Wireless Broadband Alliance

WI-FI 7 MLO ENTERPRISE FIELD TRIALS

AT&T | intel | RUCKUS NETWORKS

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Authors: NextGen Work Group

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EXECUTIVE SUMMARY

As Wi-Fi network environments become increasingly congested, the ability for client devices to dynamically navigate interference is critical for maintaining Quality of Experience (QoE).

This Wi-Fi 7 Phase 2 field trial, conducted as part of the WBA Wi-Fi 7 program in partnership with AT&T, Ruckus Networks, and Intel, empirically demonstrates the real-world performance benefits of Wi-Fi 7 Multi-Link Operation (MLO) with Enhanced Multi-Link Single Radio (EMLSR) technology in enterprise environments. The trial specifically evaluated throughput improvements and latency reduction under both co-channel interference (CCI) and clean no-CCI conditions.

The field trial revealed compelling results that validate the enterprise applicability of EMLSR. EMLSR-capable clients achieved significant performance improvements: under no-CCI conditions, downlink (DL) throughput gains reached up to 42%, while uplink (UL) throughput gains reached up to 139% compared to non-MLO operations. Under CCI scenarios, DL improvements reached 75%, and UL gains reached 116% in the 40/40 MHz configuration. Most notably, EMLSR reduced latency by up to 44% for DL traffic and 66% for UL traffic compared to non-MLO clients, demonstrating substantial benefits for latency-sensitive applications.

These results validate the enterprise applicability of Wi-Fi 7 MLO technology for improved reliability, spectrum efficiency, and latency-critical applications.

This report details the technical methodologies employed, the performance metrics collected, and the broader implications of these results for Internet Service Providers (ISPs), device manufacturers, and the global broadband ecosystem. It concludes that Multi-Link Operation represents a pivotal evolution in Wi-Fi architecture, narrowing the gap between the deterministic reliability of wired Ethernet and the flexibility of wireless connectivity.

1. INTRODUCTION

The IEEE 802.11be (Wi-Fi 7) standard [2] introduces the concept of a Multi-Link Device (MLD). An MLD has a single MAC address at the upper layer but multiple physical (PHY) layers connected to different links. Wi-Fi 7 [3] Multi-Link Operation (MLO) allows devices to utilize multiple frequency bands (2.4 GHz, 5 GHz, and 6 GHz) simultaneously or alternately to optimize data delivery.

IEEE 802.be standard defines several operational modes for MLO, each offering a different balance of performance, complexity, and cost. Table 1 provides the benefits of MLO.

Benefits	Description
Better Reliability	Enables seamless traffic redirection across bands during interference, offering built-in failover and load balancing—like having multiple paths to avoid connectivity loss.
Efficient Spectrum Use	Maximizes WLAN capacity by dynamically using the least congested band (e.g., 6 GHz when 5/2.4 GHz are crowded), adapting to regulatory constraints and spectrum availability.
Reduced Latency	Achieves sub-1ms latency by distributing packets across links or switching to cleaner bands, ideal for real-time apps like AR/VR and gaming. Even single-radio clients benefit by choosing the lowest-interference link.
Higher Throughput	Uses channels across bands (e.g., 5 GHz + 6 GHz) and increases throughput.

Table 1 – Benefits of MLO supported by Wi-Fi 7

The focus of this trial is Enhanced Multi-Link Single Radio (EMLSR), where the device uses *one* Wi-Fi radio chain to transmit/receive at a time, but it can switch that radio between different bands (links).

EMSLR allows the device to listen on multiple bands (e.g., 5GHz and 6GHz) concurrently (with separate receive chains) and dynamically switch all chains to whichever band is optimal at a given moment. In practice, this means an EMLSR client can rapidly alternate between links, but it still only transmits or receives data on one band at any given time. The benefit of single-radio MLO is lower cost and power consumption (only one main radio used), and it improves reliability/latency by always using the best band available – but it does not increase peak throughput since links are not used in parallel. It rather maximizes reliability and usable throughput in hostile RF environments.

Figure 1 – EMLSR makes spectrum into an active multi-lane road

This study builds upon earlier Wi-Fi 7 Phase 1 trials, which compared Wi-Fi 6 and Wi-Fi 7 performance across different channel sizes and examined rate versus range characteristics [1]. The objective of this Phase 2 trial was to evaluate MLO/EMLSR performance benefits in realistic enterprise environments, focusing on real-world use cases involving both clear line-of-sight (LoS) conditions and co-channel interference scenarios, aiming to achieve the following objectives:

- Quantify EMLSR Throughput Benefits: Measure peak data rate improvements with EMLSR enabled across various channel bandwidth configurations
- Evaluate Latency Characteristics: Assess latency reduction capabilities, particularly for latency-sensitive applications such as video streaming and real-time communications
- Assess Interference Resilience: Evaluate EMLSR performance under co-channel interference conditions on the 6 GHz band
- Validate Enterprise Applicability: Demonstrate practical performance benefits in realistic enterprise networking scenarios with multiple simultaneous clients

Characterize Dynamic Link Switching: Understand how EMLSR clients dynamically allocate traffic between 5 GHz and 6 GHz bands under varying conditions

2. TRIALS SETUP

The tests were executed in an enterprise office environment. The trials were setup for two primary cases to compare effects of MLO vs non-MLO and MLO performance with CCI and without CCI under different channel size combinations:

2.1 MLO VS NON-MLO WITH NO CCI TESTING

- Objective: Establish baseline EMLSR performance in ideal spectrum conditions
- Configuration: 5 MLO clients connected to primary AP, all tests conducted with no co-channel interference
- Metrics Collected: Throughput (DL/UL), latency, packet loss, link utilization
- Traffic Pattern: Concurrent testing across all 5 clients simultaneously

