Vodafone Pro 3 Broadband

Claims Substantiation

May 2025

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Introduction

Vodafone has introduced its new Pro 3 Broadband powered by Wi-Fi 7, with the new Ultra Hub 7, Super Wi-Fi 7 Booster and our 4G Broadband Back-Up.

Our marketing claim for our new Pro 3 Broadband is:

Ultra-reliable. Ultra-fast full fibre broadband for less.

Guaranteed Wi-Fi in every room with new Wi-Fi 7

Vodafone Pro 3 Broadband

This document provides the required substantiation to our marketing claim:

What is Wi-Fi 7?

Wi-Fi 7 is the next generation of Wi-Fi standard, bringing the most advanced Wi-Fi technology features.

The new standard gives faster connectivity, lower latency, and the ability to manage more connections. Wi-Fi 7 also improves network congestion and interference, bringing tangible benefits to areas with densely packed devices or neighboring networks that overlap.

New Wi-Fi standard brings a set of features[1] we can take advantage of:

- Wi-Fi 7 delivers 20% higher transmission rates then Wi-Fi 6[1] as stated by Wi-Fi Alliance, the certification and governing body for Wi-Fi, here.
- The heightened transmission rates enable greater transmission efficiency to support flawless streaming.
- Multi-link Operation (MLO) allows more efficient load balancing of traffic resulting in increased throughput, lower latency and improved reliability.
- Ultra Hub 7 will aggregate its two bands, 2.4 GHz and 5 GHz.
- Wi-Fi 7 allows a much more efficient utilisation of the channel spectrum, which results in lower latency and higher throughput.
- The sum of all these features provides a sensitive improvement in final user experience, due to throughput increase, latency reduction and more stable connections.

Benefits for the Consumer Experience[1]:

- Faster Speeds: Enjoy fast internet speeds that allow you to download, stream, and browse more easily.
- Low Latency: Experience minimal delay, making online gaming and video conferencing smoother and more responsive.
- Enhanced Capacity: Connect multiple devices simultaneously without compromising on performance, perfect for smart homes and busy households.
- Reliable Connectivity: Maintain a stable and reliable connection even in crowded network environments.

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[1] These features are only available on a Wi-Fi 7 device.

- Future-Proof Technology: Stay ahead with the latest advancements in wireless technology, ensuring your network is ready for future innovations.

Our specification comparison:

Specification	Vox 3 Wi-Fi 5	PowerHub Wi-Fi 6	UltraHub Wi-Fi 6E	Ultra Hub 7 Wi-Fi 7
Bands	Dual Band Wi-Fi 5 (2.4 + 5 GHz bands)	Dual Band Wi-Fi 6 (2.4 + 5 GHz bands)	Tri Band Wi-Fi 6E (2.4 + 5 + 6 GHz bands)	Dual Band Wi-Fi 7 (2.4 + 5 GHz bands)
Wi-Fi Antennas	4x4, 3x3	2x2 + 4x4	4x4 + 4x4 + 4x4	4x4, 4x4
RAM	512 MB DDR3	1 GB RAM	1 GB DDR4 RAM	2 GB RAM
Flash	256 MB NAND Flash	512 MB Flash	4 GB eMMC Flash	4 GB Flash
Ethernet ports	1x ADSL/VDSL/g.fast (RJ-11) 4 x Gigabit Ethernet LAN (RJ45) 1 x Gigabit Ethernet WAN (RJ45)	3 x LAN + 1 x LAN/WAN (GE); 2 x FXS; 1 x USB 2.0 1x WPS button + 1x Wi-Fi button	1 x 2.5G Ethernet LAN/WAN 2 x 1G Ethernet	1 x LAN (GE) - 2.5Gbps; 1 x LAN/WAN (GE) -2.5Gbps 2xLAN – 1 Gbps ; 1x Fibre Optic Port & 1 x FXS Port 1xTAE&FXS Combo Ports 1x WPS button + 1x Wi-Fi button
Maxspeed Fibre	900Mbs	1Gbps	2.5Gbps	2.5Gbps
Max Speed Phy Rate om Wi-Fi	1.6Gbps	5.1Gbps	10.8Gbps	7.2Gbps
Max Speed single device 2x2	500Mbps	1.68Gbps	1.68Gbps	2Gbps
Access Technology	BLE	ZigBee + Thread radio + BLE radio	BLE + ZigBee/ Thread	ZigBee + Thread radio + BLE radio
Chipset	BCM63138	Top-performance SoC	Top-performance SoC BCM63153V	Top performance SoC

