

WI-FI 7 TRIALS FOR ENTERPRISE SCENARIOS

AT&T | COMMSCOPE | intel

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EXECUTIVE SUMMARY

Wi-Fi technology evolution continues with Wi-Fi 7, enabling a host of features such as Multi-Link Operations (MLO), 320 MHz channel, 4K QAM, multiple-RU, restricted-TWT, and schedule based QoS. These enhancements aim to deliver higher throughput, improve efficiency, lower latency, and support emerging applications like XR/AR/VR, digital twins, AI/ML, cloud access, and industrial IoT.

AT&T, CommScope, and Intel have collaborated on the Wireless Broadband Alliance (WBA) field trials to evaluate Wi-Fi 7 key capabilities in an enterprise setting. This multi-phase initiative has completed its first phase, which assessed the rate vs. range performance of Wi-Fi 7 across the 5 GHz and 6 GHz bands using 160, 80, and 40 MHz channels, comparing the results with Wi-Fi 6E.

These findings demonstrated significant performance improvements with Wi-Fi 7 over Wi-Fi 6E. This report outlines our key observations and takeaways from the trials. The next phase will continue to test additional capabilities of Wi-Fi 7.

INTRODUCTION

Wi-Fi has become mission-critical for enterprise wireless connectivity, organizational productivity, collaborations, and other operations. Enterprises face the challenge of providing high-density, high-throughput, low-latency, and reliable Wi-Fi to support a growing number of diverse devices, including laptops, mobile phones, industrial IoT, and cameras, as well as demanding applications such as AR/VR/XR, cloud, AI/ML, video conferencing, automation, and IoT.

Wi-Fi has continuously improved with each generation. Wi-Fi 7 (IEEE 802.11be) is the latest advancement, designed to provide Extremely High Throughput (EHT) by enhancing some of the Wi-Fi 6 capabilities and introducing new features such as 320 MHz channel size, 4K QAM, Multi-Link Operations (MLO), MU-MIMO, MU-RU, r-TWT, and schedule-based Quality of Service (QoS). These enhancements provide higher throughput, lower latency, improved efficiency, and reliability.

It is essential for enterprises to evaluate Wi-Fi 7's capabilities and their effectiveness in meeting the needs of their applications in real-world environments before they deploy the Wi-Fi 7 networks and transition their mobile devices to Wi-Fi 7. The WBA has been conducting generational Wi-Fi trials with participating operators, AP and client vendors, and service enabler members over the years, including Wi-Fi 5, 6, 6E, and now Wi-Fi 7. Findings from these trials have been shared across the industry.

As part of the WBA Field Trials initiative, AT&T, CommScope, and Intel are collaborating on field trials to test Wi-Fi 7 capabilities in enterprise environments. This report covers the Phase 1 trial results, focusing on rate versus range performance over the 5 GHz and 6 GHz bands using 160 MHz, 80 MHz, and 40 MHz channels, comparing Wi-Fi 7 with Wi-Fi 6E.

The report details the trial setup, including the test environment, equipment used, and measurement methodologies. It also discusses the results and key takeaways that are important for the industry.

TESTING ENVIRONMENT

The tests were conducted at an AT&T office building, which included typical office elements like walls, tables, chairs, test equipment, and existing Wi-Fi networks. The environment was an open space with line of sight, rather than an RF shielded room, ensuring real-world conditions were not perfect instead of in a controlled lab setting – see the RF heat map in Figures 1 and 2.

To ensure the integrity of real-world performance assessment, no special tuning was applied to access points (Aps), and no client devices artificially affected the results. The trial was designed to reflect practical deployment scenarios and genuine user experiences.

Hardware

- Ruckus vSmartZone
- R770 (Wi-Fi 7)
- Ruckus R750 (Wi-Fi 6)
- Intel BE200 (Wi-Fi 7) on Windows 11 laptop, supporting 2 spatial streams
- Intel AX200 (Wi-Fi 6), and AX210 (Wi-Fi 6E) Window 11 laptop, supporting 2 spatial streams
- To test Wi-Fi 6 and Wi-Fi 7, we swapped the Intel Wi-Fi chips on the same laptop and updated the drivers
- 10 Gig switching and server interface
- Same VLAN & Subnet