2.1.1 MLO VS NON-MLO WITH NO CCI TESTING NETWORK TOPOLOGY

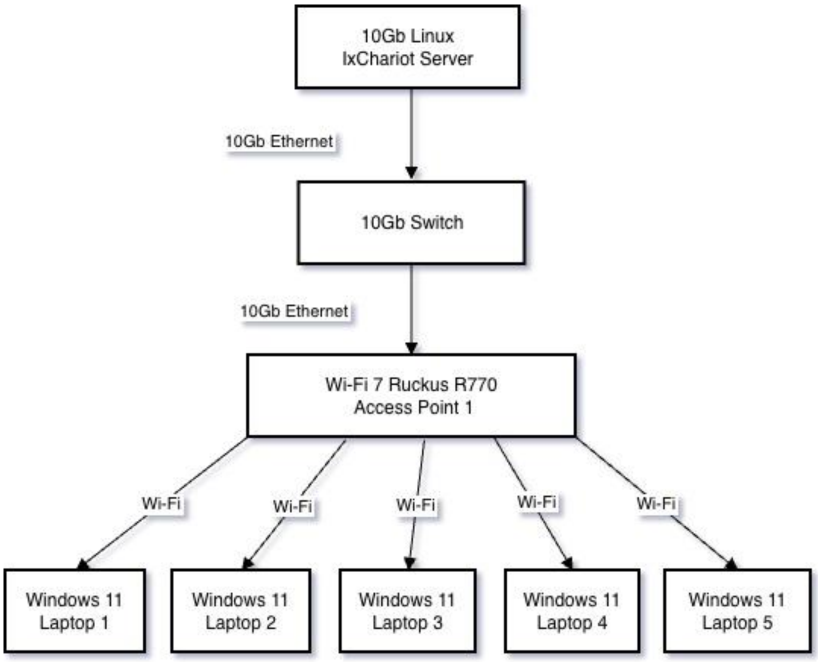

Figure 2 – Network configuration and topology for testing MLO vs no-MLO

The trial employed one AP with two different configurations for testing MLO vs non-MLO without CCI case, which is covered in section 2.2.

2.1.2 AP CONFIGURATIONS FOR MLO VS NON-MLO WITH NO CCI

The Ruckus AP [4] configuration details are shown in Table 2.

Component	MLO AP Setup	Non-MLO AP Setup
Vendor/Model	Ruckus R770 Wi-Fi 7 AP	Ruckus R770 Wi-Fi 7 AP
MLO	MLO enabled on 5 GHz + 6 GHz bands	No MLO
Configured	5 GHz and 6 GHz bands	5 GHz and 6 GHz bands
6 GHz Channel	40, 80, 160 MHz (test variable)	40, 80, 160 MHz (test variable)
5 GHz Channel	40 MHz always	40 MHz always
SSID	“R1 MLO”	“R1 non-MLO – 5&6”

Table 2: Access Point Configurations with MLO and No-MLO

2.1.3 CLIENT DEVICE CONFIGURATION FOR MLO VS NON-MLO

- 5 MLO-Capable Test Clients: Intel based Windows 11 laptops equipped with Intel BE200 wireless cards [5].

- All clients connected to the Ruckus Networks R770 AP via dual SSIDs designed to support both MLO and non-MLO testing modes.

2.2 MLO WITH CO-CHANNEL INTERFERENCE TESTING (CCI) AP

- Objective: Evaluate EMLSR resilience and dynamic link-switching behavior under realistic interference conditions
- Configuration: Secondary Ruckus Wi-Fi 7 AP operating on same 6 GHz channel (160 MHz) creating OBSS
- Interference Source: 1 laptop connected to interference AP, generating traffic to create consistent channel utilization.
- Metrics Collected: Same as Phase A, with focus on throughput degradation and link switching effectiveness

2.2.1 MLO WITH CCI TESTING NETWORK TOPOLOGY

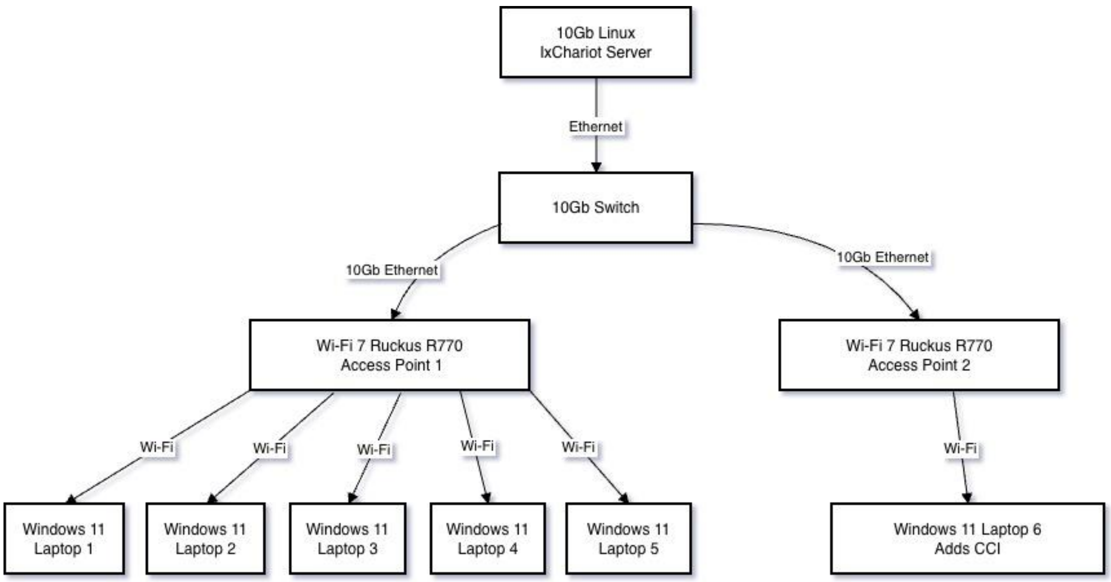

Figure 3 – Topology of the testing environment with MLO AP and CCI AP

2.1.2 AP CONFIGURATIONS FOR MLO WITH CCI TESTS

The MLO and CCI trial employed two APs with configurations designed to create realistic interference conditions while enabling controlled measurement of EMLSR performance as shown in Table 3:

Component	AP1 Setup	AP2 Setup
Vendor/Model	Ruckus R770 Wi-Fi 7 AP	Ruckus R770 Wi-Fi 7 AP
Configuration	MLO enabled on 5 GHz + 6 GHz bands	CCI source on 6Ghz only. No MLO
6 GHz Channel	40, 80, 160 MHz (test variable)	channel size - 160 MHz
5 GHz Channel	40 MHz always	N/A
Role	Primary MLO test AP	Interference generator
SSID	"MLO AP"	"6GHz Interfering AP"

Table 3 – Access Point Configurations with CCI

The two APs were configured to operate on overlapping 6 GHz channels, creating Overlapping Basic Service Set (OBSS) conditions that reflect realistic deployment scenarios where multiple Wi-Fi 7 networks may operate in proximity.

