) to connect end stations via a WLAN AP, by providing connections compliant with IEEE 802.11x:

XPS 13 Laptop

Operating System Help Me Choose

(FREE Upgrade to Windows 11 *)

Windows 11 Home, English	Windows 10 Home, English

Wireless

Killer™ Wi-Fi 6 AX1650 (2 x 2) and Bluetooth 5.1

Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor

Intel® Killer™ Wi-Fi 6 AX1650

Networking Specifications

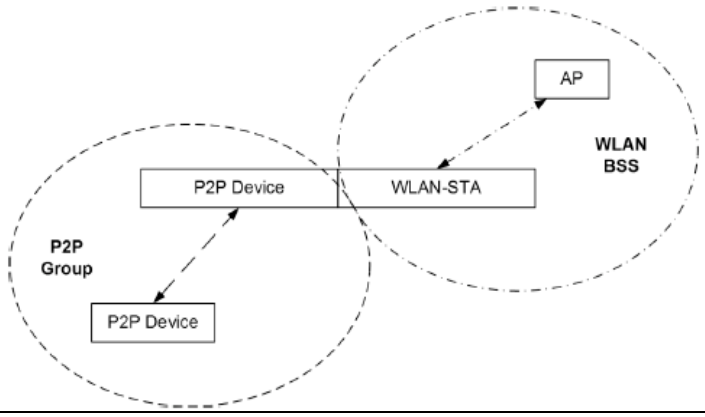
TX/RX Streams	2x2
Bands	2.4Ghz, 5Ghz (160Mhz)
Max Speed	2.4Gbps
Wi-Fi CERTIFIED*	WiFi 6 (802.11ax)

Experience the Intel® Difference	
Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.
GENERAL	
Dimensions (H x W x D)	M.2 2230: 22mm x 30mm x 2.4mm [1.5mm Max (Top Side)/ 0.1mm Max (Bottom Side)] M.2 1216: 12mm x 16mm x 1.67 (+-0.08) mm
Weight	M.2 2230: 2.83 +/– 0.3 g M.2 1216: 0.67 +/– 0.1 g
Radio ON/OFF Control	Supported
Connector Interface	M.2: PCIe*, USB
Operating Temperature (Adapter Shield)	0°C to +80°C
Humidity Non-Operating	50% to 90% RH non-condensing (at temperatures of 25°C to 35°C)
Operating Systems	Microsoft Windows* 10, Linux*, Chrome OS*
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016
Bluetooth®	Bluetooth® 5.2

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)

2.3 Concurrent operation

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



Source: Wi-Fi Direct Standard, v. 1.7, Section 2.3, Fig. 4

10.3.5 Association, reassociation, and disassociation

10.3.5.1 General

Subclause 10.3.5 describes the procedures used for IEEE 802.11 association,

10.1.2.1 TSF for infrastructure networks

In an infrastructure BSS, the AP shall be the timing master for the TSF. The AP shall initialize its TSF timer independently of any simultaneously started APs in an effort to minimize the synchronization of the TSF timers of multiple APs. The AP shall periodically transmit special frames called *Beacon frames* that contain the value of its TSF timer in order to synchronize the TSF timers of other STAs in a BSS. A receiving STA shall accept the timing information in Beacon frames sent from the AP servicing its BSS. If a STA's TSF timer is different from the timestamp in the received Beacon frame, the receiving STA shall set its local TSF timer to the received timestamp value.

10.1.3 Maintaining synchronization

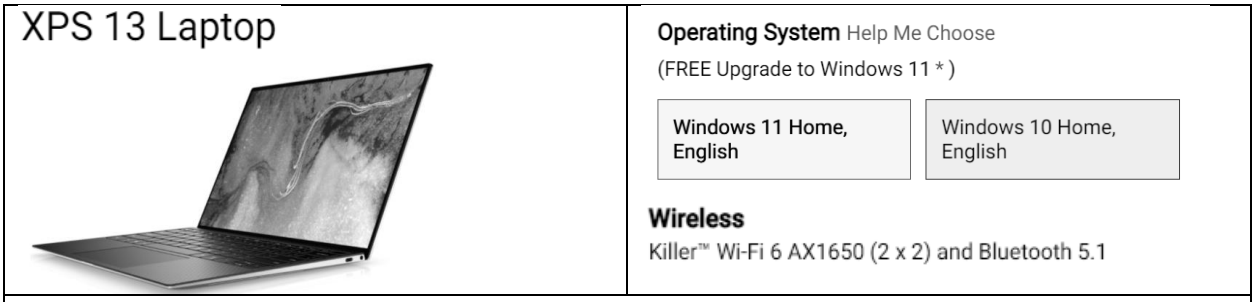
10.1.3.1 General

Each STA shall maintain a TSF timer with modulus 2^{64} counting in increments of microseconds. STAs expect to receive Beacon frames at a nominal rate. The interval between Beacon frames is defined by the dot11BeaconPeriod parameter of the STA. A STA sending a Beacon frame shall set the value of the Beacon frame's timestamp so that it equals the value of the STA's TSF timer at the time that the data symbol containing the first bit of the timestamp is transmitted to the PHY plus the transmitting STA's delays through its local PHY from the MAC-PHY interface to its interface with the WM [e.g., antenna, light-emitting diode (LED) emission surface].

