# Networks in a Box

## Objective

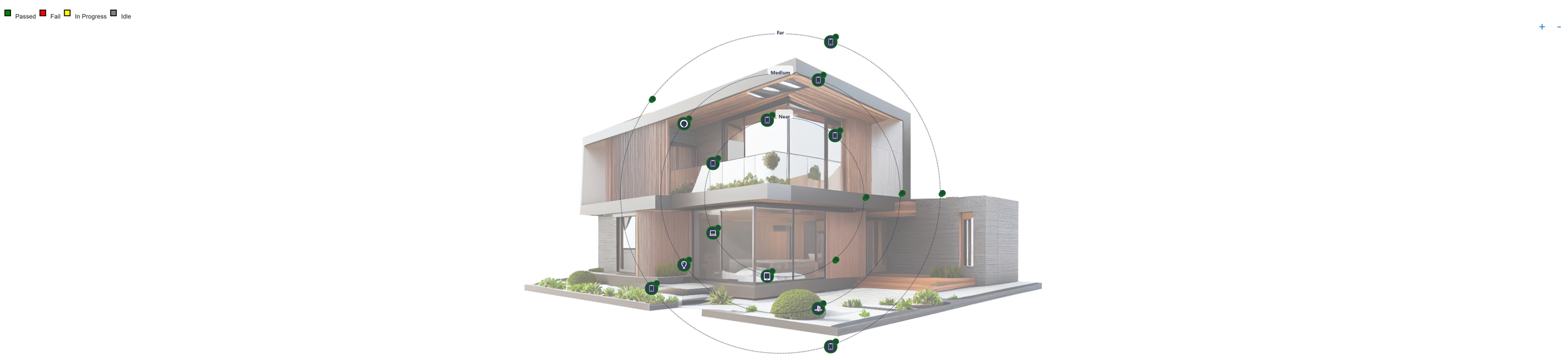
The objective of this test is to evaluate the performance and operational capabilities of access points in various real-world environments, including home, office, hospital, and stadium settings, using Candela's Networks in a Box solution. The test will involve emulating virtual devices and using real devices at different distances (near, medium, and far) and applying predefined traffic profiles to simulate activities such as video streaming, online gaming, browsing, file downloads, and application video streams (YouTube, Netflix, Zoom, etc.). Additionally, the performance of IoT devices connected to Alexa will be assessed. The aim is to identify key performance metrics and potential issues related to AP capacity, coverage, QoS, and device handling under typical usage scenarios.

## DUT Configuration

| | |
|---|---|
| **Test Network** | QualcommHlab |
| **Name of the Test Scenario** | Small_home_scenario |
| **Test Duration (minutes)** | 15 |
| **No. of Devices in test** | 17 |
| **2GHz SSID** | TPLINK_2G |
| **2GHz BSSID** | DEFAULT |
| **2GHz Security** | WPA2 |
| **5GHz SSID** | TPLINK_5G |
| **5GHz BSSID** | DEFAULT |
| **5GHz Security** | WPA2 |
| **6GHz SSID** | TPLINK_6G |
| **6GHz BSSID** | DEFAULT |
| **6GHz Security** | WPA3 |

## Client Distributions and Pass/Fail Analysis

The distribution of clients across various distances—near, medium, and far can be seen in the below image. Each client's pass/fail status was determined based on SLA criteria, with green indicating pass and red indicating fail. This representation provides a clear summary of the test outcomes across various client distances.