2.1.3 CLIENT DEVICE CONFIGURATION WITH MLO & CCI TESTING

- 5 MLO-Capable Test Clients: Intel based Windows 11 laptops equipped with Intel BE200 wireless cards. All clients connected to the MLO enabled Ruckus Networks R770 APs

- 1 Non-MLO Client for CCI Testing: Intel based Windows 11 laptop with Intel BE200 card (MLO disabled for comparison). It is connected to Ruckus "6 GHz Interfering AP" creating Co-Channel Interference. The interfering client had high-throughput traffic solely to load the 6 GHz spectrum, forcing the primary test clients to contend for airtime.

2.3 RTP TESTING WITH AND WITHOUT MLO

- Objective: Evaluate one way uplink and downlink latency and compare it with and without MLO
- AP Configuration: One Ruckus R770 Wi-Fi 7 AP operating on 6 GHz and 5Ghz
- Clients: Two Intel laptops equipped with BE200 adapters.
- Metrics Collected: Uploading and downloading over MLO client running RTP test script while running high throughput. Measure one way UL and DL RTP latency on MLO on/off client.

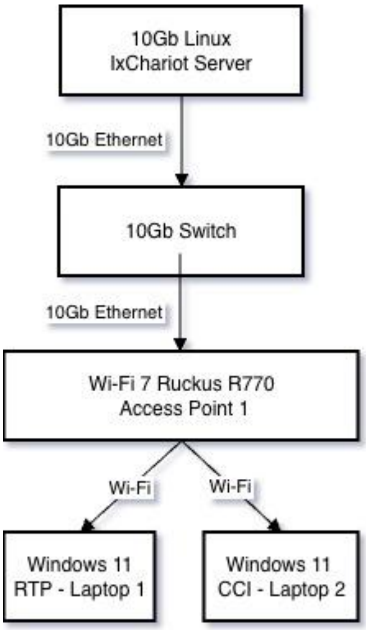

Figure 4 – RTP test setting

2.3.1 RTP TEST TOPOLOGY

For RTP testing, two clients were connected to the same MLO AP. One generating high throughput traffic and the other one RTP DL and UL traffic with MLO on and off.

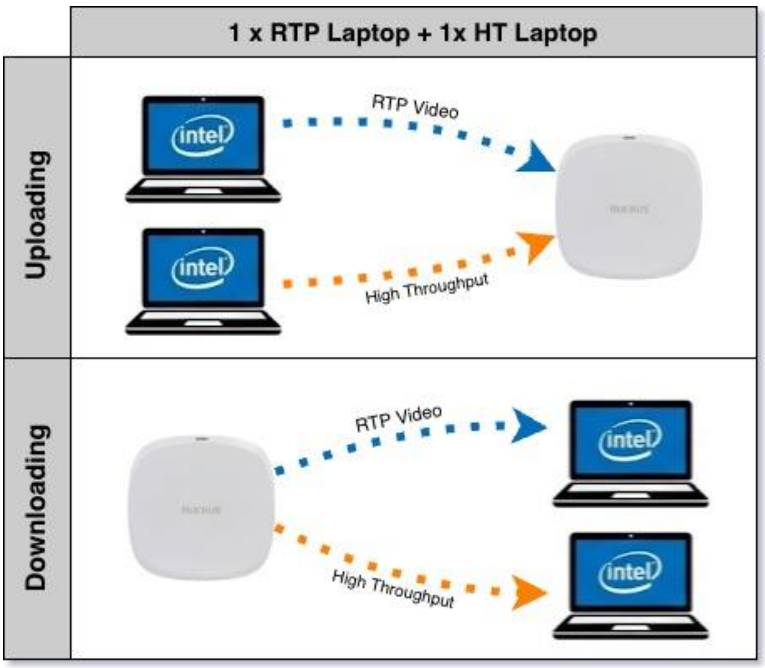

Figure 5 – RTP test topology

2.3.2 AP CONFIGURATIONS FOR RTP TESTS

Used single MLO AP configured as following

Component	AP1 Setup
Vendor/Model	Ruckus R770 Wi-Fi 7 AP
Configuration	MLO enabled on 5 GHz + 6 GHz bands
6 GHz Channel	160 MHz
5 GHz Channel	40 MHz
SSID	"RTP Test"

Table 3 – Access Point Configurations with CCI

2.3.3 CLIENT DEVICE CONFIGURATION FOR RTP TESTING

Intel based Windows 11 two laptops equipped with Intel BE200 wireless cards. MLO was enabled and disabled to test RTP traffic delay.

- For MLO testing: MLO enabled on both clients
- For non-MLO testing: MLO disabled on both clients
- Both clients were connected to the same AP
- Traffic Profile:
    - Client 1: Runs RTP traffic.
    - Client 2: Generates high throughput load on the AP.
- This setup was maintained for both MLO and non-MLO scenarios.

2.3 CHANNEL CONFIGURATION AND TEST MATRIX

The trial employed a systematic testing approach across multiple channel bandwidth combinations to evaluate EMLSR performance across practical deployment scenarios:

Test Configuration	5 GHz Bandwidth	6 GHz Bandwidth
Config 1	40 MHz	40 MHz
Config 2	40 MHz	80 MHz
Config 3	40 MHz	160 MHz

Table 4 – Channel Bandwidth Test Configurations

The 5 GHz band was held constant at 40 MHz while 6 GHz bandwidth varied across 40 MHz, 80 MHz, and 160 MHz configurations. This approach allowed systematic evaluation of how EMLSR benefits compare with different channel size combinations in 5 GHz and 6 GHz bands.

