Exhibit A
US Patent No. 11,818,591, Claims 1-5, 10, 13-18, 20-22, and 26 on Samsung's Galaxy S24 Ultra

U.S. Patent No. 11,818,591 issued on November 14, 2023. Claim 1 recites a wireless networking device (*e.g.*, a smartphone, laptop, tablet, or access point) having software and/or hardware that enables a "band aggregation" feature. Band aggregation occurs when a wireless networking device (WND) aggregates at least two portions of bandwidth from two different Wi-Fi bands (any two of 2.4 GHz, 5 GHz, and 6 GHz bands).

All Samsung products (*e.g.*, smartphones, TVs, laptops, and tablets) that implement Multi-Link Operation ("MLO") as specified in IEEE 802.11be Draft Standard for Information Technology – Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks – Specific Requirements (D7.0 Aug. 2024) ("Wi-Fi 7 Draft Standard") using two or more transceivers infringe at least claims 1-5, 10, 13-18, 20-22, and 26 of the '591 patent. An exemplary infringing Samsung product is the Galaxy S24 Ultra smartphone.

The Samsung Galaxy S24 Ultra has Wi-Fi 7 enabled, using a Qualcomm Snapdragon 8 Gen 3 processor,[1] including Qualcomm's FastConnect 7800 Mobile Connectivity System.[2] Qualcomm's FastConnect 7800 is Wi-Fi CERTIFIED™ having at least Certification ID WFA127693 that includes connectivity, optimization, security, and spectrum & regulatory features.[3] Furthermore, Samsung's Galaxy S24 Ultra is Wi-Fi CERTIFIED™ having at least Certification ID WFA127969 that includes applications & services, connectivity, optimization, security, and spectrum & regulatory features.[4] Optimization certifications include Wi-Fi Agile Multiband™.[5]

Pursuant to the Wi-Fi 7 Draft Standard, a WND comprises at least a multi-link device (MLD), which may be an access point (AP) MLD or a non-AP MLD. The Galaxy S24 Ultra is configured to operate both as an AP MLD and as a non-AP MLD. As described in more detail in the following claim chart, the Galaxy S24 Ultra is enabled to perform the claimed link aggregation operations when operating as an AP MLD and when operating as a non-AP MLD.

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[1] Samsung Galaxy S24 Ultra Specs; https://www.gsmarena.com/samsung_galaxy_s24_ultra-12771.php.

[2] FastConnect 7800 Mobile Connectivity System described here: https://www.qualcomm.com/products/technology/wi-fi/fastconnect/fastconnect-7800. *See also* https://www.qualcomm.com/snapdragon/news/wi-fi-7-unleashed-with-samsung-galaxy-s24-ultra.

[3] https://api.cert.wi-fi.org/api/certificate/download/public?variantId=137093.

[4] https://api.cert.wi-fi.org/api/certificate/download/public?variantId=129396.

[5] WiFi Alliance, Wi-Fi Agile Multiband Technical Specification, v1.5 (2020) ("Wi-Fi Agile Multiband Specification").

Exhibit A
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The accused instrumentalities include all Samsung electronics devices (including smartphones, TVs, laptops, tablets, and wearable devices) that implement MLO as specified in IEEE 802.11be Draft Standard for Information Technology—Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks—Specific Requirements (D7.0, Aug. 2024) using two or more transceivers. The accused instrumentalities include Samsung products released with MLO capabilities as well as Samsung products made MLO-capable through, for example, Samsung firmware updates. Claim 2 of the '591 patent is only asserted with respect to accused Samsung smartphones. Claim 3 of the '591 patent is only asserted with respect to accused Samsung smartphones, laptops, and tablets.

Exhibit A
US Patent No. 11,818,591, Claims 1-5, 10, 13-18, 20-22, and 26 on Samsung's Galaxy S24 Ultra

USP 11,818,591	Evidence of Use in the Galaxy S24 Ultra
1. A wireless networking device, comprising:	The Samsung Galaxy S24 Ultra mobile phone ("Galaxy S24 Ultra") is a wireless networking device (WND). A WND comprises at least a multi-link device (MLD) as specified by IEEE 802.11be/D7.0 Draft Standard for Information Technology—Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks—Specific Requirements (Aug. 2024) ("Wi-Fi 7 Draft Standard").[6] An MLD may be an access point (AP) MLD or a non-AP MLD. **multi-link device:** [MLD] A logical entity that is capable of supporting more than one affiliated station (STA) and can operate using one or more affiliated STAs, and that presents one medium access control (MAC) data service and a single MAC service access point (MAC SAP) to the logical link control (LLC) sublayer. **access point (AP) multi-link device (MLD):** [AP MLD] An MLD, where each station (STA) affiliated with the MLD is an AP. **non-access point (non-AP) multi-link device (MLD):** [non-AP MLD] An MLD, where each station (STA) affiliated with the MLD is a non-access point (non-AP) station (non-AP STA). Wi-Fi 7 Draft Standard at 61, 62, 63. In this context, for example, a wireless terminal device or a network access device may comprise one or more MLDs. A wireless networking device may be, for example, a wireless station in a Wi-Fi 7 system, such as a stationary wireless AP or a mobile wireless AP, such as the Galaxy S24 Ultra, comprising an AP MLD.

[6] *See also* all previous versions of the Wi-Fi 7 Draft Standard, including each of 802.11be/D1.0 (2021) through 802.11be/D6.0 (2024).

USP 11,818,591	Evidence of Use in the Galaxy S24 Ultra
	A WND may also be, for example, a mobile or fixed device comprising a non-AP MLD. Such devices may be, for example, mobile telephones or smartphones, such as the Galaxy S24 Ultra. In this regard, the Galaxy S24 Ultra is operable both as an AP MLD and as a non-AP MLD. For example, the Galaxy S24 Ultra is capable of operating as a mobile hotspot, thereby sharing its data connection with other devices. Mobile hotspot Mobile hotspot uses your data plan to create a Wi-Fi network that can be used by multiple devices. 1. From Settings, tap **Connections** > **Mobile hotspot and tethering** > **Mobile hotspot**. 2. Tap to turn on Mobile hotspot. 3. On the devices you want to connect, activate Wi-Fi, and select your device's Mobile hotspot. Enter the Mobile hotspot password to connect. **TIP** Tap **QR code** to connect another device to your Mobile hotspot by scanning a QR code instead of entering a password. Configure mobile hotspot settings You can customize your mobile hotspot's security and connection settings. 1. From Settings, tap **Connections** > **Mobile hotspot and tethering** > **Mobile hotspot**. 2. Tap to turn on Mobile hotspot, and then tap the following settings to change them: *Samsung Galaxy S24, S24+, S24 Ultra User Guide*, Ver. U 14.1 (English(North America)) (Sept. 6, 2024) at 120.

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	When operating as a mobile hotspot, the Galaxy S24 Ultra behaves as an AP for other devices. Otherwise, the Galaxy S24 Ultra operates as a non-AP MLD in communications with other devices.
[1.a] an application interface connected to a processing interface, the application interface being associated with a first application, the first application providing, when the wireless networking device is being used, provides a first data stream and having a first wireless bandwidth requirement;	The Galaxy S24 Ultra has an application interface connected to a processing interface, the application interface being associated with a first application, the first application providing, when the wireless networking device is being used, provides a first data stream and having a first wireless bandwidth requirement. The Samsung Galaxy S24 Ultra has Wi-Fi 7 enabled, using a Qualcomm Snapdragon 8 Gen 3 processor, including Qualcomm's FastConnect 7800 Mobile Connectivity System. **Wi-Fi Connectivity** 802.11a/b/g/n/ac/ax/be 2.4GHz+5GHz+6GHz, EHT320, MIMO, 4096-QAM Samsung Galaxy S24 Ultra Specs.

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	Samsung Galaxy S24 Ultra **Featuring Snapdragon 8 Gen 3 for Galaxy.** Introducing Samsung Galaxy S24 Ultra, now with many next-gen AI features and capabilities enabled by Snapdragon 8 Gen 3 for Galaxy. Powered with Galaxy AI, Galaxy S24 Ultra adapts to your passions and behaviors to make a new level of achievement possible. And, with Qualcomm FastConnect 7800 Mobile Connectivity System, you'll get the best possible connection and premium WiFi 7 connectivity. https://www.qualcomm.com/snapdragon/device-finder/samsung-galaxy-s24-ultra. The Galaxy S24 Ultra includes an application interface that allows the Wi-Fi module of the Galaxy S24 Ultra to interact with one or more applications having bandwidth requirements. The application interface comprises hardware and/or software engaging with software applications, such as internet browsers or video playback apps, having data streams when the wireless networking device is used. Each application data stream has a wireless bandwidth requirement. Additionally, the Galaxy S24 Ultra has a processing interface, with the application interface connected to the processing interface. The processing interface is provided by the Qualcomm Snapdragon 8 Gen 3 processor contained within the Galaxy S24 Ultra. The Wi-Fi 7 Draft Standard includes the reference model for an MLD shown below.

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	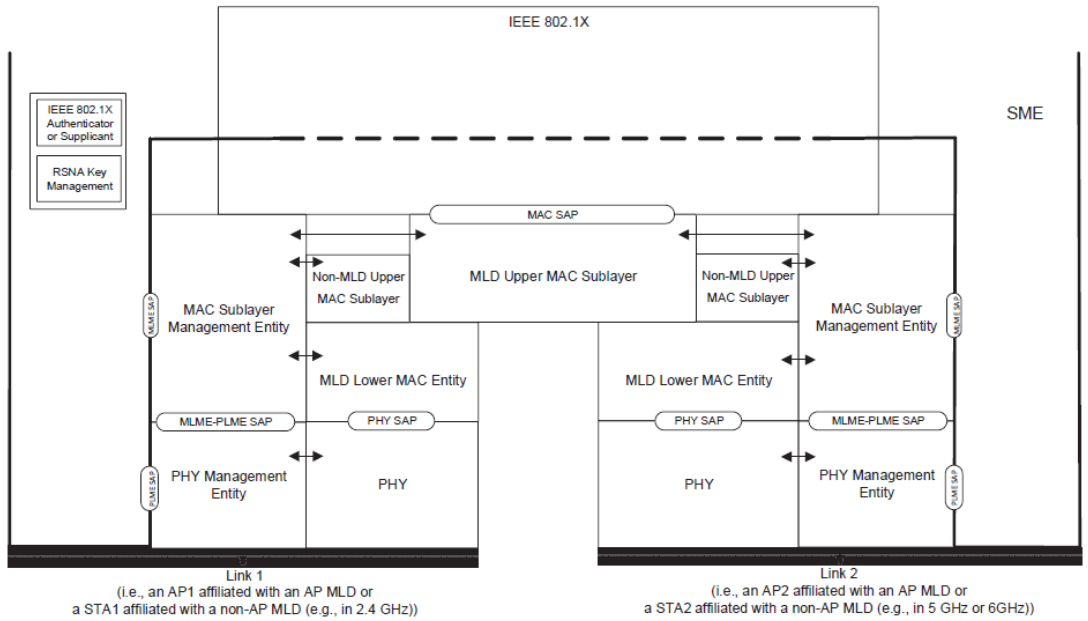 **Figure 4-33b—Reference model for an MLD for two links** Figure 4-33b, Wi-Fi 7 Draft Standard at 78. As shown in Figure 4-33b above, an MLD, such as in the Galaxy S24 Ultra, has a Station Management Entity (SME). The SME is in communication with a MAC Sublayer Management Entity (MLME), through an MLME SAP, and a PHY Management Entity (PLME), through a PLME SAP. Further, the MLME is in communication with the Upper MAC Sublayer (UMAC) and with each Lower MAC entity (LMAC). The SME is responsible for coordinating the MLD and each of the affiliated STAs used to establish links between devices. It operates at least by communicating with the MLME

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	SAP and the PLME SAP to manage the MAC and PHY interfaces affiliated with each link. The communicating may include, for example, messaging, signaling, or shared memory access. An MLD supports multiple MAC functions, with synchronization across the MAC functions as needed via the MLD synchronization service (see 35.3.25 (MLD synchronization service)) and otherwise coordinated by the SME. Each affiliated STA is enumerated with a Link ID (for example, as Link 1 and Link 2 in Figure 4-33b (Reference model for an MLD for two links)) and MLME primitives are invoked through an MLME SAP. The SME maintains the authentication and association states. The Authenticator and the MAC-SAP of the AP MLD are identified by the same AP MLD MAC address. The Supplicant and the MAC-SAP of the non-AP MLD are identified by the same non-AP MLD MAC address. The SME is responsible for coordinating the MLD and each of the affiliated STAs through the MLME, and to maintain an RSNA key management entity and IEEE 802.1X Authenticator or Supplicant, for MLO. Wi-Fi 7 Draft Standard at 78. **36.1.3.2 PHY management entity (PLME)** The PLME performs management of the local PHY functions in conjunction with the MLME. Wi-Fi 7 Draft Standard at 707. Accordingly, the processing interface comprises at least a portion of the SME and MLME. The processing interface may also include at least a portion of the MLME SAP and PLME SAP by which the SME communicates with other management layers. Additionally, the processing interface may include at least some functionality of the UMAC. As shown above in Figure 4-33b, the MLD has a MAC layer that is divided into an LMAC

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	corresponding to each STA, and a single UMAC managing common operations for all STAs. The LMACs perform certain link-specific MAC functions while the UMAC is responsible for MAC functions common to the multiple links. **5.1.5.1a MLD MAC sublayer functions** The MLD upper MAC sublayer functions include: — Authentication, association, and reassociation (between an AP MLD and a non-AP MLD) — Security association (e.g., PMKSA, PTKSA) and distribution of GTK/IGTK/BIGTK — SN/PN assignment for frames to be encrypted by PTK for individually addressed frames — SN assignment for group addressed MSDUs — Power save buffering of individually addressed frames (only on AP MLD) — Encryption/decryption using PTK for individually addressed frames — Selection of the MLD lower MAC entity for transmission (TID-to-link mapping (see 35.3.7.2 (TID-To-Link Mapping (TTLM)))) — Merging reception of MPDUs from two or more links — Reordering of packets to ensure in-order delivery per each Block Ack session — Block Ack scoreboarding for individually addressed frames (in collaboration with the MLD lower MAC entities). Optionally, the MLD upper MAC sublayer delivers successful status records of MPDUs and/or scoreboard context control information on Block Ack scoreboarding at one of the setup links to other setup links (see 35.3.8 (Block ack procedures in MLO)) — MLD level management information exchange/indication via the MLD lower MAC entity — Each affiliated STA selects its own EDCA parameters (for a non-AP STA it comes from the peer AP on that link). Wi-Fi 7 Draft Standard at 84.

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	The MLD lower MAC entity functions include: — Link specific control information exchange/indication (e.g., RTS/CTS, acknowledgements, NDP, etc.) — Power save state and mode — MAC address filtering for frame reception — Block Ack scoreboarding for individually addressed frames (in collaboration with the MLD upper MAC sublayer). Optionally, the MLD lower MAC entity receives the successful status records of the MPDUs and/or scoreboard context control information of the Block Ack agreement from the MLD upper MAC sublayer) (see 35.3.8 (Block ack procedures in MLO)) Wi-Fi 7 Draft Standard at 84-85. Operations performed by the UMAC include, for example, TID-to-Link Mapping and authentication, association, and reassociation between an AP MLD and a non-AP MLD. The processing interface may therefore include at least some functionality of the UMAC. The processing interface is located below other layers of the MLD, such as the data link layer. The application interface is connected to the processing interface. The processing interface is responsible for AP MLD and non-AP MLD multi-link operation (MLO) processes that allow the Galaxy S24 Ultra to discover, authenticate, associate, and set up links with other MLDs for meeting bandwidth requirements. Bandwidth information is exchanged between the application interface and the processing interface. For example, in order to perform TID-to-Link Mapping and other MLO operations for exchanging frames across links, the processing interface is connected to the application interface. MLO is defined for an EHT STA in 35.3 (Multi-link operation (MLO)). MLO allows an AP MLD and a non-AP MLD to set up multiple links between them. A reference model for MLO is described in 4.9.6 (Reference model for multi-link operation (MLO)). Wi-Fi 7 Draft Standard at 523.

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	4.9.6 Reference model for multi-link operation (MLO) MLO defines a set of procedures allowing communication over one or more links between MLDs. An MLD manages such communication over one or more links. Communication over links using different channels on different frequency bands or the same frequency band can occur simultaneously or not depending on the capabilities of both the AP MLD and the non-AP MLD (see 35.3.16.3 (Simultaneous transmit and receive (STR) operation) and 35.3.16.4 (Nonsimultaneous transmit and receive (NSTR) operation)). The MLO procedures (see 35.3 (Multi-link operation (MLO))) allow a pair of MLDs to discover, synchronize, (de)authenticate, (re)associate, disassociate, and manage links and other resources with each other on any common bands or channels that are supported by both MLDs. Wi-Fi 7 Draft Standard at 76. For example, the processing interface performs TID-to-Link mapping procedures to determine how data frames will be assigned for transmission. **35.3.7.2 TID-To-Link Mapping (TTLM)** **35.3.7.2.1 General** The TTLM mechanism allows an AP MLD and a non-AP MLD that performed or are performing ML setup to determine how Data frames belonging to TIDs 0–7 and Management frames will be assigned for transmission, on the setup links between the two MLDs in DL and UL. Wi-Fi 7 Draft Standard at 565. The SME is responsible for coordinating the MLD and each of the affiliated STAs through the MLME, and to maintain an RSNA key management entity and IEEE 802.1X Authenticator or Supplicant, for MLO. Wi-Fi 7 Draft Standard at 78.

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	As shown above in Figure 4-33b, the processing interface engages with other layers within the Galaxy S24 Ultra through a MAC SAP. Information regarding data streams from the application interface may be communicated to the processing interface through the MAC SAP. Thus, the processing interface of the Galaxy S24 Ultra, when operating as an AP MLD or a non-AP MLD, comprises at least portions of the MAC SAP, UMAC, MLME, and SME in providing data streams and meeting bandwidth requirements. Where the application that needs to transmit and/or receive data interacts with the UMAC through the MAC SAP, the UMAC passes data to the MLME, which is responsible for managing the MAC layer functions. The MLME communicates with the SME to request channel allocation, link selection, and other resources necessary for data transmission given the bandwidth requirements. The SME coordinates with the UMAC to determine the optimal links and channels for data transmission. Once the resources are allocated, the SME instructs the MLME to transmit/receive the data over the selected links.
[1.b] first, second, and third actual MAC interfaces connected to the processing interface;	The Galaxy S24 Ultra has first, second, and third actual MAC interfaces connected to the processing interface. As shown below, the Wi-Fi 7 Draft Standard explains that an AP MLD or a non-AP MLD has multiple STAs that can each establish a link. Each link is associated with a frequency band (*e.g.*, 2.4 GHz, 5 GHz, or 6 GHz). The reference diagram below illustrates two STAs and associated links for simplicity; a Wi-Fi 7 MLD provides three STAs and thus may form three links—one for each of the 2.4 GHz, 5 GHz, and 6 GHz frequency bands.