Comparison with Wi-Fi 6:

- Phy Rate Speeds:
  - Wi-Fi 7: Offers up to 7.2 Gbps (1.4 Gbps on 2.4 GHz and 5.8 Gbps on 5 GHz).
  - Wi-Fi 6: Offers up to 6 Gbps (1.2 Gbps on 2.4 GHz and 4.8 Gbps on 5 GHz).
- Max Speed for Single Device (2x2):
  - Wi-Fi 7: Can reach speeds up to 2 Gbps, or 2.52 Gbps in Multi-Link Operation (MLO) mode.
  - Wi-Fi 6: Can reach speeds up to 1.68 Gbps.

- Multi-Link Operation (MLO):
    - Wi-Fi 7: Allows devices to use multiple channels across different frequency bands simultaneously, enhancing speed and reliability.
- QAM (Quadrature Amplitude Modulation):
    - Wi-Fi 7: Uses 4096-QAM, providing higher data throughput compared to Wi-Fi 6's 1024-QAM.
- This means Wi-Fi 7 offers faster speeds, better performance for single devices, and improved reliability through advanced technologies.

How can Pro 3 broadband deliver Ultra-reliable, ultra-fast full fibre for less. Guaranteed Wi-Fi in every room with new Wi-Fi 7?

- Full Fibre is the UK's most reliable broadband technology: Ofcom's Broadband Terminology Research, published March 2023.
- The Wi-Fi chip used in the router is Broadcom (BCM6726)
    - This is a high-performance Wi-Fi 7 chip used in routers. It supports 2.4 GHz & 5 GHz bands with up to 160 MHz channel bandwidth. Key features include Multi-Link Operation (MLO), OFDMA and MU-MIMO, quad-stream spatial multiplexing, and 4K QAM modulation.
    - Broadcom Inc. is multinational company that designs, develops, and supplies a wide range of semiconductor and infrastructure software products. It offers credibility and technical confidence in the quality of routers.
- Vodafone Broadband Backup: Automatically switch to our mobile network in the unlikely event your broadband goes down with our 4G broadband back-up dongle. Further T&Cs can be found vodafone.co.uk/terms-and-conditions.
- Vodafone Super Wi-Fi 7 Booster gives you the latest Wi-Fi technology, intelligent band and client steering and channel planning algorithms, designed for fast-changing Wi-Fi environment. One Wi-Fi Booster is supplied as standard with your Vodafone router. Up to three Wi-Fi Boosters can be provided at no additional cost subject to the speed they are getting. Full terms: vodafone.co.uk/terms-and-conditions.
- Up to 60x faster: than the average download speed of our standard broadband: Fibre 1 (35Mbps) vs. Pro 3 Full Fibre 2.2Gbps (2200Mbps).

Pro 3 broadband is sold as follows:

- Pro 3 is exclusively available to full fibre customers only. Pro 3 will not be available for part fibre customers.
- For those eligible, Pro 3 packages can be added onto a full fibre plan for a monthly fee, and this applies to the following plans:

<table>
<tr><th></th><th>Broadband</th><th>+ Super WiFi</th><th>Pro 3</th></tr>
<tr><td>Full Fibre 74/80Mbps</td><td rowspan="5">WiFi 6 Hub Included</td><td rowspan="5">WiFi6 Hub + Booster included</td><td rowspan="5">Wifi 7 Hub, booster & 4G back up included</td></tr>
<tr><td>Full Fibre 74/80Mbps</td></tr>
<tr><td>Full Fibre 150Mbps</td></tr>
<tr><td>Full Fibre 500Mbps</td></tr>
<tr><td>Full Fibre 910Mbps</td></tr>
<tr><td>Full Fibre 1.6/1.8/2.2Gbps</td><td colspan="3">One price for eligible customers - Includes Premium Pro 3 kit & benefits.</td></tr>
</table>

Testing:

The testing was conducted by Capgemini Engineering, a highly respected independent telecommunications consultancy company. Testing was carried out controlled in a "laboratory" environment ("Test Type 1") for a) the router on its own; and b) for the router with three extenders.

