World WLAN Application Alliance

WAA-TS 013-2025

Technical Specification for Campus Office WLAN Performance and Experience (Based on IEEE 802.11be-2024)

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Foreword

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Contents

1 Overview

1.1 Scope

This document regulates the technical requirements for wireless local area network (WLAN) performance and experience of campus office devices, which refer specifically to wireless routers in this document.

This document is applicable to the design, development, production, and test of campus wireless routers.

1.2 Applicability

This document is applicable to the design, development, production, and test of campus wireless routers.

1.3 Word usage

In this document, the word "shall" is used to indicate a mandatory requirement. The word "should" is used to indicate a recommendation. The word "may" is used to indicate that something is permitted. The word "can" is used to indicate that something is possible.

2 Normative References

[1] IEEE Std. 802.11-2020 IEEE Standard for Information Technology Telecommunications and Information Exchange between Systems Local and Metropolitan Area Networks Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications.

[2] IEEE Std 802.11be-2024 (IEEE Standard for Information technology Telecommunications and information exchange between systems Local and metropolitan area networks Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 2: Enhancements for extremely high throughput (EHT)).

[2] WPA3™ Specification Version 3.5 https://www.wi-fi.org/file/wpa3-specification

3 Terms and Definitions

3.1 Scene

In this document, a scene refers to a system and its running. A system consists of terminals, networks, wireless propagation environments, servers, and users. System running includes interaction conditions of subsystems and components in specific use, including various factors that affect network performance and service performance. For example, the distance between a mobile phone and a wireless router is 3 m, and users participate in a video conference.

3.2 Campus

In this document, a campus refers to an enterprise or organization that has a management boundary, such as an enterprise, education campus, government agency, or commercial area. A campus has an internal network, which increases the operation efficiency of an enterprise or organization.

3.3 Basic Performance

During the network use, users need to evaluate network performance based on basic parameters, such as bandwidth, access STA connection capability, coverage, and latency. Most of these parameters are related to devices, while some are related to networking, such as roaming capability. Basic performance requirements can be used to evaluate service performance requirements.

3.4 Service Performance

Evaluate the performance parameters of a multi-service network based on the network application. Determine the type, quantity, and proportion of each service as well as the typical networking model. Simulate the actual user environment and evaluate the network capability of supporting application experience. The performance requirements include the user experience of interactive systems (including but not limited to video freezing, voice delay, and operation delay) and the requirements for machine-to-machine interaction (for example, processing delay required for robot control in the industrial field).

3.5 Test Bed

A test bed is a system that simulates the network environment used by users. It consists of terminals, networks, and radio propagation environments. Users can modify environment parameters, network parameters, and terminal parameters to complete performance tests of devices, networks, and services.

3.6 Scene Model

A scene model is a set of elements (such as terminals, networks, and radio propagation environments) and device requirements of users to simulate the network environment used by users. The scene model is used to configure the test bed and build a comprehensive performance test system. Different scene models may be used to meet different basic network performance requirements and service performance requirements to reflect different actual application environments of the device under test (DUT).

3.7 Latency

End-to-end latency to be guaranteed for different service networks.

3.8 Packet Loss Ratio

Ratio of the number of packets that fail to be sent to the total number of packets.

3.9 Concurrency

Concurrency refers to the concurrent use of a network or services by users who access the network within the same period of time.

3.10 Channel Bandwidth

The channel bandwidths such as 20 MHz, 40 MHz, 80 MHz, and 160 MHz are supported on different frequency bands, which must comply with the spectrum division requirements of the local country.

Note 1: 2.4 GHz refers to the available 2.4 GHz frequency band spectrum for WLANs in a country where devices are used. As available spectrum varies according to the country, devices must comply with the radio and interference avoidance technology requirements of the local country (For example,

the available 2.4 GHz frequency band for WLANs in the People's Republic of China ranges from 2400 MHz to 2483.5 MHz).

Note 2: 5 GHz refers to the available 5 GHz frequency band spectrum for WLANs in a country where devices are used. As available spectrum varies according to the country, devices must comply with the radio and interference avoidance technology requirements of the local country (For example, the available 5 GHz frequency band for WLANs in the People's Republic of China ranges from 5150–5350 MHz and 5725–5850 MHz).

3.11 Interference

Interference refers to the impact of unwanted energy, caused by one or more of transmission, radiation, induction, or their combination, on the reception of a radio communication system. It can lead to performance degradation, misunderstanding, or information loss. If such energy is reduced or eliminated, the consequences can be mitigated or avoided.

4 Acronyms and Abbreviations

The following acronyms and abbreviations apply to this document.

AC: access controller

AES: Advanced Encryption Standard

AP: access point

CSMA/CA: carrier sense multiple access with collision avoidance

CCMP: Counter Mode with CBC-MAC Protocol

DoS: denial of service

EAP: Extensible Authentication Protocol

ESSID: extended service set identifier

FTP: File Transfer Protocol

GI: guard interval

IFFT: inverse fast Fourier transformation

IP: Internet Protocol

KPI: key performance indicator

KQI: key quality indicator

MAC: Media Access Control

MLO: multi-link operation

MU-MIMO: Multi-user Multiple-input Multiple-output

NSS: number of spatial streams

OWD: one-way delay

OWE: Opportunistic Wireless Encryption

OPEN-SYS: open system

PEAP: Protected Extensible Authentication Protocol

PSK: pre-shared key

RTT: round trip time

RSSI: received signal strength indication

STA: station

SAE: Simultaneous Authentication of Equals

SN: sequence number

SSID: service set identifier

TCP: Transmission Control Protocol

TP99: top 99 percentile

TKIP: temporary key integrity protocol

UDP: User Datagram Protocol

WAPI: WLAN Authentication and Privacy Infrastructure

WEP: wired equivalent privacy

WLAN: wireless local area network

WPA: Wi-Fi Protected Access

5 Overview of Performance Requirements for a Campus Office Network

5.1 Overview of KQIs for Services Carried on a Campus Office Network

Common services carried on a campus office network include voice, Internet video, web browsing, upload/download, video conferencing, mobile gaming, and wireless projection. For the actual proportions of multiple services, see Appendix C. Figure 1 shows the network KQIs that affect user experience of the preceding services.