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	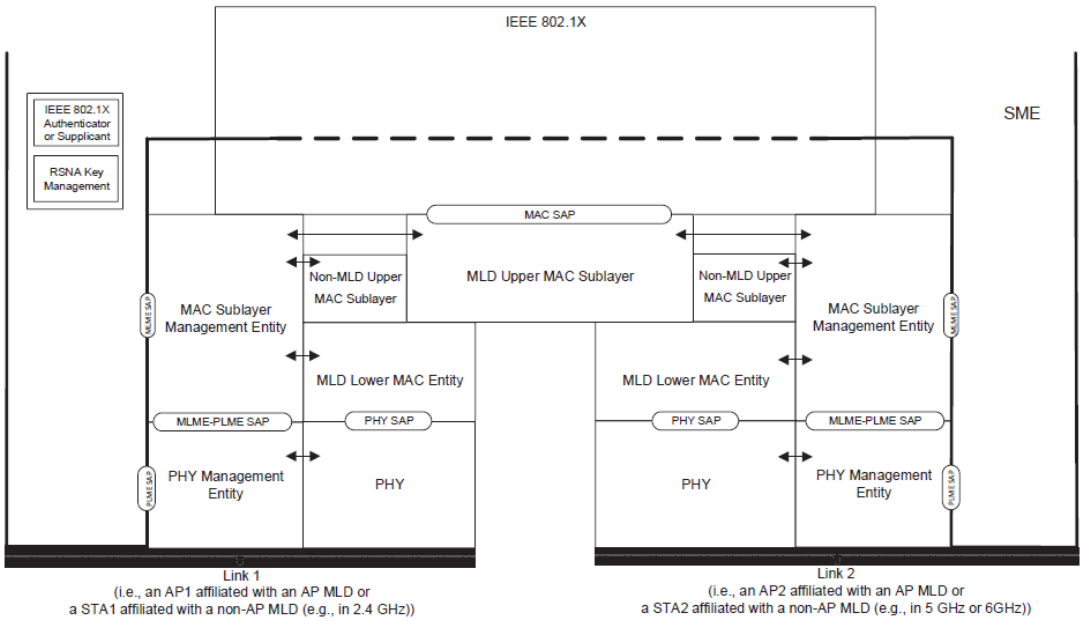 **Figure 4-33b—Reference model for an MLD for two links** Figure 4-33b, Wi-Fi 7 Draft Standard at 78. Each STA of the AP MLD or non-AP MLD has a PHY unique to that STA and associated with an affiliated link. Additionally, the MLD has a MAC layer that is divided into an LMAC corresponding to each STA and affiliated link, and a single UMAC managing common operations for all STAs and affiliated links. The LMACs perform certain link-specific MAC functions while the UMAC is responsible for MAC functions common to the multiple links.

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	5.1.5.1a MLD MAC sublayer functions The MLD upper MAC sublayer functions include: — Authentication, association, and reassociation (between an AP MLD and a non-AP MLD) — Security association (e.g., PMKSA, PTKSA) and distribution of GTK/IGTK/BIGTK — SN/PN assignment for frames to be encrypted by PTK for individually addressed frames — SN assignment for group addressed MSDUs — Power save buffering of individually addressed frames (only on AP MLD) — Encryption/decryption using PTK for individually addressed frames — Selection of the MLD lower MAC entity for transmission (TID-to-link mapping (see 35.3.7.2 (TID-To-Link Mapping (TTLM)))) — Merging reception of MPDUs from two or more links — Reordering of packets to ensure in-order delivery per each Block Ack session — Block Ack scoreboarding for individually addressed frames (in collaboration with the MLD lower MAC entities). Optionally, the MLD upper MAC sublayer delivers successful status records of MPDUs and/or scoreboard context control information on Block Ack scoreboarding at one of the setup links to other setup links (see 35.3.8 (Block ack procedures in MLO)) — MLD level management information exchange/indication via the MLD lower MAC entity — Each affiliated STA selects its own EDCA parameters (for a non-AP STA it comes from the peer AP on that link). Wi-Fi 7 Draft Standard at 84.

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	The MLD lower MAC entity functions include: — Link specific control information exchange/indication (e.g., RTS/CTS, acknowledgements, NDP, etc.) — Power save state and mode — MAC address filtering for frame reception — Block Ack scoreboarding for individually addressed frames (in collaboration with the MLD upper MAC sublayer). Optionally, the MLD lower MAC entity receives the successful status records of the MPDUs and/or scoreboard context control information of the Block Ack agreement from the MLD upper MAC sublayer) (see 35.3.8 (Block ack procedures in MLO)) Wi-Fi 7 Draft Standard at 84-85. The Galaxy S24 Ultra, when operating as an AP MLD or a non-AP MLD, has first, second, and third wireless transceivers (or STAs) that communicate in the 2.4 GHz, 5 GHz, and 6 GHz bands. **Wi-Fi Connectivity** 802.11a/b/g/n/ac/ax/be 2.4GHz+5GHz+6GHz, EHT320, MIMO, 4096-QAM Samsung Galaxy S24 Ultra Specs. In accordance with the Wi-Fi 7 Draft Standard, the Galaxy S24 Ultra has first, second, and third actual MAC interfaces corresponding to its first, second, and third STAs. Each MAC interface comprises, for each of the first, second, and third transceivers, a corresponding LMAC. The first, second, and third actual MAC interfaces are connected to the processing interface. As described above, the processing interface comprises at least a portion of the

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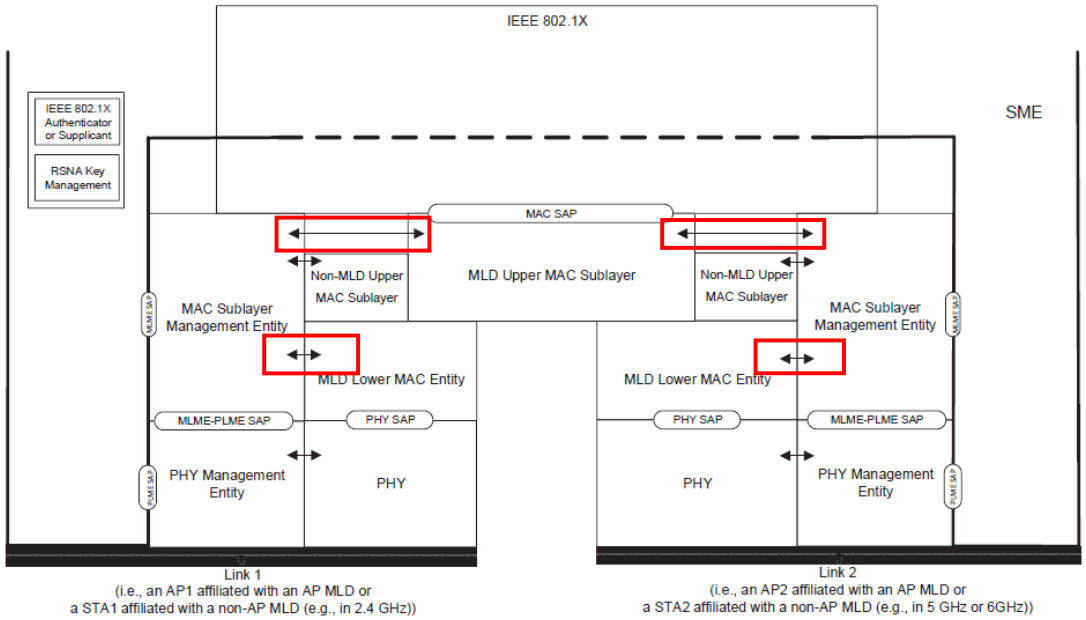
	SME, MLME, MAC SAP, MLME SAP, and PLME SAP in combination with at least some functionality of the UMAC. As shown in Figure 4-33b of the Wi-Fi 7 Draft Standard, the LMACs and the UMAC are in communication with the MLME. The MLME is further in communication with the SME via the MLME SAP.  **Figure 4-33b—Reference model for an MLD for two links** Figure 4-33b, Wi-Fi 7 Draft Standard at 78 (emphasis added).
[1.c] first, second, and third actual PHY interfaces connected to the	The Galaxy S24 Ultra has first, second, and third actual PHY interfaces connected to the first, second, and third actual MAC interfaces.

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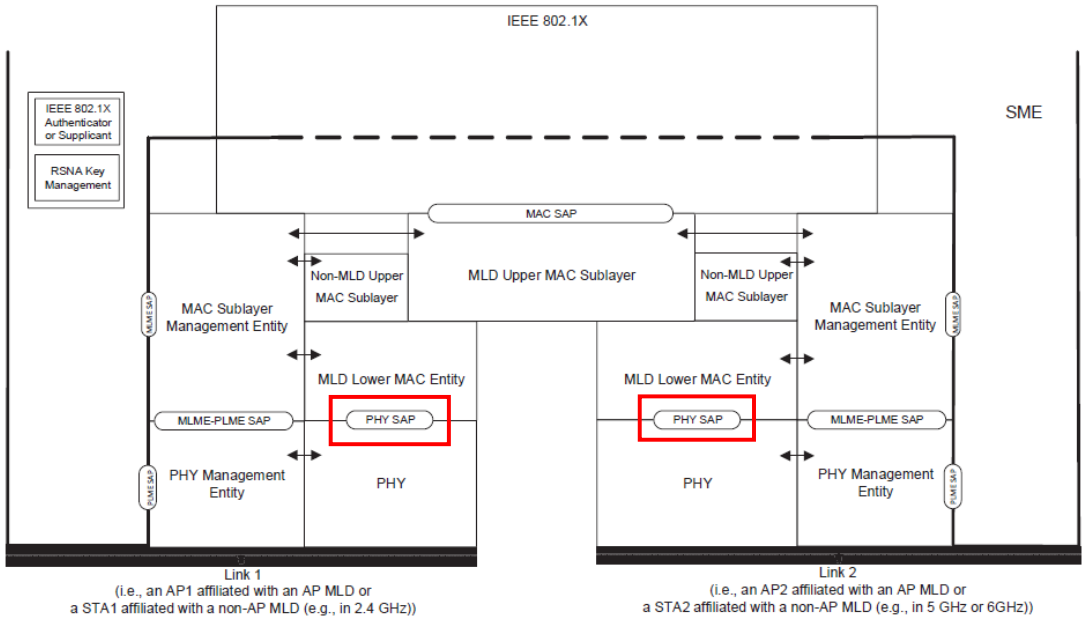
first, second, and third actual MAC interfaces;	As discussed with respect to element 1.b, the Galaxy S24 Ultra, when operating as an AP MLD or a non-AP MLD, has three transceivers that communicate in the 2.4 GHz, 5 GHz, and 6 GHz frequency bands. In addition to an associated MAC interface, each of these transceivers has an associated PHY interface. As shown in Figure 4-33b below, the PHY for each STA is connected to the corresponding actual MAC interface for that STA via a PHY SAP. The PHYs corresponding to each of the 2.4 GHz, 5 GHz, and 6 GHz band transceivers of the Galaxy S24 Ultra comprise the first, second, and third actual PHY interfaces.  **Figure 4-33b—Reference model for an MLD for two links** Figure 4-33b, Wi-Fi 7 Draft Standard at 78 (emphasis added).

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	Each PHY communicates with its corresponding MAC through the PHY SAP using certain vectors. **36.2 EHT PHY service interface** **36.2.1 Introduction** The EHT PHY provides an interface to the EHT MAC through an extension of the generic PHY service interface defined in 8.3.4 (Basic service and options). The interface includes TXVECTOR, RXVECTOR, PHYCONFIG_VECTOR, and TRIGVECTOR. The EHT MAC uses the TXVECTOR to supply the EHT PHY with per-PPDU transmit parameters. The EHT PHY uses the RXVECTOR to inform the EHT MAC of the received PPDU parameters. The EHT MAC uses the PHYCONFIG_VECTOR to configure the EHT PHY for operation that is independent of PPDU transmission or reception. The EHT MAC uses the TRIGVECTOR to configure the EHT PHY to receive EHT TB PPDUs over each assigned RU or MRU. Wi-Fi 7 Draft Standard at 708.
[1.d] first, second, and third wireless transceivers respectively associated with the first, second, and third actual PHY interfaces, wherein each one of the first, second, and third wireless transceivers (i) is suitable for use in a wireless local area network, (ii) has a first, second, and third bandwidth availability up to a first, second, and third actual bandwidth, and (iii) is adapted to emit radio waves in first, second, and third different bands of	The Galaxy S24 Ultra has first, second, and third wireless transceivers respectively associated with first, second, and third actual PHY interfaces, wherein each one of the first, second, and third wireless transceivers (i) is suitable for use in a wireless local area network, (ii) has a first, second, and third bandwidth availability up to a first, second, and third actual bandwidth, and (iii) is adapted to emit radio waves in first, second, and third different bands of frequencies, the second, and third frequency bands both being higher in frequency than the first frequency band. The Galaxy S24 Ultra, when operating as an AP MLD or a non-AP MLD, has three transceivers, each associated with an actual MAC interface and an actual PHY interface. Each of the three transceivers is suitable for use in a wireless local area network, such as a Wi-Fi network, shown below.

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frequencies, the second, and third frequency bands both being higher in frequency than the first frequency band;	**Wi-Fi Connectivity** 802.11a/b/g/n/ac/ax/be 2.4GHz+5GHz+6GHz, EHT320, MIMO, 4096-QAM Samsung Galaxy S24 Ultra Specs. The Wi-Fi 7 Draft Standard references that the transceivers are used in wireless local area networks that emit radio waves in frequency bands "ensuring backward compatibility and coexistence with legacy IEEE Std 802.11 compliant devices operating in the 2.4 GHz, 5 GHz, and 6 GHz bands." Wi-Fi 7 Draft Standard at 2. Additionally, the first, second, and third transceivers of the Galaxy S24 Ultra have first, second, and third bandwidth availability up to a first, second, and third actual bandwidth. At any given time, each of the three transceivers associated with the 2.4, 5, and 6 GHz bands has a bandwidth availability representing a portion of an actual and/or total bandwidth for that band. As described in further detail below, the UMAC, in combination with the SME (both of the processing interface), uses the bandwidth availability of each transceiver to make resource allocation decisions. The first, second, and third transceivers of the Galaxy S24 Ultra are adapted to emit radio waves in first, second, and third different bands of frequencies, the second and third frequency bands both being higher in frequency than the first frequency band. The first transceiver is the 2.4 GHz transceiver. The second transceiver is one of the 5 GHz and 6 GHz transceivers, and the third transceiver is the other one of the 5 GHz and 6 GHz transceivers. 5 GHz and 6 GHz are both higher than 2.4 GHz.

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[1.e] wherein the processing interface comprises (i) at least one virtual MAC interface and	In the Galaxy S24 Ultra, the processing interface comprises at least one virtual MAC interface. As described with respect to elements 1.a and 1.b, the processing interface of the Galaxy S24 Ultra, when operating as an AP MLD or a non-AP MLD, comprises at least a portion of the SME, MLME, MAC SAP, MLME SAP, and PLME SAP in combination with the UMAC. The processing interface performs certain functions that correspond to and comprise a virtual MAC interface. When operating as an AP MLD or a non-AP MLD, the processing interface of the Galaxy S24 Ultra performs certain functions that correspond to and comprise a virtual MAC interface. For example, the processing interface, and particularly the SME, makes strategic decisions about resource allocation and/or link recommendations based on traffic demands and network conditions. Network condition information necessarily includes bandwidth availability information resulting from channel assessments directly or indirectly by way of, for example, at least trigger frames, management frames, and feedback messages. The Galaxy S24 Ultra complies with the Wi-Fi Agile Multiband Specification, which "is built on the fundamental premise that the APs and STAs each have information which can aid in making the most effective selection of the spectrum band in which the STA and AP should be communicating. By exchanging this information with each other, APs and STAs enable each other to make decisions that collectively drive the network towards more efficient use of the available spectrum." Wi-Fi Agile Multiband Specification at § 3.1.

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	3 Wi-Fi Agile Multiband protocol **3.1 Introduction** The goal of the Wi-Fi Agile Multiband certification program is to certify features that facilitate efficient use of multiple frequency bands/channels available to APs and the STAs. The program is built on the fundamental premise that the APs and STAs each have information which can aid in making the most effective selection of the spectrum band in which the STA and AP should be communicating. By exchanging this information with each other, APs and STAs enable each other to make decisions that collectively drive the network towards more efficient use of the available spectrum. The following sections describe the information exchanged and the mechanisms by which APs and STAs exchange the desired information. Where applicable, references to existing IEEE standards are provided. In instances where there is a need to go beyond what the IEEE standards specify, the corresponding functionality, protocols and constraints are defined. Wi-Fi Agile Multiband Specification at § 3.1. As a particular example, in accordance with the Wi-Fi 7 Draft Standard, the SME's understanding of traffic priorities, queue lengths, and real-time network status enables intelligent TID-to-link mapping in the Galaxy S24 Ultra. This mapping determines which traffic (identified by TID) should be directed to which links (*i.e.*, associated bandwidth resources). The SME, in combination with the UMAC, allocates appropriate RUs/MRUs (resource units / multiple resource units) based on the data requirements of the specific traffic type mapped to a link. The SME considers factors like the amount of data to be transmitted for a particular TID and the channel bandwidth available on the chosen link. It can choose to allocate a single RU for smaller data packets or low-priority traffic, or allocate multiple RUs combined into an MRU for larger data transfers or high-priority traffic requiring more bandwidth. Accordingly, the processing interface comprises at least one virtual MAC interface. The virtual MAC interface comprises the portions of the SME and MLME, in combination with functionality of the UMAC, that perform RU/MRU allocation and TID-to-Link mapping. The virtual MAC interface may additionally include a portion of the MLME SAP by which the SME communicates with the MLME.