Test Type 1:

The Wi-Fi Test House is physically located in a remote village in Portugal, isolated from the town in a neighbourhood away from any Wi-Fi interference. The house is considered as a real house, including furniture and appliances.

No interference from external Wi-Fi networks.

Location and layout provide optimal conditions for Wi-Fi testing scenarios.

- $1200m^2$ Total Area
- $280m^2$ Covered Area
- Brick Construction
- Two floors:
  - 4 Bedrooms
  - Living Room
  - Kitchen
  - 3 Bathrooms
  - Laundry Room
  - Courtyard

Router only Testing (Sercomm's FG4278VF Wi-Fi performance)

DUT	FG4278VF
Software Version	01.07.22 / 01.07.32
Wireless Bands Supported	2.4 GHz / 5 GHz
2.4 GHz NSS	Wi-Fi 4, 6 & 7 Antennas - 4x4
5 GHz NSS	Wi-Fi 5, 6 & 7 Antennas - 4x4
Remote Management Interface	TR-069 - 181
WAN Interface	FIBER
VoIP	2 FXS

FG4278VF

Types of devices used - 3 devices in the house + the PC Server

	Asus PCE-AC88	Intel AX200	Intel BE200	WAN / LAN Server
Role	Traffic Client	Traffic Client	Traffic Client	Traffic Server
OS	Windows 11 Desktop 10.0.22631 N/A Build 22631	Windows 11 Desktop 10.0.22631 N/A Build 22631	Windows 11 Desktop 10.0.22631 N/A Build 22631	Ubuntu Desktop 22.04.5 6.8.0-49-generic
Wi-Fi Card	Asus PCE-AC88	Intel Wi-Fi 6 AX200	Intel Wi-Fi 7 BE200	-
Wi-Fi Driver	Broadcom v=1.558.48.8	Intel v=23.60.1.2	Intel v=23.60.1.2	-
NSS	4x4	2x2	2x2	-
Capabilities	Wi-Fi 4 and Wi-Fi 5	Wi-Fi 6	Wi-Fi 7	1 / 2.5 Gbps
Traffic App	IxChariot 9.6	IxChariot 9.6	IxChariot 9.6	IxChariot 9.6

Rooms of the house in which the testing was done:

4 collection points were used in the house, with different distance from the main device:
P10 - Near (on the same floor, close to router < 2 m distance)
P11 - Medium (on the floor, ~10 m distance)
P20 - Medium (different floor 1, ~7m)
P21 - Far (different, floor 1, ~ 12m)

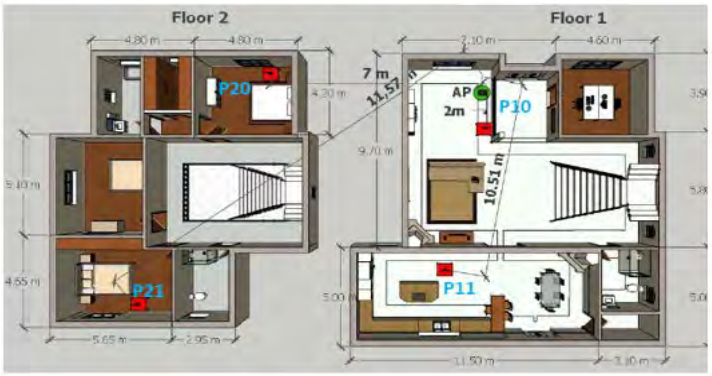
Verify the Wi-Fi performance when there are two clients (smartphone) connected simultaneously, one to each band (2.4 GHz and 5 GHz).
The test is according to the TR-398 - 6.2.4 Dual-band Throughput Test.