Test Tools

- Ixia IxChariot TCP throughput upload and download, 3 measurements averaged
- Windows file transfer speeds upload and download
- Ping & Jitter, 1 min average
- Channel utilization via BSS Load IE
- RSSI from AP and client perspective - Observed by tester at the beginning of each test, SW does not provide average
- Hamina Onsite (site survey)
- Wi-Fi Explorer

RF Environment, Bands & Channels

The tests were conducted in the 5 GHz and 6 GHz bands. The 2.4 GHz was not tested as it is a congested band in enterprise environments

- 6 GHz Band:
    - 6GHz radio operating under FCC LPI rules
    - Tested with 160 MHz, 80 MHz, and 40 MHz channel widths. Although, Wi-Fi 7 supports up to 320 MHz channels, these are unlikely to be commonly deployed in enterprise settings due to the need for densification to maximize frequency reuse. Deployments with 160 MHz and 80 MHz channels are more practical, allowing for 7 channels with 160 MHz and 14 channels with 80 MHz, compared to just three 320 MHz channels in the 6 GHz band with the 1200 MHz spectrum available under FCC regulations.

- 5GHz Band:
    - 40 MHz channel width
    - RF with no neighbouring APs with RSSI above -85dBm
    - Channel utilization was low before tests started
    - Expect clients in the area were probing in 5 GHz
    - Since 5 GHz could only support three 160 MHz channels, and enterprise commonly deploys 40 MHz channels, we used 40 MHz channels and compared Wi-Fi 7 with Wi-Fi 6.

Before beginning the testing, a thorough site survey and spectrum analysis for 5 GHz and 6 GHz bands were conducted. Figures 1 and 2 show the RF maps of the test area.

Test Locations

- For the rate versus range testing, measurements were taken at 7 locations. The test laptops were moved to each test point, starting at 5-feet and continuing in 10-foot increments until reaching 65 feet

