Anti-Interference Technology for Wi-Fi Networking

MediaTek Filogic White Paper

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Content

Key Insights

- Approximately 75% of residential Wi-Fi networks encounter significant interference and degraded performance during weekends.
- MediaTek Anti-Interference technology can intelligently mitigate >95% performance degradation in residential network environments caused by various interferences.
- During peak Wi-Fi usage, MediaTek Anti-Interference technology boosts throughput by up to 30% and reduces latency by up to 60%..

Introduction

Wi-Fi technology serves as an invisible hub in modern society, seamlessly connecting our lives, work, and entertainment. It has made information transmission faster and more convenient than ever, allowing us to access the internet anytime and anywhere, whether at home, in the office, or in public spaces. However, as Wi-Fi increasingly replaces traditional wired transmission, the deployment of Wi-Fi networks and the rapid growth of Wi-Fi devices within the same network domain have led to increasingly congested Wi-Fi spectrum, while interference between adjacent Wi-Fi domains has increasingly become more severe.

If we consider Wi-Fi Access Points (APs) in multi-story residential buildings, where each floor houses four to six families, this leads to each household AP overlapping others as they are separated only by a wall. In a densely populated neighborhood, it is even possible to detect several APs from other nearby buildings. This can cause mutual interference between each Wi-Fi network if they are set to the same channel.

Multiple AP (MAP) Wi-Fi Mesh networks are designed to cover a large area with a single network. They typically use the same wireless frequency bands to achieve seamless mobility between APs, however this can result in mutual interference between them, even though they are part of the same Wi-Fi network.

Temporary point-to-point (P2P) networks between Wi-Fi client devices, such as those used for file transfer, photo sharing, and video casting, also often experience interference from local Wi-Fi networks. This can degrade the P2P connection leading to issues such as slower speeds, increased latency, and disconnections. Conversely, the Wi-Fi network is similarly affected by the sudden presence of a P2P connection, experiencing a reduction in performance and reliability.

Similarly, Wi-Fi networks in vehicles provide internet and interactive multimedia services to passengers, but as the vehicle moves through populated areas, it frequently encounters a variety of external wireless interference sources.

Based on user experience insights, Wi-Fi network interference is a widely prevalent issue that poses significant challenges, especially as the number of wireless devices continues to increase. Interference sources in Wi-Fi networks are commonly categorized into two types: Co-Channel Interference (CCI) and Adjacent-Channel Interference (ACI). These lead to a range of connectivity issues such as reduced speed, increased latency, packet loss, and frequent disconnections, compromising the stability and reliability of Wi-Fi networks and degrading the user experience. Addressing these interference challenges is crucial for enhancing the overall performance of Wi-Fi networks, and user satisfaction.

Some methods to combat interference, such as band steering or channel switching, can reduce the impact of interference on users, but they also introduce their own challenges. Users may experience device disconnections, reconnections, unresponsive IoT devices, or limited functionality during the steering or switching period.

Therefore, developing in-use channel anti-interference technology has become a priority for solving these issues. Anti-interference technology aims to overhaul the efficiency of Wi-Fi network channel usage, increasing network throughput or improving latency in interference-prone scenarios. It provides a more seamless and cost-effective method to maintain high-quality Wi-Fi connections, particularly in dense network environments, ensuring that users always experience reliable Wi-Fi services.

Interference in Diverse Wi-Fi Networks

Wi-Fi networks have become ubiquitous, facilitating seamless internet connectivity throughout homes, businesses, and public spaces. This introduction sets the stage by three use cases at home: a Single AP network, a Multiple AP network, and a Multi-client peer-to-peer network. Each case illustrates the challenges and interference effects experienced by users, providing insights into the complexities of modern Wi-Fi networks in each setting.

- *Scenario-1: Single AP network:*

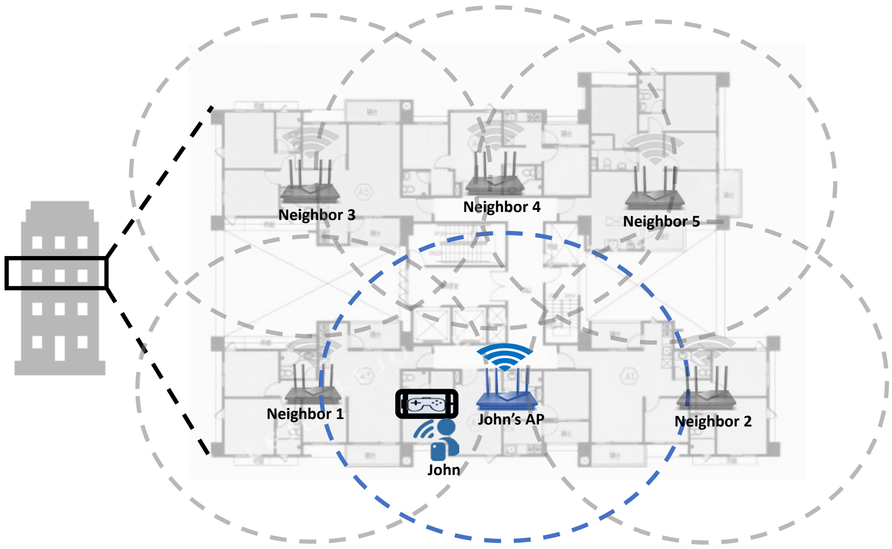

Figure 1 Single AP network access among several others.

John lives in a building with six units on one floor, as shown in Figure 1. His small apartment is covered by a single Wi-Fi AP, but he easily sees the AP SSIDs from his neighbors' networks. Since his country only allows 2.4GHz and 5GHz bands for Wi-Fi, John and his neighbors likely use overlapping frequency bands, causing signal interference.

John has 300Mbps broadband internet and uses an entry-level Wi-Fi 7 AP to connect his devices. On weekdays, he enjoys fast, low-latency Wi-Fi for working from home, gaming, and watching TV. However, every evening from 6:00 to 11:00 PM, his Wi-Fi speed slows down due to neighbors' network usage, causing frequent lag (high ping), making online gaming frustrating, and sometimes TV streaming to stutter.

Challenge: During peak traffic times, as the number of connected Wi-Fi devices among his neighbors increases, it is crucial not only to manage traffic on the home router but also to mitigate interference from multipleneighboring routers, particularly in regions with limited Wi-Fi spectrum..