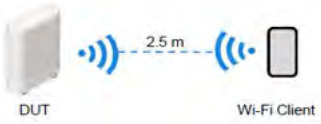
Environment and Setup

- Zero External Wi-Fi interference
- Near location:
  - P10 - Near - Floor 0
- TCP, Download, and Upload
- Testing will cover each client for the following setups:
  - ❑ 2.4 GHz
    - ✓ Wi-Fi 4, 6 and 7, Channel 6, 20 MHz Bandwidth
  - ❑ 5GHz
    - ✓ Wi-Fi 5, 6 and 7, Channel 36, 80 MHz Bandwidth

Pass/Fail Criteria
Can be consulted in Chapter 5.

Wi-Fi Clients
Can be consulted in Chapter 6.





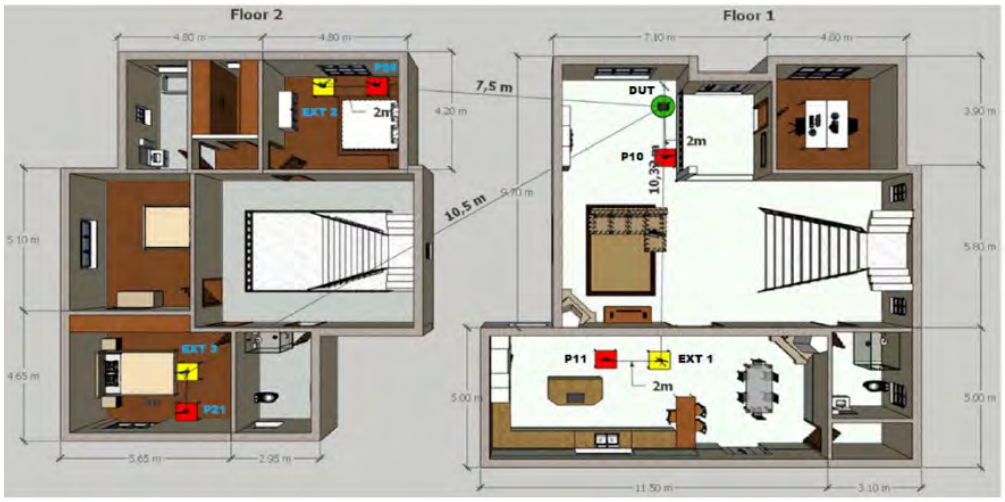
Router plus 3 extenders - the extenders used - Sercomm RP761BVF

DUT	RP761BVF
Software Version	0.2.17
Wireless Bands Supported	2.4 GHz / 5 GHz
2.4 GHz NSS	Wi-Fi 4, 6 & 7 Antennas - 2x2
5 GHz NSS	Wi-Fi 5, 6 & 7 Antennas - 4x4
Remote Management Interface	CWMP – TR-181