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	An MLD supports multiple MAC functions, with synchronization across the MAC functions as needed via the MLD synchronization service (see 35.3.25 (MLD synchronization service)) and otherwise coordinated by the SME. Each affiliated STA is enumerated with a Link ID (for example, as Link 1 and Link 2 in Figure 4-33b (Reference model for an MLD for two links)) and MLME primitives are invoked through an MLME SAP. The SME maintains the authentication and association states. The Authenticator and the MAC-SAP of the AP MLD are identified by the same AP MLD MAC address. The Supplicant and the MAC-SAP of the non-AP MLD are identified by the same non-AP MLD MAC address. The SME is responsible for coordinating the MLD and each of the affiliated STAs through the MLME, and to maintain an RSNA key management entity and IEEE 802.1X Authenticator or Supplicant, for MLO. Wi-Fi 7 Draft Standard at 78.
[1.f] (ii) first, second, and third virtual PHY interfaces that, during operation of the wireless networking device, feed information regarding the bandwidth availabilities of the first, second, and third wireless transceivers back to the at least one virtual MAC interface;	In the Galaxy S24 Ultra, the processing interface comprises first, second, and third virtual PHY interfaces that, during operation of the wireless networking device, feed information regarding the bandwidth availabilities of the first, second, and third wireless transceivers back to the at least one virtual MAC interface. As described with respect to element 1.e, when operating as an AP MLD or a non-AP MLD, at least a first portion of the processing interface of the Galaxy S24 Ultra comprises a virtual MAC interface. The virtual MAC interface comprises portions of the SME and MLME, in combination with functionality of the UMAC, and makes strategic decisions about resource allocation and/or link recommendations. For example, the virtual MAC interface comprises the portions of the SME and MLME, in combination with functionality of the UMAC, that perform RU/MRU allocation and TID-to-Link mapping. The virtual MAC interface may additionally include a portion of the MLME SAP by which the SME communicates with the MLME.

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	Additionally, in order for the processing interface to make strategic decisions about resource allocation and/or link recommendations, the SME must receive information regarding bandwidth availabilities of the transceivers. For example, to allocate RUs/MRUs to achieve the increased bandwidth utilization and efficiency objectives of the IEEE 802.11be standard and for multi-users, the SME must receive information regarding the bandwidth availabilities of the transceivers from which the RUs/MRUs may be assigned based at least on channel utilization and/or congestion. *See, e.g.*, Wi-Fi 7 Draft Standard at 629-637. Information regarding bandwidth availabilities of the transceivers may be or include information about the actual PHY itself. Information regarding bandwidth availabilities of the transceivers may additionally or alternatively include information received at the actual PHY from another device, such as an AP MLD device. In each case, information regarding bandwidth availabilities is communicated to the virtual MAC interface. As described in more detail below, the virtual PHY interfaces of the Galaxy S24 Ultra, when operating as an AP MLD or a non-AP MLD, comprise those portions of the SME that report information regarding bandwidth availabilities to the virtual MAC. Each virtual PHY interface may additionally include a portion of the MLME, where logic or pathways within the MLME are used in reporting information about bandwidth availabilities to the virtual MAC. Additionally, the path of communication by which information regarding bandwidth availabilities is fed to the virtual MAC may be or include portions of the MLME SAP and/or PLME SAP. Each virtual PHY interface may therefore additionally include a portion of the MLME SAP and/or the PLME SAP through which bandwidth information is directed to the virtual MAC. The Galaxy S24 Ultra has three STAs for its three transceivers, each with a corresponding actual PHY interface. In connection with each actual PHY interface, the Galaxy S24 Ultra has a virtual PHY interface responsible for feeding information regarding bandwidth availabilities about the corresponding actual PHY interface to the virtual MAC.

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	The Galaxy S24 Ultra therefore has first, second, and third virtual PHY interfaces corresponding to its first, second, and third transceivers. The Wi-Fi Agile Multiband Specification provides examples of information regarding bandwidth availabilities that may be communicated by the virtual PHY interfaces. In accordance with the Wi-Fi Agile Multiband Specification, when operating as a non-AP MLD, for example, the Galaxy S24 Ultra provides "to a Wi-Fi Agile Multiband AP a list of channels and bands on which it prefers not to be associated," including in each list entry: channel and band, preference value, and reason code. Wi-Fi Agile Multiband Specification at § 2.3.2. A Wi-Fi Agile Multiband STA shall support the following features: • Indicates whether or not it has a cellular data connection available (refer to section 4.2.3) • Provides to a Wi-Fi Agile Multiband AP a list of channels and bands on which it prefers not to be associated, including in each list entry: ▪ Channel and band ▪ Preference value ▪ Reason code Wi-Fi Agile Multiband Specification at § 2.3.2. Reason codes may include, for example, co-located interference, where an "unacceptable level of interference is being experienced by the Wi-Fi Agile Multiband STA in this channel," and in-device interferer, where the "Agile Multiband STA has another active connection in this channel, or near enough to this channel to cause operating interference." Wi-Fi Agile Multiband Specification at Table 10. "This information is communicated to the Wi-Fi Agile Multiband AP when the Wi-Fi Agile Multiband STA associates or reassociates, and when the information changes while the Wi-Fi Agile Multiband STA is associated." Wi-Fi Agile Multiband Specification at §3.2. For a Wi-Fi Agile Multiband AP that supports MLO as defined in the Wi-Fi 7 Draft Standard, "this list of non-preferred channels" is indicated across all affiliated non-AP STAs. *Id.*

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	In addition to the non-AP MLD communicating such channel and band information to an AP MLD, such channel and band information, including interference information, may be communicated from the Galaxy S24 Ultra's virtual PHY interfaces to the virtual MAC. Information regarding bandwidth availabilities may be communicated by the virtual PHY interfaces to the virtual MAC through multiple operations. For example: **<u>Multi-Link Beacon or Probe Response</u>** In accordance with the Wi-Fi Agile Multiband Specification, the Galaxy S24 Ultra "include[s] the MBO [Multiband Operation] Capability Indication attribute in Beacon and Probe Response frames on all links." Wi-Fi Agile Multiband Specification at §3.8. **3.8 MBO Capability Indication attribute** Wi-Fi Agile Multiband APs shall include the MBO Capability Indication attribute in Beacon frames, Probe Response frames and (Re)Association Response frames. This attribute indicates that the AP is a Wi-Fi Agile Multiband AP, and whether it is cellular data aware or not. A Wi-Fi Agile Multiband AP which supports MLO as defined in [2], shall include the MBO Capability Indication attribute in Beacon and Probe Response frames on all links. Wi-Fi Agile Multiband Specification at §3.8. Support for MBO attribute AP Beacon, Probe Response, and (Re)Association Response management frames is mandatory, as is support for non-preferred channel reports for the STA (Re)Association Request. Wi-Fi Agile Multiband Specification at Table 5. A non-AP MLD, such as the Galaxy S24 Ultra, obtains information regarding bandwidths from AP MLDs. Such information may be obtained, for example, during MLO discovery. For example, during MLO discovery and ML setup, a non-AP MLD discovers an AP MLD using either (1) passive or active scanning, or (2) transmission of a multi-link probe

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	request. The non-AP MLD receives from the AP MLD either a beacon frame or a multi-link probe response frame. **35.3.4.6 Frame exchange sequences during MLO discovery and ML setup** A non-AP MLD is expected to discover an AP MLD and affiliated AP(s) of interest before initiating an ML setup with the AP MLD. The non-AP MLD can use one or a combination of the following methods for discovering the AP MLD and affiliated AP(s) of interest: — Through each of its affiliated STAs, perform passive scanning by following the procedure defined in 11.1.4.2 (Passive scanning) or active scanning by following the procedure defined in 11.1.4.3 (Active scanning and probing procedures). — Through one of its affiliated STAs, transmit a multi-link probe request on any link that the AP MLD is operating on, with the frame addressed to the affiliated AP operating on that link, to obtain information about the AP MLD and its affiliated AP(s) by following the procedure defined in 35.3.4.2 (Use of multi-link probe request and response). Wi-Fi 7 Draft Standard at 544.

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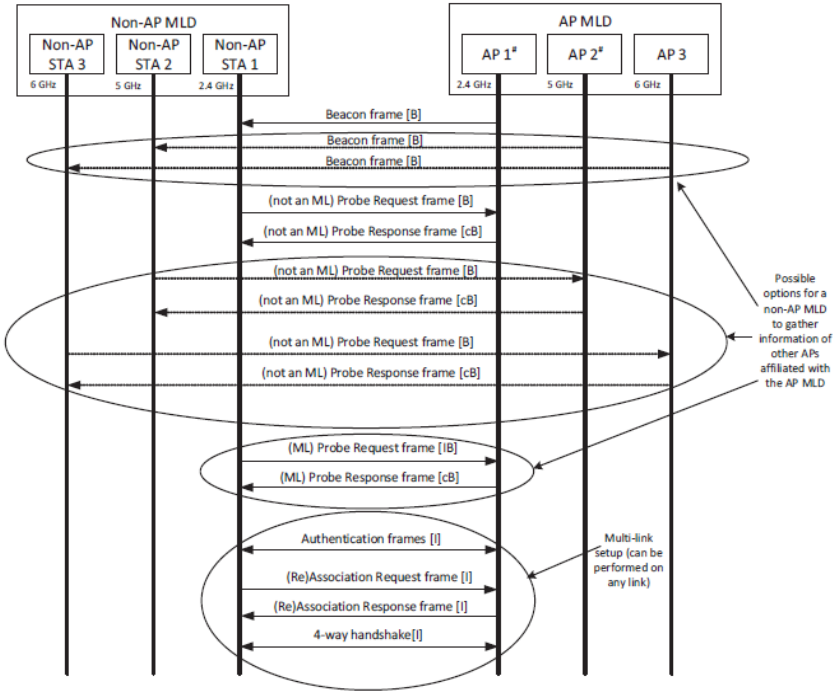
	Figure 35-5 (Possible frame exchange sequences during MLO discovery and ML setup when the AP operating on the channel does not correspond to a nontransmitted BSSID) shows a possible frame exchange sequence performed, during discovery, between a non-AP STA affiliated with a non-AP MLD and an AP that does not correspond to a nontransmitted BSSID and is affiliated with an AP MLD.  **Figure 35-5—Possible frame exchange sequences during MLO discovery and ML setup when the AP operating on the channel does not correspond to a nontransmitted BSSID** Fig. 35-5, Wi-Fi 7 Draft Standard at 545.

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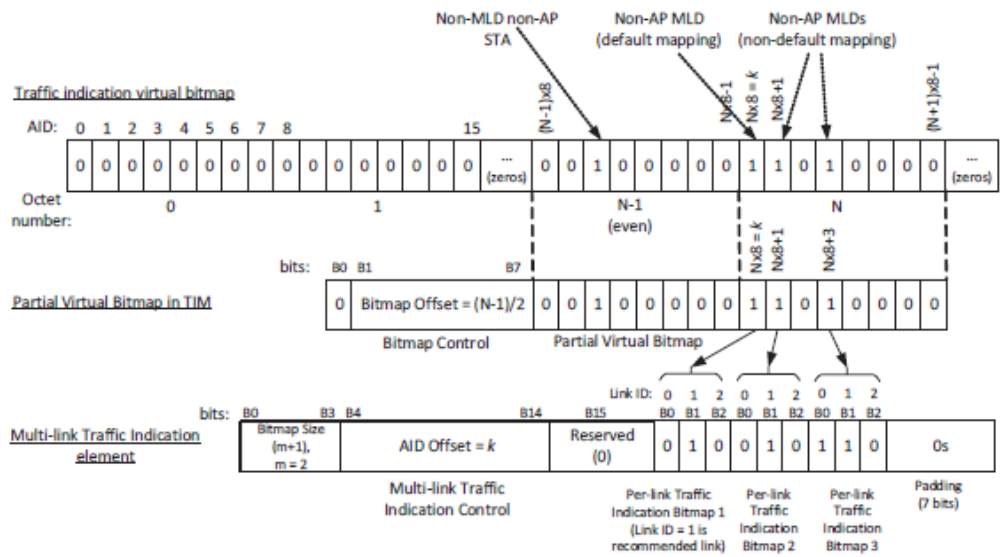
	The beacon frame and the multi-link probe response frame received by the non-AP MLD include information regarding bandwidth availabilities. In particular, both the beacon frame and the multi-link probe response frame include a multi-link traffic indication element, an EHT capabilities element, an EHT operation element, a TID-to-Link mapping element, and a channel usage element. Wi-Fi 7 Draft Standard at 183-84 (beacon frame), 190-91 (probe response frame). These elements include information regarding bandwidth availability, such as a per-link traffic indication list contained in the multi-link traffic indication element and PHY capabilities information contained in the EHT capabilities element. Wi-Fi 7 Draft Standard at 295-97 (Multi-Link Traffic Indication), 269-93 (EHT Capabilities).  **Figure 35-7—Example of Multi-Link Traffic Indication element construction** Fig. 35-7, Wi-Fi 7 Draft Standard at 587.

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	The beacon or multi-link probe response frame may additionally or alternatively include a Basic Multi-Link element, which includes a Per-STA Profile sub-element. Wi-Fi 7 Draft Standard at 248-61. The format of the Per-STA Profile subelement is defined in Figure 9-1074u (Per-STA Profile subelement format of the Basic Multi-Link element). Subelement ID | Length | STA Control | STA Info | STA Profile Octets: 1 | 1 | 2 | variable | variable **Figure 9-1074u—Per-STA Profile subelement format of the Basic Multi-Link element** Wi-Fi 7 Draft Standard at 259. Additionally, or alternatively, devices may transmit beacon frames on multiple channels simultaneously. By analyzing overlapping beacon frames from neighboring APs, the MLD can infer channel occupancy and recommend and/or allocate potential resources for its own transmissions. **<u>Punctured Subchannels</u>** Additionally, the Galaxy S24 Ultra, with Wi-Fi 7 enabled, is configured for preamble puncturing. The puncturing pattern, required of the standard, provides information regarding the first, second, and third bandwidth availabilities to the virtual MAC interface. Preamble puncturing allows WNDs, such as the Galaxy S24 Ultra, to recognize and exclude unavailable subchannels from a transmission. For example, the Wi-Fi 7 Draft Standard describes the U-SIG field that carries the information necessary to interpret EHT PPDUs, and that shows a puncturing pattern wherein RUs and MRUs are punctured. The puncturing pattern indicates what sub-portions of RUs or MRUs are not to be used for transmission or

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	reception purposes. Unavailable subchannels may be indicated, for example, in a Disabled Subchannel Bitmap. **36.3.12.11 EHT preamble of preamble punctured EHT MU PPDU** **36.3.12.11.1 General** Preamble puncturing refers to the transmission of a PPDU in which no signal is present in at least one of the 20 MHz subchannels within the PPDU bandwidth. Preamble puncturing might be the result of the unavailability of 20 MHz subchannel(s) within the PPDU bandwidth, such as a busy channel indicated by the CCA or the setting of the Disabled Subchannel Bitmap subfield in the EHT Operations element (see 9.4.2.321 (EHT Operation element)). Wi-Fi 7 Draft Standard at 867. Otherwise, an EHT STA may puncture other subchannels in addition to those indicated in the Disabled Subchannel Bitmap subfield in the EHT Operation element in an EHT MU PPDU or a non-HT duplicate PPDU. If an EHT AP punctures other subchannels in an EHT MU PPDU or a non-HT duplicate PPDU in addition to those indicated in the Disabled Subchannel Bitmap subfield and solicits a response to the PPDU, the EHT AP shall use a triggering frame to solicit the response in a TB PPDU and assign an RU or MRU within the nonpunctured subchannel set to a responding EHT STA. Wi-Fi 7 Draft Standard at 686. Regardless of the inclusion of the Disabled Subchannel Bitmap subfield in the EHT Operation element, an EHT STA may use EHT MU PPDU preamble puncturing modes as defined in 36.3.12.11 (EHT preamble of preamble punctured EHT MU PPDU) or EHT TB PPDU in which not all the 20 MHz subchannels are assigned. Wi-Fi 7 Draft Standard at 686. Unavailable subchannels (*i.e.*, punctured subchannels) may also be identified using TXVector parameters, as shown below.

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	35.11.5 INACTIVE_SUBCHANNELS An EHT STA shall not transmit on any 20 MHz subchannel that is punctured as indicated in the TXVECTOR parameter INACTIVE_SUBCHANNELS (see Table 36-1 (TXVECTOR and RXVECTOR parameters)). The indication of which subchannels are punctured in a non-HT duplicate PPDU or EHT PPDU is conveyed from the MAC to the PHY through the TXVECTOR parameter INACTIVE_SUBCHANNELS (see Table 36-1 (TXVECTOR and RXVECTOR parameters)). The parameter INACTIVE_SUBCHANNELS is present in the TXVECTOR of a non-HT duplicate PPDU or EHT PPDU when the conditions defined in 35.15.2 (Preamble puncturing operation) are satisfied. Wi-Fi 7 Draft Standard at 671. If a 20 MHz subchannel is indicated as a punctured subchannel in the most recently exchanged Disabled Subchannel Bitmap subfield in the EHT Operation element, the corresponding bit in the TXVECTOR parameter INACTIVE_SUBCHANNELS shall be set to 1 and the punctured 20 MHz subchannel shall not be used by the non-TB PPDU(s) that is transmitted during the time allocated by the associated AP. Wi-Fi 7 Draft Standard at 527. When operating as an AP MLD or a non-AP MLD, the virtual MAC interface of the Galaxy S24 Ultra evaluates the channel information, such as the puncturing pattern, to determine what portions of channels are unavailable, and therefore not to be recommended and/or used for transmission or reception purposes. **<u>Bandwidth Signaling TA</u>** As another example of information regarding bandwidth availabilities, a bandwidth signaling transmitter address (TA) indicates the presence of additional signaling related to the bandwidth to be used in a subsequent transmission. A bandwidth signaling TA may be

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	communicated in connection with control frames such as an RTS frame, a PS-Poll frame, or a BlockAckReq frame. **35.2 EHT channel access** **35.2.1 TXOP** **35.2.1.1 Bandwidth signaling** An EHT STA that is a STA 6G and is transmitting a Control frame in non-HT duplicate format with a bandwidth signaling TA addressed to an EHT STA shall set the TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT signaled via the scrambling sequence and SERVICE field according to Table 36-1 (TXVECTOR and RXVECTOR parameters). An EHT STA that is a STA 6G and is transmitting a CTS frame in non-HT duplicate format in response to an RTS frame in non-HT duplicate format with a bandwidth signaling TA addressed to the EHT STA shall set the TXVECTOR parameter CH_BANDWIDTH_IN_NON_HT signaled via the scrambling sequence and SERVICE field according to Table 36-1 (TXVECTOR and RXVECTOR parameters). Wi-Fi 7 Draft Standard at 523. Additionally, multi-link enhancements in the use of management primitives, clear channel assessments, link monitoring, bandwidth query or link quality reports, and/or channel availability mechanisms may be used for communicating information about bandwidth availabilities to the virtual MAC interface. Thus, when operating as an AP MLD or a non-AP MLD, the SME of the Galaxy S24 Ultra makes decisions and/or recommendations about which channels to use for data transmission by collecting information about channel conditions, including noise levels, and selecting the channels that offer the best performance. To accomplish this, the MLME provides the SME with information about the available channels and their characteristics, such as channel utilization and interference levels. The PLME provides feedback to the MLME about channel conditions, which the MLME may then relay to the SME.