- *Scenario-2: Multiple AP network:*

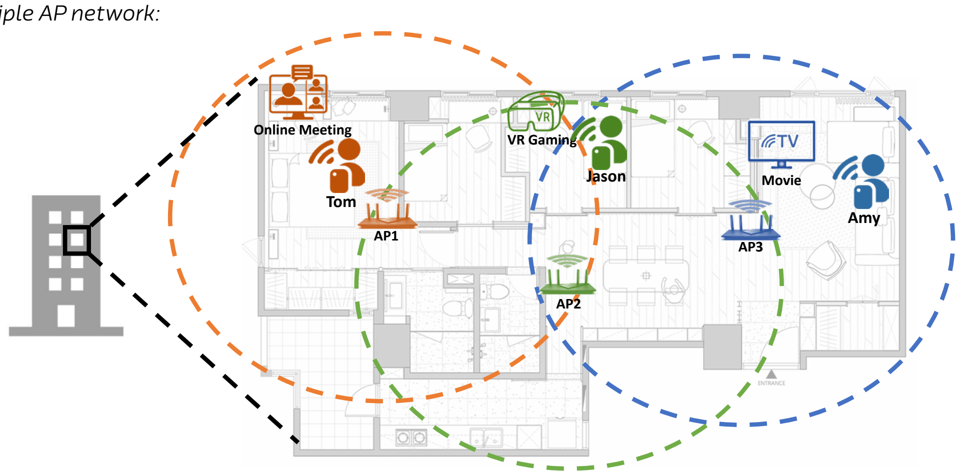

Figure 2 Multiple AP network

Tom and Amy live with their child, Jason, in a large apartment building that has two units per floor, as shown in Figure 2. To improve Wi-Fi coverage, the family has set up a Wi-Fi Mesh network using 3 APs with Wi-Fi backhaul, ensuring full home coverage. However, as data passes through each AP, wireless bandwidth usage doubles for each additional hop.

One weekend, Tom and Amy were watching a movie in the living room while Jason was playing games in his room. Tom needed to attend an urgent online meeting at his desk. With everyone using Wi-Fi simultaneously, severe channel overlaps increased packet latency, causing Tom to experience video lag and audio dropouts, while Amy and Jason noticed slower internet speeds, game lag, and streaming issues.

Challenge: A Mesh network with multiple APs extends Wi-Fi coverage in larger homes, but sharing the same channel limits each AP's capacity. During peak hours, the Mesh network faces competition for spectrum resources, which causes interference between wireless backhaul (AP to AP) and fronthaul (AP to client)..

- *Scenario-3: Multiple clients peer to peer network:*

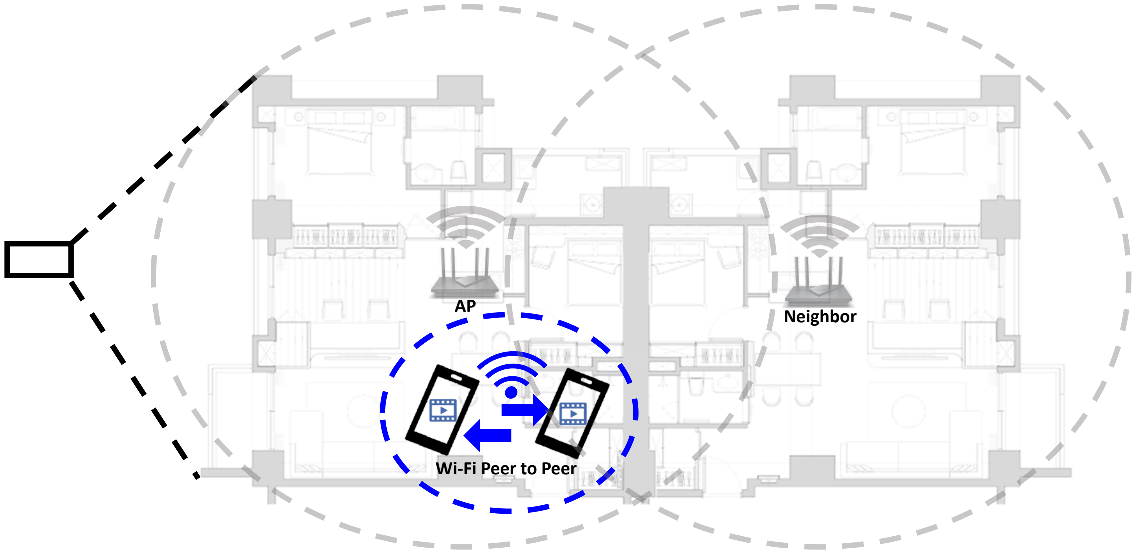

Figure 3 Multiple clients peer to peer network.

Alex and Luna live with their child, Tina, in a small two-bedroom apartment, as shown in Figure 3. They use a single Wi-Fi AP for internet access, as does their neighbor next door.

One weekend, Tina and her friends were playing mobile games while Luna watched live sports on TV. Alex invited friends over for lunch and needed to use a (Wi-Fi) peer-to-peer app to share some photos and videos. During weekend peak activity hours (10:00 AM - 11:00 PM) everyone experienced slower network performance due to Wi-Fi signal interference caused by all the device activity in their home, along with their neighbor using devices too.

Alex noticed that transferring video files was often very slow or failed entirely. Luna frequently experienced buffering issues with the live stream, and the kids were complaining about game lag. With so many devices sharing the Wi-Fi spectrum at the same time, the peer-to-peer network and the home network signals interfered with each other, leading to higher latency and lower throughput.

Challenge: Users need the flexibility to create temporary peer-to-peer networks between clients. However, these applications must contend with the signals from existing home AP Wi-Fi routers and neighboring Wi-Fi routers. Ensuring coexistence of all networks – permanent and temporary – and their devices is key challenge.

The Impact of Interference on Wi-Fi Networks

In all the scenarios described above, poor Wi-Fi performance is a common occurrence during peak hours. John faces signal interference from his neighbors; Tom and Amy experience congestion in their Wi-Fi mesh network; Alex and Luna struggle with multiple connection types sharing Wi-Fi spectrum. Increased network demand during peak hours significantly degrades the Wi-Fi experience for everyone.

Peak hours for Wi-Fi use typically occur in the evenings between 6:00 PM to 11:00 PM, and throughout the day on weekends from 10:00 AM to 11:00 PM. During these times, increased network traffic from streaming, gaming, virtual meetings, and browsing raises the overall demand.