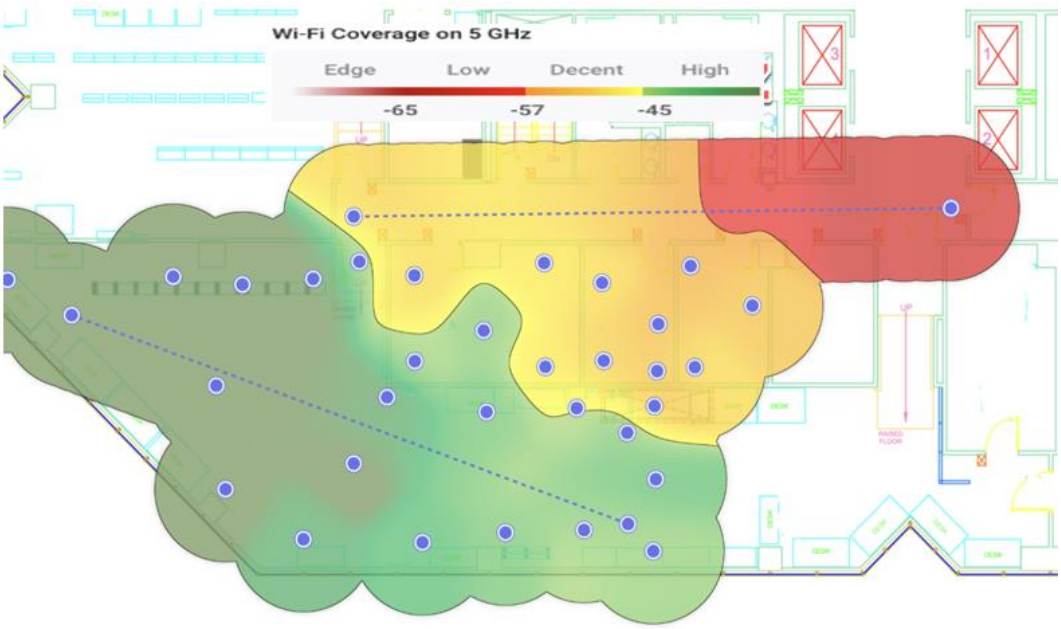


Figure 1. RF map of testing area for 5 GHz 40 MHz channel

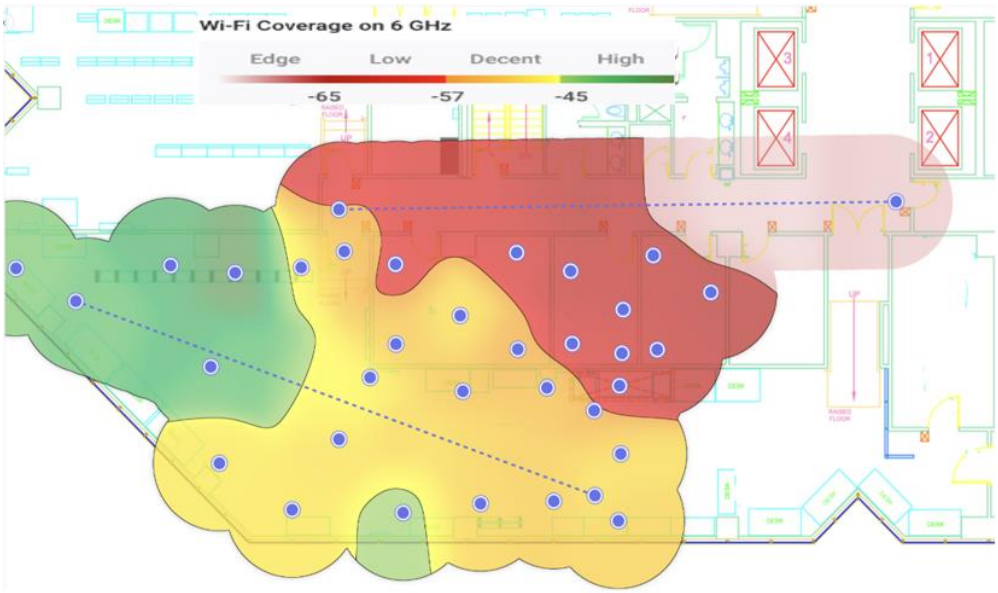


Figure 2. RF map of testing area for 6 GHz 160 MHz channel

RESULTS

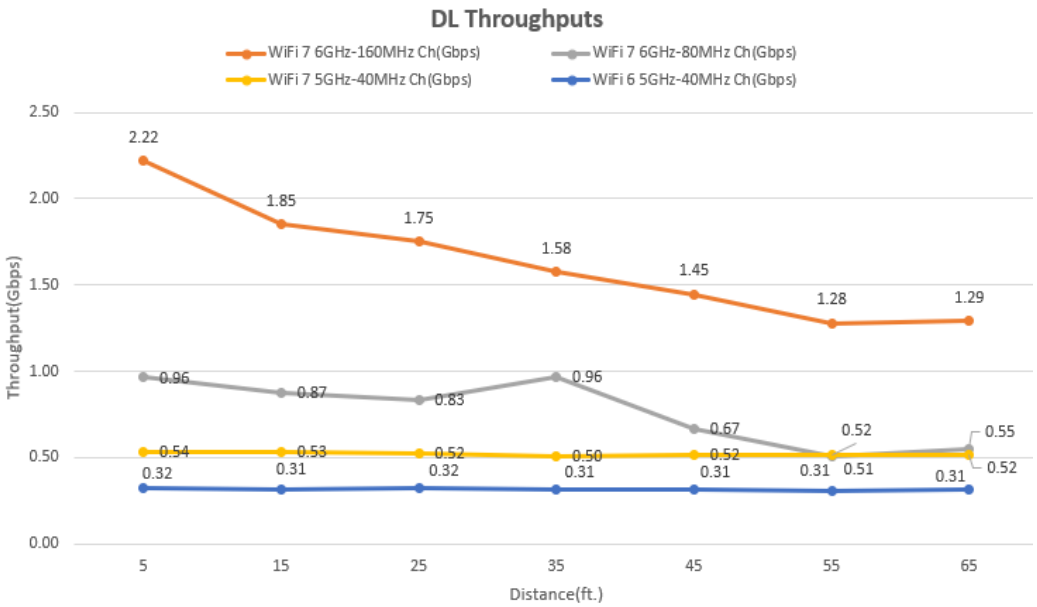


Figure 3. Wi-Fi 7 and Wi-Fi 6 downlink throughputs at different bands, channel sizes and ranges with IxChariot