2.4 NETWORK INFRASTRUCTURE AND TEST ENVIRONMENT

- Backhaul Switching: 10 Gigabit Ethernet switching infrastructure connecting APs to test servers
- Network Configuration: Single VLAN and subnet deployment for all test clients
- Test Server Interface: 10 Gbps connection for high-capacity throughput testing
- Radio Environment: Enterprise line-of-sight (LoS) environment setting - not in a chamber

2.5 TEST EQUIPMENT:

- Traffic Generation: Ixia IxChariot for controlled throughput and latency testing
- Throughput Testing: TCP high-performance upload and download streams
- Latency Testing: Real-time Protocol (RTP) video stream simulation for latency measurement

Network Analysis: Wireshark packet captures for traffic distribution analysis across 5 GHz and 6 GHz links

3. TRIAL EXECUTION AND METHODOLOGY

The trial executed a systematic testing approach that separated baseline and interference scenarios to isolate EMLSR performance gains from environmental factors. For each configuration, the methodology established baselines with the interference AP disabled, followed by identical test execution with the interference AP active, providing a clear performance delta that isolates improvements attributable to EMLSR logic rather than environmental variation.

Performance metrics were captured using Ixia IxChariot. The team executed TCP scripts to measure raw UL/DL throughput and RTP video stream scripts to assess latency. The methodology separated baselines (interference AP off) from "CCI" scenarios (interference AP active), providing a clear delta that isolates the gain attributable to EMLSR logic.

For CCI testing, the 6th laptop ran high-throughput traffic on the interference AP. Results reported reflect only the 5 test clients connected to the primary AP, with the 6th laptop's throughput excluded from reported metrics to isolate EMLSR performance impact.

Latency testing under CCI conditions was structured to compare the performance of an MLO-enabled laptop against a non-MLO laptop, both associated with the same AP. One device generated high-throughput TCP traffic to create consistent channel utilization, while the other transmitted RTP streams to measure latency impact under interference. This approach provided a controlled environment to evaluate how EMLSR influences latency-sensitive applications when subjected to real-world interference.

3.4 PACKET CAPTURE AND TRAFFIC ANALYSIS

Detailed packet captures were collected during both MLO-enabled and non-MLO testing to visualize traffic distribution across 5 GHz and 6 GHz links:

- Capture Scope: Frame-by-frame capture at AP transmit/receive
- Analysis Focus: Downlink (DL) traffic distribution between 5 GHz and 6 GHz bands
- Key Observations: Identification of dynamic link-switching behavior and spectrum utilization patterns
- Comparison: Non-MLO vs. MLO traffic patterns to quantify spectrum efficiency improvements

4. TRIAL RESULTS

4.1 THROUGHPUT PERFORMANCE – MLO VS NON-MLO WITHOUT CCI

The trial produced a comprehensive set of throughput measurements comparing MLO with non-MLO configurations across three channel bandwidths under clean channel conditions, where no CCI was present.

Table 5 presents comprehensive throughput results for MLO vs non-MLO across all three channel bandwidth configurations under no CCI conditions. The results provide us a direct comparison between MLO and non-MLO configurations under no-CCI conditions.

Channel Config	Direction	Non-MLO (Mbps)	MLO (Mbps)	Gain (Mbps)	Improvement %
40+40 MHz	DL	475.3	675.8	200.5	42.18%
	UL	265.7	637.5	371.8	139.93%
40+80 MHz	DL	859.3	952.5	93.2	10.85%
	UL	637.3	814.0	176.7	27.73%
40+160 MHz	DL	1503.0	1545.17	42.17	2.87%
	UL	1192.7	1420.3	227.6	19.08%

Table 5: Throughput Summary – Clean Channel (No CCI)

This test result demonstrated substantial throughput improvements across no-CCI channel scenarios. In the 40/40 MHz configuration—representing bandwidth-constrained enterprise environments—DL throughput improved 42.18% from 475.3 Mbps without MLO to 675.8 Mbps with MLO enabled. UL throughput in the same configuration showed dramatic improvement of 139.93%, increasing from 265.7 Mbps without MLO to 637.5 Mbps with MLO. These results demonstrate EMLSR's particular effectiveness in bandwidth-constrained scenarios where dual-band utilization provides substantial relief from per-band saturation.

In the 40/80 MHz configuration, DL throughput improvement reached 10.85% (859.3 Mbps to 952.5 Mbps), while UL improvement reached 27.73% (637.3 Mbps to 814.0 Mbps).

The 40/160 MHz configuration, representing the highest-bandwidth scenario with maximum 6 GHz channel width, showed more modest improvements: 2.87% DL improvement (1,503.0 Mbps to 1,545.17 Mbps) and 19.08% UL improvement (1,192.7 Mbps to 1,420.3 Mbps).

Key Observations – Clean Channel Performance:

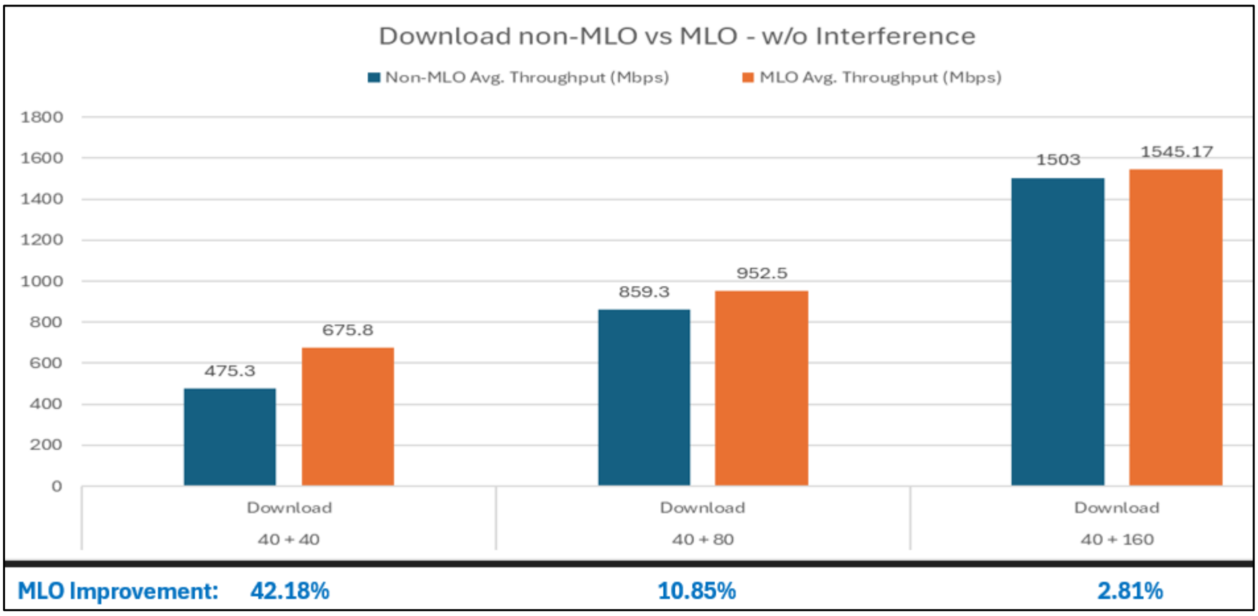

Figure 6 – MLO vs non-MLO Downlink performances

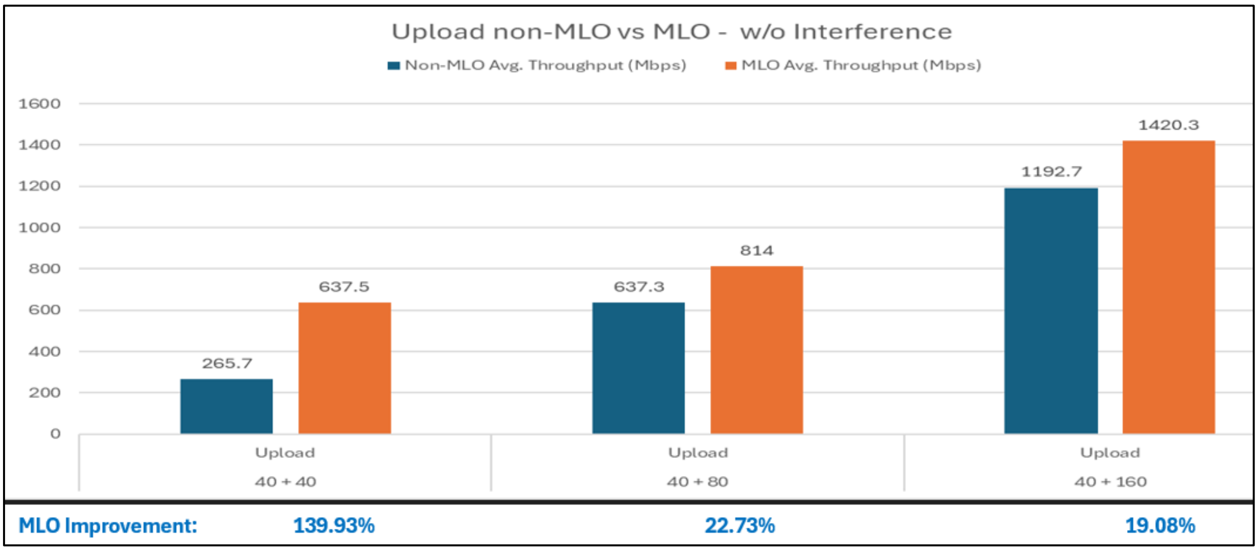

Figure 6. MLO vs non-MLO UL performances.

As 6 GHz channel width increases, EMLSR performance gains diminish substantially, with minimal improvements observable at 40/160 MHz. This pattern suggests that single-band saturation becomes the limiting factor rather than band availability when individual bands provide sufficient bandwidth to satisfy client's need.

The results also confirm that MLO clients distribute traffic dynamically across available bands rather than simply favoring higher-capacity channels, validating the advanced scheduling logic that balances traffic intelligently to optimize performance.

4.2 THROUGHPUT PERFORMANCE – MLO VS NON-MLO WITH CCI

The co-channel interference testing revealed the most compelling value proposition of Enhanced Multi-Link Single Radio (EMLSR). In the 40/40 MHz configuration, downlink throughput improved by 75.92%, rising from 317.2 Mbps without MLO to 558.0 Mbps with MLO enabled. Uplink throughput showed an even more dramatic gain of 116.04%, increasing from 244.8 Mbps to 528.8 Mbps. These results underscore the strength of MLOs ability to deliver substantial performance improvements under interference conditions.

In the 40/80 MHz configuration, DL improvement reached 22.14% (551.6 Mbps to 673.7 Mbps) and UL improvement reached 35.94% (593.2 Mbps to 806.4 Mbps). In the 40/160 MHz configuration, DL improvement reached 19.45% (676.2 Mbps to 807.7 Mbps) while UL improvement reached 16.25% (1,105.9 Mbps to 1,285.6 Mbps).

Table 2 presents throughput results under co-channel interference conditions, where a secondary Ruckus Wi-Fi 7 AP operates on the same 6 GHz 160 MHz channel.

Channel Config	Direction	Non-MLO (Mbps)	MLO (Mbps)	Gain (Mbps)	Improvement %
40+40 MHz	DL	317.2	558.0	240.8	75.92%
	UL	244.8	528.8	284.0	116.04%
40+80 MHz	DL	551.6	673.7	122.1	22.14%
	UL	593.2	806.4	213.2	35.94%
40+160 MHz	DL	676.2	807.7	131.5	19.45%
	UL	1105.9	1285.6	179.7	16.25%

Table 7 – Throughput Summary – Co-Channel Interference (CCI) at 6 GHz

The interference test results reveal critical insights into EMLSR's practical enterprise value. The dramatic 75.92% DL improvement at 40/40 MHz configuration highlights EMLSR's most compelling value proposition for real-world deployments where interference is inevitable.

The interference test results confirm that EMLSR provides substantial improvements in both DL and UL throughput under challenging conditions. The ability to dynamically switch between bands allows MLO-enabled clients to sustain performance levels that non-MLO devices cannot achieve, validating EMLSR's value as a solution for environments where interference is a constant reality.