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[1.g] wherein the processing interface is configured to, when the wireless network device is being used, in a manner transparent to any layer of the wireless networking device above the processing interface,	The Galaxy S24 Ultra includes a processing interface that, when the wireless network device is being used, operates in a manner transparent to any layer of the wireless networking device above the processing interface. Layers between the processing interface and the application interface include, for example, a data link interface. As described with respect to elements 1.a and 1.b, when operating as an AP MLD or a non-AP MLD, the processing interface of the Galaxy S24 Ultra comprises at least a portion of the SME, MLME, MAC SAP, MLME SAP, and PLME SAP in combination with at least some functionality of the UMAC. The SME, MLME, PLME, and UMAC exchange information and operate to make bandwidth allocation decisions and/or recommendations in a manner transparent to all layers of the wireless networking device above the processing interface such as the data link layer. **4.2.5 Interaction with other IEEE 802® layers** IEEE Std 802.11 is required to appear to higher layers [logical link control (LLC) sublayer] as a general-purpose IEEE 802 LAN. This requires that the IEEE 802.11 network handle STA mobility within the MAC sublayer. To meet reliability assumptions (that LLC makes about lower layers), it is necessary for IEEE Std 802.11 to incorporate functionality that is untraditional for MAC sublayers. IEEE 802.11-2020 Standard for Information Technology—Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks—Specific Requirements (2020) at 219.

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	An MLD supports multiple MAC functions, with synchronization across the MAC functions as needed via the MLD synchronization service (see 35.3.25 (MLD synchronization service)) and otherwise coordinated by the SME. Each affiliated STA is enumerated with a Link ID (for example, as Link 1 and Link 2 in Figure 4-33b (Reference model for an MLD for two links)) and MLME primitives are invoked through an MLME SAP. The SME maintains the authentication and association states. The Authenticator and the MAC-SAP of the AP MLD are identified by the same AP MLD MAC address. The Supplicant and the MAC-SAP of the non-AP MLD are identified by the same non-AP MLD MAC address. The SME is responsible for coordinating the MLD and each of the affiliated STAs through the MLME, and to maintain an RSNA key management entity and IEEE 802.1X Authenticator or Supplicant, for MLO. Wi-Fi 7 Draft Standard at 78. The SME maintains the authentication and association states. The same AP MLD MAC address and same non-AP MLD MAC address are used. Thus, when the Galaxy S24 Ultra is being used, operating as an AP MLD or a non-AP MLD, its processing interface operates in a manner transparent to any layer of the Galaxy S24 Ultra above the processing interface. Further, testing of the Galaxy S24 Ultra indicates that, when the Galaxy S24 Ultra is in use, its processing interface, including its virtual MAC interface, operates to make bandwidth allocation decisions and/or recommendations in a manner transparent to all layers of the wireless networking device above the processing interface such as the data link layer. For example, the screenshots below demonstrate that, in use, the processing interface of the Galaxy S24 Ultra operates to make, for example, bandwidth allocation decisions using each of the 2.4 GHz, 5 GHz, and 6 GHz bands.

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	 WiFiman application screenshot taken on Galaxy S24 Ultra demonstrating connection with local access point (emphasis added).

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	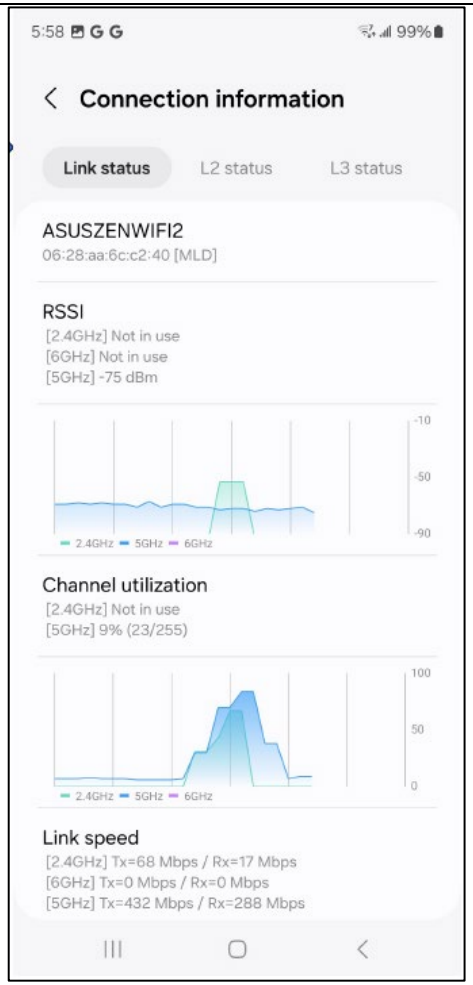 WiFiman application screenshot taken on Galaxy S24 Ultra demonstrating connection with local access point.

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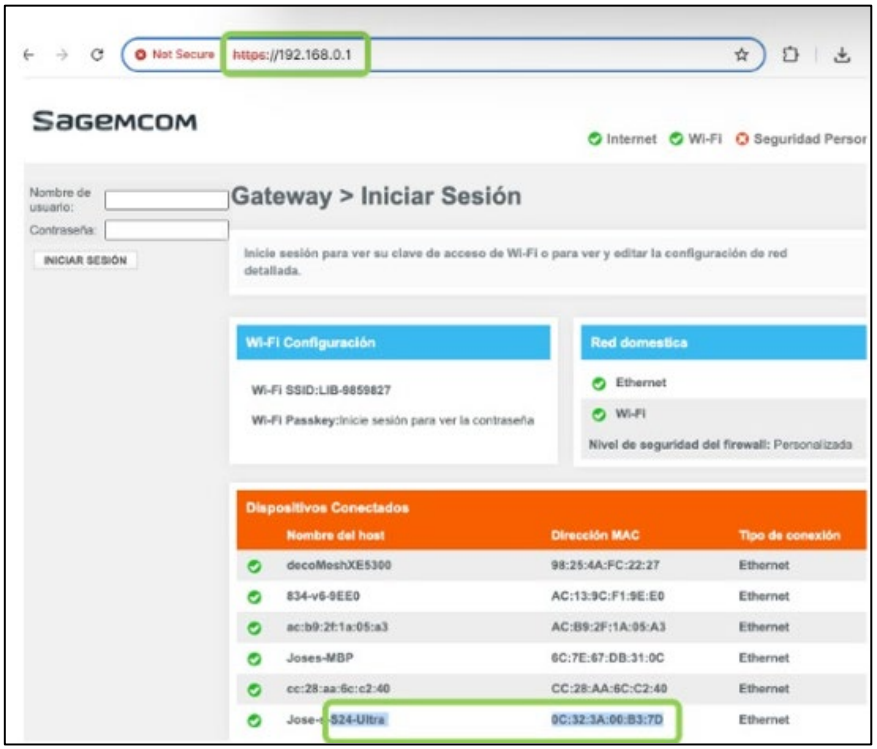
	As shown above, the processing interface's utilization of the available channels changes over time. Despite this, as shown below, in use, the Galaxy S24 Ultra is associated with only a single IP address and a single MAC address used to route Internet traffic to the Galaxy S24 Ultra.  Internet browser screenshot indicating connection between Sagemcom Internet Gateway router and Galaxy S24 Ultra (emphasis added).

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[1.h] (a) request or create (i) a first association between a recipient and the first actual MAC and PHY interfaces, (ii) a second association between the recipient and the second actual MAC and PHY interfaces and (iii) a third association between the recipient and the third actual MAC and PHY interfaces, and	The processing interface of the Galaxy S24 Ultra is configured to request or create (i) a first association between a recipient and the first actual MAC and PHY interfaces, (ii) a second association between the recipient and the second actual MAC and PHY interfaces and (iii) a third association between the recipient and the third actual MAC and PHY interfaces. MLO allows a non-AP MLD and an AP MLD to establish multiple links between their corresponding STAs. The Galaxy S24 Ultra, when operating as an AP MLD or a non-AP MLD, is configured to request or create associations between its STAs and those of another device. As described above, the Galaxy S24 Ultra has multiple STAs, each having a corresponding actual PHY interface and a corresponding actual MAC interface. Each station is associated with a frequency band, such as 2.4 GHz, 5 GHz, or 6 GHz. MLO is defined for an EHT STA in 35.3 (Multi-link operation (MLO)). MLO allows an AP MLD and a non-AP MLD to set up multiple links between them. A reference model for MLO is described in 4.9.6 (Reference model for multi-link operation (MLO)). Wi-Fi 7 Draft Standard at 523.

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	4.9.6 Reference model for multi-link operation (MLO) MLO defines a set of procedures allowing communication over one or more links between MLDs. An MLD manages such communication over one or more links. Communication over links using different channels on different frequency bands or the same frequency band can occur simultaneously or not depending on the capabilities of both the AP MLD and the non-AP MLD (see 35.3.16.3 (Simultaneous transmit and receive (STR) operation) and 35.3.16.4 (Nonsimultaneous transmit and receive (NSTR) operation)). The MLO procedures (see 35.3 (Multi-link operation (MLO))) allow a pair of MLDs to discover, synchronize, (de)authenticate, (re)associate, disassociate, and manage links and other resources with each other on any common bands or channels that are supported by both MLDs. Each MLD has a single MAC-SAP. Each STA affiliated with an MLD has a MAC address different from any other STA affiliated with the same MLD. Wi-Fi 7 Draft Standard at 76. When a link is established between a non-AP MLD and an AP MLD, an association is requested or created between the actual MAC and actual PHY interfaces of the non-AP MLD and the AP MLD.

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	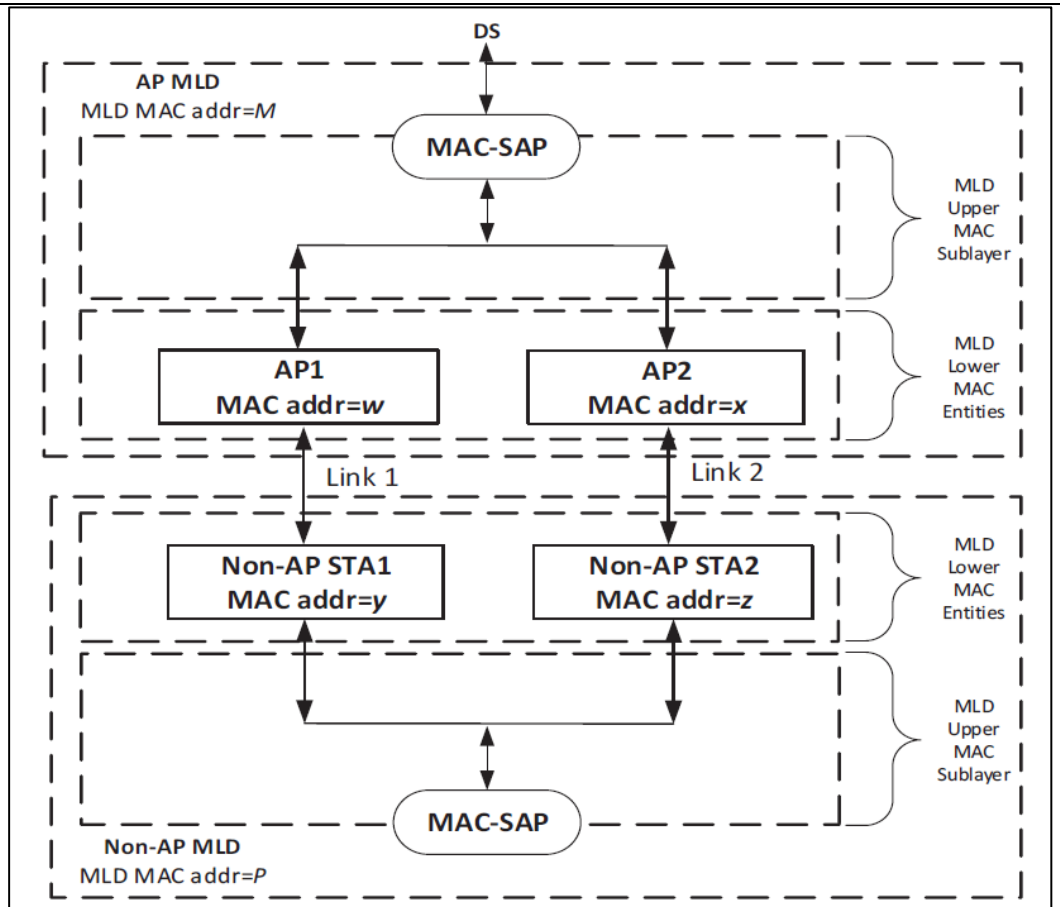 Figure 4-33a—Example communication system between two MLDs via their affiliated STAs (for individually addressed MSDUs) Fig. 4-33a, Wi-Fi 7 Draft Standard at 77.

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	During MLO discovery and ML setup, a non-AP MLD may discover an AP MLD using either (1) passive or active scanning, or (2) transmission of a multi-link probe request. The non-AP MLD receives from the AP MLD either a beacon frame or a multi-link probe response frame. These exchanges of frames allow the non-AP MLD and the AP MLD (here, the recipient) to request or create an association between their STAs. Operating as an AP MLD, the Galaxy S24 Ultra may request or create associations between its actual MAC and PHY interfaces and a recipient, such as a non-AP MLD device. Additionally, when operating as a non-AP MLD, the Galaxy S24 Ultra may request or create associations between its actual MAC and PHY interfaces and a recipient, such as an AP MLD device. **35.3.4.6 Frame exchange sequences during MLO discovery and ML setup** A non-AP MLD is expected to discover an AP MLD and affiliated AP(s) of interest before initiating an ML setup with the AP MLD. The non-AP MLD can use one or a combination of the following methods for discovering the AP MLD and affiliated AP(s) of interest: — Through each of its affiliated STAs, perform passive scanning by following the procedure defined in 11.1.4.2 (Passive scanning) or active scanning by following the procedure defined in 11.1.4.3 (Active scanning and probing procedures). — Through one of its affiliated STAs, transmit a multi-link probe request on any link that the AP MLD is operating on, with the frame addressed to the affiliated AP operating on that link, to obtain information about the AP MLD and its affiliated AP(s) by following the procedure defined in 35.3.4.2 (Use of multi-link probe request and response). Wi-Fi 7 Draft Standard at 544.

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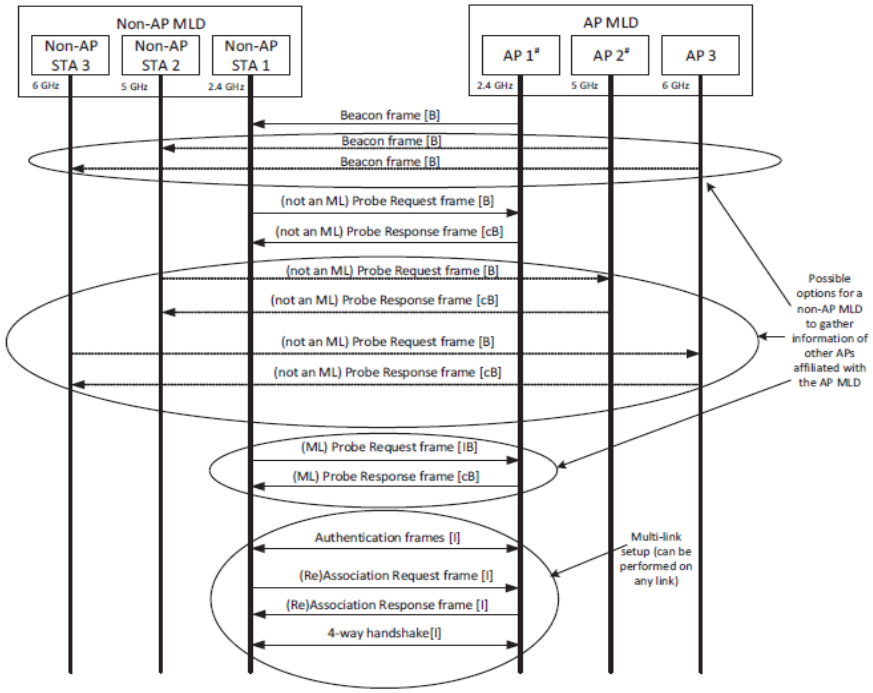
	Figure 35-5 (Possible frame exchange sequences during MLO discovery and ML setup when the AP operating on the channel does not correspond to a nontransmitted BSSID) shows a possible frame exchange sequence performed, during discovery, between a non-AP STA affiliated with a non-AP MLD and an AP that does not correspond to a nontransmitted BSSID and is affiliated with an AP MLD.
	 
	
	= Alternate sequence
	#This example assumes that APs on 2.4 GHz and 5 GHz do not corresponding to a nonTxBSSID
	[I] = Individually addressed
	[IB] = Individual or broadcast address (i.e., A1 is set to BSSID or broadcast address)
	[B] = Broadcast (A1 is set to broadcast address),
	[cB] = Conditionally broadcast (i.e., A1 set to broadcast address in 6 GHz or if dot11FILSOmitReplicateProbeResponses equal to true); otherwise, individually addressed (i.e., A1 set to the MAC address of the non-AP STA operating on the link)
	Figure 35-5—Possible frame exchange sequences during MLO discovery and ML setup when the AP operating on the channel does not correspond to a nontransmitted BSSID
	Fig. 35-5, Wi-Fi 7 Draft Standard at 545.

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	As indicated above, the Galaxy S24 Ultra has three wireless transceivers, each having an associated actual PHY interface and an associated actual MAC interface. Thus, when operating as an AP MLD or a non-AP MLD, the Galaxy S24 Ultra may request or create an association between each of its actual PHY and MAC interfaces and a recipient. Further, testing of the Galaxy S24 Ultra indicates that, when the Galaxy S24 Ultra is in use, its processing interface operates to request or create associations between the Galaxy S24 Ultra and a recipient, such as an AP MLD, over multiple bands. For example, the screenshot below demonstrates that, in use, the Galaxy S24 Ultra may have an association between a recipient and each of its three transceivers.

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	 WiFiman application screenshot taken on Galaxy S24 Ultra demonstrating connection with local access point (emphasis added).