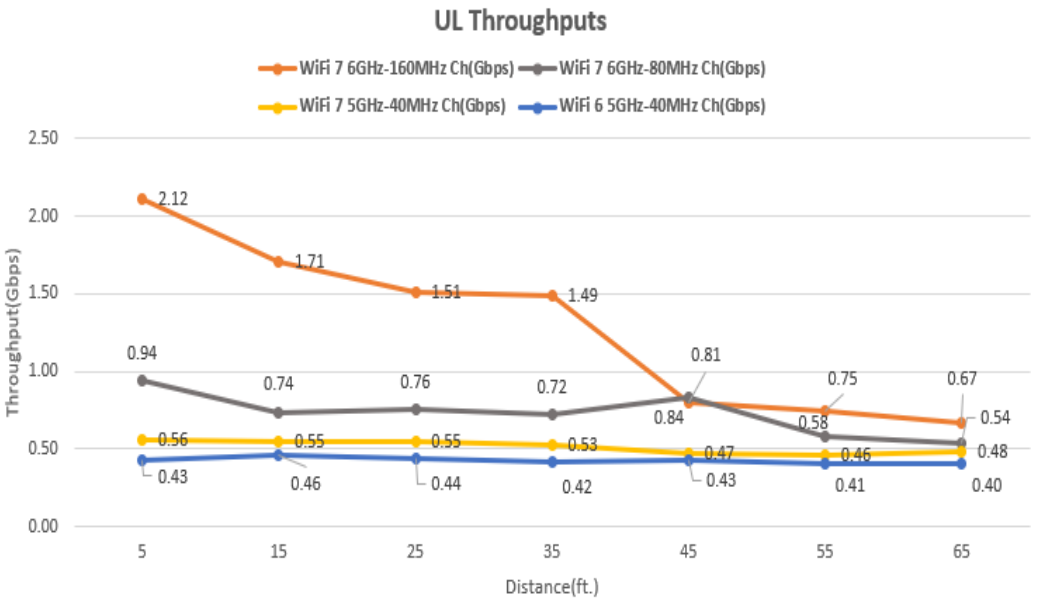


Figure 4. Wi-Fi 7 and Wi-Fi 6 uplink throughputs at different bands, channel sizes and ranges with IxChariot

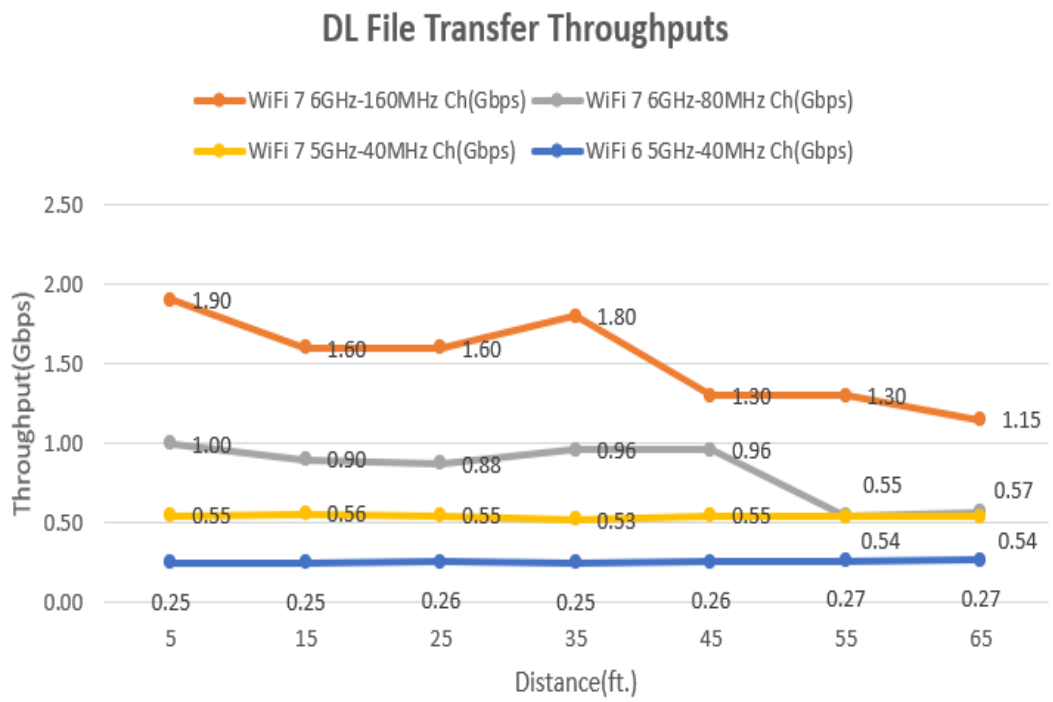


Figure 5. Wi-Fi 7 and Wi-Fi 6 file transfer downlink throughputs at different bands, channel sizes and ranges with Windows file transfer