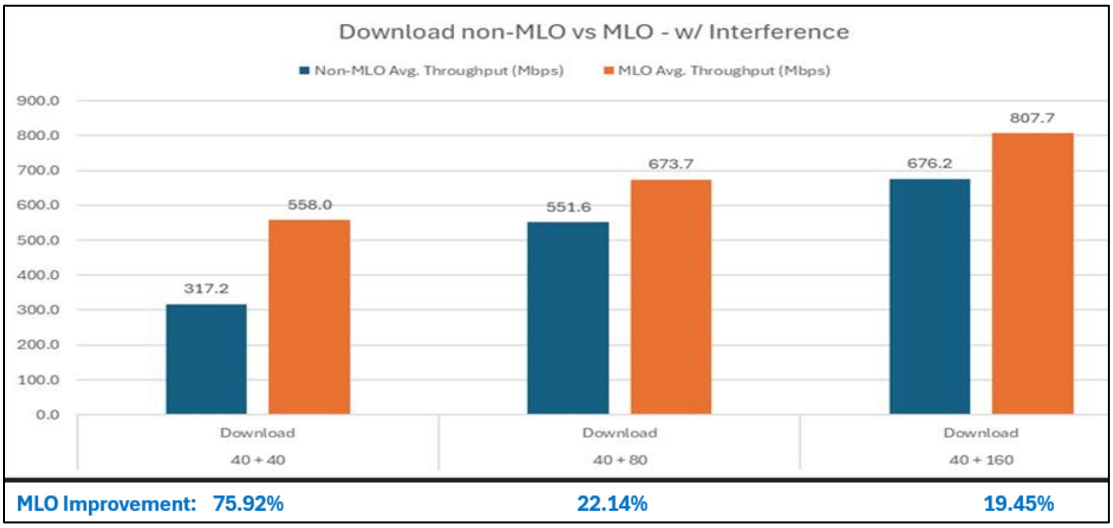

Figure 7 – MLO vs non-MLO DL performances with interference

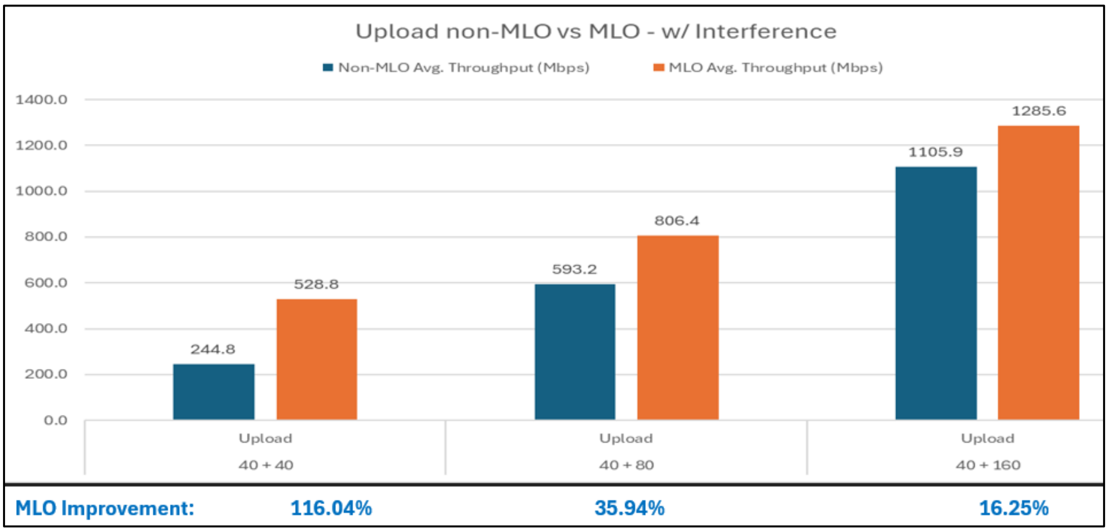

Figure 8 – MLO vs non-MLO UL performances with interference

In contrast, MLO clients experienced only modest degradation from 675.8 Mbps to 558.0 Mbps, a 17.4% reduction. This resilience demonstrates EMLSR's fundamental architectural advantage: MLO clients automatically exploit the 5 GHz band when 6 GHz experiences interference, achieving substantial throughput even under adverse RF conditions.

Non-MLO clients remain locked to their selected band even when interference degrades performance, resulting in throughput drop. EMLSR improvements remain substantial across all bandwidth configurations under interference (16.25% to 116.04%), validating the technology's practical enterprise value across diverse deployment scenarios.

MLO clients maintain acceptable performance levels even under adverse interference, whereas non-MLO clients experience significant degradation, highlighting EMLSR's superior reliability characteristics.

These performance improvements under CCI conditions highlight EMLSR's enterprise value for real-world deployment scenarios.

4.3 TRAFFIC DISTRIBUTION ANALYSIS – WIRESHARK CAPTURES

Detailed packet captures were collected during both MLO-enabled and non-MLO testing to visualize traffic distribution across the 5 GHz and 6 GHz links and to better understand dynamic link-switching behavior. This analysis provides valuable insight into how Enhanced Multi-Link Single Radio (EMLSR) clients allocate traffic across available bands in real time.

Figure 9 shows DL traffic distribution comparison (non-MLO vs. MLO) demonstrating dynamic band allocation in 40+160 MHz configuration.