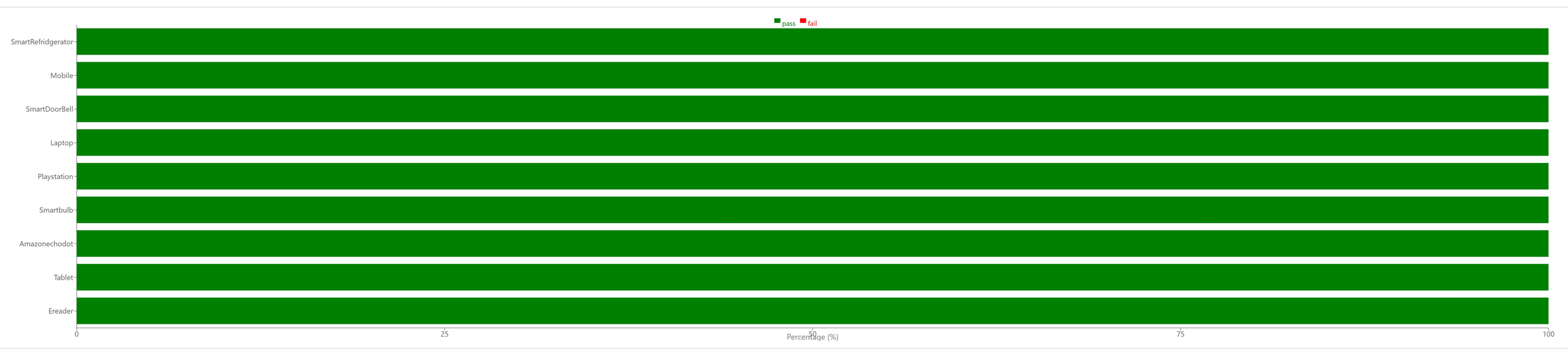



## Device Information

| Device Name | Traffic Profile | Distance | Device Type | Client Type | Bandwidth | Mac | Channel | Mode | RSSI |
|---|---|---|---|---|---|---|---|---|---|
| samsung refridgerator | SmartRefridgerator_Cloud_Controls | far | SmartRefridgerator | Virtual | 2.4GHz | 38:f8:f6:a7:a5:94 | 6 | 802.11bg 20 1x1 | -41 dBm |
| Oneplus10 | Spotify_Mobile_Streamingaudio-TCP | far | Mobile | Virtual | 5GHz | 38:f8:f6:e6:28:9a | 36 | 802.11an-AC 80 2x2 | -60 dBm |
| Pixel4a | Amazonshopping_Mobile_WebBrowsing | far | Mobile | Virtual | 6GHz | 38:f8:f6:6d:fa:96 | 259 | 802.11a-BE 160 2x2 | -72 dBm |
| Amazon Ring | SmartDoorBell_Steamingvideo-UDP | far | SmartDoorBell | Virtual | 2.4GHz | 38:f8:f6:44:db:94 | 6 | 802.11bgn 40 2x2 | -40 dBm |
| Oneplus11 | Amazonshopping_Mobile_WebBrowsing | far | Mobile | Virtual | 6GHz | 38:f8:f6:2d:0f:96 | 259 | 802.11a-BE 160 2x2 | -72 dBm |
| Kindle | Kindle_WebBrowsing | medium | Ereader | Virtual | 2.4GHz | 38:f8:f6:2d:dc:e4 | 6 | 802.11bgn 40 2x2 | -36 dBm |
| PS5 | Gaming_Playstation_Streamingvideo-UDP | medium | Playstation | Virtual | 5GHz | 38:f8:f6:f3:55:ea | 36 | 802.11an-AX 80 2x2 | -55 dBm |
| Amazon Ring | SmartDoorBell_Steamingvideo-UDP | near | SmartDoorBell | Virtual | 2.4GHz | 14:13:33:f2:c1:33 | 6 | 802.11bgn 40 1x1 | -27 dBm |
| samsung refridgerator | SmartRefridgerator_Cloud_Controls | near | SmartRefridgerator | Virtual | 2.4GHz | 14:13:33:aa:ee:71 | 6 | 802.11bg 20 1x1 | -26 dBm |
| iPad | Amazonshopping_Tablet_WebBrowsing | near | Tablet | Virtual | 5GHz | 14:13:33:6f:e0:ed | 36 | 802.11an-AC 80 2x2 | -43 dBm |
| Macbook pro | Zoom_Laptop_Streamingvideo-UDP | near | Laptop | Virtual | 5GHz | 50:c2:e8:41:6a:47 | 36 | 802.11an-AX 80 2x2 | -42 dBm |
| Pixel4a | Spotify_Mobile_Streamingaudio-TCP | near | Mobile | Virtual | 6GHz | 70:15:fb:a5:7c:c8 | 259 | 802.11a-BE 160 2x2 | -47 dBm |
| iphone 16 pro max | Amazonshopping_Mobile_WebBrowsing | near | Mobile | Virtual | 6GHz | 70:15:fb:93:0b:e3 | 259 | 802.11a-BE 160 2x2 | -54 dBm |
| Oneplus11 | Youtube_Mobile_Downloadvideo-UDP | near | Mobile | Virtual | 6GHz | 70:15:fb:ea:b2:1a | 259 | 802.11a-BE 160 2x2 | -47 dBm |
| Wipro Bulb | SmartBulb_IOT_Controls | medium | Smartbulb | Virtual | 2.4GHz | 38:f8:f6:d3:e9:e4 | 6 | 802.11bgn 40 2x2 | -36 dBm |
| Amazonecho | Alexa_AmazonEchoDot_Streamingaudio-TCP | medium | Amazonechodot | Virtual | 5GHz | 38:f8:f6:db:d8:ea | 36 | 802.11an-AC 80 2x2 | -55 dBm |
| iphone 16 pro max | Spotify_Mobile_Streamingaudio-TCP | medium | Mobile | Virtual | 6GHz | 38:f8:f6:30:d1:e6 | 259 | 802.11a-BE 160 2x2 | -60 dBm |