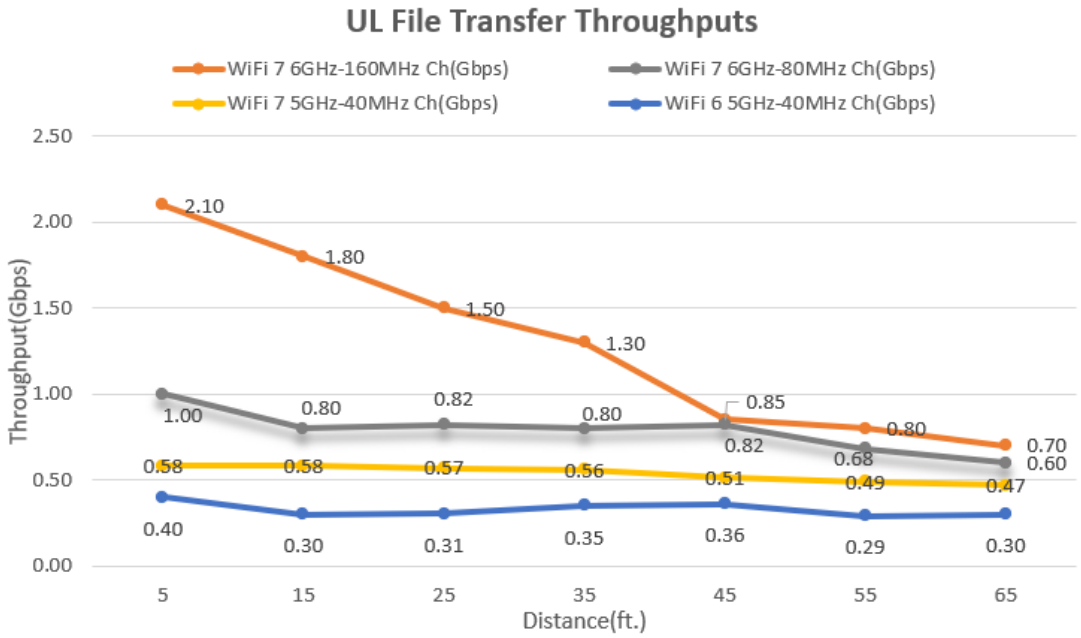


Figure 6. Wi-Fi 7 and Wi-Fi 6 file transfer downlink throughputs at different bands, channel sizes and ranges with Windows file transfer

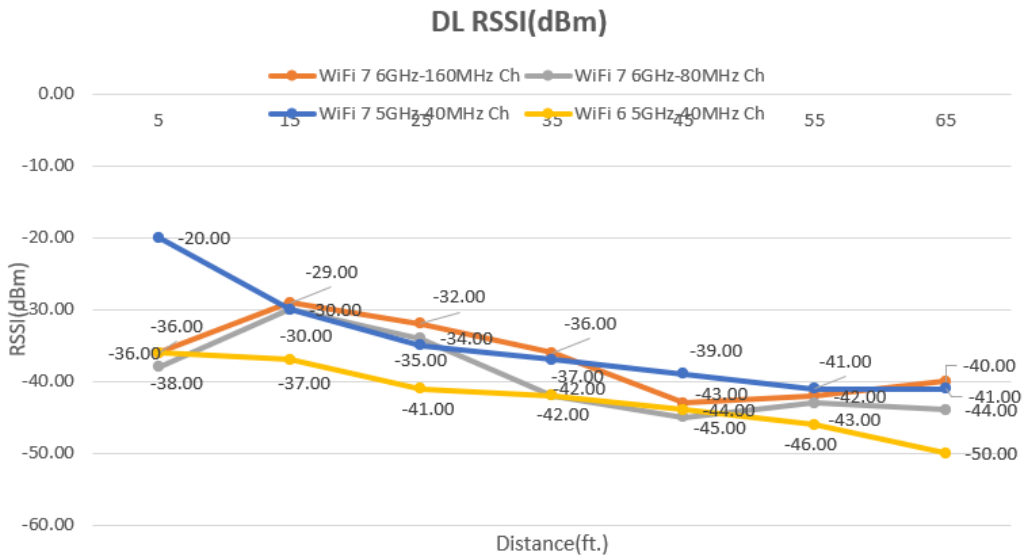


Figure 7. Downlink RSSI (how the client hears the AP) at different bands, channel sizes and ranges – taken before the tests each time.