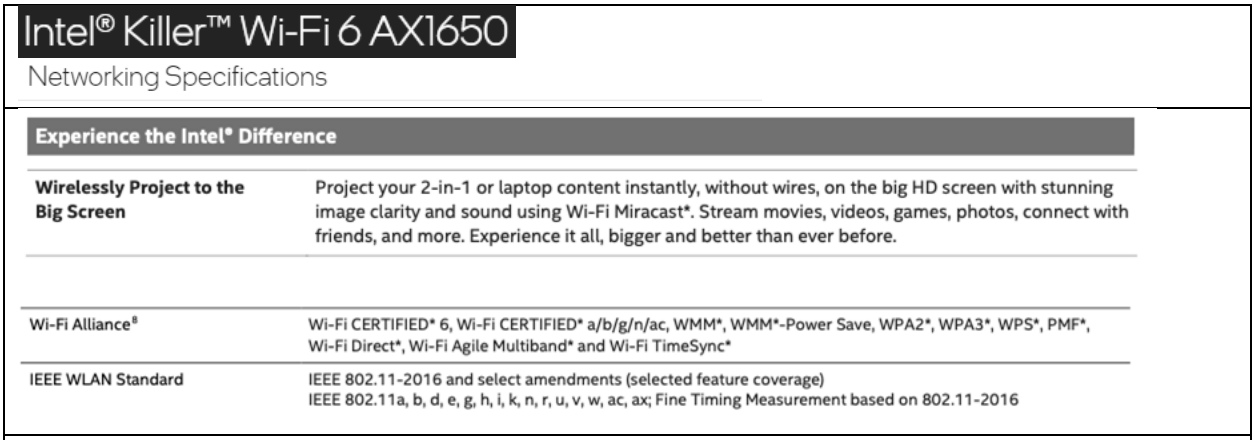
Source: IEEE 802.11-2012, Sections 10.1.2.1, 10.1.3, 10.1.3.1, 10.3.5 & 10.3.5.1

236. The XPS 13 Laptop is operable to maintain, via its wireless radio circuit, a second association with the second wireless network over a second wireless network connection, the second wireless network connection using a WPAN protocol operable to connect end stations

without going through a WLAN AP. For example, the XPS 13 Laptop includes the Intel Killer AX1650 wireless module (a wireless radio circuit), configured to support the Wi-Fi Direct protocol (as shown above) by, for example, maintaining a second association with the Wi-Fi Direct network to connect to end STAs, such as a wireless monitor or other peripheral device (including, but not limited to, other Accused Products), without going through an 802.11x AP, by supporting Wi-Fi Direct connections using the Wi-Fi Direct Standard:



Source: https://www.dell.com/en-us/shop/laptops/13-new/spd/xps-13-9310-laptop#tech-specs-anchor



Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)

Me and My Dell

For Inspiron, G-Series, XPS, and Alienware computers

Display

Displays are classified according to their screen size, resolution, color gamut, and so on. Generally, a screen with higher resolution and better color support provides better image quality. Some external displays also have USB ports, media-card readers, and so on. Displays may also support features such as, touch screen, 3D, and wireless connection.

Wireless display

The wireless display feature enables you to share your computer display with a compatible TV without the use of cables. To check if your TV supports this feature, see the documentation of the TV.

NOTE: Wireless display may not be supported on all computers. For more information, see www.intel.com.

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_reference-guide_en-us.pdf

Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

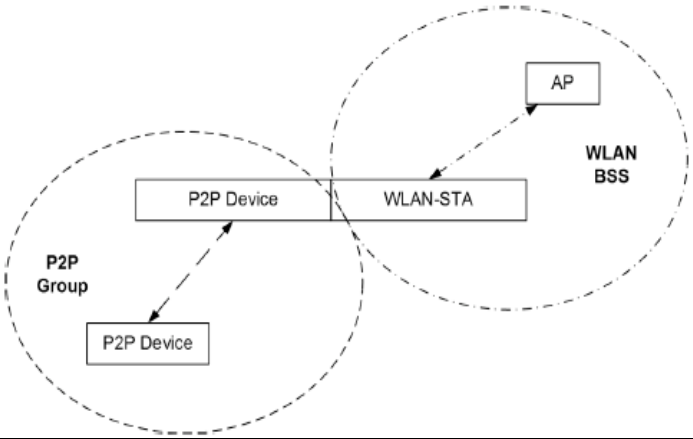
NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778

2.3 Concurrent operation

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



3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.

3.2.2 Starting and maintaining a P2P Group session

The P2P Group Owner may be determined through the Group Formation Procedure described in Section 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.

3.2.3 Connecting to a P2P Group

The P2P Client acquires the Group Credentials through static configuration or through Wi-Fi Simple Configuration [2]. When using Wi-Fi Simple Configuration [2], the P2P Group Owner shall serve as the WSC Registrar and the P2P Client shall serve as the WSC Enrollee. In order to connect to a P2P Group, the P2P Client operating outside DMG, using the Credentials, shall engage in the authentication procedure in Section 10.3.4.2 of IEEE 802.11-2012 [1] and the association procedure in Section 10.3.5.2 of IEEE 802.11-2012 [1] with the P2P Group Owner. In order to connect to a P2P Group, the P2P Client operating within DMG, using the Credentials, shall engage in the association procedure in Section 11.3.5.2 of IEEE 802.11-REVmc [11] with the P2P Group Owner.

When a P2P Client associates with a P2P Group Owner, it provides its Device Name, Primary Device Type, and optionally Secondary Device Type List information to the P2P Group Owner by including the P2P Device Info attribute (see Section 4.1.15) and the P2P Capability attribute (see Section 4.1.4) in the P2P IE in the Association Request frame. This information shall be used by the

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.3, Fig. 4, 3.2, 3.2.2 & 3.2.3

10.1.2.1 TSF for infrastructure networks

In an infrastructure BSS, the AP shall be the timing master for the TSF. The AP shall initialize its TSF timer independently of any simultaneously started APs in an effort to minimize the synchronization of the TSF timers of multiple APs. The AP shall periodically transmit special frames called *Beacon frames* that contain the value of its TSF timer in order to synchronize the TSF timers of other STAs in a BSS. A receiving STA shall accept the timing information in Beacon frames sent from the AP servicing its BSS. If a STA's TSF timer is different from the timestamp in the received Beacon frame, the receiving STA shall set its local TSF timer to the received timestamp value.