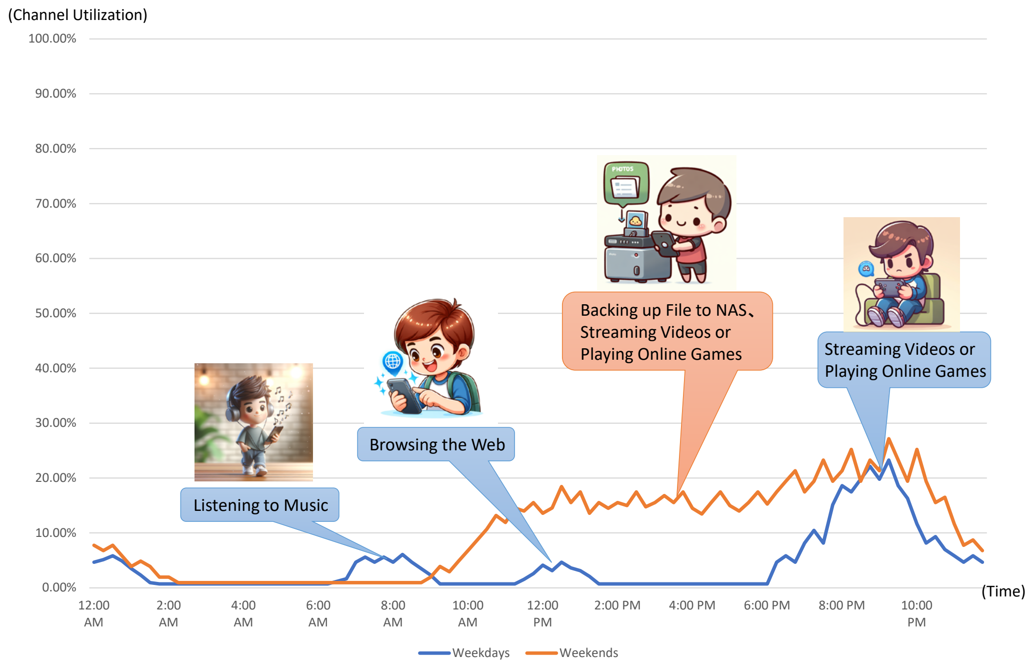

Figure 4 John's Wi-Fi AP BE3600 Channel Utilization without Interference

People often prioritize maximum speed when choosing a Wi-Fi AP. In the single AP network scenario, John has a 300Mbps broadband connection, and chose an entry-level Wi-Fi 7 AP (BE3600). Figure 4 shows John's Wi-Fi channel utilization during weekdays and weekends when not experiencing interference. High channel utilization indicates heavy load, which can lead to congestion, slower speeds, increased latency, service interruptions, and reduced performance due to competition for limited bandwidth.

On weekdays (blue line), John's internet usage follows a daily pattern. From 7:00 AM to 9:00 AM he listens to music or browses the web, then around lunchtime, 11:30 AM to 1:00 PM, he streams videos. The highest demand occurs in the evening between 6:00 PM to 11:00 PM when he streams videos and plays games.

On weekends (orange line), John's internet usage is consistently high throughout the day from 10:00 AM to 11:00 PM. He often spends more time at home, using the Wi-Fi for activities like backing up photos and videos to his NAS, resulting in higher usage compared to weekdays.

Without interference, John's channel utilization never exceeds 30% during peak hours, meeting his Wi-Fi needs. However, in reality his neighbors' overlapping Wi-Fi networks cause spectrum interference, so that actual channel utilization will exceed 70% during peak hours, sometimes reaching full capacity (Figure 5). Consequently, John enjoys smooth gaming (ping < 50ms) during off-peak hours, but experiences frequent lag and disconnections (ping > 150ms) during peak hours, upsetting his gaming experience.

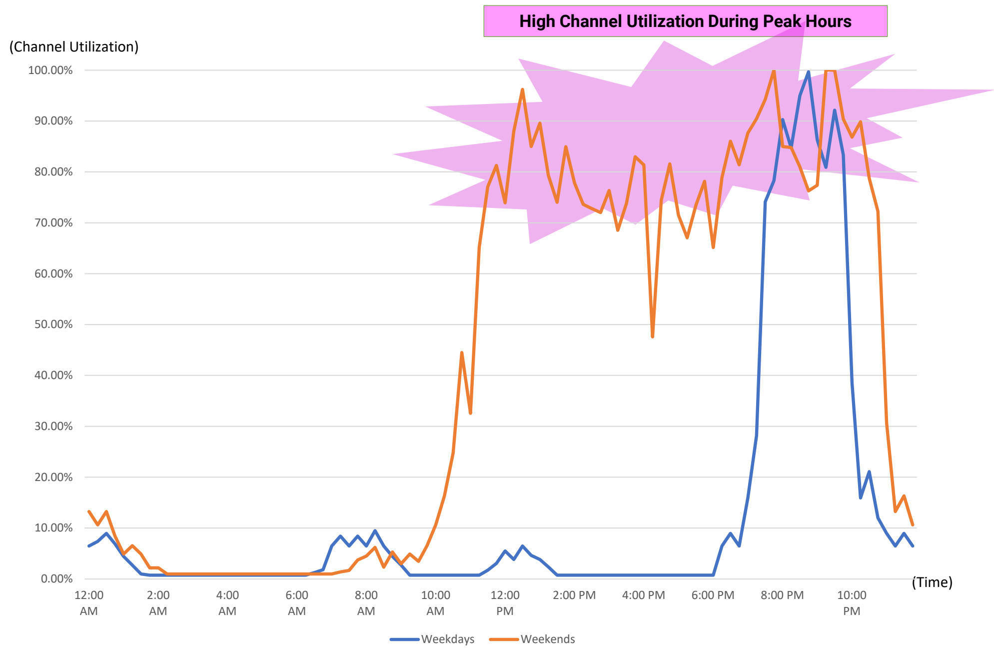

Figure 5 John's Wi-Fi AP BE3600 Channel Utilization in a Real Environment.

To understand the increased channel utilization, let us look at the Wi-Fi spectrum in use via spectrum analysis app.

Figure 6 shows the 5 GHz channels (36 to 64) and the received signal strength indicator (RSSI) of nearby Wi-Fi networks. John's Wi-Fi operates on 5 GHz with 160 MHz bandwidth, using channel 36 as the primary channel. The analysis revealed six overlapping Wi-Fi networks, including John's. Two neighboring access points, AP4 and AP5, overlap with John's channel 36, causing co-channel interference (CCI). Neighbor access points AP1, AP2, and AP3 partially share the frequency band, causing adjacent channel interference (ACI). Living in a crowded residential area with limited 2.4 GHz and 5 GHz bands frequently leads to network overlap and interference.