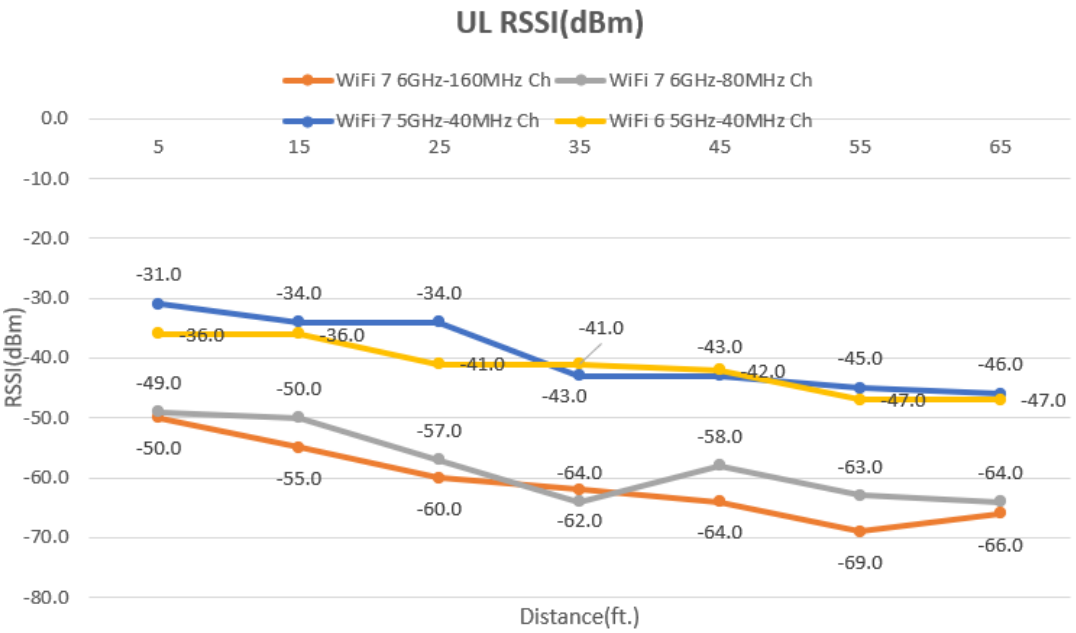


Figure 8. Uplink RSSI (How the AP hears the client) at different bands, channel sizes and ranges