RP761BVF

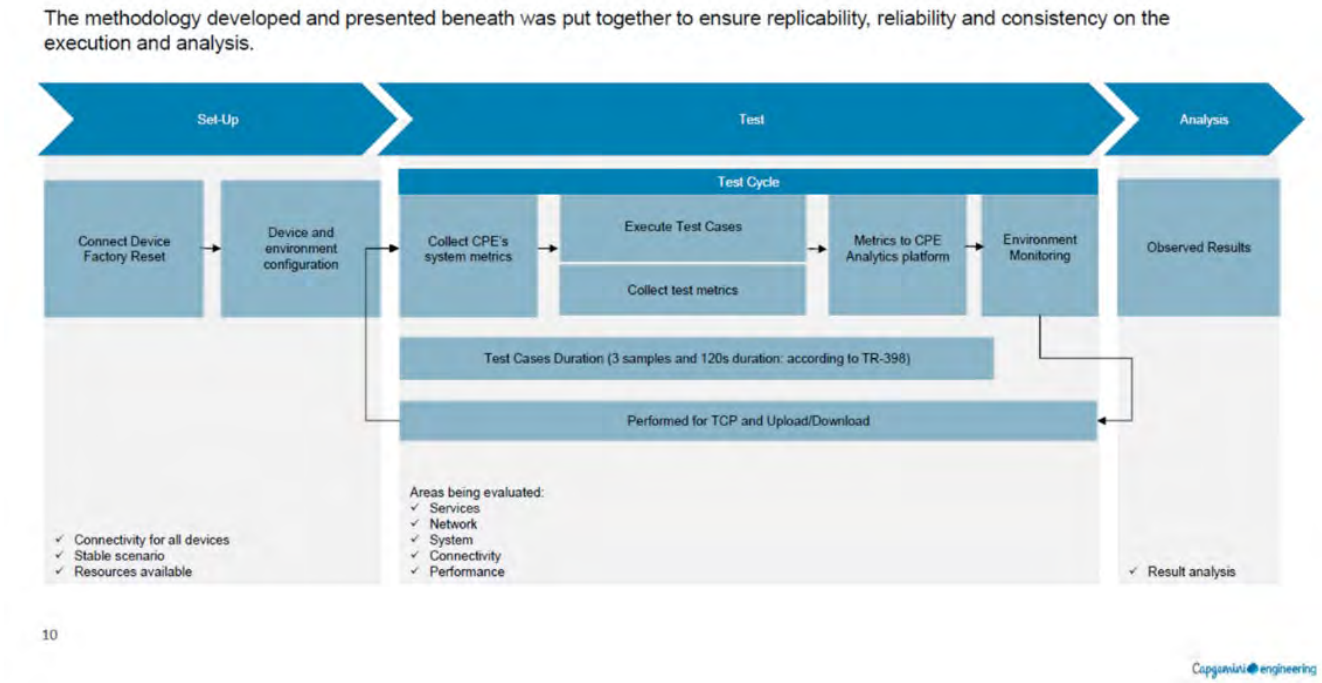
Placement of the device/s from the Ultra Hub 7 & 3 extenders:

Key - Green is Ultra Hub 7 router, Red is device location, Yellow is Wi-Fi 7 Boosters



Note: The extenders are ~2m away from the testing location points (P11, P20 and P21) to make sure there is no bottleneck between the Extender and the specific Location point. Limitation will always come from the Wi-Fi backhaul/mesh.

Methodology:



- The following tests were performed during the day across a number of days at various times:
    - Performance - Single Client End User Devices
    - Airtime Fairness
    - Performance: Dual Band Aggregation

- Stability/Robustness: AP Coexistence

The following tests were executed overnight across a number of days:

- Maximum Performance: Single Client
- Performance: Wi-Fi Mesh End User Real-Life Scenario

Types of online activities were downloaded and uploaded on the devices:

- o Raw data was uploaded & downloaded (like a web-based commercial speed test - reference tool from the market).
- o No other activities were conducted simultaneously. Single client connected tests, with no other parallel/ concurrent traffic or devices connected.