10.1.3 Maintaining synchronization

10.1.3.1 General

Each STA shall maintain a TSF timer with modulus 2^{64} counting in increments of microseconds. STAs expect to receive Beacon frames at a nominal rate. The interval between Beacon frames is defined by the dot11BeaconPeriod parameter of the STA. A STA sending a Beacon frame shall set the value of the Beacon frame's timestamp so that it equals the value of the STA's TSF timer at the time that the data symbol containing the first bit of the timestamp is transmitted to the PHY plus the transmitting STA's delays through its local PHY from the MAC-PHY interface to its interface with the WM [e.g., antenna, light-emitting diode (LED) emission surface].

Source: IEEE 802.11-2012, Sections 10.1.2.1 & 10.1.3.1

237. The XPS 13 Laptop is operable to maintain, via the wireless radio circuit, a second association with the second wireless network over a second wireless network connection, the second wireless network connection using a WPAN protocol operable to connect end stations without going through a WLAN access point. For example, the XPS 13 Laptop can connect to another wireless device without going through an 802.11x AP (i.e., "without the use of an access point" and "a Wi-Fi network connection is not required") by using the Wi-Fi Direct protocol, as shown above and reiterated below:

Wi-Fi Peer-to-Peer (P2P)

Technical Specification

Version 1.7

This document is the specification for the Wi-Fi Alliance Wi-Fi CERTIFIED Wi-Fi Direct® program, which allows Wi-Fi client devices to connect directly without the use of an access point.

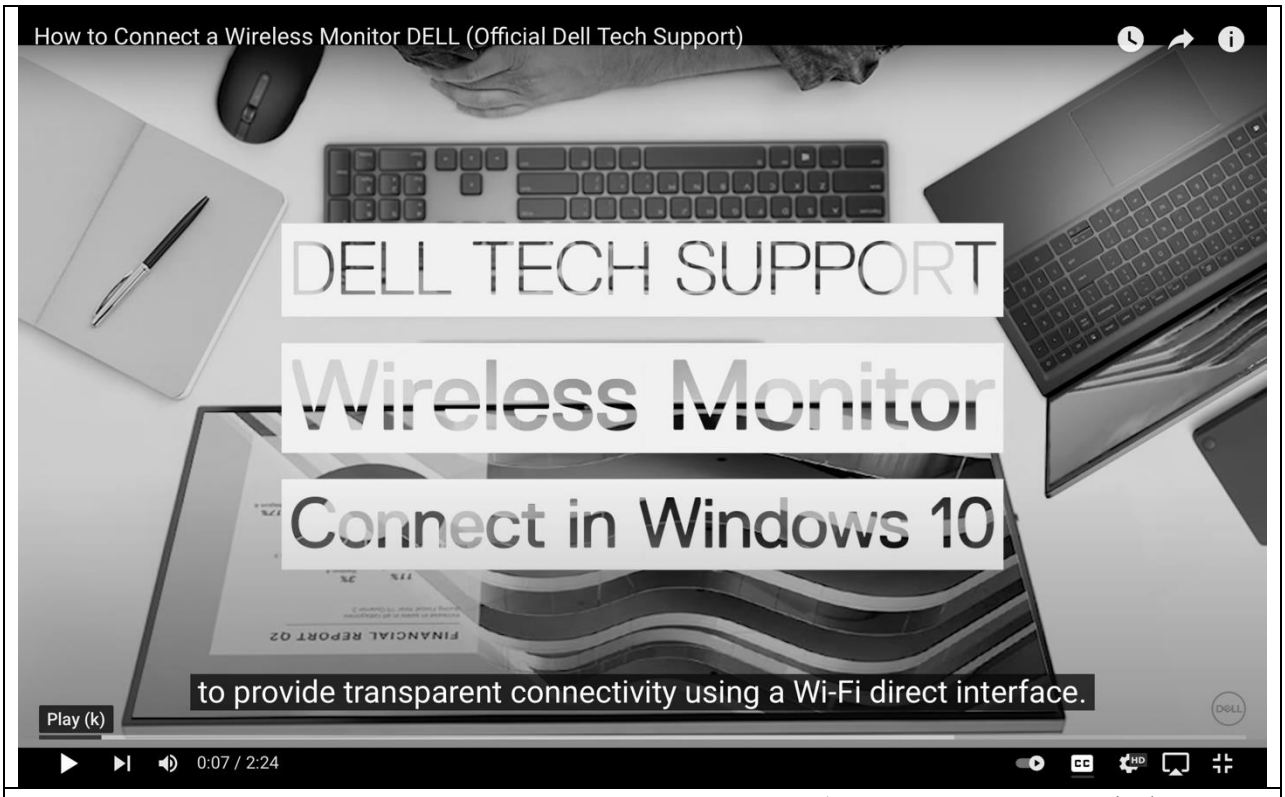
Source: Wi-Fi Direct Standard, v. 1.7, Cover Page

Standards-based Miracast advances life without wires

Miracast is an industry-wide solution, allowing technology to work across device types and vendors. Connections are easy to set up and use since Miracast devices choose the appropriate settings automatically. Miracast can connect two devices using network infrastructure or **Wi-Fi Direct®**. When content to be shared is stored on a Miracast-certified device, such as a smartphone to an automobile infotainment display, a Wi-Fi network connection is not required.

Only devices marked Wi-Fi CERTIFIED Miracast have been certified by Wi-Fi Alliance® to work well with other Wi-Fi CERTIFIED™ devices, employ the latest security protections, and deliver a high-quality user experience.