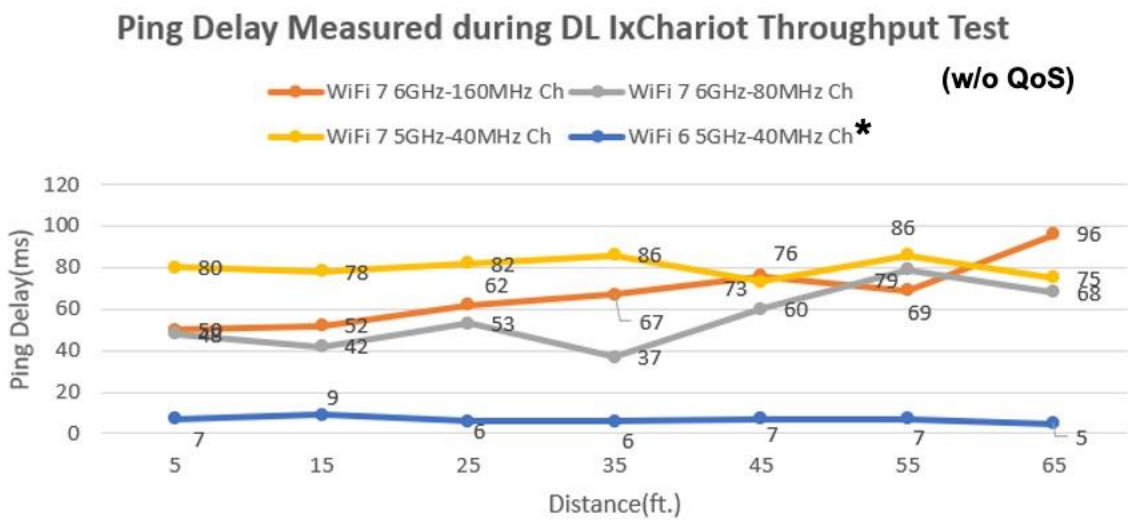


Figure 9. Ping delays for downlink at different bands, channel sizes and ranges

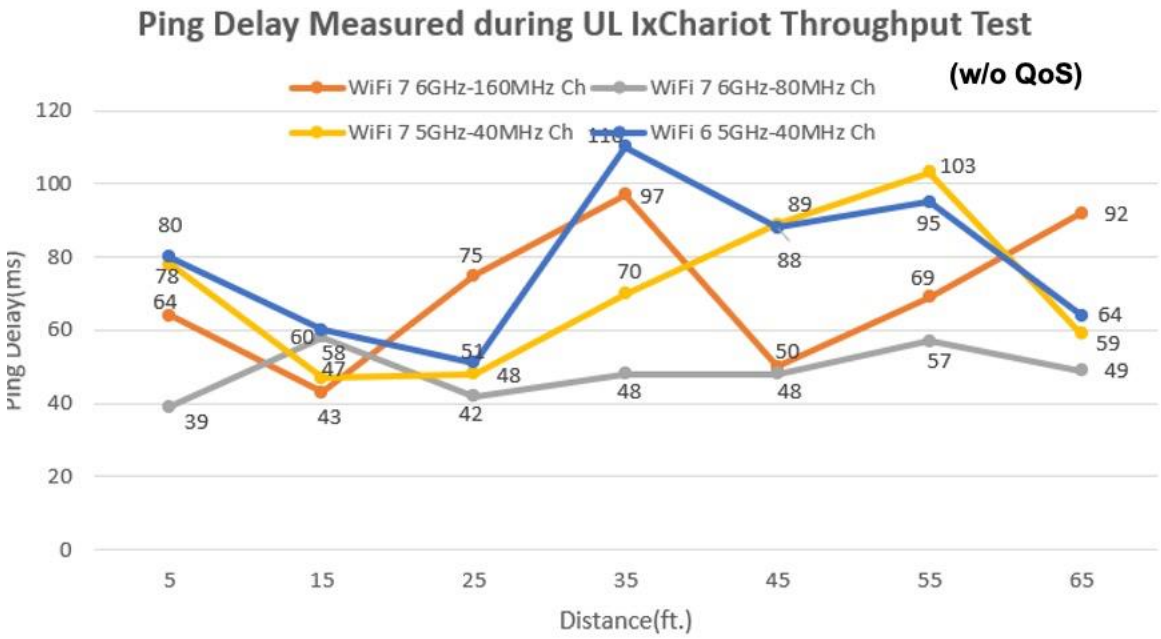


Figure 10. Ping delays for uplink at different bands, channel sizes and ranges

KEY INSIGHTS AND TAKEAWAYS

Our evaluation of 6 GHz 160 MHz channel demonstrated that Wi-Fi 7 achieved 1.9 Gbps downlink and 2.1 Gbps uplink throughput at 5 feet away from AP, and the throughput gradually decreased as client was moved away from the AP, however, it sustained the performance over 1 Gbps throughput until 40 feet.

Beyond this point, uplink throughput dropped due to the limited power restrictions and lower MCS in the uplink, as explained below. The RF map analysis reveals that the corner of the wall close to test location at 35 feet may have influenced the test results beyond that point and cause a sudden drop in throughput.

The tests were conducted using Low Power Indoor (LPI) settings, which restricts APs to indoor use with internal antennas and limit the power spectral density to 5 dBm/MHz and the total power limit of 30 dBm EIRP on a 320 MHz channel. With LPI, the mobile devices are also restricted to have a maximum power 6 dB below the AP's allowed maximum EIRP contributing to the throughput drop around 35 feet.

Standard Power 6GHz, enabled by Automated Frequency Coordination (AFC), allows APs to operate up to 36 dBm EIRP, a 6dB power increase compared to LPI. This increase in power significantly helps with the signal strength and range, typically increasing power by 6dB doubles the coverage.

In enterprise Wi-Fi deployments densification of APs is crucial for increasing network capacity. High-density deployments are designed for capacity rather than coverage, balancing channel size to avoid co-channel and adjacent channel interferences and increase the network capacity. As a result, 160 MHz and 80 MHz channels are typically selected over 320 MHz channels, which would allow only three non-overlapping channels in the 6 GHz.