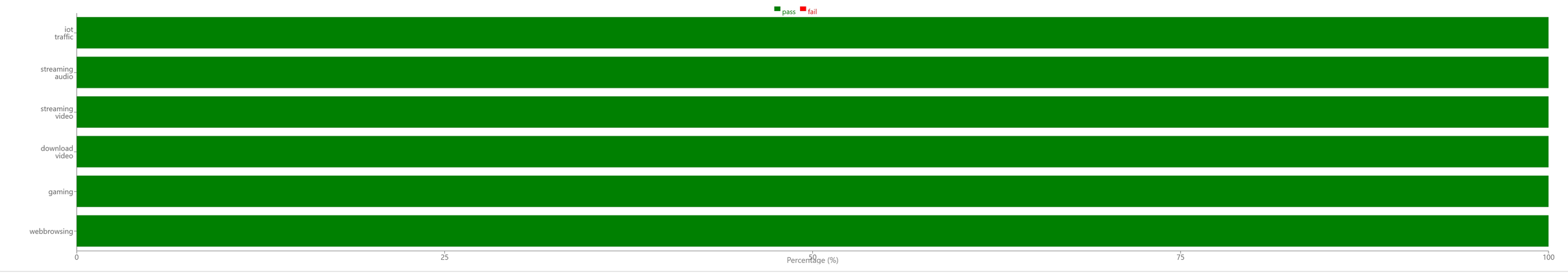
## Performance with respect to device types

This representation highlights the pass/fail performance rates across various device types, including mobiles, laptops, tablets, gaming consoles, IoT devices, and smart wearables. The data allows us to assess which device categories perform optimally with the Access Point, providing insights that similar devices are likely to exhibit comparable performance in real-world scenarios.



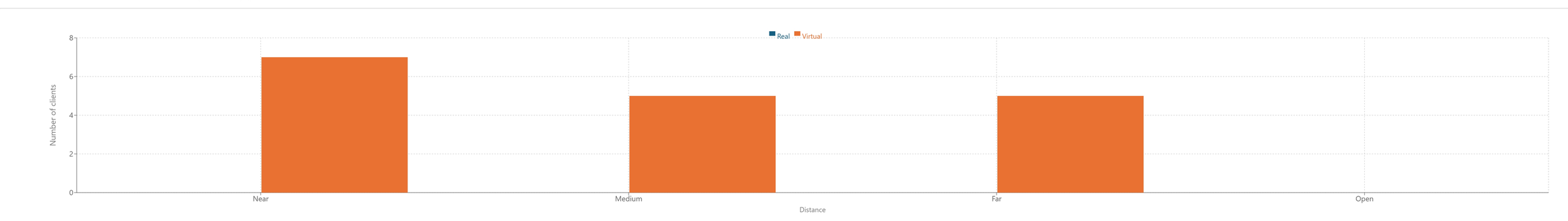

## Performance with respect to traffic types

This representation presents the pass/fail performance rates across different traffic types, including video conferencing, audio/video streaming, gaming, and IoT applications. By examining these results, we can determine which traffic types perform better with the Access Point and infer that similar traffic can be effectively deployed in real-world scenarios.