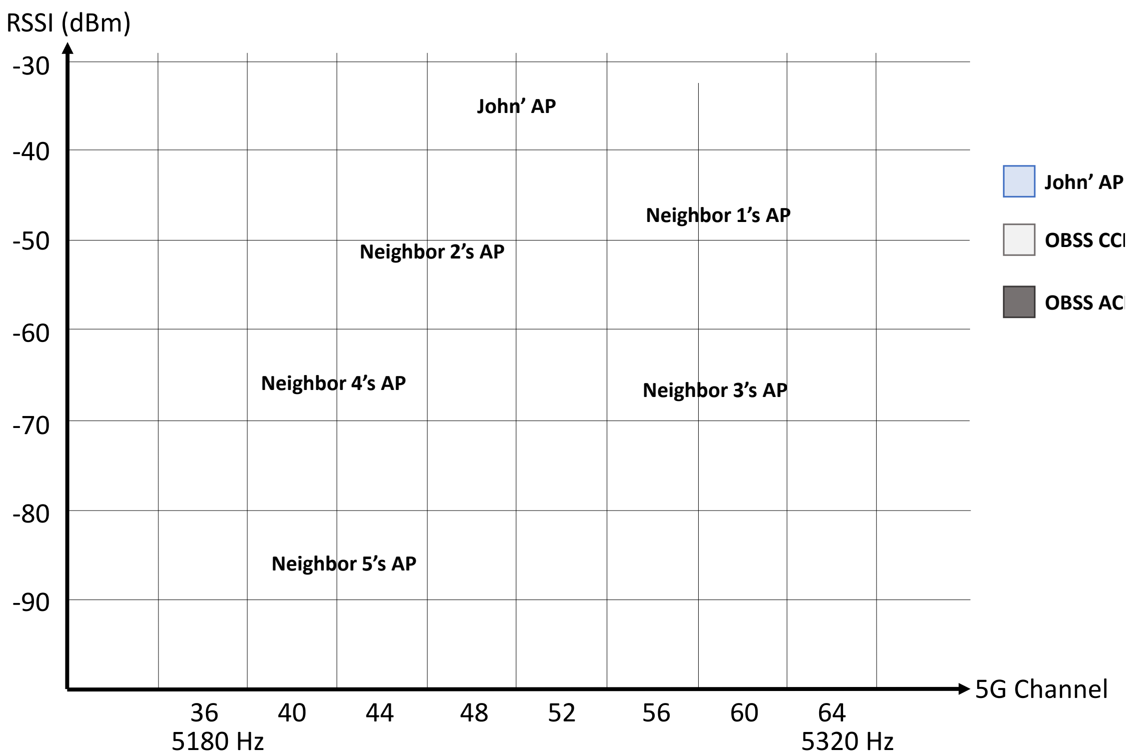

Figure 6 Wi-Fi Spectrum Analysis.

When his neighbors' Wi-Fi causes CCI, it results in increased channel utilization due to bandwidth competition. This reduces available airtime and leads to elevated latency. On the other hand, when his neighbors' Wi-Fi causes ACI, it degrades the signal quality and increases data packet errors. To maintain the data quality, his AP employs more robust transmission methods and retransmits data, further increasing channel utilization.

iIf both CCI and ACI occur simultaneously, interference worsens even further. During peak hours, the combined interference leads to intense competition and poor signal quality, pushing channel utilization to saturation. This is the main reason for poor Wi-Fi performance.

MediaTek's R&D labs established a Wi-Fi network to simulate John's home Wi-Fi network, connected to a 300Mbps broadband internet connection. A neighbor network was also setup to replicate ACI. By adjusting the ACI load levels we can mimic interference during off-peak hours (ACI load at 15%) and peak hours (ACI load at 60%). These tests were conducted to compare the performance in the following four common applications:• Mr. Smith and is video conferencing while collaboratively working on documents with remote coworkers.

- Online gaming: requiring a very low latency and frequent, small data packets for real-time interaction.
- Video conferencing: requiring a consistent bandwidth for high-quality audio and video streaming.
- 4K media streaming: requires consistent high bandwidth for smooth playback.
- File download: Utilizes high bandwidth for fast, efficient transfers.

Table 1 provides the baseline requirements of these four applications, along and the test results obtained after individually testing each application. Latency refers to the end-to-end latency.

During off-peak hours, the latency and throughput of each application consistently meets their respective requirements. However, during peak hours, performance degradation is evident as Packet Error Rate (PER) rises, throughput declines, and latency worsens.

Application Type	Requirement		Off-Peak Hours (ACI load at 15%)	Peak Hours (ACI load at 60%)
Online gaming	Average Latency	< 100 ms	57 ms	98 ms
	PR95 Latency <	150 ms	93 ms	176 ms
Video conferencing	Average Latency	< 100 ms	72 ms	111 ms
	PR95 Latency	< 200 ms	105 ms	215 ms
4K media streaming	Buffer Health >	10 sec	12 sec <	5 sec
File download (5 GB)	Speed	The Faster, The Better	Speed > 200 Mbps Download Time < 4 min	Speed < 55 Mbps Download Time > 13 min

Table 1 Observed latency in four distinct applications when experiencing different ACI load

In online gaming, end-to-end latency (ping) directly influences how quickly a player's actions are registered and reflected in the game. When latency exceeds a required time, for example, an average of 100ms, players may encounter delayed or unresponsive controls, and in extreme cases visual jitter or stuttering, which severely degrades the gaming experience. Traditional metrics like average latency fail to capture these inconsistencies, particularly during critical moments. To address this, we introduced the PR95 latency metric, which quantifies latency variability by representing the threshold below that 95% of all observed latency values fall during the measurement period. Testing revealed that while average latency remained within acceptable limits during peak hours, PR95 latency frequently exceeded the threshold, negatively impacting the experience. In games, this means more than 5% of a player's inputs could be rendered unresponsive, significantly impairing the player experience and highlighting the need for more robust network performance than current technology can provide.

Video conferencing encounters similar challenges. When the latency exceeds the acceptable threshold for real-time interaction it leads to audio-video desynchronization and fragmented conversations. In severe cases, this can cause brief but noticeable stuttering, disrupting the flow of communication. During peak hours, both average latency and PR95 latency surpass the acceptable threshold, resulting in an obviously degraded user experience.

Buffer health is a critical factor in ensuring smooth 4K video streaming. Insufficient buffer health results in frequent jittering, playback interruptions, and potential reductions in video quality. During peak hours, increased interference can significantly degrade buffer health, leading to a disrupted and subpar viewing experience.

In file download performance tests, download speed and time serve as the most direct metrics for evaluating user experience. During peak hours, increased interference exacerbates latency and reduces throughput, leading to prolonged download times and noticeably worsened the user experience.

Anti-Interference Technologies

In IEEE 802.11ax (Wi-Fi 6), two primary anti-interference technologies are developed: Spatial Reuse (SR) and Preamble Puncture (PP). SR technology primarily addresses CCI by allowing multiple devices to communicate simultaneously on the same channel without significant interference. PP technology combats ACI in multi-user environments by leveraging OFDMA, dividing the channel into smaller sub-bands, discarding interference overlaps to opts for slices of clean spectrum.