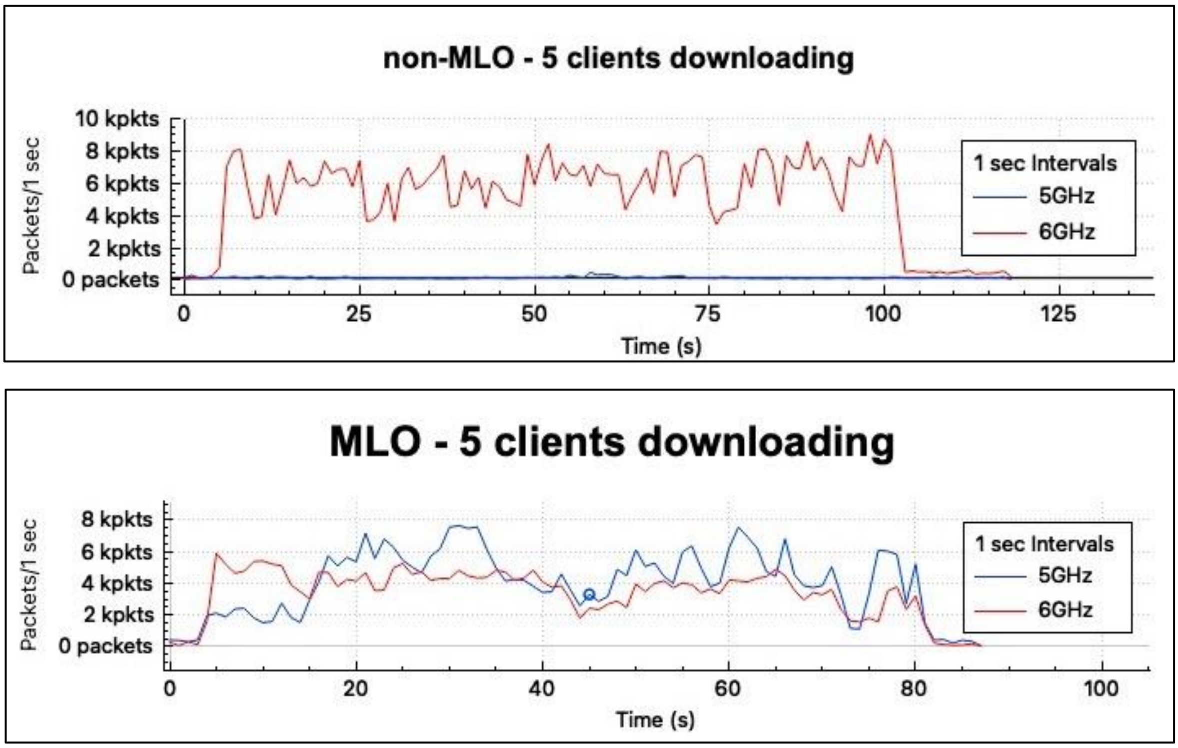

Figure 9 – Wireshark MLO and non-MLO DL Captures with no CCI

Non-MLO Traffic Pattern:

- Single Band Dominance: Without MLO, all DL traffic concentrates on the 6 GHz band
- Band Selection: Clients choose 6 GHz as the preferred band regardless of interference conditions due to higher theoretical capacity
- Performance Limitation: Single-band operation becomes the throughput bottleneck
- Interference Vulnerability: Co-channel interference on 6 GHz directly impacts all traffic with no alternative path

MLO Traffic Pattern:

- Dual-Band Utilization: DL traffic is distributed across both 5 GHz and 6 GHz bands
- Dynamic Switching: AP and STAs rapidly switch frames between bands based on real-time channel quality assessment
- Interference Avoidance: When 6 GHz experiences CCI, traffic automatically redirects to the cleaner 5 GHz band
- Concurrent Listening: EMLSR clients listen on both bands simultaneously, enabling rapid detection of interference and optimal band selection
- Latency Optimization: Frame-by-frame optimization allows selection of the band with lowest latency at the moment of transmission

The results reveal a stark contrast between non-MLO and MLO traffic patterns. In non-MLO configurations, all downlink traffic is concentrated on the 6 GHz band. Clients consistently select

6 GHz as the preferred band due to its higher theoretical capacity, but this static preference creates a throughput bottleneck. More critically, it leaves non-MLO clients vulnerable to co-channel interference, as all traffic is exposed to degradation without an alternative path.

By contrast, MLO-enabled clients demonstrate dynamic dual-band utilization. Downlink traffic is distributed across both 5 GHz and 6 GHz bands, with access points and stations rapidly switching frames between them based on real-time channel quality assessments. When interference occurs on the 6 GHz band, traffic is automatically redirected to the cleaner 5 GHz band, ensuring continuity of service. EMLSR clients are able to listen concurrently on both bands, enabling rapid detection of interference and immediate optimization of band selection. This frame-by-frame decision-making process also minimizes latency, as transmissions are routed through whichever band offers the lowest delay at the moment of transmission.

Wireshark captures clearly demonstrate that MLO implementation achieves the intended benefit of dynamic spectrum utilization, with traffic allocation responsive to real-time channel conditions rather than static band preferences.

Dynamic spectrum switching provides inherent resilience to interference that traditional single-band solutions cannot achieve. Non-MLO clients experiencing CCI cannot adapt—they remain locked to their selected band and experience proportional throughput degradation. MLO clients exploit available spectrum diversity to maintain performance.

4.4 LATENCY PERFORMANCE

Latency measurements were conducted using RTP video stream simulation to assess performance for real-time applications. RTP latency testing quantified EMLSR's benefits for latency-sensitive applications. In the CCI test scenario, MLO clients achieved substantial latency reductions compared to non-MLO clients.

Table 7 and Figure 10 show the reduction in RTP traffic latencies for UL and DL and comparing MLO and non-MLO both CCI results.

MLO vs non-MLO	DL One way Delay(ms)	UL One way Delay(ms)
non-MLO with 6GHz CCI	9	3
MLO with 6GHz CCI	5	1

Table 7 – RTP one-way latency of MLO and non-MLO with CCI

The results demonstrate that downlink one-way latency decreased from 9 milliseconds without MLO to 5 milliseconds with MLO enabled, representing a 44% reduction. Uplink latency showed an even greater improvement, dropping from 3 milliseconds to 1 millisecond, a 66% reduction. These improvements are particularly significant for applications such as video conferencing, and interactive cloud services, where latency directly impacts user experience and service quality.