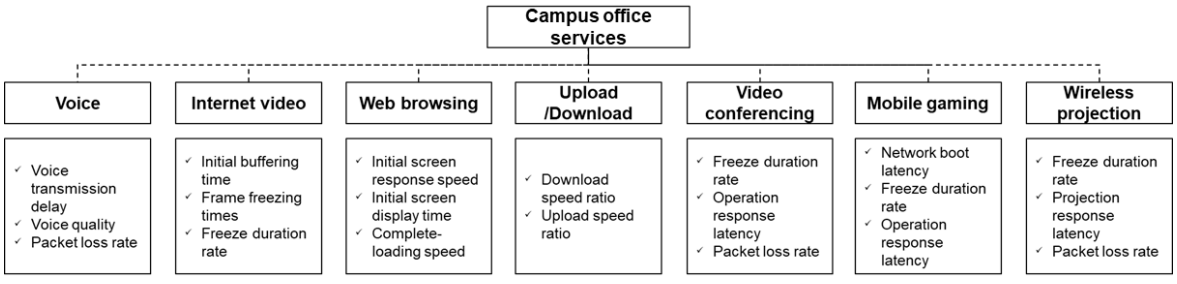

Figure 1 Service types carried by the campus office network

In a campus office environment, service KQIs refer to indicators that can be perceived by users and affect their service experience, such as operation duration and frame freezing ratio. From the perspective of network performance, the network KPIs that affect the KQIs of a service include the following:

a. Minimum bandwidth required by the service

b. Minimum latency and jitter required by the service

c. Maximum packet loss ratio required by the service

5.2 Overview of the Test Environment for Basic Performance Requirements of Campus Office Network Devices

On a campus office network, network device performance is the basis of network services. Experienced network experts can determine whether a network can carry a single service or a combination of multiple services based on network device performance. This document uses six general network performance parameters for ensuring WLAN service experience as basic requirements for devices and as a reference for experts to evaluate the service bearing capability of devices. The six parameters are bandwidth, latency, coverage, connection, roaming, and security, as shown in Figure 2.

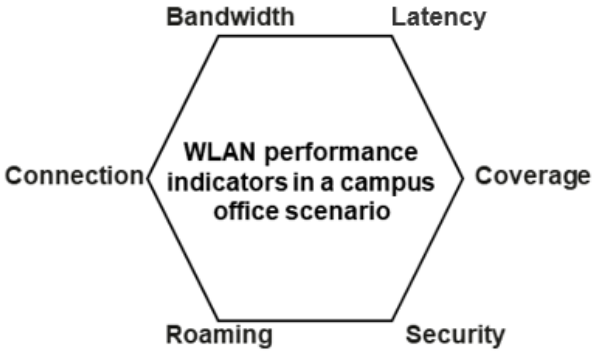

Figure 2 Basic performance parameters of a campus office network

5.3 Overview of Typical Service Performance Requirements for a Campus Office Network

Network users may not know the technologies used by a network to provide network services. This document clarifies the typical service application scenarios of a campus office network. By constructing a typical service scene model for the campus office network, this document describes how to evaluate the network bandwidth, latency, jitter, and packet loss ratio of a wireless router when multiple services are used.

5.4 Requirements for Devices Under Test and Protocol Versions in Campus Office Network Tests

As WLAN standards are classified by generation, the performance parameters also vary by generation. As such, this document also defines the performance requirements in two versions: *IEEE 802.11ax-2021-IEEE Standard for Information Technology--Telecommunications and Information Exchange between Systems Local and Metropolitan Area Networks--Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 1: Enhancements for High-Efficiency WLAN (IEEE 802.11ax)* and *IEEE P802.11be™/D6.0 Draft Standard for Information technology— Telecommunications and Information Exchange Between Systems Local and Metropolitan Area Networks— Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 2: Enhancements for Extremely High Throughput (EHT) (IEEE 802.11be)*. If the performance requirements comply with IEEE 802.11ax, all STAs are

configured with the test requirements of IEEE 802.11ax by default. If the performance requirements comply with IEEE 802.11be, all STAs are configured with the test requirements of IEEE 802.11be by default.

In chapters 6 and 7 of this document, unless otherwise specified, the scene model definitions and corresponding technical requirements apply to both IEEE 802.11ax and IEEE 802.11be.

6 Basic Performance Requirements of Campus Office Network Devices

6.1 Bandwidth

6.1.1 Bandwidth Parameter and Scene Models

6.1.1.1 Bandwidth Parameter

The bandwidth parameter refers to the maximum performance parameter that is available to STAs using a WLAN. In a campus office scenario, the bandwidth parameter directly affects user experience of bandwidth-hungry services, such as the speed test, data download, Internet video, and video conferencing.

The bandwidth parameter of a WLAN device interface is the maximum throughput that can be tested on the WLAN device interface. The scene models are defined as follows.

6.1.1.2 Bandwidth Scene Model 1: Single Frequency Band and Single STA Without Interference

In an interference-free scenario, a single STA accesses a single frequency band (2.4 GHz or 5 GHz) of an AP at a short distance to obtain the maximum throughput of the single frequency band. Figure 3 shows the scenario model. This model is used to measure the TCP service bearing capability of an AP operating in an interference-free air interface environment. To test the maximum TCP service bearing capability, conform to the following air interface conditions:

a. There are no other interference sources on the same frequency band in the environment, including Wi-Fi interference sources (such as other gateways or routers) and non-Wi-Fi interference sources (such as Bluetooth devices, cordless phones, and microwave ovens).

b. There are no obstacles between the STA and AP. The AP is ceiling mounted at a height of 3 m, and the STA is located directly below the AP.

c. The STA has two transmit/receive (Tx/Rx) antennas.

d. The number of access STAs is 1.

e. The packet length of TCP service flows is 1500 bytes.