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[1.i] (b) (i) identify at least one portion of each one of the first, second, and third bandwidths of the first, second, and third wireless transceivers that are available for communication, and	The processing interface of the Galaxy S24 Ultra is configured to identify at least one portion of each one of the first, second, and third bandwidths of the first, second, and third wireless transceivers that are available for communication. To achieve the increased bandwidth utilization and efficiency objectives of the Wi-Fi 7 Draft Standard and for MLO, when operating as an AP MLD or a non-AP MLD, the processing interface of the Galaxy S24 Ultra monitors and identifies portions of bandwidths for each of the device's three transceivers that are available for communication so that the processing interface can make resource allocations and/or recommendations based at least on channel utilization and/or congestion. *See, e.g.*, Wi-Fi 7 Draft Standard at 629-637. As described with respect to element 1.f, information regarding bandwidth availabilities is communicated to the virtual MAC using a variety of operations. Once received, the information regarding bandwidth availabilities allows the processing interface to identify at least one portion of each of the first, second, and third bandwidths of the first, second, and third transceivers that are available for communication. As a particular example, when operating as a non-AP MLD, the Galaxy S24 Ultra may operate in EMLMR mode. The Wi-Fi 7 Draft Standard states that EMLMR mode is an operating mode wherein a non-AP MLD like the Galaxy S24 Ultra aggregates some physical resources of its different radios used on different links (so-called EMLMR links) in order to transmit or receive data up to a pre-defined number of supported Rx/Tx spatial streams, which number may be greater than the number of supported Rx/Tx spatial streams of each radio.

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	35.3.18 Enhanced multi-link multi-radio (EMLMR) operation The enhanced multi-link multi-radio (EMLMR) operation defined in this subclause allows a non-AP MLD with multiple radios on multiple links to listen a set of links as defined below for an initial frame sent by an AP affiliated with an AP MLD, followed by frame exchanges that satisfy the MCS and number of spatial streams (N_{SS}) capabilities in the EMLMR mode on the link on which the initial frame was received. Here initial frame is transmitted in a PPDU whose N_{SS} satisfies the receiving STA's capabilities. A non-AP MLD may operate in the EMLMR mode on a specified set of the enabled links as defined in 9.4.1.76 (EML Control field) between the non-AP MLD and its associated AP MLD. The specified set of the enabled links in which the EMLMR mode is applied is called EMLMR links. A non-AP STA affiliated with the non-AP MLD that is on an EMLMR link is an EMLMR STA. The EMLMR links shall be indicated in the EMLMR Link Bitmap subfield of the EML Control field of the EML Operating Mode Notification frame (see 9.6.38.8 (EML Operating Mode Notification frame details)) by setting the bit positions corresponding to the link IDs of these links in the EMLMR Link Bitmap subfield to 1. Wi-Fi 7 Draft Standard at 613. A portion of available bandwidth may comprise a single RU, a group of RUs or an MRU. Further, a portion of bandwidth comprises a set of resources that include, for example, bandwidth channels or subchannels associated with a particular frequency band. As a particular example, a set of given resources may comprise a plurality of 20 MHz subchannels for a particular frequency band.
[1.j] (ii) evaluate the identified bandwidth availabilities of the first, second, and third wireless transceivers with respect to the first bandwidth requirement of the first application;	The processing interface of the Galaxy S24 Ultra is configured to evaluate the identified bandwidth availabilities of the first, second, and third wireless transceivers with respect to the first bandwidth requirement of the first application. As described with respect to element 1.f, the Galaxy S24 Ultra, when operating as an AP MLD or a non-AP MLD, obtains information about bandwidth availabilities from other devices through, for example, beacon frames and multi-link response frames. For example, both the beacon frame and the multi-link probe response frame include a multi-link traffic

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	indication element, an EHT capabilities element, an EHT operation element, a TID-to-Link mapping element, and a channel usage element. Wi-Fi 7 Draft Standard at 183-84 (beacon frame), 190-91 (probe response frame). These elements include information regarding bandwidth availability, such as a per-link traffic indication list contained in the multi-link traffic indication element and PHY capabilities information contained in the EHT capabilities element. Wi-Fi 7 Draft Standard at 295-97 (Multi-Link Traffic Indication), 269-93 (EHT Capabilities). The Wi-Fi Agile Multiband Specification provides examples of information regarding bandwidth availabilities that may be communicated by the virtual PHY interface. In accordance with the Wi-Fi Agile Multiband Specification, when operating as a non-AP MLD, for example, the Galaxy S24 Ultra provides "to a Wi-Fi Agile Multiband AP a list of channels and bands on which it prefers not to be associated," including in each list entry: channel and band, preference value, and reason code. Wi-Fi Agile Multiband Specification at § 2.3.2. A Wi-Fi Agile Multiband STA shall support the following features: • Indicates whether or not it has a cellular data connection available (refer to section 4.2.3) • Provides to a Wi-Fi Agile Multiband AP a list of channels and bands on which it prefers not to be associated, including in each list entry: ▪ Channel and band ▪ Preference value ▪ Reason code Wi-Fi Agile Multiband Specification at § 2.3.2. Reason codes may include, for example, co-located interference, where an "unacceptable level of interference is being experienced by the Wi-Fi Agile Multiband STA in this channel," and in-device interferer, where the "Agile Multiband STA has another active connection in this channel, or near enough to this channel to cause operating interference." Wi-Fi Agile Multiband Specification at Table 10. "This information is

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	communicated to the Wi-Fi Agile Multiband AP when the Wi-Fi Agile Multiband STA associates or reassociates, and when the information changes while the Wi-Fi Agile Multiband STA is associated." Wi-Fi Agile Multiband Specification at §3.2. For a Wi-Fi Agile Multiband AP that supports MLO as defined in the Wi-Fi 7 Draft Standard, "this list of non-preferred channels" is indicated across all affiliated non-AP STAs. *Id.* The Galaxy S24 Ultra, when operating as an AP MLD or a non-AP MLD, enables the use of TID-to-link mapping in accordance with the Wi-Fi 7 Draft Standard. For example, when operating as an AP MLD, the SME and UMAC (through a Resource Allocation Manager) may determine TID-to-link mapping and assign RUs/MRUs based on traffic needs and available resources on each link. Likewise, when operating as a non-AP MLD, the SME and UMAC may monitor and evaluate traffic needs and available resources to provide recommendation information to an AP MLD device assigning RUs/MRUs. Thus, the system architecture solves limitations of multi-band to enable MLO in IEEE 802.11be to be based on the processing interface's unique understanding of traffic priorities, queue lengths, and real-time network status enabling intelligent TID-to-link mapping. This mapping determines which traffic (*e.g.,* identified by TID) should be directed to which links (*i.e.*, associated bandwidth resources). As a particular example, when operating as an AP MLD, the SME and UMAC allocate appropriate RU(s)/MRU(s) based on the data requirements of the specific traffic type mapped to a link. The UMAC considers factors like the amount of data to be transmitted for a particular TID and the channel bandwidth available on the chosen link. It can choose to allocate a single RU for smaller data packets or low-priority traffic, or allocate multiple RUs combined into an MRU for larger data transfers or high-priority traffic requiring more bandwidth. Assigning RUs or MRUs is an integral part of TID-to-link mapping.

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	In a survey paper published in IEEE Access and discussing MLO operations as presented in the Wi-Fi 7 Draft Standard, the authors describe that the processing interface of an MLD assigns traffic flows to channels based on channel availability and traffic needs. The motivation for MLO stems from its projected benefits across various dimensions [20]. Firstly, the introduction of the multi-link framework enables significantly improved coordinated operations across multiple links [34], [35]. Through unified and cooperative link management, Wi-Fi 7 can more easily accomplish additional throughput for data flows separated across links than earlier Wi-Fi technologies with separate and independent operations across multiple bands. Secondly, using several lines concurrently enhances the likelihood that a channel will be accessed, considerably reducing latency [36]. Thirdly, MLO permits duplication across numerous connections[3] to guarantee the successful transmission of crucial data that demands extremely high reliability. Finally, depending on the application's requirements, MLO can be used to assign data flows to specific links to accomplish traffic separation [37]. Abdalhafid, Alsadg A., *et al.*, *Multi-Link Operation in IEEE802.11be Extremely High Throughput: A Survey*, 12 IEEE Access 46891, 46892 (2024) (emphasis added).

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	B. TID-TO-LINK MAPPING The IEEE 802.11 standard defines a Traffic Identifier (TID) as a four-bit value (ranging from 0 to 7) used to differentiate packets for QoS purposes [37]. There are $(2^4) = 16$ possible TID values; 8 identify Traffic Categories (TCs), and the other 8 identify parameterized Traffic Streams (TSs). The TID is assigned to an MSDU in the layers above the MAC () [76]. In MLO, TID is crucial in directing traffic with specific QoS requirements to the appropriate connections or channels. TID-to-link mapping associates each TID with a connection set, allowing any link within that set to transmit data frames associated with that TID. All established connections are initially linked to each TID, though this mapping can later be adjusted through negotiation processes [20], [77]. Abdalhafid, Alsadg A., *et al.*, *Multi-Link Operation in IEEE802.11be Extremely High Throughput: A Survey*, 12 IEEE Access 46891, 46895 (2024) (emphasis added). Thus, when the Galaxy S24 Ultra is operating as an AP MLD or a non-AP MLD, based on the information provided to the SME portions of the processing interface, the processing interface may evaluate the bandwidth availabilities of the wireless transceivers with respect to application bandwidth requirements.
[1.k] wherein, if the first bandwidth requirement is at least partially satisfied by the bandwidth availabilities of a selected two transceivers of the first, second, and third wireless transceivers, preparing the first data stream for	The Galaxy S24 Ultra is configured such that, if the first bandwidth requirement is at least partially satisfied by the bandwidth availabilities of a selected two transceivers of the first, second, and third wireless transceivers, the device can perform preparing the first data stream for simultaneous transmission to the recipient from both the selected transceivers of the first, second, and third wireless transceivers using a specific subset of frequencies corresponding to the identified portions of their available bandwidth.

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simultaneous transmission to the recipient from both the selected transceivers of the first, second, and third wireless transceivers using a specific subset of frequencies corresponding to the identified portions of their available bandwidth and	The processing interface of the Galaxy S24 Ultra receives a data stream from the application interface and prepares the data stream for simultaneous transmission by first packetizing it. Packets are then assigned to links for transmission in accordance with, for example, TID-to-Link mapping that is negotiated between an AP MLD and a non-AP MLD. **35.3.7.2 TID-To-Link Mapping (TTLM)** **35.3.7.2.1 General** The TTLM mechanism allows an AP MLD and a non-AP MLD that performed or are performing ML setup to determine how Data frames belonging to TIDs 0–7 and Management frames will be assigned for transmission, on the setup links between the two MLDs in DL and UL. Wi-Fi 7 Draft Standard at 565.

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	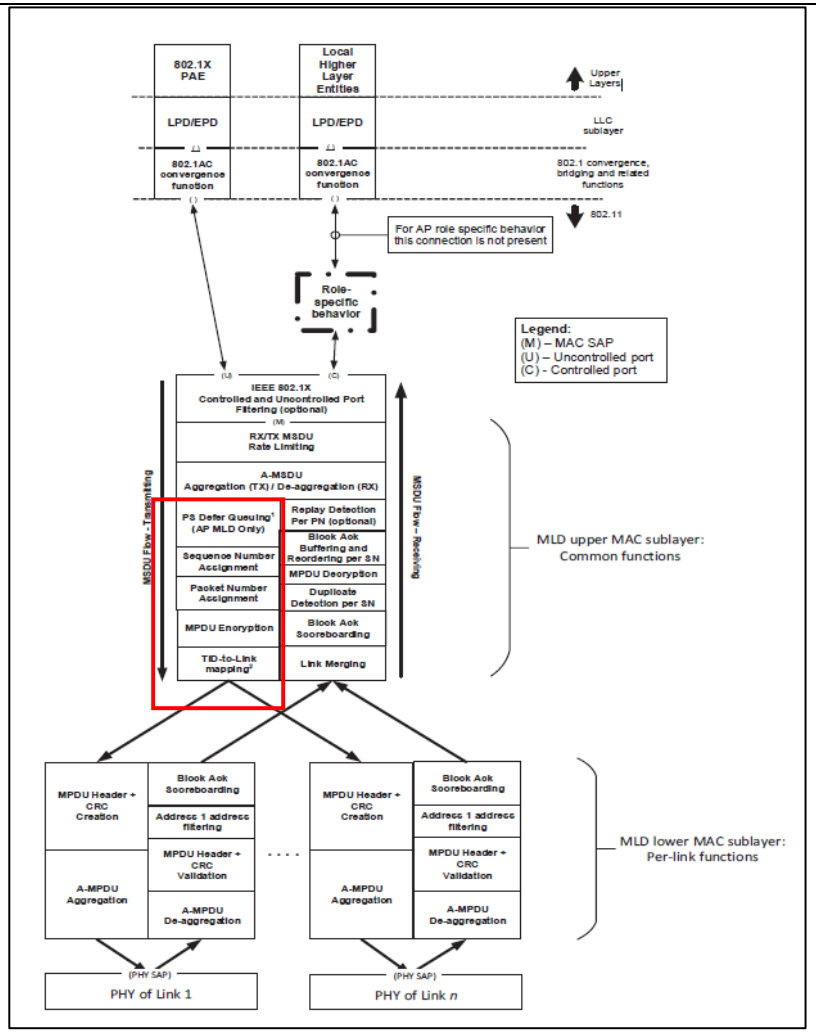 Fig. 5-2a, Wi-Fi 7 Draft Standard at 82 (emphasis added).

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	Additionally, MLO allows a non-AP MLD to transmit data over multiple links with different frequencies simultaneously. The processing interface may prepare the data stream for simultaneous transmission to the recipient from two selected transceivers of the first, second, and third wireless transceivers using a subset of frequencies corresponding to their available bandwidths. With MLO procedures, the processing interface may assign some data packets to a first link and other data packets to a second link for simultaneous transmission. **4.9.6 Reference model for multi-link operation (MLO)** MLO defines a set of procedures allowing communication over one or more links between MLDs. An MLD manages such communication over one or more links. Communication over links using different channels on different frequency bands or the same frequency band can occur simultaneously or not depending on the capabilities of both the AP MLD and the non-AP MLD (see 35.3.16.3 (Simultaneous transmit and receive (STR) operation) and 35.3.16.4 (Nonsimultaneous transmit and receive (NSTR) operation)). The MLO procedures (see 35.3 (Multi-link operation (MLO))) allow a pair of MLDs to discover, synchronize, (de)authenticate, (re)associate, disassociate, and manage links and other resources with each other on any common bands or channels that are supported by both MLDs. Each MLD has a single MAC-SAP. Each STA affiliated with an MLD has a MAC address different from any other STA affiliated with the same MLD. Wi-Fi 7 Draft Standard at 76. As shown below, Abdalhafid *et al.* describe the processing interface's ability to satisfy the requirements of a traffic flow using multiple links with simultaneous transmission.

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	C. MULTI-LINK CHANNEL ACCESS MLO offers a distinct advantage over a single wide channel by facilitating asynchronous channel access and data transmission across multiple links. This enables simultaneous transmission and reception in separate frequency bands [40], Abdalhafid, Alsadg A., *et al.*, *Multi-Link Operation in IEEE802.11be Extremely High Throughput: A Survey*, 12 IEEE Access 46891, 46896 (2024) (emphasis added). The motivation for MLO stems from its projected benefits across various dimensions [20]. Firstly, the introduction of the multi-link framework enables significantly improved coordinated operations across multiple links [34], [35]. Through unified and cooperative link management, Wi-Fi 7 can more easily accomplish additional throughput for data flows separated across links than earlier Wi-Fi technologies with separate and independent operations across multiple bands. Secondly, using several lines concurrently enhances the likelihood that a channel will be accessed, considerably reducing latency [36]. Thirdly, MLO permits duplication across numerous connections[3] to guarantee the successful transmission of crucial data that demands extremely high reliability. Finally, depending on the application's requirements, MLO can be used to assign data flows to specific links to accomplish traffic separation [37]. Abdalhafid, Alsadg A., *et al.*, *Multi-Link Operation in IEEE802.11be Extremely High Throughput: A Survey*, 12 IEEE Access 46891, 46892 (2024) (emphasis added).

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	2) 1-TO-M TID-TO-LINK MAPPING, WHICH COMES IN AT NUMBER (PACKET-LEVEL AGGREGATION) This mapping enables traffic associated with a particular TID to travel via any link within a designated set. This strategy accelerates the resolution of congested TID queues, enhancing traffic handling capacity. UMAC manages TID-specific packet routing on the transmitter's end. However, this approach introduces packet reordering, requiring the receiver's UMAC to temporarily store data and orderly transmit packets to the LLC layer [20]. In other words UMAC serves as a shared component within the MAC sub-layer across all interfaces. Within the UMAC, operations that re independent of specific links are carried out. Examples include the assignment of sequence numbers and the aggregation/de-aggregation of MAC service data units (MSDUs). It is crucial to note that the assignment of sequence numbers is specifically conducted at the UMAC, as packets from the same traffic flow may undergo fragmentation and transmission across different links. This approach facilitates the reordering of packets at the receiver's end. Furthermore, this layer is responsible for executing common management functions applicable to all links, such as setup, association, and authentication [71]. Abdalhafid, Alsadg A., *et al.*, *Multi-Link Operation in IEEE802.11be Extremely High Throughput: A Survey*, 12 IEEE Access 46891, 46895-6 (2024) (emphasis added). As a particular example, when operating as a non-AP MLD, the Galaxy S24 Ultra may operate in EMLMR mode. The Wi-Fi 7 Draft Standard states that EMLMR mode is an operating mode wherein a non-AP MLD like the Galaxy S24 Ultra aggregates some physical resources of its different radios used on different links (so-called EMLMR links) in order to

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	transmit or receive data up to a pre-defined number of supported Rx/Tx spatial streams, which number may be greater than the number of supported Rx/Tx spatial streams of each radio. To operate in EMLMR mode, the Galaxy S24 Ultra makes allocation decisions that involve use of at least some of the first and second bandwidth availabilities. **35.3.18 Enhanced multi-link multi-radio (EMLMR) operation** The enhanced multi-link multi-radio (EMLMR) operation defined in this subclause allows a non-AP MLD with multiple radios on multiple links to listen a set of links as defined below for an initial frame sent by an AP affiliated with an AP MLD, followed by frame exchanges that satisfy the MCS and number of spatial streams (N_{SS}) capabilities in the EMLMR mode on the link on which the initial frame was received. Here initial frame is transmitted in a PPDU whose N_{SS} satisfies the receiving STA's capabilities. A non-AP MLD may operate in the EMLMR mode on a specified set of the enabled links as defined in 9.4.1.76 (EML Control field) between the non-AP MLD and its associated AP MLD. The specified set of the enabled links in which the EMLMR mode is applied is called EMLMR links. A non-AP STA affiliated with the non-AP MLD that is on an EMLMR link is an EMLMR STA. The EMLMR links shall be indicated in the EMLMR Link Bitmap subfield of the EML Control field of the EML Operating Mode Notification frame (see 9.6.38.8 (EML Operating Mode Notification frame details)) by setting the bit positions corresponding to the link IDs of these links in the EMLMR Link Bitmap subfield to 1. Wi-Fi 7 Draft Standard at 613. As described with respect to element 1.a of claim 1, the Galaxy S24 Ultra's processing interface is provided by the Qualcomm Snapdragon 8 Gen 3 System on a Chip processor that includes the FastConnect 7800 connectivity system contained within the Galaxy S24 Ultra. The Qualcomm FastConnect 7800 connectivity system is compliant with Wi-Fi 7 standards.