In IEEE 802.11be (Wi-Fi 7), a further enhancement through Multiple Resource Unit (MRU) was introduced. MRU and PP can combine to improve communication flexibility and effectiveness in multi-user environments. MRU allows all available resource portions to be allocated to a single user, removing the Wi-Fi 6 PP limitation that only allows one resource portion to one user. Additionally, by dynamically adjusting resource units, MRU enables more efficient interference handling, leading to better data throughput and reduced latency.

MediaTek has concentrated its research and development efforts on interference mitigation technologies, focusing not only on standards defined by IEEE, but also proprietary enhancements. To effectively address issues encountered by real, end users in single AP networks, multiple AP networks, and multiple clients in peer-to-peer networks, we have developed a range of anti-interference technologies. The following are the four most effective technologies:

- Universal Bandwidth Adaption (UBA): In environments with CCI or ACI, UBA uses bandwidth control and rate adaptation to select the most appropriate bandwidth and rate. This reduces the impact of interference, enhances transmission reliability, effectively increases throughput, and reduces latency.
- Customized Preamble Puncture (CPP): By utilizing the flexibility of PP and MRU, CPP enables APs and STAs to exchange detected interference information in hidden node scenarios, allowing PP and MRU to fully function andavoid the impact of hidden nodes, thereby improving overall network performance
- Enhanced Spatial Reuse (ESR): ESR is designed to enhance the scenarios for Spatial Reuse on single AP This technique differentiates inter-BSS legacy Wi-Fi signals at mid-to-far ranges through PHY payload decoding capabilities, thereby enhancing anti-interference performance.
- Coordinate Spatial Reuse (CSR): CSR is specifically designed for Mesh Network multi-AP setups, introducing coordination between APs through a transmission power control mechanism. This significantly enhances airtime for each router, reduces interference, and improves transmission opportunities within the Mesh network.

Universal Bandwidth Adaption (UBA)

ACI primarily weakens Wi-Fi signals and increases data transmission error rates. While PP can effectively combat ACI, it requires understanding the impact range of ACI to proactively avoid interference-affected subcarriers, ensuring optimal performance and stable connections. However, in typical home scenarios, interference is often detected by only one party, leading to the hidden node problem.

As shown in Figure 7, in the single AP network scenario previously discussed, John's AP is unaware of interference from Neighbor 1. When John plays mobile games and moves into a room closer to his neighbor it creates the hidden node scenario due to Neighbor 1's Wi-Fi interference. Channel Bandwidth (CBW) operation with ACI leads to poor PER, low data rates, and reduced throughput. To maintain stable transmission, different strategies can be applied based on the intensity and density of interference. For example, when interference is strong but not dense, the AP can ensure data accuracy through retransmission. However, as interference density increases, relying solely on retransmission may significantly increase latency and reduce throughput. Therefore, it is necessary to lower the rate to improve stability or reduce bandwidth to avoid interference. MediaTek's UBA technology aims to find the optimal combination of bandwidth and rate to maximize Wi-Fi speed and minimize latency.

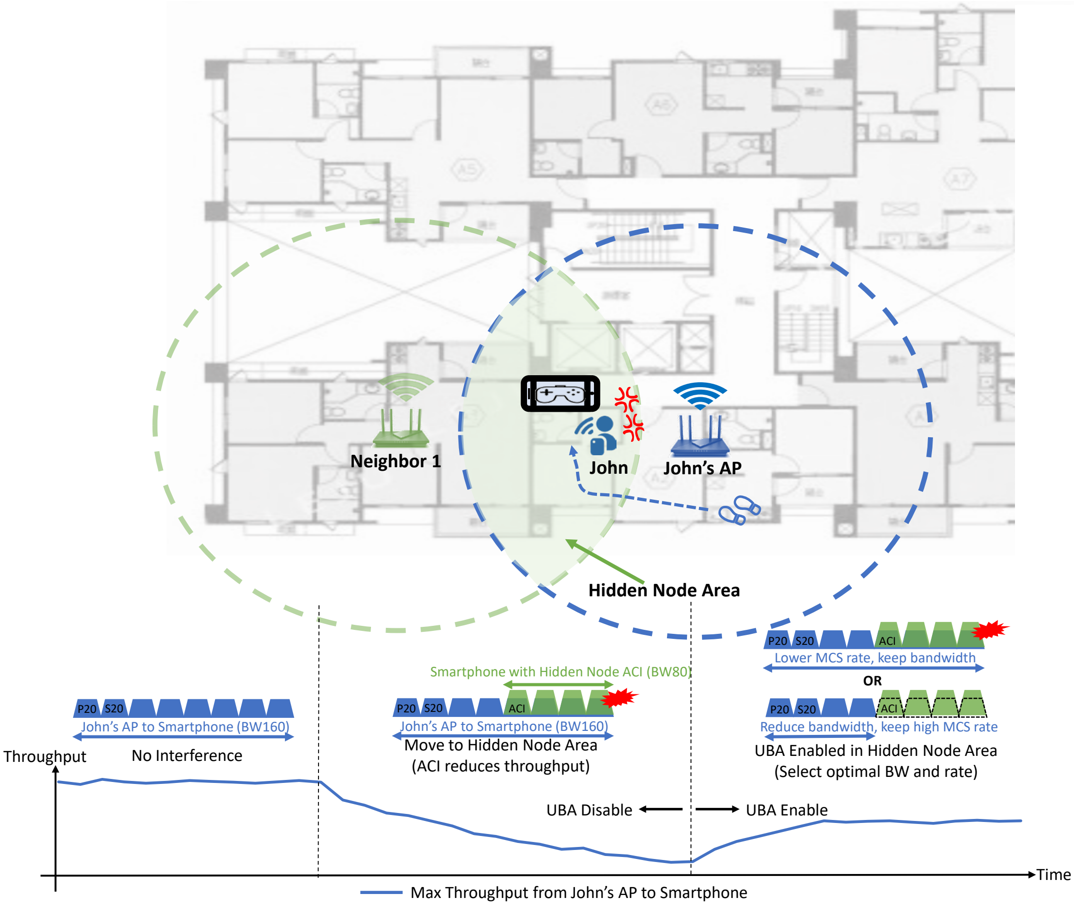

Figure 7 Selecting Optimal Bandwidth to Avoid Interference

The following steps outline how UBA technology finds the optimal combination of bandwidth and rate in a hidden node scenario.

- Observe Wi-Fi PHY indicators to identify whether a hidden node exists: such as whether similar upload and download RSSI have significant differences in PHY rate. Or, whether the rate remains normal but experiences unpredictable periods of severe PER.
- When potential hidden node conditions are detected, bandwidth and rate combinations are selected close to the current Wi-Fi speed. These are quickly tested by continuously sending short PPDUs to observe the result.
- The most appropriate combination of bandwidth and rate are selected based on the calculated Wi-Fi speed and latency, in accordance with PER severity.