Source: https://www.wi-fi.org/discover-wi-fi/miracast



Source: https://www.youtube.com/watch?v=kXBwdWp7sFM ("How to Connect a Wireless Monitor DELL (Official Dell Tech Support)"

238. In the XPS 13 Laptop, the WPAN protocol is partially compliant with respect to the WLAN protocol. Aspects of the Wi-Fi Direct (WPAN) protocol which are compliant with the 802.11x Wi-Fi (WLAN) protocol include, for example, how P2P devices utilize and access the wireless medium. For example, the XPS 13 Laptop, in supporting Wi-Fi Direct, is required to implement the underlying IEEE 802.11g (or newer) Standard at the PHY level, as shown below. By implementing the underlying PHY protocol, WPAN devices use and access the wireless medium in a manner that is coordinated with communications occurring outside of the WPAN, yet in a common wireless space (such as communications occurring in the first wireless network (an 802.11x infrastructure (WLAN) BSS) between, for example, the XPS 13 Laptop an AP), such that the problems of device interference are reduced.

2.4.1 Basic functions and services

For P2P operation outside the DMG, this specification assumes that the following STA functions and services are implemented in P2P Devices:

- IEEE 802.11g or newer 2.4 GHz PHY [1]
- IEEE 802.11i (AES-CCMP) [1]
- Wi-Fi Simple Configuration [2]
- Wi-Fi Multimedia [3]

3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.1 & 3.2

9.2 MAC architecture

9.2.1 General

A representation of the MAC architecture is shown in Figure 9-1 in which the PCF and HCF services are provided using the services of the DCF. Note that in a non-QoS STA, HCF is not present. In a QoS STA implementation, both DCF and HCF are present. PCF is optional in all STAs.

Due to the distributed nature of the MBSS, only the MCF is present in a mesh STA.

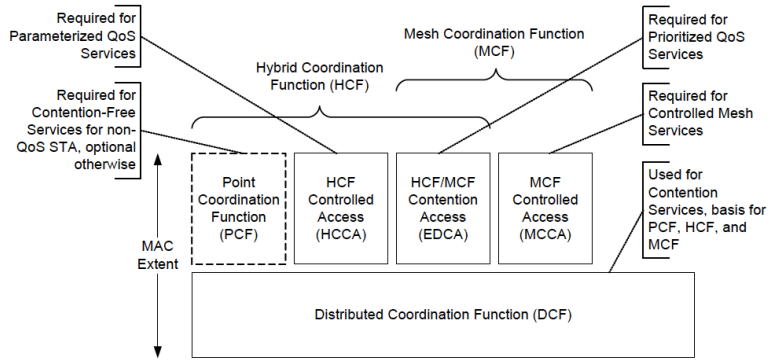


Figure 9-1—MAC architecture

9.2.2 DCF

The fundamental access method of the IEEE 802.11 MAC is a DCF known as *carrier sense multiple access with collision avoidance* (CSMA/CA). The DCF shall be implemented in all STAs.

9.3 DCF

9.3.1 General

The basic medium access protocol is a DCF that allows for automatic medium sharing between compatible PHYs through the use of CSMA/CA and a random backoff time following a busy medium condition. In addition, all individually addressed traffic uses immediate positive acknowledgment (ACK frame) where retransmission is scheduled by the sender if no ACK is received.

The CSMA/CA protocol is designed to reduce the collision probability between multiple STAs accessing a medium, at the point where collisions would most likely occur. Just after the medium becomes idle following a busy medium (as indicated by the CS function) is when the highest probability of a collision exists. This is because multiple STAs could have been waiting for the medium to become available again. This is the situation that necessitates a random backoff procedure to resolve medium contention conflicts.

* * *

are not already members of the BSSDescriptionSet. To actively scan, the STA shall transmit Probe request frames containing the desired SSID or one or more SSID List elements. When the SSID List element is pres-

8.3.3.9 Probe Request frame format

The frame body of a management frame of subtype Probe Request contains the information shown in Table 8-26.

Table 8-26—Probe Request frame body

Order	Information	Notes
1	SSID	If dot11MeshActivated is true, the SSID element is the wildcard value as described in 8.4.2.2.
2	Supported rates	
SupportedRates	Set of integers	2–127 inclusive (for each integer in the set)	The set of data rates (in units of 500 kb/s) that are supported by the STA that is requesting association.

Source: IEEE 802.11-2012 Standard, Sections 9.2, 9.2.1, 9.2.2, 9.3 & 8.3.3.9

239. In the XPS 13 Laptop, the WPAN protocol is partially compliant with respect to the WLAN protocol. Aspects of the Wi-Fi Direct protocol which are not compliant with the WLAN protocol (Wi-Fi) include, for example, aspects of P2P Discovery, P2P Power Management, and Managed P2P Device Operation as set out below:

2.4.2 P2P specific functions and services

In addition to the assumed functions listed in Section 2.4.1, a P2P Device supports the 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 802.11-2012 [1] when operating outside DMG and PBSS operation as defined in IEEE 802.11-REVmc [11] when operating within DMG, and provides additions for a P2P Group operation.
- **P2P Power Management** provides a set of functions to reduce power consumption of P2P Devices that operate outside DMG.
- **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.