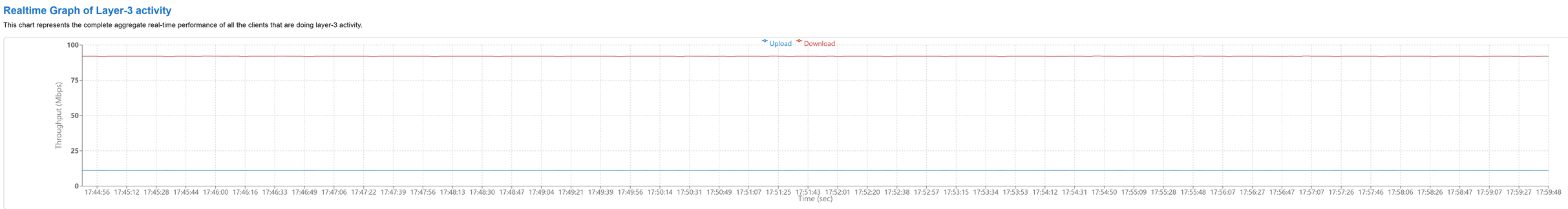

## Number of Clients vs Distance

This chart represents the number of clients both real and virtual placed at varying distances—near, medium, and far



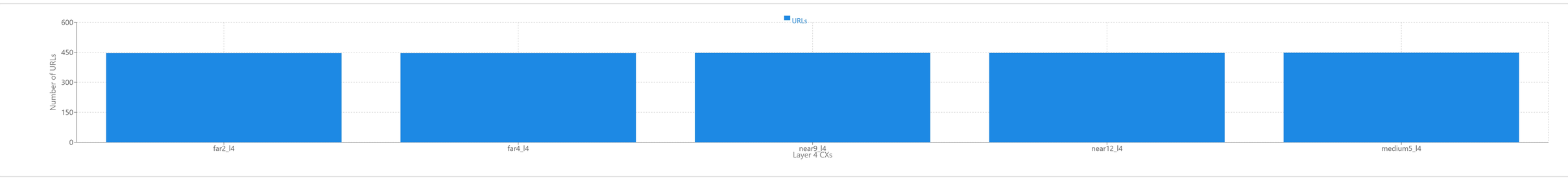

## Realtime Graph of Layer-3 activity

This chart represents the complete aggregate real-time performance of all the clients that are doing layer-3 activity.




## Realtime Graph of Layer-4 activity

This chart represents the complete aggregate real-time performance of all the clients that are doing layer-4 activity.