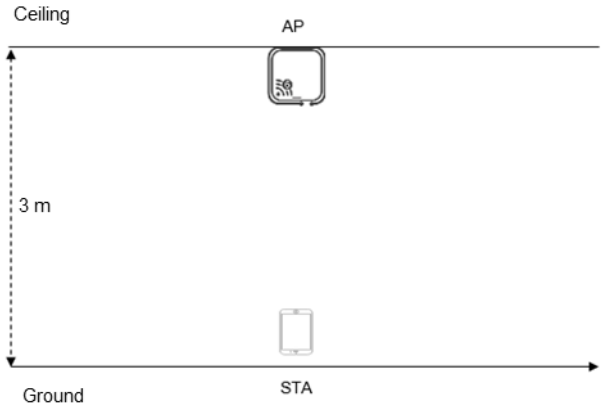

Figure 3 Single-band single-STA performance scene model

6.1.1.3 Bandwidth Scene Model 2: Concurrent Access of Two STAs on Multiple Frequency Bands Without Interference

This model is used to obtain the maximum throughput of concurrent multi-band access when two STAs access multiple frequency bands of an AP concurrently in an interference-free environment. Figure 4 shows the scene model, where the AP supports concurrent access on the 2.4 GHz and 5 GHz frequency bands. This model is used to measure the TCP service bearing capability of an AP in multi-band concurrency scenarios. To test the maximum TCP service bearing capability of the multi-band concurrency model, conform to the following air interface conditions:

a. There are no other interference sources on the same frequency band in the environment, including Wi-Fi interference sources (such as other gateways or routers) and non-Wi-Fi interference sources (such as Bluetooth devices, cordless phones, and microwave ovens).

b. There are no obstacles between the STAs and AP. The AP is ceiling mounted at a height of 3 m, and the STAs are located within a range of 1 m below the AP.

c. Each STA has two Tx/Rx antennas.

d. The number of access STAs on the AP is the same as the number of frequency bands supported by the AP. For example, each radio of a dual-band AP connects to one STA.

e. The packet length of TCP service flows is 1500 bytes.

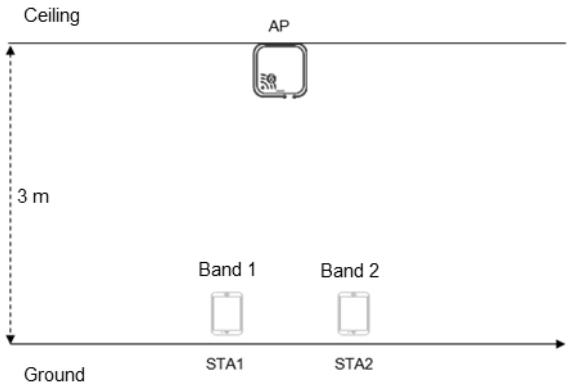

Figure 4 Performance scene model of dual-STA concurrency on multiple frequency bands

6.1.1.4 Bandwidth Scene Model 3: Single Frequency Band MU-MIMO Without Interference

In an interference-free scenario, two STA access a single frequency band (5 GHz) of an AP at a short distance to obtain the maximum MU-MIMO throughput of the single frequency band. Figure 5 shows the scene model, where the AP supports MU-MIMO concurrency. This model is used to measure the TCP service bearing capability of an AP upon MU-MIMO concurrency of two STAs in an interference-free environment. To test the maximum TCP service bearing capability, conform to the following air interface conditions:

a. There are no other interference sources on the same frequency band in the environment, including Wi-Fi interference sources (such as other gateways or routers) and non-Wi-Fi interference sources (such as Bluetooth devices, cordless phones, and microwave ovens).

b. There are no obstacles between the STAs and AP. The AP is ceiling mounted at a height of 3 m, and the STAs are located within a range of 1 m below the AP.

c. Each STA has two Tx/Rx antennas and supports MU-MIMO.

d. The number of access STAs on a single radio is 2.

e. The packet length of TCP service flows is 1500 bytes.

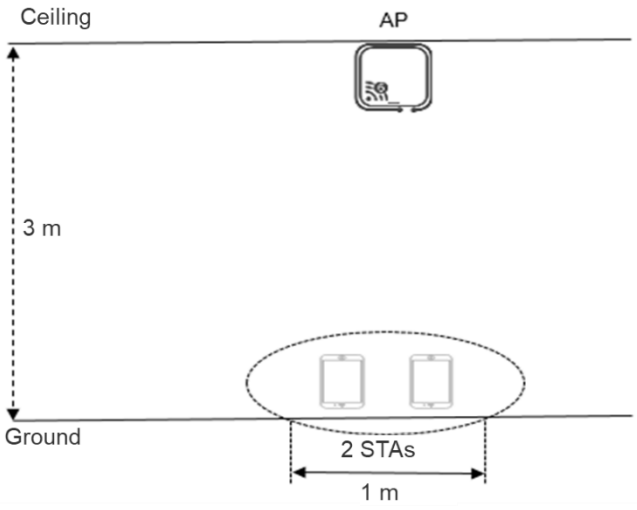

Figure 5 Single-band MU-MIMO performance scene model

6.1.1.5 Bandwidth Scene Model 3: Single-STA MLO Without Interference

This model is used to obtain the maximum throughput of concurrent multi-band coordination when an MLO-capable STA accesses multiple frequency bands of an AP in an interference-free environment. Figure 6 shows the scene model, where the AP supports MLO. This model is used to measure the TCP service bearing capability of an AP in MLO coordination concurrency scenarios. To test the maximum TCP service bearing capability in this scene model, conform to the following air interface conditions:

a. There are no other interference sources on the same frequency band in the environment, including Wi-Fi interference sources (such as other gateways or routers) and non-Wi-Fi interference sources (such as Bluetooth devices, cordless phones, and microwave ovens).

b. There are no obstacles between the STA and AP. The AP is ceiling mounted at a height of 3 m, and the STA is located within a range of 1 m below the AP.

c. The STA has two Tx/Rx antennas.

d. The number of access STAs is 1.

e. The packet length of TCP service flows is 1500 bytes.