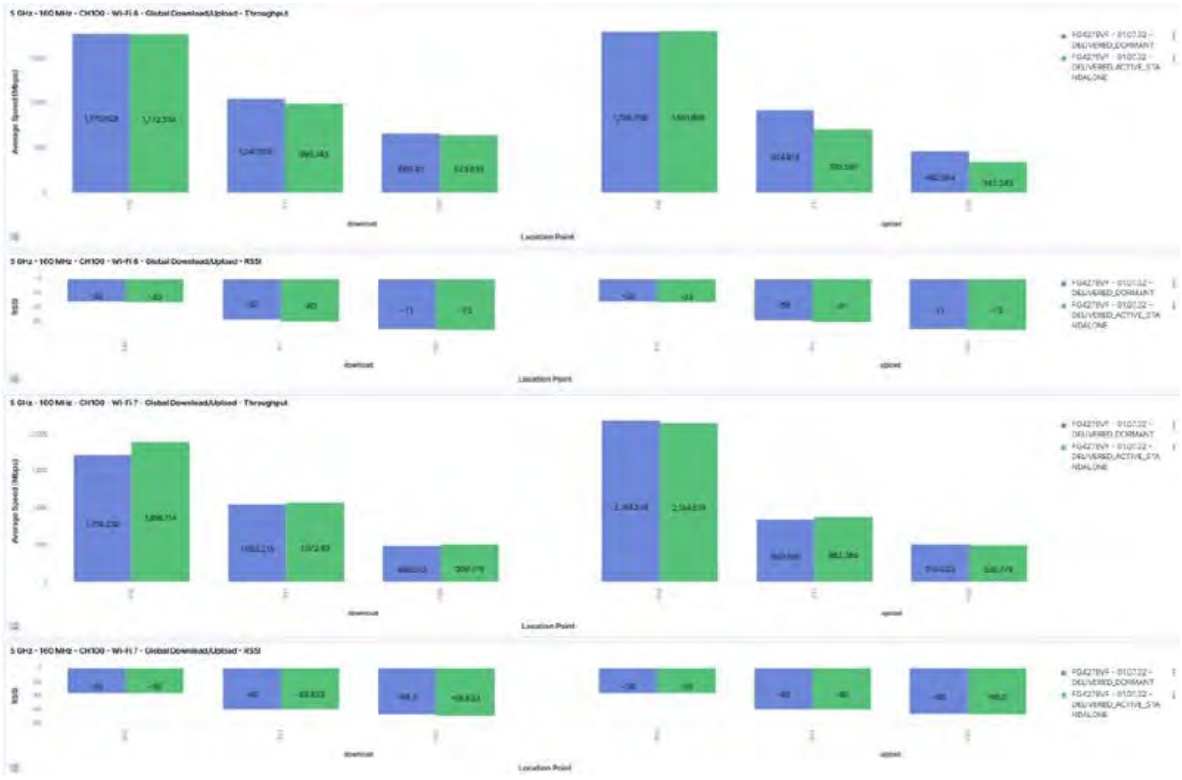
How long did you run the tests?

- o For the performance tests, each test consists of 3 throughput samples, which are then averaged to determine the iteration throughput.
- o Each isolated iteration persists for a duration of 120 seconds, and the entire interaction process typically takes around 600 seconds.

Findings to substantiate 'Ultra-fast' (speed/ throughput (Ultra-fast in the industry standard is 300Mbp/s as defined by Ofcom: UK Home Broadband Performance.)

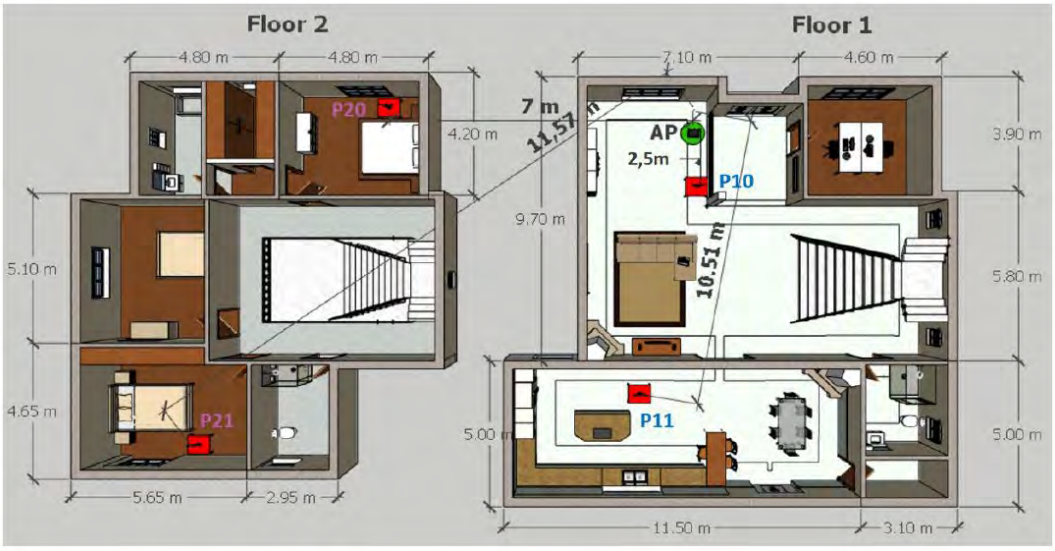
Router - on the default Wi-Fi Configuration, using just the router those speeds can be reached on 3 out of 4 locations within the Test House using both Wi-Fi 6 and 7 devices. Location 4 is in a more difficult position coverage wise and will be observed on the Router + Extenders Scenarios.