## Per-client data analysis

Layer3

| Traffic Profile | Distance | Profile Name | Device Type | Client Type | Traffic Type | Packet Size | Protocol | Priority DL | DL SLA% | DL Rate | Avg DL Rate | Priority UL | UL SLA% | UL Rate | Avg UL Rate | Result |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SmartRefridgerator_Cloud_Controls | far | samsung refridgerator | SmartRefridgerator | Virtual | iot traffic | 1500 | TCP | BE | 70% | 0.05 | 0.05 | BE | 70% | 1.00 | 1.00 | Pass |
| Spotify_Mobile_Streamingaudio-TCP | far | Oneplus10 | Mobile | Virtual | streaming audio | 790 | TCP | VO | 70% | 0.50 | 0.50 | BE | 70% | 0.00 | 0.00 | Pass |
| SmartDoorBell_Steamingvideo-UDP | far | Amazon Ring | SmartDoorBell | Virtual | streaming video | 256 | UDP | BE | 70% | 0.00 | 0.00 | BE | 70% | 3.00 | 3.00 | Pass |
| SmartDoorBell_Steamingvideo-UDP | near | Amazon Ring | SmartDoorBell | Virtual | streaming video | 256 | UDP | BE | 70% | 0.00 | 0.00 | BE | 70% | 3.00 | 3.00 | Pass |
| SmartRefridgerator_Cloud_Controls | near | samsung refridgerator | SmartRefridgerator | Virtual | iot traffic | 1500 | TCP | BE | 70% | 0.05 | 0.05 | BE | 70% | 1.00 | 1.00 | Pass |
| Zoom_Laptop_Streamingvideo-UDP | near | Macbook pro | Laptop | Virtual | streaming video | 1170 | UDP | BE | 70% | 0.11 | 0.11 | BE | 70% | 0.02 | 0.02 | Pass |
| Spotify_Mobile_Streamingaudio-TCP | near | Pixel4a | Mobile | Virtual | streaming audio | 790 | TCP | VO | 70% | 0.50 | 0.50 | BE | 70% | 0.00 | 0.00 | Pass |
| Youtube_Mobile_Downloadvideo-UDP | near | Oneplus11 | Mobile | Virtual | download video | 1402 | UDP | BE | 70% | 80.00 | 79.98 | BE | 70% | 0.01 | 0.01 | Pass |
| Gaming_Playstation_Streamingvideo-UDP | medium | PS5 | Playstation | Virtual | gaming | 1500 | UDP | BE | 70% | 10.00 | 10.00 | BE | 70% | 3.00 | 3.00 | Pass |
| SmartBulb_IOT_Controls | medium | Wipro Bulb | Smartbulb | Virtual | iot traffic | 280 | TCP | BE | 70% | 0.00 | 0.00 | BE | 70% | 0.00 | 0.00 | Pass |
| Alexa_AmazonEchoDot_Streamingaudio-TCP | medium | Amazonecho | Amazonechodot | Virtual | streaming audio | 1575 | TCP | BE | 70% | 0.35 | 0.35 | BE | 70% | 0.03 | 0.03 | Pass |
| Spotify_Mobile_Streamingaudio-TCP | medium | iphone 16 pro max | Mobile | Virtual | streaming audio | 790 | TCP | VO | 70% | 0.50 | 0.50 | BE | 70% | 0.00 | 0.00 | Pass |

Layer4-7

| Traffic Profile | Distance | Profile Name | Device Type | Client Type | Traffic Type | Protocol | Max Speed | File Size/URL | SLA URLs | Total URLs | Result |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Amazonshopping_Mobile_WebBrowsing | far | Pixel4a | Mobile | Virtual | webbrowsing | HTTPS | 0.50 | https://www.amazon.in/Samsung-Fully-Automatic-Ecobubble-WA80BG4545BYTL-technology/dp/B0B7JZG8R1 | 5 | 446 | Pass |
| Amazonshopping_Mobile_WebBrowsing | far | Oneplus11 | Mobile | Virtual | webbrowsing | HTTPS | 0.50 | https://www.amazon.in/Samsung-Fully-Automatic-Ecobubble-WA80BG4545BYTL-technology/dp/B0B7JZG8R1 | 5 | 446 | Pass |
| Amazonshopping_Tablet_WebBrowsing | near | iPad | Tablet | Virtual | webbrowsing | HTTPS | 0.50 | https://www.amazon.in/Samsung-Fully-Automatic-Ecobubble-WA80BG4545BYTL-technology/dp/B0B7JZG8R1?th=1 | 5 | 447 | Pass |
| Amazonshopping_Mobile_WebBrowsing | near | iphone 16 pro max | Mobile | Virtual | webbrowsing | HTTPS | 0.50 | https://www.amazon.in/Samsung-Fully-Automatic-Ecobubble-WA80BG4545BYTL-technology/dp/B0B7JZG8R1 | 5 | 447 | Pass |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Kindle_WebBrowsing | medium | Kindle | Ereader | Virtual | webbrowsing | HTTPS | 0.12 | https://openlibrary.org/works/OL7924103W/The_Eye_of_the_World_%28The_Wheel_of_Time_Book_1%29 | 5 | 448 | Pass |