This scene model applies to IEEE 802.11be.

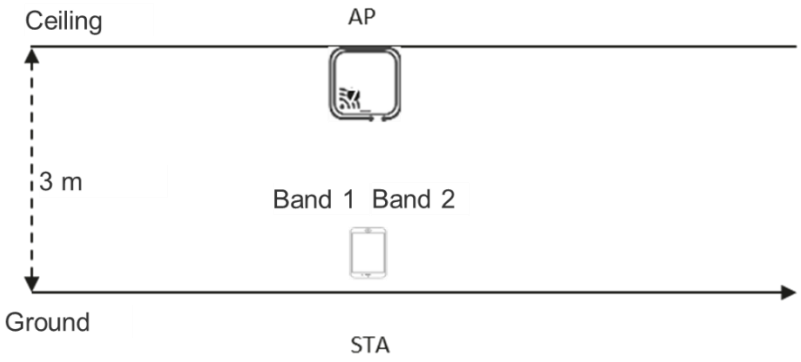

Figure 6 Single-STA MLO performance scene model

6.1.2 Bandwidth Requirements

Table 1 lists the bandwidth requirements of the single-band single-STA scene model without interference (see section 6.1.1.2).

Table 1 Maximum performance requirements for a single-band single-STA scenario

NSS of the STA	Frequency Band (GHz)	Bandwidth (MHz)	Downlink Throughput (Mbps)	Uplink Throughput (Mbps)
2	2.4	20	≥ 260	≥ 260
2	2.4	40	≥ 520	≥ 520
2	5	40	≥ 520	≥ 520
2	5	80	≥ 1040	≥ 1040
2	5	160	≥ 2000	≥ 2000

Table 2 lists the bandwidth requirements of the scene model with concurrent access of two STAs on multiple frequency bands without interference (see section 6.1.1.3).

Table 2 Maximum performance requirements for concurrent access of two STAs on multiple frequency bands

NSS of the STA	Band 1 (GHz)	Bandwidth 1 (MHz)	Band 2 (GHz)	Bandwidth 2 (MHz)	Downlink Throughput (Mbps)	Uplink Throughput (Mbps)
2	2.4	20	5	20	≥ 520	≥ 520
2	2.4	20	5	40	≥ 780	≥ 780
2	2.4	40	5	80	≥ 1520	≥ 1520
2	2.4	40	5	160	≥ 2520	≥ 2520

Table 3 lists the bandwidth requirements of the single-band MU-MIMO scene model without interference (see section 6.1.1.4).

Table 3 Maximum performance requirements for the single-band MU-MIMO scene model

NSS of the AP	NSS of the STA	Frequency Band (GHz)	Bandwidth (MHz)	Downlink Throughput (Mbps)
4	2	5	40	≥ 570
4	2	5	80	≥ 1100

Table 4 lists the bandwidth requirements of the single-STA MLO scene model without interference (see section 6.1.1.5), which are applicable to IEEE 802.11be.

Table 4 Bandwidth performance requirements of the single-STA MLO scene model

NSS of the STA	Frequency Band (GHz)	Bandwidth (MHz)	Frequency Band (GHz)	Bandwidth (MHz)	Downlink Throughput (Mbps)
2	2.4	20	5	40	≥ 780
2	2.4	40	5	80	≥ 1520
2	5	40	5	40	≥ 1080
2	5	80	5	160	≥ 3000

6.2 Connection

6.2.1 Connection Parameters and Scene Models

6.2.1.1 Connection Parameters

Service concurrency is a characteristic of a campus office network. Connections reflect the degree of integration between the network and the physical world. Connection parameters include the number

of connected users (users who access the network concurrently) and the number of concurrent users (users who run services concurrently). The theoretical model of the WLAN duty cycle is calculated using the formula (1):

$$\text{Duty Cycle} = \frac{\sum_1^n T_{\text{nrate}}}{N_{\text{ss}} * (N_{\text{CBPS}} * R) * (1/(T_S + T_{GI}))} \quad (1)$$

In the formula:

N_{SS}: number of spatial streams

N_{CBPS}: total number of code bits in each OFDM symbol

R: coding rate

T_{GI}: GI length

T_S: symbol (IFFT) length

T_{nrate}: actual rate of a STA

A larger number of concurrent users indicate a higher air interface utilization, resulting in more severe contention conflicts and degrading service experience. Scene models of connection parameters are defined based on the number of concurrent users.

6.2.1.2 Connection Scene Model 1: Single-Band Multi-STA Concurrent Throughput

In an interference-free scenario, 10, 20, and 30 STA access a single frequency band (5 GHz) of an AP to obtain the total concurrent throughput and the minimum throughput of the single frequency band.

Different STAs carry different traffic services. Based on formula (1) (see section 6.2.1.1), when the service traffic of STAs increases, the air interface utilization increases, the contention conflict intensifies, and the service experience deteriorates. In this case, the maximum throughput of multiple concurrent STAs is used to measure the service scheduling capability of an AP in multi-STA concurrent service scenarios. Figure 7 shows the scene model.