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	Leading Wi-Fi 7, premium Wi-Fi 6/6E, and advanced Bluetooth audio come together in this powerful and versatile connectivity system to unlock extreme performance for mobile, compute, and XR experiences. The Qualcomm® FastConnect™ 7800 Mobile Connectivity System is an advanced 14nm Wi-Fi and Bluetooth® Connectivity system delivering ultra-high speeds (up to 5.8 Gbps*), sustained low latency (2 ms), and premium Bluetooth audio. While maintaining compliance with the latest Wi-Fi 6/6E and Wi-Fi 7 standards, FastConnect 7800 is packed with sophisticated innovation that goes beyond standard benchmarks. High Band Simultaneous Multi-Link Wi-Fi technology uniquely harnesses the potential of 5 and 6GHz bands for multiple links of high band performance for throughput hungry and latency sensitive applications, eliminating dependence on comparatively narrow and congested 2.4GHz band. https://www.qualcomm.com/products/technology/wi-fi/fastconnect/fastconnect-7800. As demonstrated below, the Qualcomm FastConnect 7800 connectivity system allows the Galaxy S24 Ultra to aggregate resources from multiple links.

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	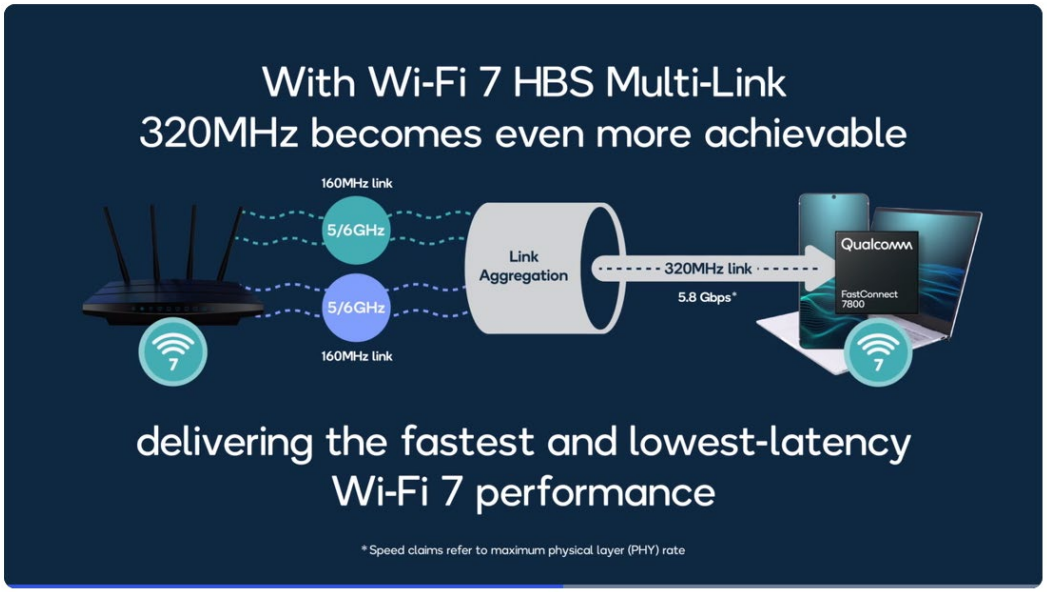 https://www.qualcomm.com/products/technology/wi-fi/fastconnect/fastconnect-7800. This evidences that devices, such as the Galaxy S24 Ultra, for example, can aggregate a 160 MHz channel in the 5 GHz band with a 160 MHz channel in the 6 GHz band. Testing of the Galaxy S24 Ultra indicates that, when the Galaxy S24 Ultra is in use, it operates in EMLMR mode to aggregate resources from multiple links. For example, the screenshot below illustrates the Galaxy S24 Ultra's aggregation of the 2.4 GHz and the 5 GHz bands.

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	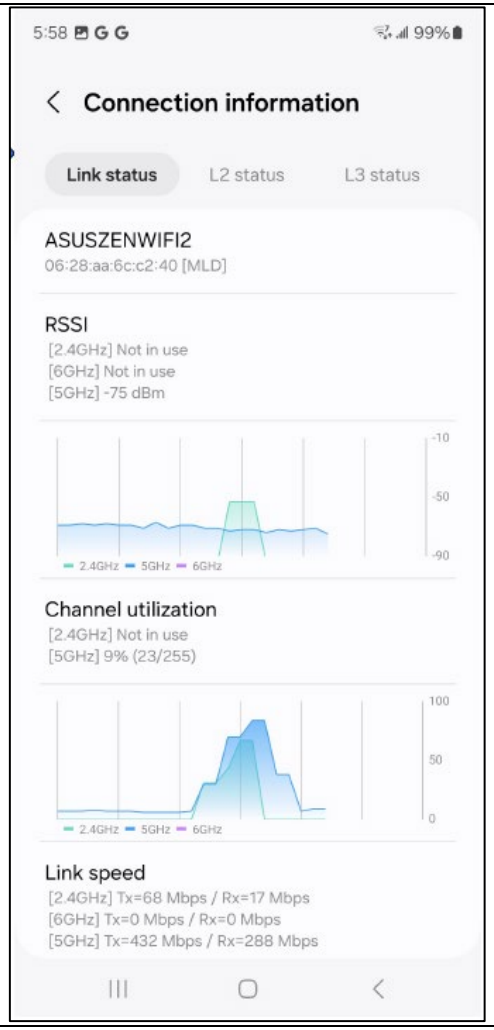

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	WiFiman application screenshot taken on Galaxy S24 Ultra demonstrating connection with local access point.
[1.l] causing the prepared first data to be transmitted from the selected two transceivers of the first, second, and third wireless transceivers to thereby at least partially satisfy the first wireless bandwidth requirement of the first application; and	The Galaxy S24 Ultra is configured such that the device can perform causing the prepared first data to be transmitted from the selected two transceivers of the first, second, and third wireless transceivers to thereby at least partially satisfy the first wireless bandwidth requirement of the first application. When the Galaxy S24 Ultra operates as an AP MLD or a non-AP MLD, its processing interface instructs the actual MAC and actual PHY to transmit data packets using primitives. These instructions specify the chosen link and may specify the allocated RU/MRU configuration. Based on the instructions, the actual PHY layer segments data packets into units, modulates the data units using appropriate techniques for transmission over the designated link, and transmits the modulated data units using the allocated radio frequencies on the chosen transceiver. For example, the processing interface uses certain vectors, including TXVECTOR, RXVECTOR, PHYCONFIG_VECTOR, and TRIG_VECTOR to instruct the PHY.

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	36.2 EHT PHY service interface **36.2.1 Introduction** The EHT PHY provides an interface to the EHT MAC through an extension of the generic PHY service interface defined in 8.3.4 (Basic service and options). The interface includes TXVECTOR, RXVECTOR, PHYCONFIG_VECTOR, and TRIGVECTOR. The EHT MAC uses the TXVECTOR to supply the EHT PHY with per-PPDU transmit parameters. The EHT PHY uses the RXVECTOR to inform the EHT MAC of the received PPDU parameters. The EHT MAC uses the PHYCONFIG_VECTOR to configure the EHT PHY for operation that is independent of PPDU transmission or reception. The EHT MAC uses the TRIGVECTOR to configure the EHT PHY to receive EHT TB PPDUs over each assigned RU or MRU. Wi-Fi 7 Draft Standard at 708, 709-23 (listing TXVECTOR and RXVECTOR parameters). In all options, in order to transmit data, the MAC generates a PHY-TXSTART.request primitive, which causes the PHY entity to respond with a PHY-TXSTART.confirm primitive and enter the transmit state. Further, the PHY is set to operate at the appropriate frequency through station management via the PLME, as specified in 36.4 (EHT PLME). Other transmit parameters, such as EHT-MCS, coding types, and transmit power, are set via the PHY-SAP using the PHY-TXSTART.request primitive (containing TXVECTOR), as described in 36.2.2 (TXVECTOR and RXVECTOR parameters). After transmitting a PPDU that carries a Trigger frame, the MAC sublayer issues a PHY-TRIGGER.request with a TRIGVECTOR parameter that provides the PHY entity with the information needed to demodulate the expected EHT TB PPDU response. The remainder of the subclause applies to the first two paths. Wi-Fi 7 Draft Standard at 940. Thus, when operating as an AP MLD or a non-AP MLD, the processing interface of the Galaxy S24 Ultra is configured to cause the prepared first data stream to be transmitted from the selected two transceivers of the first, second, and third wireless transceivers to thereby at least partially satisfy the first wireless bandwidth requirement of the first application.

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[1.m] wherein the wireless networking device's utilization of the available bandwidth of the first, second, and third wireless transceivers does not prevent other wireless networking devices from utilizing a range of frequencies corresponding to the remaining portion of the bandwidth availability of the first, second, and third wireless transceivers for data transmission purposes at the same time that processed data is being sent from the selected one of the first, second, and third wireless transceivers.	The Galaxy S24 Ultra is configured such that the wireless networking device's utilization of the available bandwidth of the first, second, and third wireless transceivers does not prevent other wireless networking devices from utilizing a range of frequencies corresponding to the remaining portion of the bandwidth availability of the first, second, and third wireless transceivers for data transmission purposes at the same time that processed data is being sent from the selected one of the first, second, and third wireless transceivers. As described in the Wi-Fi 7 Draft Standard, an AP or non-AP MLD like the Galaxy S24 Ultra will use each of the first, second, and third wireless transceivers to communicate via channels and the RUs/MRUs that have been respectively assigned. The Galaxy S24 Ultra is configured for Multi-user Multiple Input Multiple Output (MU-MIMO) procedures, as well as Orthogonal Frequency Division Multiple Access (OFDMA) procedures. The EHT PHY provides support for DL OFDMA, UL OFDMA, DL MU-MIMO, and UL MU-MIMO. Both DL MU-MIMO and UL MU-MIMO transmissions are supported on both the entire PPDU bandwidth and portions of the PPDU bandwidth, with the assigned resource unit of size greater than or equal to 242 tones. On a resource unit utilizing MU-MIMO transmission, there is support for up to 8 users with up to 4 spatial streams per user with the total number of spatial streams across all users not exceeding 8. The EHT PHY also supports preamble puncturing of an EHT MU PPDU for both OFDMA and non-OFDMA. Wi-Fi 7 Draft Standard at 701.

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	Wi-Fi CERTIFIED 7™ (continued) MCS 8-9 Rx MCS 8-9 Tx MCS 10-11 Rx MCS 10-11 Tx MCS 12-13 Rx MCS 12-13 Tx Multi-link reconfiguration – AP removal Multi-link reconfiguration – AP restart Multi-RU Operating mode indication Operating mode indication for 320 MHz Static puncturing STR (Simultaneous Transmit and Receive) SU-MIMO Triggered uplink access optimization UL MU-MIMO UL OFDMA Wi-Fi CERTIFIED Certificate for Qualcomm FastConnect 7800 Mobile Connectivity System, Cert. I.D. WFA127693 (2024) (emphasis added). Further, testing of the Galaxy S24 Ultra indicates that the wireless networking device's utilization of identified bandwidth portions does not prevent any wireless networking device from utilizing a range of frequencies corresponding to remaining portions of bandwidth availability. For example, when one MLD, a Galaxy S25 Ultra, was used to transmit video data to another MLD, a Galaxy S24 Ultra, via an AP using portions of available bandwidth, other bandwidth portions remained available for use by the S24 Ultra, the S25 Ultra, and other devices.

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	The screenshots below taken from the Galaxy S24 Ultra and Galaxy S25 Ultra devices show connections to the AP using the same three channels: a 20 MHz channel ("Ch 9") of the 2.4 GHz frequency band, a 160 MHz channel ("Ch 104") of the 5 GHz frequency band, and a 320 MHz channel ("Ch 85") of the 6 GHz frequency band.

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	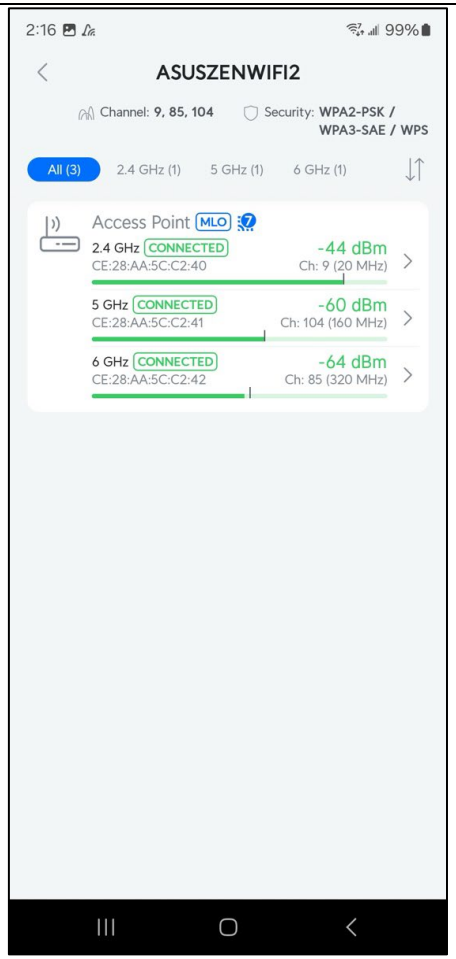 WiFiman application screenshot taken on Galaxy S24 Ultra showing associations on three frequency bands (Left); WiFiman application screenshot taken on Galaxy S25 Ultra showing associations on three frequency bands (Right).

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	As shown below, the Galaxy S24 Ultra and Galaxy S25 Ultra used only a portion of available bandwidth to communicate the video stream, such that other devices were not impeded from using available bandwidth of the 2.4 GHz, 5 GHz, or 6 GHz transceivers.

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	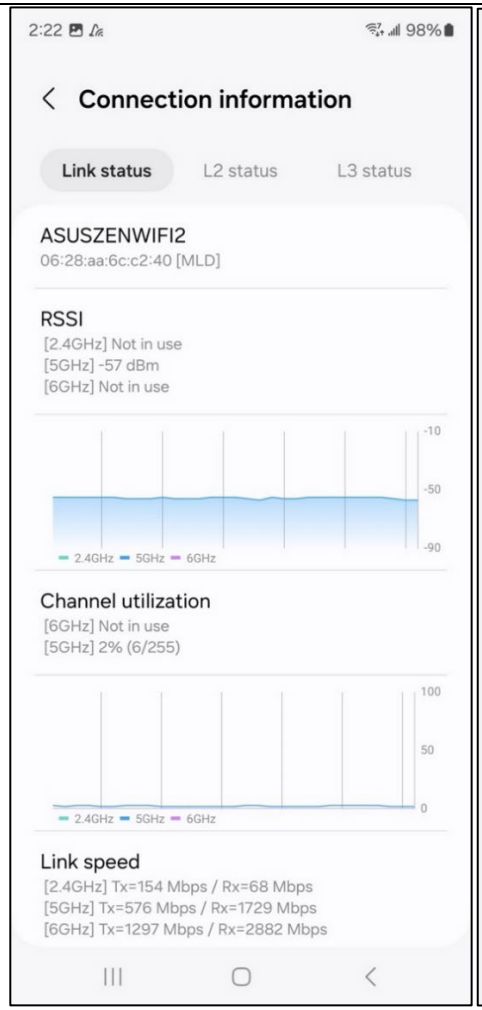 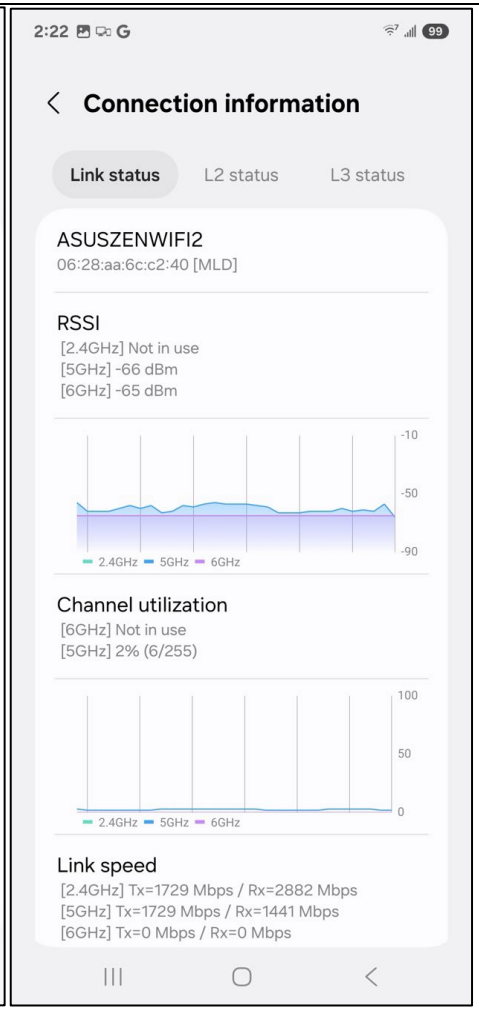 WiFiman application screenshot taken on Galaxy S24 Ultra during data reception (Left); WiFiman application screenshot taken on Galaxy S25 Ultra during data transmission (Right).