When the interference status of the hidden node is unknown, UBA tests various combinations of bandwidths and rates to effectively avoid interference. By continuously sending short PPDUs, UBA reduces testing overhead and quickly identifies the optimal combination of bandwidth and rate to achieve the best Wi-Fi speed for the current environment.

Customized Preamble Puncture (CPP)

The main purpose of PP is to avoid interference-affected subcarriers while Wi-Fi 7 MRU combines multiple Resource Units for better utilization of the available spectrum. Combining these two can maximize the benefits of PP, creating a synergistic effect that significantly enhances performance. However, in hidden node scenarios the inability to detect interference renders PP ineffective. As shown in Figure 8, in the single AP scenario previously discussed, John's AP is unaware of interference from Neighbor 2. If John's smartphone could relay interference information to the AP, the AP could adjust the PP + MRU to avoid the interference, providing a more stable Wi-Fi connection.

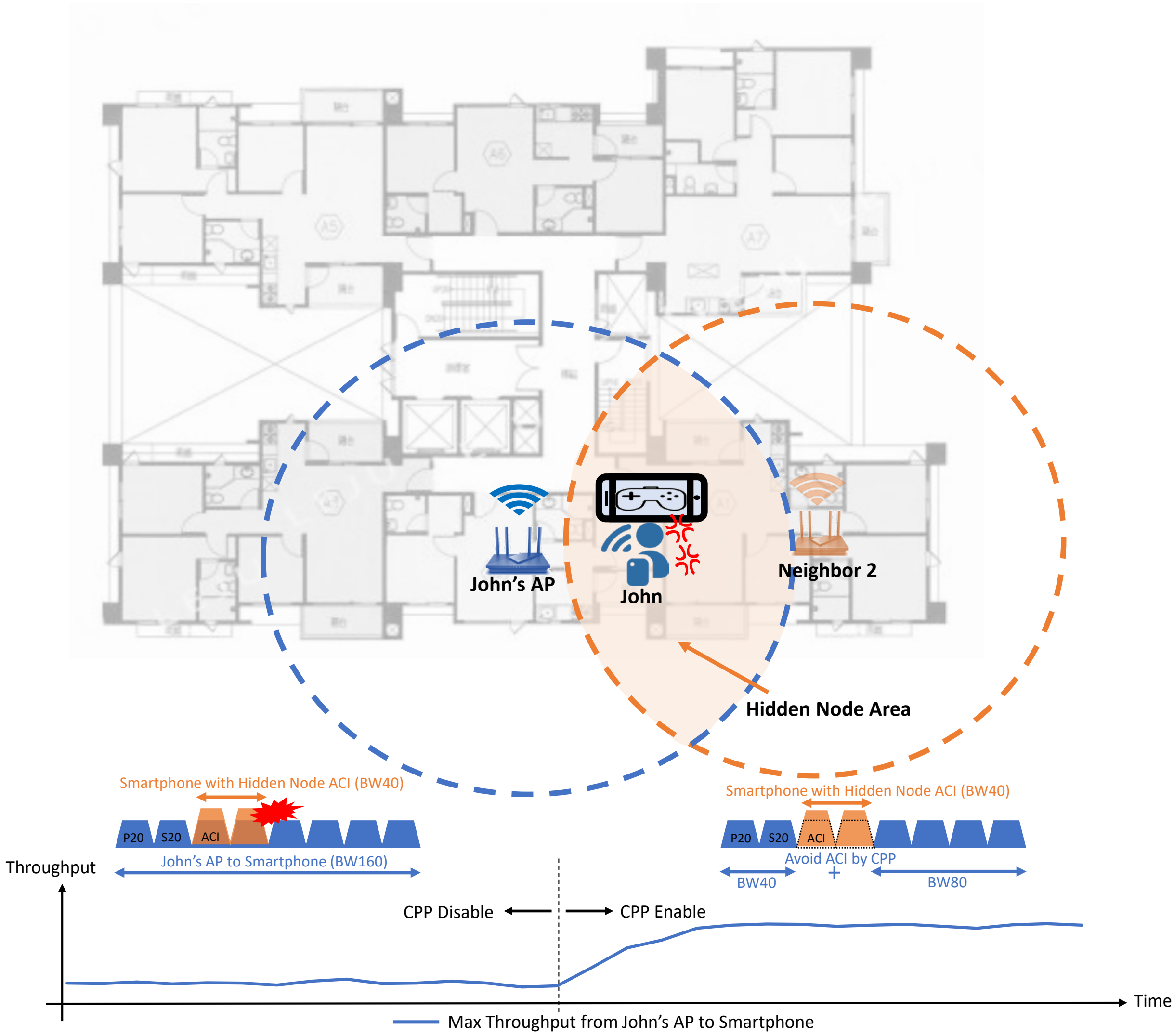

Figure 8 Solving Hidden Node Issues with CPP

MediaTek has designed CPP to address all hidden node situations. This technology uses MediaTek's proprietary protocol to enable APs and STAs to exchange interference detection results and automatically apply the best anti-interference techniques. The procedure is as follows:

- AP / STA actively detects interference.
- The AP / STA exchanges information with its counterpart to confirm if a hidden node situation exists.
- Upon confirmation, the best interference avoidance method is calculated by the AP and applied.

For example, if ACI interference is affecting only at the STA, causing a severe impact in receiving data from the AP, the AP can use PP + MRU to avoid the impact of ACI. Additionally, combining SR allows SR transmission to also avoid interference, significantly reducing the effect of ACI on the STA.

Enhanced Spatial Reuse (ESR)

SR leverages inter-BSS (Basic Service Set) PPDUs (Physical Protocol Data Unit) to enable multiple devices to transmit simultaneously by managing interference and coordinating transmissions. To detect inter-BSS PPDUs, Wi-Fi 6 includes a BSS color in the PHY header, allowing the AP to quickly distinguish whether it is an inter-BSS transmission. In contrast, Wi-Fi 5 and earlier standards needed to compare the SSID in the MAC header to confirm whether it was an inter-BSS PPDU. Despite technological progress, pre-Wi-Fi 6 devices still exist in many home environments, often constituting a sizable proportion of the network. MAC decode errors can easily result in missed opportunities for SR transmission due to differences in PHY and MAC payload decoding capabilities.