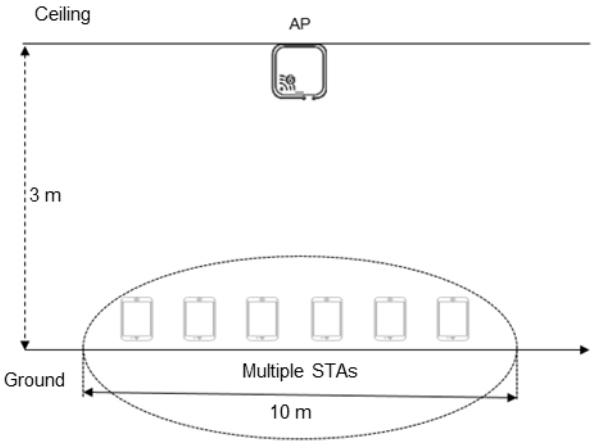

Figure 7 Single- band multi-STA concurrent throughput scene model

In this scene model, multiple STAs concurrently access an AP. This model is used to measure the maximum number of STAs supported by the system using unlimited-rate TCP flows to evaluate the concurrent performance of the AP and the fairness of multi-user concurrent scheduling when certain

performance requirements are met. Key constraints and conditions in the scene model are defined as follows:

a. The air interface conditions between each STA and the AP are the same. The AP is ceiling mounted at a height of 3 m, and the STAs are located within a range of 10 m below the AP.

b. Each STA has two Tx/Rx antennas.

c. The packet length of TCP service flows is 1500 bytes.

6.2.2 Connection Requirements

Table 5 lists the connection performance requirements for the device under test based on the connection scene model (see section 6.2.1.2).

Table 5 Performance requirements of the single-band multi-STA concurrent throughput scene model

NSS of the AP	NSS of the STA	Frequency Band (GHz)	Bandwidth (MHz)	10 Concurrent STAs Total/Minimum Throughput	20 Concurrent STAs Total/Minimum Throughput	30 Concurrent STAs Total/Minimum Throughput
2	2	5	40	≥ 330/16	≥ 310/7	≥ 260/4
2	2	5	80	≥ 660/33	≥ 620/15	≥ 520/8
2	2	5	160	≥ 1280/64	≥ 1200/30	≥ 1000/16
4	2	5	40	≥ 415/20	≥ 360/9	≥ 310/5
4	2	5	80	≥ 830/41	≥ 720/18	≥ 620/10
4	2	5	160	≥ 1600/80	≥ 1400/35	≥ 1200/20

6.3 Coverage

6.3.1 Coverage Parameter and Scene Models

6.3.1.1 Coverage Parameter

In office WLAN deployment on a campus, each AP covers a certain space. WLAN signals attenuate as the distance increases or walls block the signals, and the throughput obtained by users decreases. User experience varies with the space distance.

6.3.1.2 Coverage Scene Model 1: Single-STA at an LOS Distance of 10 m or 20 m Without Obstacles

This model is used to obtain the maximum downlink throughput of a single STA connected to an AP at a line of sight (LOS) distance of 10 m or 20 m without obstacles and interference. Figure 8 shows the scene model, which is used to evaluate the service performance of an AP at a long LOS distance. This scene model has the following constraints:

a. There are no other interference sources on the same frequency band in the environment, including Wi-Fi interference sources (such as other gateways or routers) and non-Wi-Fi interference sources (such as Bluetooth devices, cordless phones, and microwave ovens).

b. There are no obstacles between the STA and AP. The AP is ceiling mounted at a height of 3 m, and the STA is located at an LOS distance of 10 m or 20 m away from the AP.

c. The STA has two Tx/Rx antennas.

d. The packet length of TCP service flows is 1500 bytes.

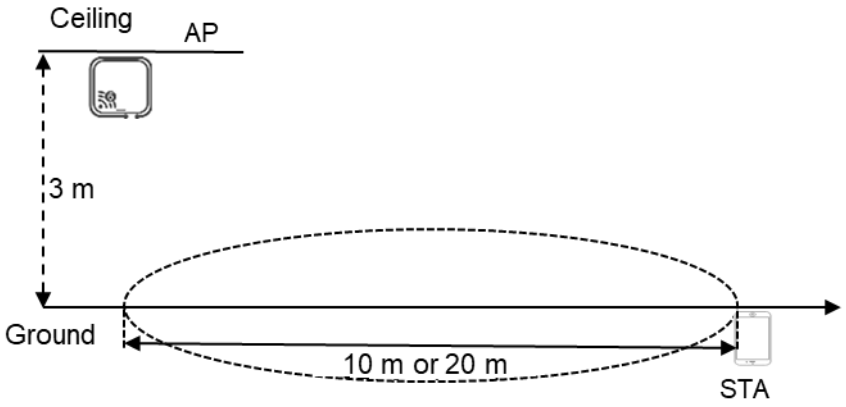

Figure 8 Performance scene model of single-STA at an LOS distance of 10 m or 20 m without obstacles

6.3.1.3 Coverage Scene Model 2: Single-STA Wall-Penetration

This model is used to obtain the maximum downlink throughput of a single STA connected to an AP at an LOS distance of 10 m without interference. Figure 9 shows the scene model, which is used to evaluate the wall-penetration capability of an AP. The scene model has the following constraints:

a. There are no other interference sources on the same frequency band in the environment, including Wi-Fi interference sources (such as other gateways or routers) and non-Wi-Fi interference sources (such as Bluetooth devices, cordless phones, and microwave ovens).

b. There are no obstacles between the STA and AP. The AP is ceiling mounted at a height of 3 m, and the STA is located at an LOS distance of 10 m away from the AP, with a brick wall with a thickness of 120 mm between them. (The attenuation value of a wall with a thickness of 120 mm is about 10 dB on the 2.4 GHz frequency band, and that on the 5 GHz frequency band is about 20 dB. The attenuation of obstacles should be set according to Appendix B.)

c. The STA has two Tx/Rx antennas.

d. The packet length of TCP service flows is 1500 bytes.