A P2P Group Owner shall respond to Probe Request frames following the rules in IEEE 802.11-2012 [1] for operation outside DMG and the rules in IEEE 802.11-REVmc [11] for operation within DMG, 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 802.11-2012 [1], Clause Section 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.
Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.2 & 3.2.2

240. For example, the Wi-Fi Direct protocol is not compliant with the 802.11x protocol for aspects of P2P Group Operation, such as when a P2P Group Owner shall respond to Probe Request frames. As shown below, there is an 802.11x protocol rule that applies to STAs, in an infrastructure BSS, receiving Probe Request frames which require those STAs to respond with a probe response when one the following are true: (1) the SSID in the probe request frame is the wildcard SSID; (2) the SSID in the probe request frame is the specific SSID of the STA; or (3) the specific SSID of the STA is included in the SSID List element. However, as can be seen in the below Wi-Fi Direct protocol excerpt, there are different rules for setting this same SSID field of a Probe Request frame that include, for example, the use of a P2P wildcard SSID. Thus, when the

XPS 13 Laptop communicates using the Wi-Fi Direct protocol to, for example, respond to Probe Request frames, it disobeys the analogous 802.11x protocol rule.

10.1.4.3.2 Sending a probe response

STAs, subject to the criteria below, receiving Probe Request frames shall respond with a probe response only if:

a) The Address 1 field in the probe request is the broadcast address or the specific MAC address of the STA, and either item b) or item c) below.

b) The STA is a mesh STA and the Mesh ID in the probe request is the wildcard Mesh ID or the specific Mesh ID of the STA.

c) The STA is not a mesh STA and

1) The SSID in the probe request is the wildcard SSID, the SSID in the probe request is the specific SSID of the STA, or the specific SSID of the STA is included in the SSID List element, and

2) The Address 3 field in the probe request is the wildcard BSSID or the BSSID of the STA.

In an infrastructure BSS or in an IBSS, STAs receiving Probe Request frames shall respond with a probe response when the SSID in the probe request is the wildcard SSID or matches the specific SSID of the STA or when the specific SSID of the STA is included in the SSID List element. Furthermore, a STA with dot11RadioMeasurementActivated true receiving a probe request with a DSSS Parameter Set element containing a Current Channel field value that is not the same as the value of dot11CurrentChannel shall not respond with a probe response. An AP shall respond to all probe requests meeting the above criteria. In an IBSS a STA that transmitted a Beacon frame since the last TBTT shall respond to group addressed Probe Request frames. A STA in an IBSS shall respond to Probe Request frames sent to the individual address of the STA.

Source: IEEE 802.11-2012 Standard, Section 10.1.4.3.2

A P2P Group Owner shall respond to Probe Request frames following the rules in IEEE 802.11-2012 [1] for operation outside DMG and the rules in IEEE 802.11-REVmc [11] for operation within DMG, 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 802.11-2012 [1], Clause Section 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,”)

Source: Wi-Fi Direct Standard, v. 1.7, Section 3.2.2

241. In the XPS 13 Laptop, the WPAN protocol is partially compliant with respect to the WLAN protocol in that the WPAN protocol uses a WLAN protocol frame including a field adapted to support at least one feature of the WPAN protocol that is not part of the WLAN protocol. For example, Wi-Fi Direct frames (WPAN protocol frames) are based on 802.11x frames

(WLAN protocol frames) and use the vendor specific field of an 802.11x management frame. The Wi-Fi Direct protocol processes the data in the vendor-specific field of a Wi-Fi management frame to convey certain features of the Wi-Fi Direct protocol (i.e., the P2P IE):

2.4.1 Basic functions and services

For P2P operation outside the DMG, this specification assumes that the following STA functions and services are implemented in P2P Devices:

- IEEE 802.11g or newer 2.4 GHz PHY [1]
- IEEE 802.11i (AES-CCMP) [1]
- Wi-Fi Simple Configuration [2]
- Wi-Fi Multimedia [3]

Any required 'AP-like' functions and services required for P2P Group Owner operation outside DMG are described within this specification. A P2P Group Owner operating within DMG is required to support PCP functions and services.

3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.

* * *

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 802.11-2012 [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.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.4.1, 3.2 & 4

8.3.3 Management frames

8.3.3.1 Format of management frames

The format of a management frame is defined in Figure 8-34. The Frame Control, Duration, Address 1, Address 2, Address 3, and Sequence Control fields are present in all management frame subtypes. The maximum unencrypted MMPDU size, excluding the MAC header and FCS, is 2304 octets.

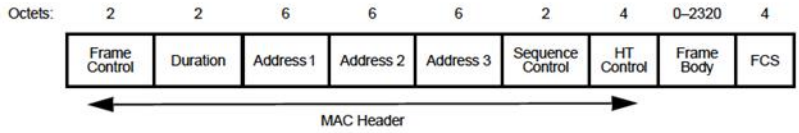


Figure 8-34—Management frame format

The HT Control field is defined in 8.2.4.6. The presence of the HT Control field is determined by the Order subfield of the Frame Control field, as specified in 8.2.4.1.10.

The frame body consists of the fields followed by the elements defined for each management frame subtype. All fields and elements are mandatory unless stated otherwise and appear in the specified, relative order. STAs that encounter an element ID they do not recognize in the frame body of a received management frame ignore that element and continue to parse the remainder of the management frame body (if any) for additional elements with recognizable element IDs. See 9.24.7. Unused element ID codes are reserved.

Gaps may exist in the ordering of fields and elements within frames. The order that remains is ascending.

8.4 Management frame body components

8.4.1 Fields that are not information elements

8.4.2 Information elements

8.4.2.1 General

Elements are defined to have a common general format consisting of a 1 octet Element ID field, a 1 octet Length field, and a variable-length element-specific Information field. Each element is assigned a unique Element ID as defined in this standard. The Length field specifies the number of octets in the Information field. See Figure 8-81.

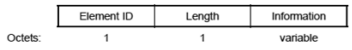


Figure 8-81—Element format

The set of valid elements is defined in Table 8-54.