To enhance the opportunity for SR transmission, MediaTek developed ESR. When a new data PPDU is detected, ESR uses the rate information obtained from the PHY header and the PHY signal strength to determine whether it is an inter-BSS PPDU. The rate describes the requirements for successfully decoding the MAC payload. If the PHY signal strength does not meet the rate requirements, the MAC payload decoding is likely to fail. By combining this information, ESR can quickly distinguish an inter-BSS PPDU, thereby increasing the opportunity to identify inter-BSS PPDUs from pre-Wi-Fi 6 devices, significantly expanding the range and opportunity for SR transmission.

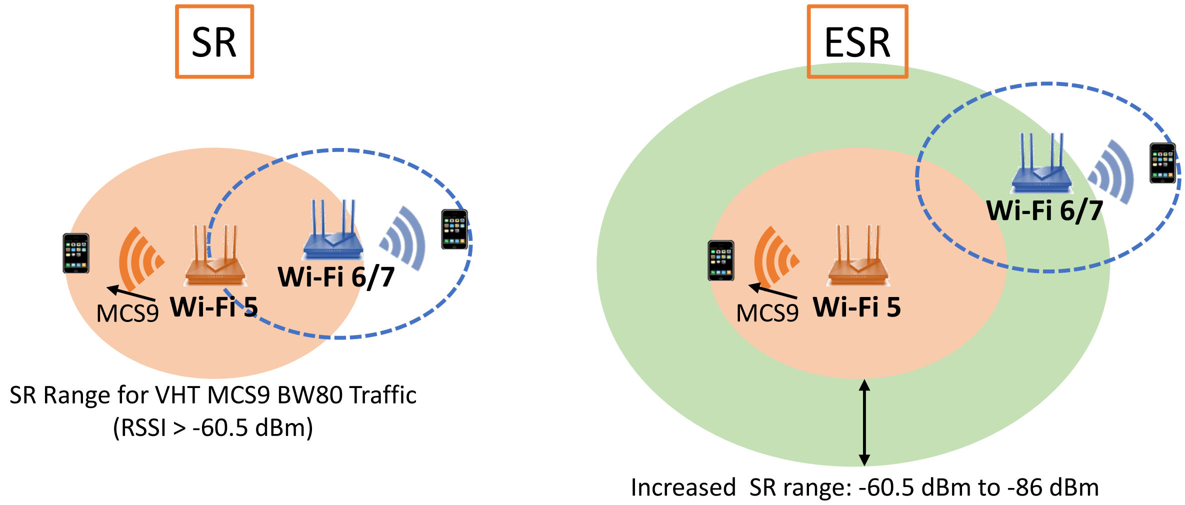

Figure 9 SR Working Range (By MediaTek Lab)

As shown in Figure 9, according to MediaTek's experimental data, SR requires an RSSI greater than -60.5 dBm to reuse VHT MCS9 BW80 traffic. Otherwise, SR transmission cannot be initiated due to a MAC decode failure. However, in a typical home Wi-Fi network, APs are usually not positioned close to each other, which significantly reduces the ability to use SR. As shown in the figure on the right, through ESR technology, we can extend the usable range of SR from an RSSI of -60.5 dBm up to -86 dBm, significantly enhancing SR performance.

Coordinate Spatial Reuse (CSR)

Mesh networks provide whole-home Wi-Fi with seamless roaming within the coverage area. However, a common issue is that all devices share the same channel. As more APs are deployed, the Wi-Fi CSMA/CA management reduces the available airtime for each AP. Figure 10 shows the effect of CSR on the previously detailed multi-AP network scenario.

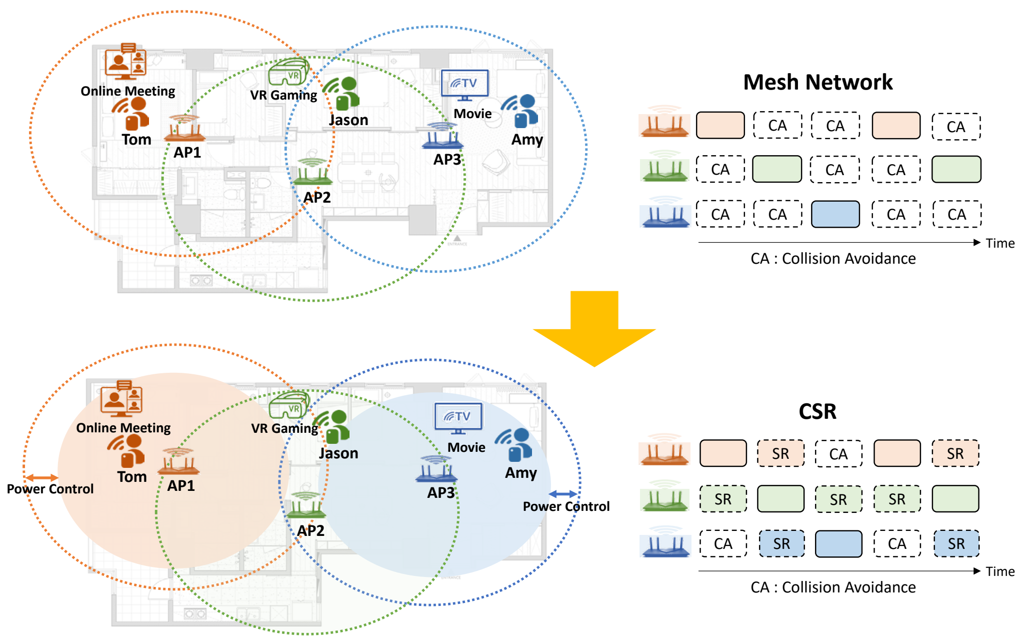

Figure 10 Enhancing Mesh Network Throughput with MediaTek's CSR

To address this issue, MediaTek has developed CSR, which coordinates APs through a transmission power control mechanism, improving the SR efficiency of multiple APs within mesh networks. It involves four main steps:

- The AP detects information from each BSS, such as collecting RSSI from other APs/STAs.
- APs exchange the collected information.
- Using the exchanged information, when an AP contends for bandwidth and is ready to send a PPDU it first sends a CSR-A (Announce) frame to other APs, which includes the expected PPDU transmission duration and transmission power control information.
- When other APs receive the CSR-A frame, they can decide whether to initiate SR transmission based on the PPDU duration and the transmission power control information.

In addition to enabling APs in a Mesh Network to exchange information, CSR-A frames allow other APs to more accurately determine when they can reuse the channel and understand transmission power limitations. This greatly increases SR transmission opportunities and reduces interference from concurrent transmissions, allowing SR to achieve maximum effectiveness across multiple APs in Mesh Networks.

MediaTek Anti-Interference Technology

MediaTek Anti-Interference is a smart core technology for various gateway and client configurations. It senses interference under different conditions and automatically selects the optimal solution from multiple anti-interference technologies based on the severity and characteristics of the interference. It continuously and dynamically adjusts the chosen technology in response to environmental changes, thereby enhancing Wi-Fi performance and reliability.