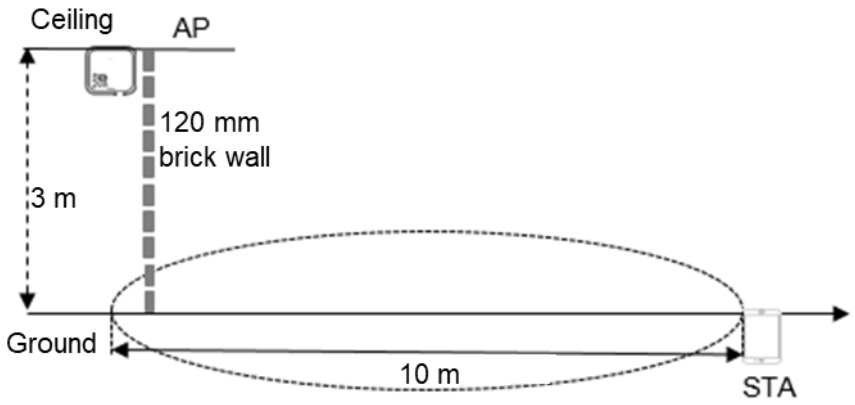

Figure 9 Performance scene model of single-STA wall-penetration at an LOS distance of 10 m

6.3.1.4 Coverage Scene Model 3: Single-STA at an LOS Distance of 5 m Without Obstacles

This model is used to obtain the maximum downlink throughput of a single STA connected to an AP at an LOS distance of 5 m without obstacles and interference. Figure 10 shows the scene model, which is used to evaluate the service performance of an AP at a long LOS distance. This scene model has the following constraints:

a. There are no other interference sources on the same frequency band in the environment, including Wi-Fi interference sources (such as other gateways or routers) and non-Wi-Fi interference sources (such as Bluetooth devices, cordless phones, and microwave ovens).

b. There are no obstacles between the STA and AP. The AP is ceiling mounted at a height of 3 m, and the STA is located at an LOS distance of 5 m away from the AP.

c. The STA has two Tx/Rx antennas.

d. The packet length of TCP service flows is 1500 bytes.

This model applies to IEEE 802.11be.

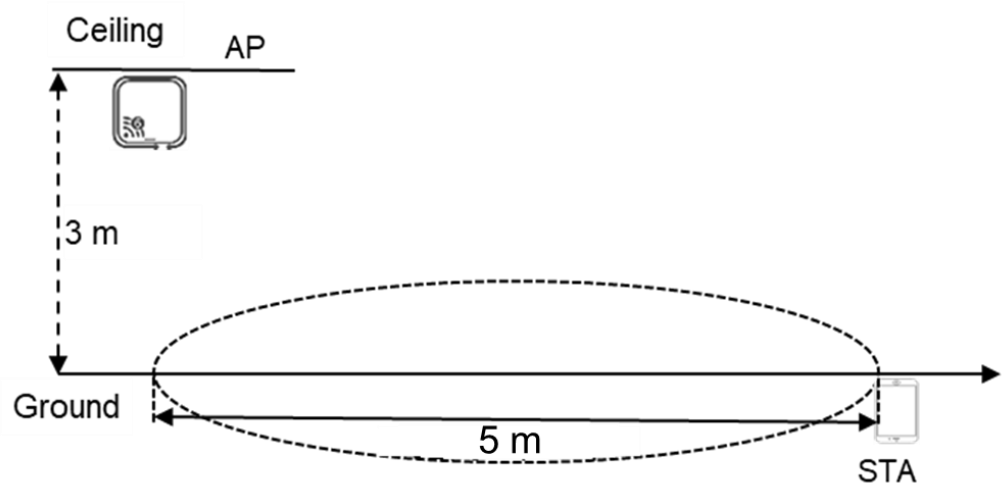

Figure 10 Performance scene model of single-STA at an LOS distance of 5 m without obstacles

6.3.2 Coverage

Table 6 lists the coverage performance requirements of the scene models of single-STA at an LOS distance of 10 m or 20 m without obstacles and single-STA wall-penetration (corresponding to 6.3.1.2 and 6.3.1.3) based on the coverage distance and coverage direction.

Table 6 Coverage performance requirements in scenarios of single-STA at an LOS distance of 10 m or 20 m without obstacles and single-STA wall-penetration

NSS of the AP	NSS of the STA	Frequency Band (GHz)	Bandwidth (MHz)	Downlink Throughput @ 10 m LOS Coverage	Downlink Throughput @ 20 m LOS Coverage	Downlink Throughput @ 10 m Distance + Penetrating One Wall
2	2	2.4	20	≥ 230	≥ 195	≥ 130
2	2	2.4	40	≥ 430	≥ 350	≥ 230
2	2	5	40	≥ 390	≥ 310	≥ 180
2	2	5	80	≥ 720	≥ 540	≥ 270
2	2	5	160	≥ 1300	≥ 970	≥ 340
4	2	2.4	20	≥ 260	≥ 215	≥ 150
4	2	2.4	40	≥ 460	≥ 390	≥ 260
4	2	5	40	≥ 430	≥ 350	≥ 220
4	2	5	80	≥ 810	≥ 650	≥ 380
4	2	5	160	≥ 1440	≥ 1080	≥ 540

Table 7 lists the coverage performance requirements of the scene model of single-STA at an LOS distance of 5 m without obstacle (corresponding to 6.3.1.4) based on the coverage distance and coverage direction (applicable to IEEE 802.11be).