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	Thus, when operating as an AP MLD or a non-AP MLD, the Galaxy S24 Ultra is configured such that the wireless networking device's utilization of the available bandwidth of the first, second, and third wireless transceivers does not prevent other wireless networking devices from utilizing a range of frequencies corresponding to the remaining portion of the bandwidth availability of the first, second, and third wireless transceivers for data transmission purposes at the same time that processed data is being sent from the selected one of the first, second, and third wireless transceivers.
2. The wireless networking device of claim 1, wherein the wireless networking device comprises a wireless access point.	*See* claim 1, above. The Galaxy S24 Ultra comprises a wireless access point. An MLD may be an AP MLD or a non-AP MLD. **multi-link device:** [MLD] A logical entity that is capable of supporting more than one affiliated station (STA) and can operate using one or more affiliated STAs, and that presents one medium access control (MAC) data service and a single MAC service access point (MAC SAP) to the logical link control (LLC) sublayer. **access point (AP) multi-link device (MLD):** [AP MLD] An MLD, where each station (STA) affiliated with the MLD is an AP. **non-access point (non-AP) multi-link device (MLD):** [non-AP MLD] An MLD, where each station (STA) affiliated with the MLD is a non-access point (non-AP) station (non-AP STA). Wi-Fi 7 Draft Standard at 61, 62, 63. A wireless terminal device or a network access point may comprise one or more MLDs. A wireless networking device may be, for example, a wireless station in a Wi-Fi 7

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	system, such as a stationary wireless AP or a mobile wireless AP, such as the Galaxy S24 Ultra, comprising an AP MLD. In this regard, the Galaxy S24 Ultra is operable both as an AP MLD and as a non-AP MLD. For example, the Galaxy S24 Ultra is capable of operating as a mobile hotspot wireless access point, thereby sharing its data connection with other devices using Wi-Fi 7. Mobile hotspot Mobile hotspot uses your data plan to create a Wi-Fi network that can be used by multiple devices. 1. From Settings, tap **Connections** > **Mobile hotspot and tethering** > **Mobile hotspot**. 2. Tap to turn on Mobile hotspot. 3. On the devices you want to connect, activate Wi-Fi, and select your device's Mobile hotspot. Enter the Mobile hotspot password to connect. **TIP** Tap **QR code** to connect another device to your Mobile hotspot by scanning a QR code instead of entering a password. Configure mobile hotspot settings You can customize your mobile hotspot's security and connection settings. 1. From Settings, tap **Connections** > **Mobile hotspot and tethering** > **Mobile hotspot**. 2. Tap to turn on Mobile hotspot, and then tap the following settings to change them: *Samsung Galaxy S24, S24+, S24 Ultra User Guide*, Ver. U 14.1 (English(North America)) (Sept. 6, 2024) at 120.

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	When operating as a mobile hotspot, the Galaxy S24 Ultra behaves as a wireless access point for other devices.
3. The wireless networking device of claim 1, wherein the wireless networking device comprises a handheld computing device.	*See* claim 1, above. The Galaxy S24 Ultra comprises a handheld computing device. As described with respect to claim 1, above, the Galaxy S24 Ultra is a WND comprising an MLD, which is a computing device. **multi-link device:** [MLD] A logical entity that is capable of supporting more than one affiliated station (STA) and can operate using one or more affiliated STAs, and that presents one medium access control (MAC) data service and a single MAC service access point (MAC SAP) to the logical link control (LLC) sublayer. Wi-Fi 7 Draft Standard at 61. The Galaxy S24 Ultra has a processor, including for example, a Qualcomm Snapdragon 8 Gen 3 processor, including Qualcomm's FastConnect 7800 Mobile Connectivity System. **Wi-Fi Connectivity** 802.11a/b/g/n/ac/ax/be 2.4GHz+5GHz+6GHz, EHT320, MIMO, 4096-QAM Samsung Galaxy S24 Ultra Specs. The Galaxy S24 Ultra is also a handheld smartphone, shown below.

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	  Samsung Galaxy S24 Ultra Specs.
4. The wireless networking device of claim 1, wherein at least one of the first, second and third wireless frequency bands are specified in at least one member of the family of IEEE 802.11 standards.	*See* claim 1, above. The Galaxy S24 Ultra has first, second, and third wireless frequency bands, wherein at least one of the first, second, and third wireless frequency bands are specified in at least one member of the family of IEEE 802.11 standards.

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	As described with respect to claim 1, the Galaxy S24 Ultra has three frequency bands: 2.4 GHz, 5 GHz, and 6 GHz. Each such band is specified in, for example, the Wi-Fi 7 Draft Standard (IEEE 802.11be) and the IEEE 802.11 Base Standard. **36.3.24.1 General** The STA may operate in the 2.4 GHz band, 5 GHz band, or 6 GHz band. The set of valid operating channel numbers by regulatory domain is defined in Annex E. Channel allocation for each band is defined as follows: — In 19.3.15.2 (Channel allocation in the 2.4 GHz band) for the 2.4 GHz band — In 19.3.15.3 (Channel allocation in the 5 GHz band) for the 5 GHz band — In 27.3.23.2 (Channel allocation in the 6 GHz band) for the 6 GHz band Wi-Fi 7 Draft Standard at 909 (referencing Sections 19.3.15.2-3 of Base Standard).
5. The wireless networking device of claim 4, wherein the at least one member of the family of IEEE 802.11 standards was in existence as of Oct. 30, 2013.	*See* claim 4, above. The Galaxy S24 Ultra has first, second and third wireless frequency bands, wherein at least one of the first, second, and third wireless frequency bands are specified in at least one member of the family of IEEE 802.11 standards that was in existence as of Oct. 30, 2013. As described with respect to claim 1, the Galaxy S24 Ultra has three frequency bands: 2.4 GHz, 5 GHz, and 6 GHz. At least the 2.4 GHz and 5 GHz bands had been specified, for example, in the IEEE 802.11n standard that is one of the IEEE 802.11 standards that was in existence as of October 30, 2013, and in particular since 2009.

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	36.3.24.1 General The STA may operate in the 2.4 GHz band, 5 GHz band, or 6 GHz band. The set of valid operating channel numbers by regulatory domain is defined in Annex E. Channel allocation for each band is defined as follows: — In 19.3.15.2 (Channel allocation in the 2.4 GHz band) for the 2.4 GHz band — In 19.3.15.3 (Channel allocation in the 5 GHz band) for the 5 GHz band — In 27.3.23.2 (Channel allocation in the 6 GHz band) for the 6 GHz band Wi-Fi 7 Draft Standard at 909 (referencing Sections 19.3.15.2-3 of Base Standard). **19.3.15.1 General** The STA may operate in the 5 GHz band and/or 2.4 GHz band. When using 20 MHz channels, it uses channels defined in 17.3.8.4 (5 GHz band) or 16.3.6 (2.4 GHz band). When using 40 MHz channels, it can operate in the channels defined in 19.3.15.2 and 19.3.15.3. IEEE 802.11-2020 Base Standard Section 19.3.15.1 at 2928. **20.3.15 Channel numbering and channelization** The STA may operate in the 5 GHz band and/or 2.4 GHz band. When using 20 MHz channels it uses channels defined in 17.3.8.3 (5 GHz band) or 18.4.6 (2.4 GHz band). When using 40 MHz channels, it can operate in the channels defined in 20.3.15.1 and 20.3.15.2. IEEE 802.11n Standard Section 20.3.15 (2009). The Qualcomm FastConnect 7800 Mobile Connectivity System of the Galaxy S24 Ultra supports the corresponding 802.11 predecessor 2.4 GHz and 5 GHz bands, as confirmed from the certification excerpt shown below.

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	Summary of Certifications CLASSIFICATION: Connectivity CERTIFICATION: 2.4 GHz Spectrum Capabilities; 5 GHz Spectrum Capabilities Wi-Fi CERTIFIED Certificate for Qualcomm FastConnect 7800 Mobile Connectivity System, Cert. I.D. WFA127693 (2024).
10. The wireless networking device of claim 1, wherein the application interface is associated with a second application, the second application providing, when the wireless networking device is being used, a second data stream and having a second wireless bandwidth requirement;	*See* claim 1, above. The Galaxy S24 Ultra has an application interface associated with a second application providing, when the wireless networking device is being used, a second data stream and having a second wireless bandwidth requirement. As described with respect to claim 1, the Galaxy S24 Ultra includes an application interface that allows the Wi-Fi module of the Galaxy S24 Ultra to interact with one or more applications having bandwidth requirements. The application interface comprises hardware and/or software engaging with software applications, such as internet browsers or video playback apps, having data streams when the wireless networking device is used. Each application data stream has a wireless bandwidth requirement. *See* element 1.a of claim 1, above.
[10.a] wherein the processing interface is configured to, when the wireless network device is being used, in a manner transparent to any layer of the wireless networking device above the processing interface,	The processing interface of the Galaxy S24 Ultra is configured to, when the wireless networking device is being used, operate in a manner transparent to any layer of the wireless networking device above the processing interface. Layers between the processing interface and the application interface include, for example, a data link interface.

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	As described with respect to elements 1.a and 1.b of claim 1, when operating as an AP MLD or a non-AP MLD, the processing interface of the Galaxy S24 Ultra comprises at least a portion of the SME, MLME, MAC SAP, MLME SAP, and PLME SAP in combination with at least some functionality of the UMAC. The SME, MLME, PLME, MAC SAP, and UMAC exchange information and operate to make bandwidth allocation decisions and/or recommendations in a manner transparent to all layers of the wireless networking device above the processing interface such as the data link layer. **4.2.5 Interaction with other IEEE 802® layers** IEEE Std 802.11 is required to appear to higher layers [logical link control (LLC) sublayer] as a general-purpose IEEE 802 LAN. This requires that the IEEE 802.11 network handle STA mobility within the MAC sublayer. To meet reliability assumptions (that LLC makes about lower layers), it is necessary for IEEE Std 802.11 to incorporate functionality that is untraditional for MAC sublayers. IEEE 802.11-2020 Standard for Information Technology—Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks—Specific Requirements (2020) at 219.

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	An MLD supports multiple MAC functions, with synchronization across the MAC functions as needed via the MLD synchronization service (see 35.3.25 (MLD synchronization service)) and otherwise coordinated by the SME. Each affiliated STA is enumerated with a Link ID (for example, as Link 1 and Link 2 in Figure 4-33b (Reference model for an MLD for two links)) and MLME primitives are invoked through an MLME SAP. The SME maintains the authentication and association states. The Authenticator and the MAC-SAP of the AP MLD are identified by the same AP MLD MAC address. The Supplicant and the MAC-SAP of the non-AP MLD are identified by the same non-AP MLD MAC address. The SME is responsible for coordinating the MLD and each of the affiliated STAs through the MLME, and to maintain an RSNA key management entity and IEEE 802.1X Authenticator or Supplicant, for MLO. Wi-Fi 7 Draft Standard at 78. The SME maintains the authentication and association states. The same AP MLD MAC address and the same non-AP MLD MAC address are used. Thus, when the Galaxy S24 Ultra is being used, either operating as an AP MLD or a non-AP MLD, its processing interface operates in a manner transparent to any layer of the Galaxy S24 Ultra above the processing interface. Further, testing of the Galaxy S24 Ultra indicates that, when the Galaxy S24 Ultra is in use, its processing interface operates to make bandwidth allocation decisions and/or recommendations in a manner transparent to all layers of the wireless networking device above the processing interface such as the data link layer. For example, the screenshots below demonstrate that, in use, the processing interface of the Galaxy S24 Ultra operates to make, for example, bandwidth allocation decisions using each of the 2.4 GHz, 5 GHz, and 6 GHz bands.

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	 WiFiman application screenshot taken on Galaxy S24 Ultra demonstrating connection with local access point (emphasis added).

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	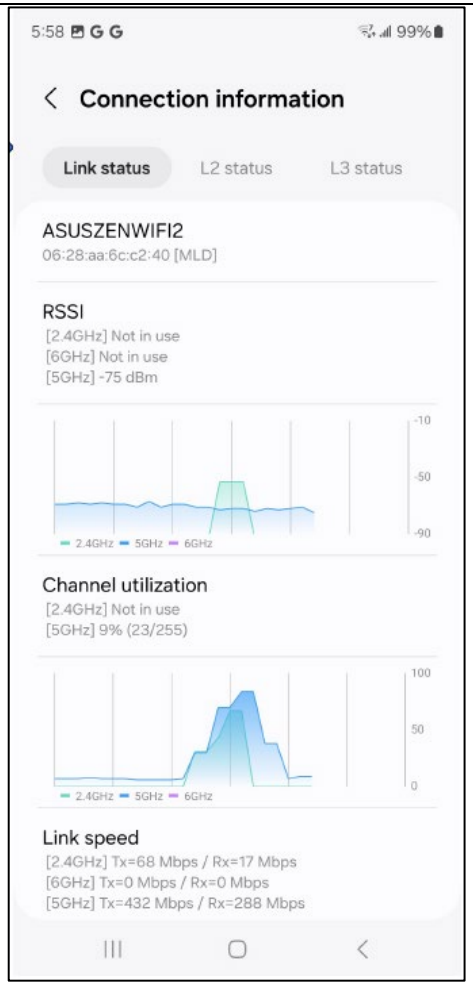 WiFiman application screenshot taken on Galaxy S24 Ultra demonstrating connection with local access point.

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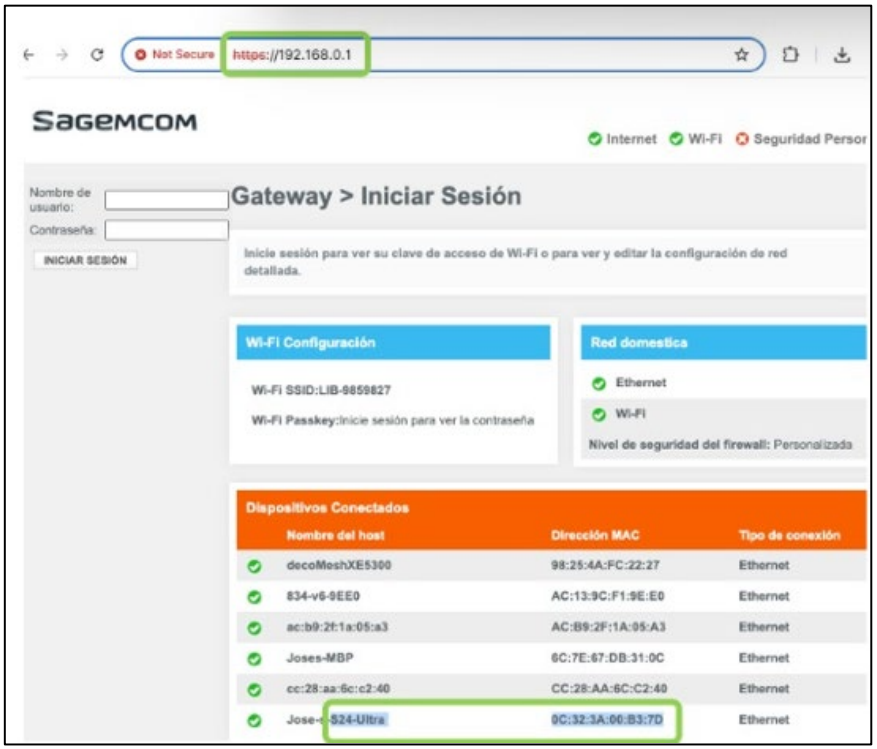
	As shown above, the processing interface's utilization of the available channels changes over time. Despite this, as shown below, in use, the Galaxy S24 Ultra is associated with only a single IP address and a single MAC address used to route Internet traffic to the Galaxy S24 Ultra.  Internet browser screenshot indicating connection between Sagemcom Internet Gateway router and Galaxy S24 Ultra (emphasis added).

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[10.b] (i) identify at least one portion of each one of the first, second, and third bandwidths of the first, second, and third wireless transceivers that are available for communication, and	The processing interface of the Galaxy S24 Ultra is configured to identify at least one portion of each one of the first, second, and third bandwidths of the first, second, and third wireless transceivers that are available for communication. *See* element 1.i of claim 1, above.
[10.c] (ii) evaluate the identified bandwidth availabilities of the first, second, and third wireless transceivers with respect to the first and second bandwidth requirements of the first and second applications; and	The processing interface of the Galaxy S24 Ultra is configured to evaluate the identified bandwidth availabilities of the first, second, and third wireless transceivers with respect to the first and second bandwidth requirements of the first and second applications. As described with respect to element 1.j of claim 1, above, the processing interface is configured to evaluate identified bandwidth availabilities of the first, second, and third wireless transceivers with respect to the first bandwidth requirement of the first application. The processing interface is likewise configured to evaluate the wireless transceivers with respect to the second bandwidth requirement of the second application. *See* element 1.j of claim 1, above.
[10.d] wherein if the bandwidth requirements of the first and second applications are at least partially satisfied by the bandwidth availabilities of the selected transceivers of the first, second, and third wireless transceivers, preparing the first and second data streams for simultaneous transmission to the recipient from both the selected transceivers of the first, second, and third wireless transceivers using a specific subset of frequencies	The Galaxy S24 Ultra is configured such that, if the bandwidth requirements of the first and second applications are at least partially satisfied by the bandwidth availabilities of the selected transceivers of the first, second, and third wireless transceivers, preparing the first and second data streams for simultaneous transmission to the recipient from both the selected transceivers of the first, second, and third wireless transceivers using a specific subset of frequencies corresponding to the identified portions of their available bandwidth and causing the prepared first and second data streams to be transmitted from the selected transceivers of the first, second, and third transceivers to thereby at least partially satisfy the first and second wireless bandwidth requirements of the first and second applications. As described with respect to element 1.k of claim 1, above, the processing interface is configured to prepare the first data stream for simultaneous transmission to the recipient from both the selected transceivers of the first, second, and third wireless transceivers. Using the

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corresponding to the identified portions of their available bandwidth and causing the prepared first and second data streams to be transmitted from the selected transceivers of the first, second, and third transceivers to thereby at least partially satisfy the first and second wireless bandwidth requirements of the first and second applications.	same mechanism, the processing interface prepares the second data stream for transmission to a recipient from both the selected transceivers. *See* element 1.k of claim 1, above. Additionally, the processing interface can prepare more than one data stream for simultaneous transmission on two transceivers. Operating in EMLMR mode, the processing interface considers the number of spatial streams (Nss) that a recipient can receive. When a non-AP MLD operates in the EMLMR mode, after the initial frame exchange, subject to its per-link spatial stream capabilities and operating mode defined by the exchanged Operating Mode Notification frame, (EHT) OM control on one of the EMLMR link(s), the non-AP MLD shall be able to support the following until the end of the frame exchange sequence initiated by the initial frame exchange: — Receive PPDUs with the number of spatial streams up to the value as indicated in the EMLMR Supported MCS And NSS Set subfield of the EML Control field of the EML Operating Mode Notification frame at a time on the link for which the initial frame exchange was made. — Transmit PPDUs with the number of spatial streams up to the value as indicated in the EMLMR Supported MCS And NSS Set subfield of the EML Control field of the EML Operating Mode Notification frame at a time on the link for which the initial frame exchange was made. Wi-Fi 7 Draft Standard at 615. Further, the processing interface causes the prepared first and second data streams to be transmitted from the selected transceivers to at least partially satisfy the first and second wireless bandwidth requirements. When the Galaxy S24 Ultra operates as an AP MLD or a non-AP MLD, its processing interface instructs the actual MAC and actual PHY to transmit data packets using primitives. These instructions specify the chosen link and may specify the allocated RU/MRU configuration. Based on the instructions, the actual PHY layer segments data packets into units, modulates the data units using appropriate techniques for transmission over the

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	designated link, and transmits the modulated data units using the allocated radio frequencies on the chosen transceiver. For example, the processing interface uses certain vectors, including TXVECTOR, RXVECTOR, PHYCONFIG_VECTOR, and TRIG_VECTOR to instruct the PHY. **36.2 EHT PHY service interface** **36.2.1 Introduction** The EHT PHY provides an interface to the EHT MAC through an extension of the generic PHY service interface defined in 8.3.4 (Basic service and options). The interface includes TXVECTOR, RXVECTOR, PHYCONFIG_VECTOR, and TRIGVECTOR. The EHT MAC uses the TXVECTOR to supply the EHT PHY with per-PPDU transmit parameters. The EHT PHY uses the RXVECTOR to inform the EHT MAC of the received PPDU parameters. The EHT MAC uses the PHYCONFIG_VECTOR to configure the EHT PHY for operation that is independent of PPDU transmission or reception. The EHT MAC uses the TRIGVECTOR to configure the EHT PHY to receive EHT TB PPDUs over each assigned RU or MRU. Wi-Fi 7 Draft Standard at 708, 709-23 (listing TXVECTOR and RXVECTOR parameters). In all options, in order to transmit data, the MAC generates a PHY-TXSTART.request primitive, which causes the PHY entity to respond with a PHY-TXSTART.confirm primitive and enter the transmit state. Further, the PHY is set to operate at the appropriate frequency through station management via the PLME, as specified in 36.4 (EHT PLME). Other transmit parameters, such as EHT-MCS, coding types, and transmit power, are set via the PHY-SAP using the PHY-TXSTART.request primitive (containing TXVECTOR), as described in 36.2.2 (TXVECTOR and RXVECTOR parameters). After transmitting a PPDU that carries a Trigger frame, the MAC sublayer issues a PHY-TRIGGER.request with a TRIGVECTOR parameter that provides the PHY entity with the information needed to demodulate the expected EHT TB PPDU response. The remainder of the subclause applies to the first two paths. Wi-Fi 7 Draft Standard at 940.