The single AP–STA scenario is similar to a peer-to-peer setup. The main difference is the source of interference; however, both scenarios are prone to hidden node interference. To replicate a hidden node from John's home, we simulated the AP and a smartphone operating on the 5 GHz with 160 MHz bandwidth, utilizing channel 36 as the primary channel. Another AP and STA operate on the 5 GHz with 40 MHz bandwidth, using channel 44 as the primary channel, were to simulate the neighbor's Wi-Fi interference, affecting the smartphone. By adjusting the ACI loading, we simulate various levels of interference from the neighbor's Wi-Fi to John's home. We simultaneously tested both file download and video conferencing applications, with the test results summarized in Table 2. The three key performance indicators are:

- Throughput represents the average file download speed, indicating the efficiency of data transfer.
- Average latency and PR95 latency reflect the quality of video conferencing, including aspects such as responsiveness and smooth communication.

Interference	Anti-Interference Off			Anti-Interference On		
	Throughput (Mbps)	Latency (ms)	PR95 Latency (ms)	Throughput (Mbps)	Latency (ms)	PR95 Latency (ms)
No Interference	450 5	9	81	450 5	9	81
15% ACI Loading	345	65	101	405	61	85
60% ACI Loading	55	134	252	330 7	2	97

Table 2 The effect of MediaTek Anti-Interference technology versus a hidden node scenario

When ACI loading is at 15%, MediaTek Anti-Interference technology utilizes UBA to maintain stable throughput, achieving a 17% increase in throughput and 6% reduction in latency. At 60% ACI loading, the high PER causes significant throughput drops and increased latency, primarily caused by the hidden node. MediaTek Anti-Interference technology applies CPP to address this, marking preamble puncturing on the second BW40 within BW160 to avoid interference. This intervention restores the throughput to 73% of the non-interference state, reducing average latency by 46%, and PR95 latency by 61%

We established a multiple AP scenario using three APs and one STA to simulate Tom's home Wi-Fi Mesh network. The STA represents Tom's laptop for performance testing, with the results are shown in Table 3.

	Backhaul	Fronthaul	Mesh Throughput (Mbps)		
			CSR Off	CSR On	Gain
STA<->AP 1m, RSSI -25dBm			2036 2	657 3	0%
STA<->AP 3m, RSSI -38dBm	EHT 5G BW160 H	E 5G BW160	1860	2406	29%
STA<->AP 5m, RSSI -52dBm			1803 2	035 1	2%

Table 3: CSR results in a three AP (Mesh) network with one STA

MediaTek Anti-Interference automatically actives CSR technology in Mesh network, enabling APs to dynamically manage the transmission power sent to the STA. When the STA is closer to the AP, adjusting transmission power appropriately enhances the success rate of SR while minimizing interference with neighboring devices. The optimization can result in up to a 30% increase in throughput.

Residential networks face several types of interference, such as Wi-Fi interference, Dynamic Frequency Selection (DFS) interference, microwave interference, and Bluetooth interference. Currently, Wi-Fi can only avoid microwave interference by switching channels, as there is no effective technology to counter it. Excluding this, MediaTek Anti-Interference technology can mitigate or improve performance degradation caused by the remaining interference scenarios.

Conclusion

MediaTek has developed several proprietary anti-interference technologies to further mitigate interference in different network scenarios. These include UBA for optimizing bandwidth and rate in hidden node scenarios, CPP for exchanging interference information and applying optimal anti-interference techniques, ESR for improving SR opportunities and usage range by distinguishing inter-BSS transmissions, and CSR for enhancing Mesh Network performance through AP coordination. By leveraging MediaTek Anti-Interference as a smart core technology, appropriate anti-interference techniques are intelligently executed based on different interference scenarios. These techniques can be used individually or in combination with one another. This smart core technique helps improve Wi-Fi throughput, reduce latency, and enhance network reliability, ensuring a consistently excellent Wi-Fi experience for users.

The Wi-Fi Alliance has introduced several anti-interference technologies across different Wi-Fi standards to address the challenges of interference in densely populated Wi-Fi environments. In the future Wi-Fi 8 standard, these advancements will include technologies focused on enhancing signal reception and reducing interference, such as Coordinated Beamforming (C-BF), technologies aimed at improving frequency band utilization like Non-Primary Channel Access (NPCA) and Dynamic Sub-Channel Operation (DSO), and unequal QAM, a technique for enhancing the SNR and MCS of multiple antennas. MediaTek Anti-Interference technology will continue to evolve, incorporating these Wi-Fi 8 anti-interference technologies and continuously enhancing and advancing to strengthen the interference resistance of MediaTek Filogic gateways and clients. This allows users to experience reliable connections, reliable throughput, and reliable latency in various interference environments, providing a consistently excellent Wi-Fi experience.

Glossary

ACI	Adjacent Co-Interference
AP	Access Point (i.e., router)
BSS	Basic Service Set
C-BF	Coordinated Beamforming
CCI	Co-Channel Interference
CPP	Customized Preamble Puncture
CSMA/CA	Carrier Sense Multiple Access with Collision Avoidance
CSR	Coordinate Spatial Reuse
DFS	Dynamic Frequency Selection
DSO	Dynamic Sub-Channel Operation
ESR	Enhanced Spatial Reuse
MAC	Media Access Control
MCS	Modulation Coding Scheme
NPCA	Non-Primary Channel Access
PER	Packet Error Rate
PHY	Physical Layer
PP	Preamble Puncturing
PPDU	Physical Protocol Data Unit
QAM	Quadrature Amplitude Modulation
RSSI	Received Signal Strength Indicator
SNR	Signal-to-Noise Ratio
SR	Spatial Reuse
STA	Station (i.e., a smartphone)
UBA	Universal Bandwidth Adaption

MediaTek in the Wi-Fi Industry

MediaTek is the world's largest supplier of Wi-Fi solutions, including standalone networking products such as routers, repeaters, and mesh access points, and devices with embedded Wi-Fi connectivity such as smartphones, tablets, TVs, IoT, smart home devices, PCs and laptops, games consoles, and many others.

Besides delivering high performance and low power integrated solutions to these platforms, MediaTek is actively participating in IEEE and Wi-Fi Alliance certification development to ensure top performance and industry interoperability. Some recent examples include selection of MediaTek's Filogic platforms as Wi-Fi 6E and Wi-Fi 6 R2 test bed devices. With Wi-Fi 7 and more, MediaTek continues to contribute technical expertise and knowledge of diverse market segment standards for improved Wi-Fi performance in daily applications.

Acknowledgments

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