Table 7 Coverage performance requirements of single-STA at an LOS distance of 5 m without obstacle

NSS of the AP	NSS of the STA	Frequency Band (GHz)	Bandwidth (MHz)	Downlink Throughput @ 5 m LOS Coverage
2	2	5	80	≥ 900
2	2	5	160	≥ 1620
4	2	5	80	≥ 970
4	2	5	160	≥ 1800

6.4 Roaming

6.4.1 Roaming Parameters and Scene Models

6.4.1.1 Roaming Parameters

STAs require uninterrupted network services when they move between different areas on a campus network. For example, users may move between different locations while participating in a video conference. The roaming parameter of a WLAN is mainly used to measure the minimum and average throughputs of WLAN interfaces during roaming.

6.4.1.2 Roaming Scene Model 1: Single-STA Roaming Between Two APs

This model is used to measure the minimum and average throughputs of a single STA that roams between two APs without interference. Figure 11 shows the scene model. This scene model is used to measure the minimum and average throughputs during STA roaming using unlimited-rate TCP service flows when a STA moves repeatedly between two APs. This evaluates the time when the AP steers STA roaming and the STA roaming duration. The key constraints and conditions of this scene model are defined as follows:

a. There are no other interference sources on the same frequency band in the environment, including Wi-Fi interference sources (such as other gateways or routers) and non-Wi-Fi interference sources (such as Bluetooth devices, cordless phones, and microwave ovens).

b. There are no obstacles between the STA and APs. The APs are ceiling mounted at a height of 3 m and are configured with a transmit power of 15 dBm. The STA moves between the APs at a speed of 0.5 m/s.

c. The STA has two Tx/Rx antennas.

d. The packet length of TCP service flows is 1500 bytes.

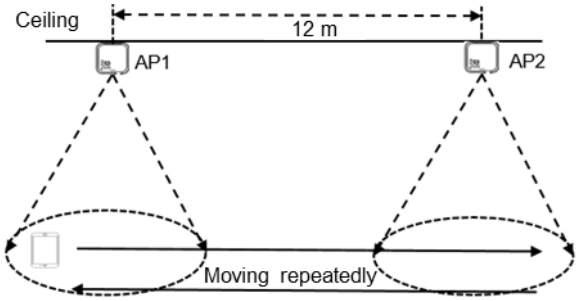

Figure 11 Roaming performance scene model

6.4.2 Roaming Requirements

Table 8 lists the roaming performance requirements for campus office devices.

Table 8 Roaming performance requirements

NSS of the AP	NSS of the STA	Frequency Band (GHz)	Bandwidth (MHz)	Minimum Throughput During Roaming (Mbps)	Average Throughput During Roaming (Mbps)
2	2	2.4	20	≥ 20	≥ 120

NSS of the AP	NSS of the STA	Frequency Band (GHz)	Bandwidth (MHz)	Minimum Throughput During Roaming (Mbps)	Average Throughput During Roaming (Mbps)
2	2	2.4	40	≥ 35	≥ 210
2	2	5	40	≥ 35	≥ 210
2	2	5	80	≥ 60	≥ 350
2	2	5	160	≥ 100	≥ 610
4	2	2.4	20	≥ 25	≥ 140
4	2	2.4	40	≥ 40	≥ 240
4	2	5	40	≥ 40	≥ 240
4	2	5	80	≥ 70	≥ 400
4	2	5	160	≥ 120	≥ 660

6.5 Latency

6.5.1 Latency Parameters and Scene Models

6.5.1.1 Latency Parameters

Latency refers to the time required for data transmission between distributed applications over a network, including the sending latency, propagation latency, queuing latency, and processing latency. Delay parameters of a WLAN are mainly involved in services that have high requirements on real-time performance, such as video conferencing, online real-time streaming media, and gaming.

In traditional latency measurement, there are two types of latency parameters: round-trip time (RTT) and one-way delay (OWD). Different latency parameters are used for different service types. The RTT is used to evaluate the latency of TCP service interaction, and the OWD is used to evaluate the latency of UDP service interaction.

For common services with uplink and downlink interaction, the RTT is recommended to evaluate the service experience perceived by users.

Latency scene models are defined based on different service types, packet sizes, and air interface concurrency conditions.

6.5.1.2 Latency Scene Model 1: RTT in a Single-STA Interference-Free Environment

This model is used to measure the RTT of a single STA carrying services with different traffic volumes and packet sizes without interference. Figure 12 shows the scene model, requiring the following settings:

a. For a campus WLAN, the latency parameter refers to the latency from the LAN side of the AP to the STA. (During the latency test, shield the uplink ports of the AP and use the STA-side Ethernet ports for parameter testing.)

b. There are no other interference sources on the same frequency band in the environment, including Wi-Fi interference sources (such as other gateways or routers) and non-Wi-Fi interference sources (such as Bluetooth devices, cordless phones, and microwave ovens).

c. There are no obstacles between the STA and AP. The AP is ceiling mounted at a height of 3 m, and the STA is located within a range of 1 m below the AP.

d. The STA has two Tx/Rx antennas.

e. The traffic model for latency measurement is 1500 bytes + 80% load.