Table 8-54—Element IDs

Element	Element ID	Length of indicated element (in octets)	Extensible
SSID (see 8.4.2.2)	0	2 to 34	
Supported rates (see 8.4.2.3)	1	3 to 10	

Table 8-54—Element IDs *(continued)*

Element	Element ID	Length of indicated element (in octets)	Extensible
U-APSD Coexistence (see 8.4.2.93)	142	14 to 257	Subelements
Reserved	143–173		
MCCAOP Advertisement Overview (see 8.4.2.110)	174	8	Yes
Reserved	175–220		
Vendor Specific (see 8.4.2.28)	221	3 to 257	
Reserved	222–255		

8.5.6 Vendor-specific action details

The Vendor Specific Action frame is defined for vendor-specific signaling. The format of the Action field of the Vendor Specific Action frame is shown in Figure 8-437. An Organization Identifier, in the octet field immediately after the Category field, differentiates the vendors (see 8.4.1.31).

NOTE—If management frame protection is negotiated, then Vendor Specific Protected Action frames (see Table 8-38) are protected; otherwise they are unprotected.

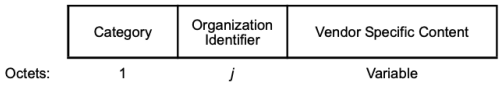


Figure 8-437—Vendor Specific Action frame Action field format

The Category field is set to the value indicating the vendor-specific category, as specified in Table 8-38.

The Organization Identifier contains a public organizationally unique identifier assigned by the IEEE and is specified in 8.4.1.31. The order of the Organization Identifier field is described in 8.2.2.

The Vendor Specific Content contains vendor-specific field(s). The length of the Vendor Specific Content in a Vendor Specific Action frame is limited by the maximum allowed MMPDU size.

Source: IEEE 802.11-2012, Sections 8.3.3.1, 8.4.2.1 & 8.5.6

242. In further detail, in the XPS 13 Laptop, the WPAN protocol may adapt the Vendor Specific Information Element (IE) field of an 802.11x protocol frame (a WLAN protocol frame) to carry information not defined by the IEEE 802.11x Standard so that interoperability operations that are not part of the 802.11x Standard can be implemented, such as those required by the power save features defined by the Wi-Fi Direct Standard. For example, in Wi-Fi Direct, two of the P2P Group Owner's adapted power saving protocol schemes are Notice of Absence and Opportunistic Power Save:

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 802.11-2012 [1] for operation outside DMG and in IEEE 802.11-REVmc [11] for operation within DMG, with the Wi-Fi Alliance OUI and an OUI Type indicating P2P. A number of P2P attributes are defined; a single P2P IE carries one or more P2P attributes.

* * *

3.3 P2P Power Management

The P2P power management approach for operation outside DMG 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.

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.

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

4.1.14 Notice of Absence attribute

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

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.
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.

The Notice of Absence attribute shall be present in the P2P IE in the Beacon frames and Probe Response frames transmitted by a P2P Group Owner when a Notice of Absence schedule is being advertised or when the CTWindow is non-zero, as described in Section 4.2.1 and Section 4.2.3. If there is neither a Notice of Absence schedule nor a CTWindow, the GO may omit the Notice of Absence attribute from Beacon and Probe Response frames. The Notice of Absence shall be also present in Notice of Absence frames, as described in Section 4.2.10.2, P2P Presence Request frames, as described in Section 4.2.10.3, and P2P Presence Response frames, as described in Section 4.2.10.4.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 4, 3.3.1, 3.3.2, & 4.1.14

243. The XPS 13 Laptop is operable to coordinate data exchanges, via the wireless radio circuit, with a first node over the first wireless network connection using the WLAN protocol and with a second node over the second wireless network connection using the WPAN protocol, while maintaining both the first association with the first wireless network and the second association with the second wireless network. For example, the XPS 13 Laptop includes Wi-Fi and Wi-Fi Direct circuitry and drivers, which enable applications that involve coordinating data exchanges, including, for example, using Miracast (also known as "screen mirroring"). The XPS 13 Laptop coordinates data exchanges, for example, from an 802.11x AP (a first node) over the first wireless connection using an 802.11x (WLAN) protocol to a wireless screen or television (a second node) over the second wireless connection using the Wi-Fi Direct (WPAN) protocol. The XPS 13 Laptop

is, for example, a P2P Device that can operate concurrently with a WLAN infrastructure network. For example, the Hub Accused Products implement the Wi-Fi Direct protocol to coordinate data exchanges in each of the first and second networks using the procedure defined in the 802.11x protocol, as shown below:

Experience the Intel® Difference	
Wirelessly Project to the Big Screen	Project your 2-in-1 or laptop content instantly, without wires, on the big HD screen with stunning image clarity and sound using Wi-Fi Miracast*. Stream movies, videos, games, photos, connect with friends, and more. Experience it all, bigger and better than ever before.
Operating Systems	Microsoft Windows* 10, Linux*, Chrome OS*
Wi-Fi Alliance[8]	Wi-Fi CERTIFIED* 6, Wi-Fi CERTIFIED* a/b/g/n/ac, WMM*, WMM*-Power Save, WPA2*, WPA3*, WPS*, PMF*, Wi-Fi Direct*, Wi-Fi Agile Multiband* and Wi-Fi TimeSync*
IEEE WLAN Standard	IEEE 802.11-2016 and select amendments (selected feature coverage) IEEE 802.11a, b, d, e, g, h, i, k, n, r, u, v, w, ac, ax; Fine Timing Measurement based on 802.11-2016
Bluetooth*	Bluetooth* 5.2

Source: https://www.intel.com/content/www/us/en/products/sku/211609/intel-killer-wifi-6-ax1650-xw/specifications.html (& embedded Product Brief link: https://www.intel.com/content/dam/www/public/us/en/documents/product-briefs/wi-fi-6-ax200-module-brief.pdf)

Me and My Dell

For Inspiron, G-Series, XPS, and Alienware computers

Display

Displays are classified according to their screen size, resolution, color gamut, and so on. Generally, a screen with higher resolution and better color support provides better image quality. Some external displays also have USB ports, media-card readers, and so on. Displays may also support features such as, touch screen, 3D, and wireless connection.