In high-density enterprise office environments, the average distance between Wi-Fi APs is generally around 30 to 40 feet. This spacing helps ensure high capacity to support a large number of devices, which is essential in dense enterprise settings.

Wider channels in Wi-Fi 7 provide significant performance benefits. Based on our findings, Wi-Fi 7 with 160 MHz supports over one Gbps throughput within a 35-foot range in typical high density enterprise environments, and it will help significantly addressing to meet the needs of new high throughput applications in enterprises. Additionally, the results also show that Wi-Fi deployments at 5 GHz bands primarily use 40 MHz channels and increasing the channel sizes to 80 or 160 MHz, doubles or quadruples the throughput with the clean 6 GHz band.

As well known, when a Wi-Fi 7 client is very close to Wi-Fi 7 AP, it can utilize 4K QAM (MCS12/13), increasing the peak PHY data rates. As the client moves away from the AP, the throughput decreases as expected. Wi-Fi 7 4K QAM improves the throughput 20% at the high MCS compared to Wi-Fi 6 1K QAM.

Comparing the throughput of Wi-Fi 7 and Wi-Fi 6 at 40 MHz, our results indicate that Wi-Fi 7 achieved 0.55 Gbps downlink throughput, nearly twice that of Wi-Fi 6 DL with 0.25 Gbps, while Wi-Fi 7 uplink throughput of 0.58 Gbps was nearly double Wi-Fi 6's throughput of 0.31 Gbps.

This represents a nearly 100% improvement in Wi-Fi 7 over Wi-Fi 6 at 5 GHz 40 MHz channels highlighting significant MAC/PHY improvements beneficial for enterprise deployments at 5 GHz.

The throughput of 40 MHz channel at 5 GHz remained consistent from 5 to 65 feet.

We have not compared the other channel sizes at 6 GHz and 5 GHz, which could be interesting area for further study.

The 6 GHz spectrum is clean, with only new Wi-Fi 6E and Wi-Fi 7 devices operating on it, avoiding legacy device issues that could negatively impact the performance.

Latency was tested without QoS being configured, meaning the test applications were not tagging traffic. The SmartZone was using the default QoS setting, best effort. The ping delay performance is influenced by the channel utilization. In most of the testing we were able to drive high channel utilization leading to high ping delays & poor jitter. Please note the Wi-Fi 6 @ 5GHz download measurements show low latency during the test but the goodput and channel utilization were also low. We were unable to drive up channel utilization and throughput for this test. This same test for upload showed ping delays & poor jitter.

Regarding RSSI results, at the 5-foot test point signal strength shows lower than at 10 feet for the Wi-Fi 7 6GHz tests. We found at closer range the laptop was very sensitive to the orientation of the laptop. This is common with Wi-Fi multipath propagation. The R770 has a 2x2 6GHz radio and a 4x4 5GHz radio. The same AP shows much better and consistent results on 5GHz due to the extra radios' ability adjust for multipath challenges even if the client is only a 2x2.

At the 35-foot test point a corner wall (steel stud / drywall) from an adjust office comes within 5.5 feet from the test point (see heatmap above). While this does not block line of sight, we do feel it impacts the multipath propagation enough to change the results. In reviewing the data, it seems this helped some of the tests while hurting others. This is expected as the testing was done in a realistic office space environment.

CONCLUSIONS

Our testing of Wi-Fi 7 demonstrates significant throughput improvements with the use of wider channels, higher modulation and efficiency. Wi-Fi 7 will help the enterprise to meet the growing demands of applications by providing higher throughput, lower latency and greater reliability, thereby enhancing Wi-Fi connectivity experience in high-density environments. Wi-Fi 7 even showed performance gains over Wi-Fi 6 in 5GHz using the same size 40MHz channel.

We expect even greater performance with the adoption of 6 GHz standard power products. Additionally, Wi-Fi 7 offers other key advancements such as Multi-Link Operation (MLO) and uplink (UL) triggered access. Our feature work will focus on evaluating overall network performance, MLO capabilities and Quality of Service (QoS).

PARTICIPANT LIST

We would like to express our sincere gratitude to all Project Leaders and the Editorial Team for their invaluable contributions, which played a crucial role in the success of this initiative.

Company	Name	Role
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AT&T	Feng Wang	Trial Participant
Intel	Necati Canpolat	Trial Leader
Intel	Cosmin Cazan	Technical Lead
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CommScope	Sidharth Garde	Trial AP Technical Lead

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