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	The processing interface of the Galaxy S24 Ultra evaluates channel information, such as a puncturing pattern, to determine what portions of channels are unavailable for transmission or reception purposes. Additionally, the Galaxy S24 Ultra, when operating as an AP MLD or a non-AP MLD, enables the use of TID-to-link mapping in accordance with the Wi-Fi 7 Draft Standard. For example, when operating as an AP MLD, the SME and UMAC (through a Resource Allocation Manager) determine TID-to-link mapping and assign RUs/MRUs based on traffic needs and available resources on each link. Likewise, when operating as a non-AP MLD, the SME and UMAC may monitor and evaluate traffic needs and available resources to provide recommendation information to an AP MLD device assigning RUs/MRUs. Further, when operating as a non-AP MLD, the Galaxy S24 Ultra follows the TID-to-link mapping determined by the AP. Thus, the system architecture solves limitations of multi-band to enable MLO in IEEE 802.11be to be based on the processing interface's unique understanding of traffic priorities, queue lengths, and real-time network status enabling intelligent TID-to-link mapping. This mapping determines which traffic (*e.g.,* identified by TID) should be directed to which links (*i.e.*, associated bandwidth resources). As a particular example, when operating as an AP MLD, the SME and UMAC allocate appropriate RU(s)/MRU(s) based on the data requirements of the specific traffic type mapped to a link. The UMAC considers factors like the amount of data to be transmitted for a particular TID and the channel bandwidth available on the chosen link. It can choose to allocate a single RU for smaller data packets or low-priority traffic, or allocate multiple RUs combined into an MRU for larger data transfers or high-priority traffic requiring more bandwidth. Assigning RUs or MRUs is an integral part of TID-to-link mapping. Likewise, when operating as a non-AP MLD, the SME and UMAC direct packets to links based on the TID-to-link mapping identified by an AP.

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13. The wireless networking device of claim 1, wherein the at least one portion of the first bandwidth of the first transceiver comprises a single portion.	*See* claim 1, above. The processing interface of the Galaxy S24 Ultra is configured to identify at least one portion of each one of the first, second, and third bandwidths of the first, second, and third wireless transceivers, wherein the at least one portion of the first bandwidth of the first transceiver comprises a single portion. A single portion may be, for example, an RU or a portion of a punctured RU. A single portion may be a contiguous portion. **contiguous transmission:** A transmission that uses only one frequency segment. IEEE 802.11-2020 Standard for Information Technology—Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks—Specific Requirements (2020) at 160.
14. The wireless networking device of claim 1, wherein the at least one portion of the first bandwidth of the first transceiver is contiguous.	*See* claim 1, above. The processing interface of the Galaxy S24 Ultra is configured to identify at least one portion of each one of the first, second, and third bandwidths of the first, second, and third wireless transceivers, wherein the at least one portion of the first bandwidth of the first transceiver is contiguous. In contrast to a non-contiguous bandwidth portion, a contiguous bandwidth portion may be, for example, an RU, a portion of a punctured RU, or an MRU. **contiguous transmission:** A transmission that uses only one frequency segment. IEEE 802.11-2020 Standard for Information Technology—

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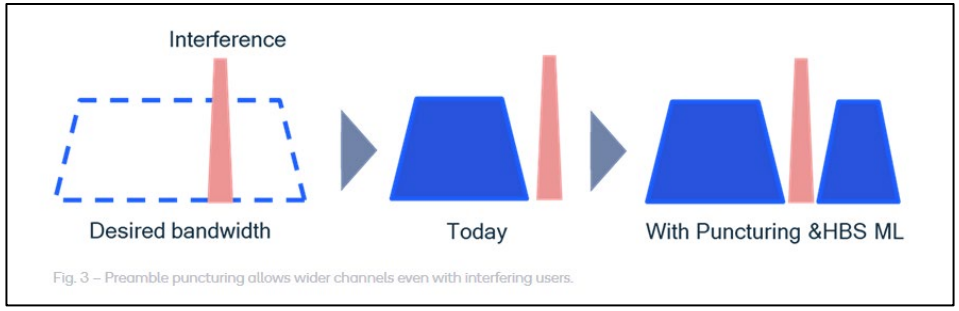
	Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks—Specific Requirements (2020) at 160. **noncontiguous transmission:** A transmission that uses nonadjacent frequency segments. IEEE 802.11-2020 Standard for Information Technology—Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks—Specific Requirements (2020) at 166. For example, the image below shows two available bandwidth portions separated by a punctured subchannel. Each available bandwidth portion is a contiguous bandwidth portion.  https://www.qualcomm.com/news/onq/2022/02/pushing-limits-wi-fi-performance-wi-fi-7.
15. The wireless networking device of claim 1, wherein the at least one portion of the second bandwidth of the second transceiver comprises a single portion.	*See* claim 1, above. The processing interface of the Galaxy S24 Ultra is configured to identify at least one portion of each one of the first, second, and third bandwidths of the first, second, and third wireless transceivers, wherein the at least one portion of the second bandwidth of the second transceiver comprises a single portion.

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	A single portion may be, for example, an RU or a portion of a punctured RU. A single portion may be a contiguous portion. **contiguous transmission:** A transmission that uses only one frequency segment. IEEE 802.11-2020 Standard for Information Technology—Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks—Specific Requirements (2020) at 160.
16. The wireless networking device of claim 1, wherein the at least one portion of the second bandwidth of the second transceiver is contiguous.	*See* claim 1, above. The processing interface of the Galaxy S24 Ultra is configured to identify at least one portion of each one of the first, second, and third bandwidths of the first, second, and third wireless transceivers, wherein the at least one portion of the second bandwidth of the second transceiver is contiguous. In contrast to a non-contiguous bandwidth portion, a contiguous bandwidth portion may be, for example, an RU, a portion of a punctured RU, or an MRU. **contiguous transmission:** A transmission that uses only one frequency segment. IEEE 802.11-2020 Standard for Information Technology—Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks—Specific Requirements (2020) at 160. **noncontiguous transmission:** A transmission that uses nonadjacent frequency segments. IEEE 802.11-2020 Standard for Information Technology—Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks—Specific Requirements (2020) at 166.

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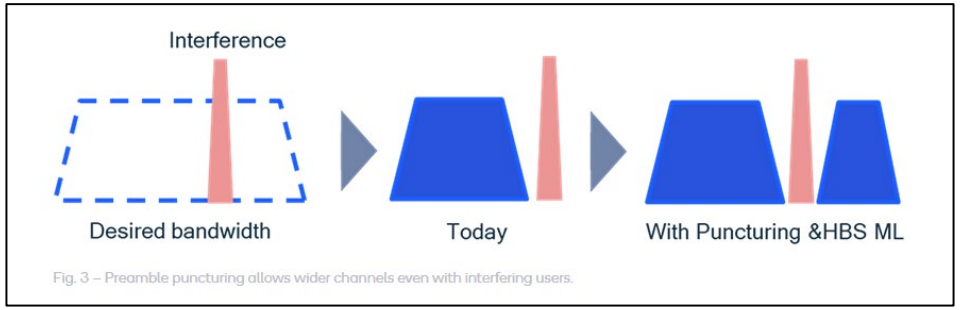
	For example, the image below shows two available bandwidth portions separated by a punctured subchannel. Each available bandwidth portion is a contiguous bandwidth portion.  https://www.qualcomm.com/news/onq/2022/02/pushing-limits-wi-fi-performance-wi-fi-7.
17. The wireless networking device of claim 1, wherein the at least one portion of the third bandwidth of the third transceiver comprises a single portion.	*See* claim 1, above. The processing interface of the Galaxy S24 Ultra is configured to identify at least one portion of each one of the first, second, and third bandwidths of the first, second, and third wireless transceivers, wherein the at least one portion of the third bandwidth of the third transceiver comprises a single portion. A single portion may be, for example, an RU or a portion of a punctured RU. A single portion may be a contiguous portion. **contiguous transmission:** A transmission that uses only one frequency segment. IEEE 802.11-2020 Standard for Information Technology—Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks—Specific Requirements (2020) at 160.

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18. The wireless networking device of claim 1, wherein the at least one portion of the third bandwidth of the third transceiver is contiguous.	*See* claim 1, above. The processing interface of the Galaxy S24 Ultra is configured to identify at least one portion of each one of the first, second, and third bandwidths of the first, second, and third wireless transceivers, wherein the at least one portion of the third bandwidth of the third transceiver is contiguous. In contrast to a non-contiguous bandwidth portion, a contiguous bandwidth portion may be, for example, an RU, a portion of a punctured RU, or an MRU. **contiguous transmission:** A transmission that uses only one frequency segment. IEEE 802.11-2020 Standard for Information Technology—Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks—Specific Requirements (2020) at 160. **noncontiguous transmission:** A transmission that uses nonadjacent frequency segments. IEEE 802.11-2020 Standard for Information Technology—Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks—Specific Requirements (2020) at 166. For example, the image below shows two available bandwidth portions separated by a punctured subchannel. Each available bandwidth portion is a contiguous bandwidth portion.

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	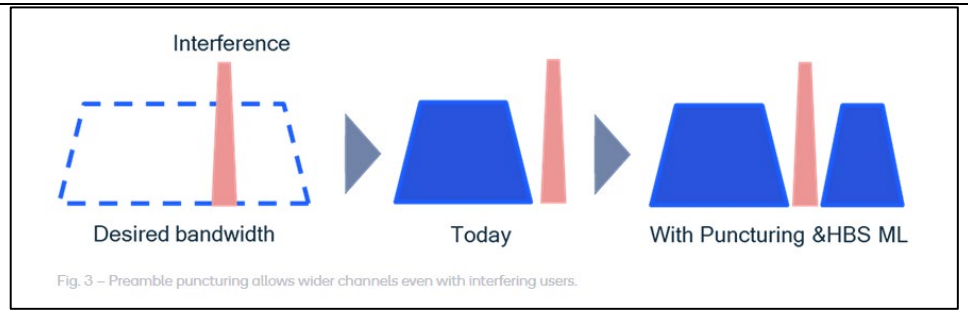 https://www.qualcomm.com/news/onq/2022/02/pushing-limits-wi-fi-performance-wi-fi-7.
20. The wireless networking device of claim 1, wherein the virtual MAC interface includes a decision block.	*See* claim 1, above. The virtual MAC interface of the Galaxy S24 Ultra includes a decision block. The Galaxy S24 Ultra may use a TID-to-link mapping element to identify the link(s) on which a corresponding MAC Protocol Data Unit (MPDU) is intended to be transmitted in its proper format at least based upon a unique traffic identifier (TID). The TID represents quality of service (QoS) characteristics such as the type of data stream and its size. TIDs are used to classify traffic based on such QoS characteristics including their bandwidth requirements. For example, the processing interface performs TID-to-Link mapping procedures to determine how data frames should be assigned for transmission. *See* elements 1.a, 1.f, and 1.k of claim 1. Accordingly, the decision block of the Galaxy S24 Ultra comprises at least those portions of the UMAC and SME that determine the size and type of data to be transmitted for purposes of TID-to-link mapping.

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21. The wireless networking device of claim 1, wherein the virtual MAC interface includes a processing block.	*See* claim 1, above. The virtual MAC interface of the Galaxy S24 Ultra includes a processing block. The Galaxy S24 Ultra may use a TID-to-link mapping element to identify the link(s) on which a corresponding MAC Protocol Data Unit (MPDU) is intended to be transmitted in its proper format at least based upon a unique traffic identifier (TID). The TID represents quality of service (QoS) characteristics such as the type of data stream and its size. TIDs are used to classify traffic based on such QoS characteristics including their bandwidth requirements. For example, the processing interface performs TID-to-Link mapping procedures to determine how data frames should be assigned for transmission including processing data streams accordingly. *See* elements 1.a, 1.f, and 1.k of claim 1, above. Accordingly, the processing block of the Galaxy S24 Ultra comprises at least those portions of the UMAC and SME that prepare the data stream to be packetized for purposes of TID-to-link mapping.
22. The wireless networking device of claim 1, wherein the virtual MAC interface includes an ultra-streaming block.	*See* claim 1, above. The virtual MAC interface of the Galaxy S24 Ultra includes an ultra-streaming block. The Galaxy S24 Ultra may use a TID-to-link mapping element to identify the link(s) on which a corresponding MAC Protocol Data Unit (MPDU) is intended to be transmitted in its proper format at least based upon a unique traffic identifier (TID). The TID represents quality of service (QoS) characteristics such as the type of data stream and its size. TIDs are used to classify traffic based on such QoS characteristics including their bandwidth requirements.

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	For example, the processing interface performs TID-to-Link mapping procedures to determine how data frames should be assigned for transmission including processing data streams accordingly. *See* elements 1.a, 1.f, and 1.k of claim 1, above. Accordingly, the ultra-streaming block of the Galaxy S24 Ultra comprises at least those portions of the UMAC and SME that packetizes the prepared data stream for purposes of TID-to-link mapping.
26. The wireless networking device of claim 1, wherein the processing interface includes a bandwidth allocator.	*See* claim 1, above. The processing interface of the Galaxy S24 Ultra comprises a bandwidth allocator. The Galaxy S24 Ultra complies with the Wi-Fi Agile Multiband Specification, which "is built on the fundamental premise that the APs and STAs each have information which can aid in making the most effective selection of the spectrum band in which the STA and AP should be communicating. By exchanging this information with each other, APs and STAs enable each other to make decisions that collectively drive the network towards more efficient use of the available spectrum." Wi-Fi Agile Multiband Specification at § 3.1. **3 Wi-Fi Agile Multiband protocol** **3.1 Introduction** The goal of the Wi-Fi Agile Multiband certification program is to certify features that facilitate efficient use of multiple frequency bands/channels available to APs and the STAs. The program is built on the fundamental premise that the APs and STAs each have information which can aid in making the most effective selection of the spectrum band in which the STA and AP should be communicating. By exchanging this information with each other, APs and STAs enable each other to make decisions that collectively drive the network towards more efficient use of the available spectrum. The following sections describe the information exchanged and the mechanisms by which APs and STAs exchange the desired information. Where applicable, references to existing IEEE standards are provided. In instances where there is a need to go beyond what the IEEE standards specify, the corresponding functionality, protocols and constraints are defined.

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	Wi-Fi Agile Multiband at §3.1. As described with respect to element 1.a of claim 1, the processing interface of the Galaxy S24 Ultra comprises at least a portion of the SME, MLME, MAC SAP, MLME SAP, and PLME SAP in combination with certain functionality of the UMAC. When operating as an AP MLD or a non-AP MLD, the processing interface of the Galaxy S24 Ultra performs certain functions that correspond to and comprise a bandwidth allocator. For example, the processing interface, and particularly the SME, makes strategic decisions about resource allocation and/or link recommendations based on traffic demands and network conditions. Network condition information necessarily includes bandwidth availability information resulting from channel assessments directly or indirectly by way of at least trigger frames and feedback messages. As a particular example, in accordance with the Wi-Fi 7 Draft Standard, the SME's understanding of traffic priorities, queue lengths, and real-time network status enables intelligent TID-to-link mapping in the Galaxy S24 Ultra. This mapping determines which traffic (identified by TID) should be directed to which links (*i.e.*, associated bandwidth resources). The SME, in combination with the UMAC, allocates appropriate RUs/MRUs (resource units / multiple resource units) based on the data requirements of the specific traffic type mapped to a link. The SME considers factors like the amount of data to be transmitted for a particular TID and the channel bandwidth available on the chosen link. It can choose to allocate a single RU for smaller data packets or low-priority traffic, or allocate multiple RUs combined into an MRU for larger data transfers or high-priority traffic requiring more bandwidth. Accordingly, the processing interface comprises at least one bandwidth allocator. The bandwidth allocator comprises the portions of the SME and MLME, in combination with functionality of the UMAC, that perform RU/MRU allocation and TID-to-Link mapping. The bandwidth allocator may additionally include a portion of the MLME SAP by which the SME communicates with the MLME.

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	An MLD supports multiple MAC functions, with synchronization across the MAC functions as needed via the MLD synchronization service (see 35.3.25 (MLD synchronization service)) and otherwise coordinated by the SME. Each affiliated STA is enumerated with a Link ID (for example, as Link 1 and Link 2 in Figure 4-33b (Reference model for an MLD for two links)) and MLME primitives are invoked through an MLME SAP. The SME maintains the authentication and association states. The Authenticator and the MAC-SAP of the AP MLD are identified by the same AP MLD MAC address. The Supplicant and the MAC-SAP of the non-AP MLD are identified by the same non-AP MLD MAC address. The SME is responsible for coordinating the MLD and each of the affiliated STAs through the MLME, and to maintain an RSNA key management entity and IEEE 802.1X Authenticator or Supplicant, for MLO. Wi-Fi 7 Draft Standard at 78.