- Router testing throughput and RSSI - the clients are Wi-Fi 6 and Wi-Fi 7 devices.



- How it performs with active noise/ interference/ RSSI (pros/ cons)
    - Based on AP Coexistence tests from TR-398 (TR-398 is the industry-standard to address the performance test of Wi-Fi APs and routers) - the router behaves in line with expectations.
    - No specific performance test executed with interference.
- Latency (pros /cons)
    - Based on the outcomes provided before (see below) for Wi-Fi 7 capable devices, MLO will bring benefits up to 70% in terms of observed latency. Test executed using IxChariot testing solution, on a 90% airtime congested environment - where the challenges of latency are really significant for customer experience.

<u>Test environment of the Wi-Fi test House in Portugal – Isolated house where no external interference exists.</u>



- Within this scenario, with default Wi-Fi configurations, on 5GHz the speeds are always higher than 300Mbps for both Wi-Fi 6 & 7 devices.

Router plus extenders:

- Latency (pros /cons)
    - No specific tests. Benefits should be similar to the ones observed on the Gateway with an extra baseline delay due to the mesh scenario.

RSSI (strength of signal in different locations):

	RSSI Values in dBm			
	UH7 - FG4278VF (Default mixed topology)	UH6e (Default mixed topology)	UH7 - FG4278VF (Star Topology)	UH7 - FG4278VF (Daisy Chain topology)
P10	N/A			
P11	-56	-53	-56	-56
P20	-68	-70	-68	-63
P21	-65	-72	-72	-58

3.2.2. TI 1 – RSSI – Comparison with Reference Device

Firmware	01.07.32
Standards	n, ac, ax, be
Test Result	Pass
Defect #	N/A

DUT
FG4278VF
01.07.32
(Dormant)

2.4 GHz @ 4x4
5 GHz @ 4x4

Overall RSSI

	Score (%)
Overall	0.0
Download	-0.1
Upload	0.0

2.4 GHz @ 4x4
5 GHz @ 4x4

Reference Device
FG4278VF
01.07.32
(Active Standalone)

(Positive values mean DUT is better than Reference Device – Please refer to chapter 10)

Per Standard

Frequency (GHz)	Standard	Score (%)	
2.4	n	1.2	-0.2
	ax	-2.2	
	be	0.3	
5	ac	-0.3	0.0
	ax	0.3	
	be	0.0	

Per Location

Location	Direction	Score (%)	
P10	download	-0.9	-0.8
	upload	-0.6	
P11	download	0.2	0.3
	upload	0.5	
P20	download	0.9	0.8
	upload	0.8	
P21	download	-0.4	-0.5
	upload	-0.6	

Per Channel

Channel	Standard	Score (%)	
6	n	1.2	-0.2
	ax	-2.2	
	be	0.3	
36	ac	-0.1	-0.7
	ax	-1.2	
	be	-0.3	
100	ac	-0.5	0.8
	ax	1.8	
	be	0.2	

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Full Results can be checked in the PDF attached to this delivery.

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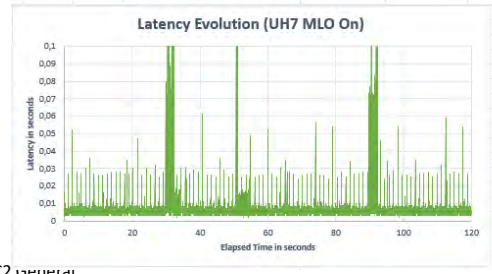
Findings to substantiate ultra-reliable

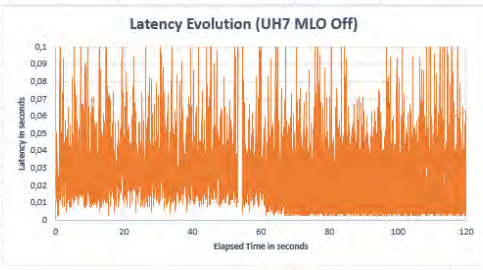
Based on the outcomes provided before (see below) for Wi-Fi 7 capable devices, MLO will bring benefits up to 70% in terms of observed latency. Test executed using IxChariot testing solution, on a 90% airtime congested environment - where the challenges of latency are significant for customer experience.