Wireless display

The wireless display feature enables you to share your computer display with a compatible TV without the use of cables. To check if your TV supports this feature, see the documentation of the TV.

NOTE: Wireless display may not be supported on all computers. For more information, see www.intel.com.

Source: https://dl.dell.com/topicspdf/xps-13-9310-laptop_reference-guide_en-us.pdf

Connect the computer to a TV wirelessly

Wireless display technology lets you project photos, web content and more from a compatible computer or mobile device onto a TV or projector. This is also called screen mirroring, screen casting, or streaming to a TV. There are two easy ways to wirelessly connect your computer to a TV:

NOTE: Connecting a Dell desktop computer to a TV wirelessly requires a compatible Wi-Fi adapter installed in the computer.

- Connect to a compatible smart TV.
- Connect to any TV with an available HDMI port and USB port using a wireless display adapter.

Source: https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778

Figure 2. Wi-Fi Direct Concurrent Mode

Source: https://arxiv.org/ftp/arxiv/papers/1810/1810.06964.pdf

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) when not operating within DMG, or a PCP that provides PBSS functionality and services for Clients (P2P Clients) when operating within DMG.
- Provides WSC Internal Registrar functionality.
- May provide communication between associated Clients.
- May provide access to a simultaneous WLAN connection for its associated Clients.

2.3 Concurrent operation

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

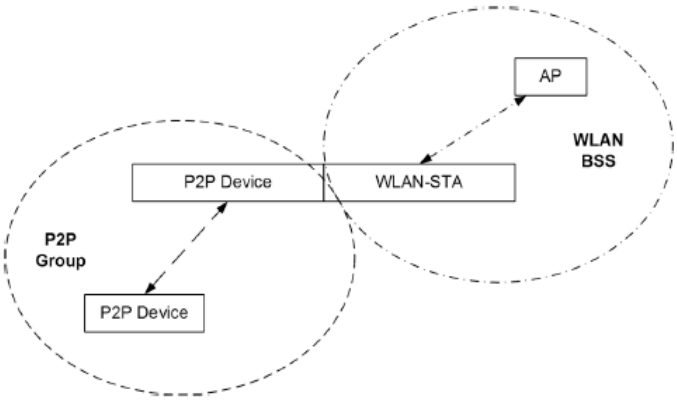


Figure 4—P2P Concurrent device

As an example, Figure 4 shows a P2P Concurrent Device that has one MAC entity operating as a WLAN-STA and the second MAC entity operating as a P2P Device. The dual MAC functionality can be provided via two separate physical MAC entities each associated with its own PHY entity, two virtual MAC entities over one PHY entity, or any other approach. Implementation of multiple MAC functionality is out of scope of this specification.

2.4.1 Basic functions and services

For P2P operation outside the DMG, this specification assumes that the following STA functions and services are implemented in P2P Devices:

- IEEE 802.11g or newer 2.4 GHz PHY [1]
- IEEE 802.11i (AES-CCMP) [1]
- Wi-Fi Simple Configuration [2]
- Wi-Fi Multimedia [3]

3.2 P2P Group operation

P2P Group operation outside DMG closely resembles infrastructure BSS operation as defined in IEEE 802.11-2012 [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 outside DMG are described in this section.

Source: Wi-Fi Direct Standard, v. 1.7, Sections 2.1, 2.3, 2.4.1, & 3.2

9.2 MAC architecture

9.2.1 General

A representation of the MAC architecture is shown in Figure 9-1 in which the PCF and HCF services are provided using the services of the DCF. Note that in a non-QoS STA, HCF is not present. In a QoS STA implementation, both DCF and HCF are present. PCF is optional in all STAs.

Due to the distributed nature of the MBSS, only the MCF is present in a mesh STA.

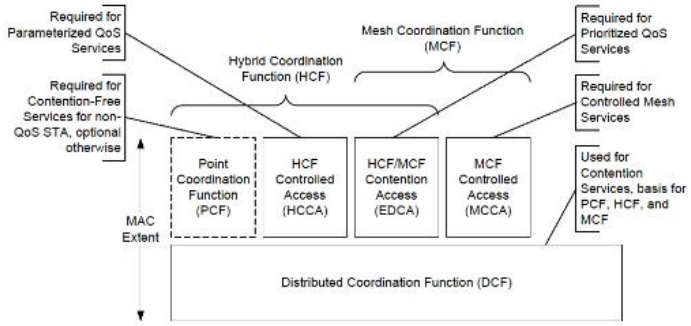


Figure 9-1—MAC architecture

9.2.2 DCF

The fundamental access method of the IEEE 802.11 MAC is a DCF known as *carrier sense multiple access with collision avoidance* (CSMA/CA). The DCF shall be implemented in all STAs.

9.3 DCF

9.3.1 General

The basic medium access protocol is a DCF that allows for automatic medium sharing between compatible PHYs through the use of CSMA/CA and a random backoff time following a busy medium condition. In addition, all individually addressed traffic uses immediate positive acknowledgment (ACK frame) where retransmission is scheduled by the sender if no ACK is received.

The CSMA/CA protocol is designed to reduce the collision probability between multiple STAs accessing a medium, at the point where collisions would most likely occur. Just after the medium becomes idle following a busy medium (as indicated by the CS function) is when the highest probability of a collision exists. This is because multiple STAs could have been waiting for the medium to become available again. This is the situation that necessitates a random backoff procedure to resolve medium contention conflicts.