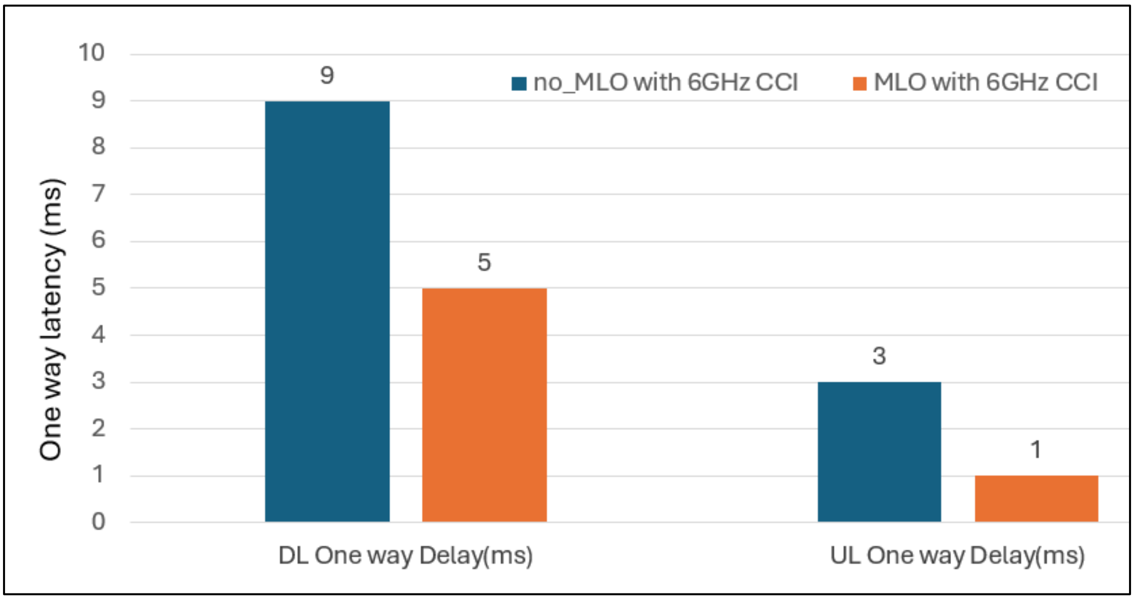

Figure 10 – RTP one-way latency of MLO and non-MLO with CCI

The latency improvements observed in the trial reflect several EMLSR architectural advantages. Link-switching enabled immediate band switching to the lower-latency band during interference events, eliminating the queuing delay associated with a congested primary band.

Real-time frame-level optimization allowed selection of the band with lowest latency characteristics for each packet and frame transmission, optimizing not just throughput but specifically latency. Sub-millisecond response to interference events ensured that latency-sensitive applications experienced minimal disruption when spectrum conditions changed.

The combination of these mechanisms enabled EMLSR clients to maintain lower latency even under interference conditions where non-MLO clients experienced latency spikes or complete performance loss.

4.5 EMLSR CLIENT BEHAVIOR ANALYSIS

Analysis of the trial data confirmed several critical client behavior characteristics that explain EMLSR's performance advantages. EMLSR clients maintained simultaneous band listening capability, with receive functionality active on both 5 GHz and 6 GHz simultaneously through independent receive chains. This simultaneous listening enabled clients to assess channel conditions on both bands continuously without explicit switching overhead.

Clients demonstrated transmit flexibility, dynamically selecting the optimal transmission band frame-by-frame based on real-time channel quality assessment. Rather than committing to a single band and suffering interference consequences, EMLSR clients selected the best available band for each transmission opportunity. Upon detection of interference or throughput degradation, clients switched bands rapidly—typically within microseconds—demonstrating the effectiveness of link switching.

Under clean-channel conditions where neither band experienced interference, clients distributed traffic across bands to balance load rather than concentrating on the single theoretically highest-capacity band. This load-balancing behavior optimized both throughput and latency by reducing per-link queue depths and preventing saturation of individual bands.

Collectively, these behaviors illustrate the architectural strengths of EMLSR. By combining simultaneous multi-band listening, quick link switching, and intelligent load balancing, EMLSR clients achieved superior *resilience*, *efficiency*, and *performance* in both interference-prone and interference-free environments.

5. ANALYSIS AND DISCUSSION

5.1 MLO VALUE PROPOSITION

The trial results confirm three key advantages of EMLSR for enterprise deployment.

Reliability improves through spectrum diversity, as clients seamlessly fail over between 5 GHz and 6 GHz bands when interference occurs, avoiding the performance drops seen in non-MLO devices.

Spectrum utilization is more efficient, with traffic dynamically distributed across bands to maximize capacity and relieve bottlenecks, demonstrated by uplink gains of nearly 139% in bandwidth-constrained scenarios.

Latency is reduced through frame-level link switching, enabling sub-millisecond responses and lowering delays by 44% for DL and 66% for UL, ensuring predictable performance for real-time applications.

5.2 PERFORMANCE SCALING WITH CHANNEL BANDWIDTH

Performance scaling shows that EMLSR delivers the greatest benefits in narrow-channel configurations where per-band capacity is limited. At 40/40 MHz, throughput gains were substantial, while at 40/160 MHz improvements were modest, as wide channels already meet device need. This indicates EMLSR's strongest value lies in bandwidth-constrained environments, where its ability to balance load and reduce latency provides meaningful operational advantages.

6. CONCLUSIONS

The Phase 2 Wi-Fi 7 MLO field trial, conducted with Intel, Ruckus Networks, and AT&T, provides strong evidence supporting enterprise adoption of MLO-capable Wi-Fi 7 devices. Results confirm substantial throughput improvements, with DL gains up to 75% and UL gains up to 139% depending on channel configuration under CCI conditions.

The trial highlights EMLSR's primary value in co-channel interference scenarios, where resilience and performance advantages exceed those of non-MLO solutions.

Wireshark analysis further validates dynamic spectrum allocation, showing that EMLSR clients intelligently distribute traffic across 5 GHz and 6 GHz bands in response to real-time conditions.

The single-radio architecture proves practical, offering cost-effective and power-efficient implementations while delivering substantial benefits.

Performance scaling was shown to be predictable, with the greatest improvements in bandwidth-constrained environments.

Collectively, these findings demonstrate that EMLSR addresses critical enterprise challenges by improving reliability through spectrum diversity, maximizing efficiency through dynamic band switching, and reducing latency for real-time applications. As a future-proof architecture, MLO positions enterprises to meet next-generation application demands.

Enterprises are encouraged to prioritize deployment of Wi-Fi 7 MLO-capable devices, particularly in scenarios requiring high reliability, efficient spectrum utilization, and support for latency-sensitive workloads.

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EXECUTION TEAM

Company	Name	Role
Necati Canpolat	Intel	Project Leader & Chief Editor
Cosmin Cazan	Intel	Technical Lead
Feng Wang	AT&T	Technical Lead
Jieying Williams	AT&T	Technical Lead
Doug Woleben	RUCKUS Networks	Program Manager
Kevin Franzen	RUCKUS Networks	Technical Lead
Sidharth Garde	RUCKUS Networks	Technical Lead