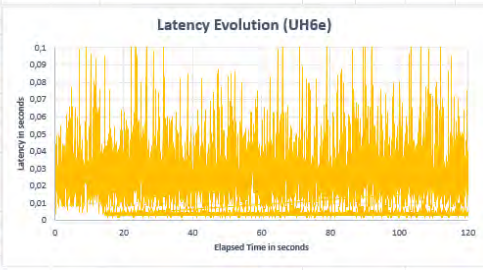
Latency Analysis for UH7 MLO On (in ms)	
Minimum	2
1Q	5
Median	6
Average	5,98
3Q	6
99th Percentile	15
Maximum	298

Latency Analysis for UH7 MLO Off (in ms)	
Minimum	2
1Q	5
Median	11
Average	15,94
3Q	21
99th Percentile	69,98
Maximum	887

Latency Analysis for UH6e (in ms)	
Minimum	2
1Q	3
Median	3
Average	10,44
3Q	15
99th Percentile	60
Maximum	392







AP coexistence test intends to verify Wi-Fi device performance with the existence of an Alien AP. The alien AP in the test SHALL support the same Wi-Fi standard. This test is part of TR-398 Issue 2 Corrigendum 1 standard and is available on section 6.5.2 - AP Coexistence Test.

Test Procedure

These steps are done for 2.4Ghz and 5Ghz.

1. Place the DUT 2 meters apart from the alien AP.
2. Place the STAs 2.5 meters apart from the DUT and AP in an orthogonal configuration.
3. Turn off the DUT and the peer STA.
4. Turn on the alien AP and alien STA, allow the alien STA to associate with the alien AP, then wait for 10 seconds.
5. Measure the downlink TCP throughput to the alien STA, using a test time of 120 seconds. Record this measurement as **THROUGHPUT_SHORT_ALIEN**.
6. Turn off the alien AP and alien STA, turn on the DUT and peer STA.
7. Allow peer STA to associate with the DUT.
8. The channel of alien network SHALL be set to the same channel as DUT.
9. Keep the alien network radios shutdown (not transmitting any signals).
10. Wait for 10 seconds. Measure the downlink TCP throughput to peer STA, using a test time of 120 seconds. Record this measurement as **THROUGHPUT_SHORT_DUT.**
11. Enable the alien network radios. The alien network will be configured for the same channel as the DUT. No traffic is generated on the alien network for this step.
12. Wait for 10 seconds. Measure the downlink TCP throughput to peer STA, using a test time of 120 seconds. Record this measurement as **THROUGHPUT_SHORT_DUT_1.**
13. Configure the alien network to transmit a UDP data stream at 40% of the measurement THROUGHPUT_SHORT_ALIEN or THROUGHPUT_SHORT_ALIEN_40MHz, depending on the configuration of the alien AP bandwidth (80 MHz or 40 MHz).
14. Wait for 10 seconds. Measure the downlink TCP throughput to peer STA, using a test time of 120 seconds. Record this measurement as **THROUGHPUT_SHORT_DUT_2**.
15. Change the channel configuration of alien AP according to Table 35 until all the configuration has been tested. Repeat Step 8. Stop the packet transmission for alien network.
16. Shut down the radios on the alien network.
17. Repeat steps 2 to 10 for each additional configuration listed in Table 34 above

If testing the 5 GHz working frequency, configure the DUT to use the 40 MHz channel bandwidth, measure the downlink TCP throughput to peer STA, using a test time of 120 seconds. Record this measurement as THROUGHPUT_SHORT_DUT_40MHz. Note, this value is used to calculate the performance deduction only for the adjoining channel case; for all other tests, the DUT is configured to use the 80 MHz channel bandwidth.

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Conclusion

Based on the testing above, barring exceptional circumstances, Vodafone Pro 3 home broadband enables their customers to attain a Wi-Fi signal in every room of their house on at least the minimum speed needed to carry out typical online activities without experiencing issues associated with unreliable and slow Wi-Fi.