Source: IEEE 802.11-2012 Standard, Sections 9.2, 9.2.1, 9.2.2, & 9.3.1

244. As set forth above, Dell has directly infringed at least claim 1 of the ’659 patent by using the Hub Accused Products, including at least through its employees, product demonstrations and product testing.

245. Dell designed and incorporated the IEEE 802.11x and the Wi-Fi Direct features and functionalities described above into the Hub Accused Products.

246. Dell provides instructions (in the form of at least user interface prompts and customer support instructional videos) to its customers advertising, encouraging, and directing the customers to use the Hub Accused Products in an infringing manner as described above to

implement the IEEE 802.11x/Wi-Fi Direct functionality, as intended by Dell. For example, Dell provides operating instructions and the like for the Hub Accused Products, including the citations above and the following:

- https://www.youtube.com/watch?v=kXBwdWp7sFM
- https://www.dell.com/support/kbdoc/en-us/000155875/how-to-connect-a-computer-to-high-definition-television-hdtv-kb-article-347778
- https://www.dell.com/support/kbdoc/en-us/000136674/miracast-to-replace-wi-di
- https://www.dell.com/support/kbdoc/en-us/000129880/miracast-users-may-encounter-various-issues-in-the-windows-10-operating-system
- https://www.dell.com/support/kbdoc/en-us/000130716/guide-to-dell-wireless-monitors
- https://www.dell.com/support/kbdoc/en-us/000152972/how-do-i-enable-widi-miracast-on-my-venue-7-3740-or-venue-8-3840?lang=en
- https://www.dell.com/support/kbdoc/en-us/000129818/a-guide-to-miracast-on-the-latitude-13-7350-tablet-pc?lang=en
- https://www.dell.com/support/kbdoc/en-us/000141601/xps-13-9350-touch-cursor-and-sound-may-have-a-lag-when-system-connected-wifi-miracast-and-bluetooth-audio?lang=en
- https://www.dell.com/support/manuals/en-us/latitude-13-7390-laptop/latitude_7290_7390_7490_tgb/wlan-—-miracast-support-matrix?guid=guid-76975785-70c3-4039-b5bb-eb0b83e669b3&lang=en-us

- https://www.dell.com/support/manuals/en-us/inspiron-11-3179-2-in-1-laptop/inspiron_11_3179_setupandspecs/communications?guid=guid-5fea805b-7f8a-420f-b984-b0e93e13048e&lang=en-us
- https://www.dell.com/support/manuals/en-us/alienware-15-laptop/alienware-15-r3-setupandspecifications/communications?guid=guid-935baab6-b4b4-4960-9783-971e87de151c&lang=en-us

247. Dell's customers who use the Hub Accused Products as described above directly infringe the '659 patent. By its instructions, including those set forth above, Dell has induced its customers to infringe the '659 patent. Dell also induces such direct infringement by its customers by failing to remove the infringing features from the Hub Accused Products.

248. As a result of communications with Ozmo Licensing, Dell has had knowledge of the '659 patent since at least as early as the day the '659 patent issued, February 15, 2022, but, in any event, no later than the date of service upon it of this Complaint.

249. Dell has known that the use of the above functionality by its customers constitutes infringement of the '659 patent, and specifically intended that infringement.

250. Dell has also contributed to its customers' infringement of the '659 patent. The Hub Accused Products are used by Dell's customers to practice the inventions claimed in the '659 patent. The IEEE 802.11x/Wi-Fi Direct features as performed by the Hub Accused Products as described above constitute material parts of the claimed inventions of the '659 patent. Dell knows that portions of the hardware and software in the Hub Accused Products infringe and were specifically made or adapted by Dell solely to provide such functionality and that such features are not staple articles or commodities of commerce suitable for substantial non-infringing use. Dell

also knows that such combinations of hardware and software have no use other than to provide such functionality as intentionally designed into the Hub Accused Products by Dell.

251. By the time of trial, Dell will have known and intended that its continued actions would directly infringe, and would induce and contribute to the infringement by its customers of, at least claim 1 of the '659 patent.

252. Ozmo Licensing has been damaged by Dell's past and ongoing direct and indirect infringement of the '659 patent.

253. With knowledge of the allegations set forth herein, Dell nonetheless refuses to remove the infringing functionalities from the Hub Accused Products or to compensate Ozmo Licensing for the use of such features. Dell's infringement described above will continue unabated unless and until Dell is enjoined or ordered to pay a reasonable royalty for a license to the '659 patent.

PRAYER FOR RELIEF

Ozmo Licensing requests that the Court enter judgment against Dell as follows:

A. Dell has infringed one or more claims of each of the above patents-in-suit, directly and/or indirectly, literally and/or under the doctrine of equivalents;

B. award damages sufficient to compensate Ozmo Licensing for Dell's infringement under 35 U.S.C. § 284;

C. ordering Dell to pay Ozmo Licensing an ongoing royalty for Dell's future infringement of the patents-in-suit or, in the alternative, enjoining from the remaining life of the patents-in-suit any further acts of infringement by Dell, its officers, directors, agents, consultants, contractors, affiliates and all others acting in privity and/or in concert with Dell;

D. finding this case exceptional under 35 U.S.C. § 285 and awarding Ozmo Licensing enhanced damages and its reasonable attorneys' fees;

E. awarding Ozmo Licensing its costs and expenses incurred in this action;

F. awarding Ozmo Licensing prejudgment and post-judgment interest; and

G. granting Ozmo Licensing such other and further relief as the Court deems just and appropriate.

DEMAND FOR JURY TRIAL

Ozmo Licensing demands trial by jury on all issues so triable under, *inter alia*, Fed. R. Civ. P. 38.

Date: June 21, 2022

Respectfully submitted,

/s/ Karl Rupp

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