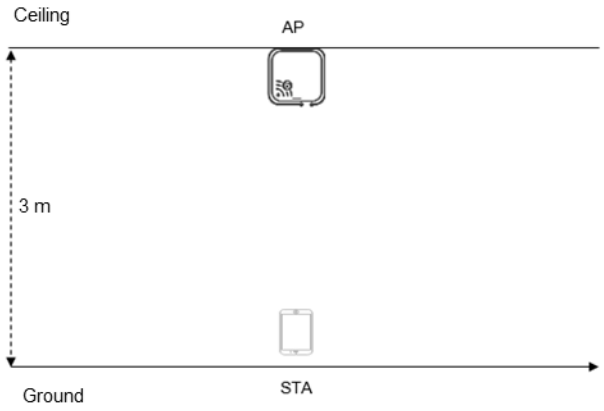

Figure 12 Single- STA RTT scene model

6.5.1.3 Latency Scene Model 2: RTT in a Multi-STA Interference-Free Environment

The carrier sense multiple access with collision avoidance (CSMA/CA) mechanism is used as the MAC layer scheduling mechanism of WLAN. As the number of STAs increases, the latency parameter deteriorates sharply. Therefore, performance evaluation in multi-STA concurrency scenarios is particularly important. Figure 13 shows the RTT scene model for multi-STA concurrency without interference, with the following requirements:

a. According to the survey and statistics on the number of STAs in the current campus office environment, the average number of concurrent STAs is 12. It is recommended that the number of STAs be set to 15 in the multi-STA concurrency latency measurement scenario.

b. For a campus WLAN, the latency parameter refers to the latency from the LAN side of the AP to the STA. (During the latency test, shield the uplink ports of the AP and use the STA-side Ethernet ports for parameter testing.)

c. There are no other interference sources on the same frequency band in the environment, including Wi-Fi interference sources (such as other gateways or routers) and non-Wi-Fi interference sources (such as Bluetooth devices, cordless phones, and microwave ovens).

d. There are no obstacles between the STA and AP. The AP is ceiling mounted at a height of 3 m, and the STA is located within a range of 10 m below the AP.

e. The STA has two Tx/Rx antennas.

f. The service traffic model for latency measurement is 1500 bytes + 15 concurrent STAs + 80% load.

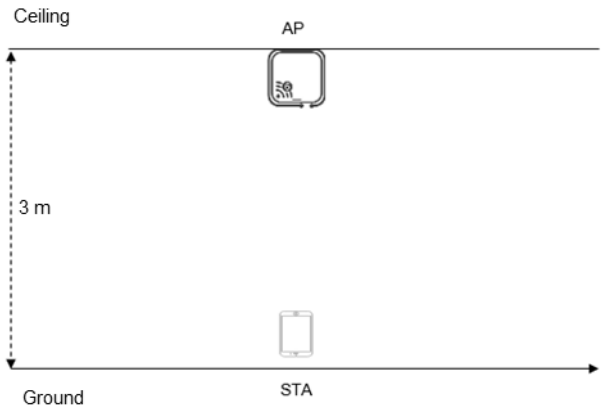

Figure 13 Multi-STA concurrency RTT scene model

6.5.1.4 Latency Scene Model 3: RTT in a Multi-STA Environment with Interference

Because the WLAN air interface is occupied by other interference signals, packet loss and retransmission occur during data transmission. Retransmission increases the latency. Figure 14 shows the RTT delay model for multi-STA concurrency with interference, with the following setting requirements:

a. According to the survey and statistics on the number of STAs in the general campus office environment, the average number of concurrent STAs is 12. It is recommended that the number of STAs be set to 15 in the multi-STA concurrency latency scene model.

b. For a campus WLAN, the latency parameter refers to the latency from the LAN side of the AP to the STA. (During the latency test, shield the uplink ports of the AP and use the STA-side Ethernet ports for parameter testing.)

c. There are no obstacles between the STAs and AP. The AP is ceiling mounted at a height of 3 m, and the STAs are located within a range of 10 m below the AP.

d. Each STA has two Tx/Rx antennas.

e. The interference source is defined as follows:

   - 5 GHz frequency band: 12 Mbps @ 1500-byte co-channel interference service flow, with the interference signal strength ranging from –65 dBm to –70 dBm
   - 2.4 GHz frequency band: 6 Mbps @ 1500-byte co-channel interference service flow, with the interference signal strength ranging from –65 dBm to –70 dBm

f. The service traffic model for latency measurement is 1500 bytes + 15 concurrent STAs + 80% load.

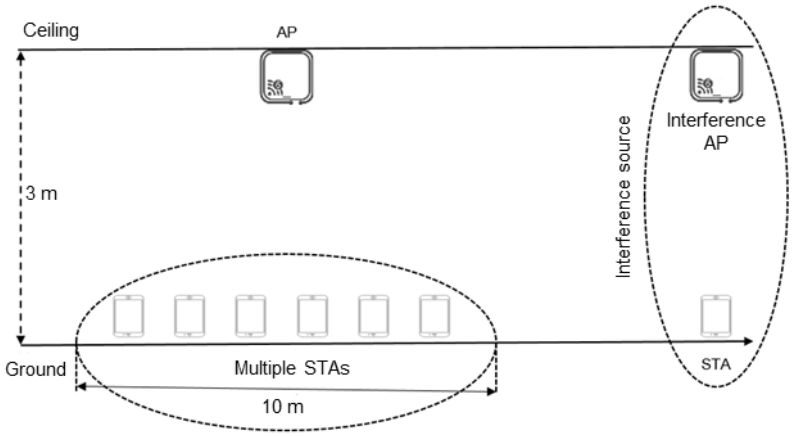

Figure 14 Multi-STA concurrency RTT scene model with interference

6.5.2 Latency Requirements

Table 9 lists the latency requirements of different service traffic volumes for a single STA without interference.

Table 9 Latency requirements for a single user in the absence of interference

NSS of the STA	Frequency Band (GHz)	Bandwidth (MHz)	Byte Length (Byte)	Traffic Volume (Mbps)	Average Downlink Latency (ms)
2	2.4	20	1500	145	≤ 6
2	2.4	40	1500	290	≤ 6
2	5	40	1500	290	≤ 6
2	5	80	1500	600	≤ 6
2	5	160	1500	1200	≤ 6

Table 10 lists the latency requirements of different service traffic volumes in a multi-STA interference-free environment.

Table 10 Latency requirements for a multi-STA interference-free environment

NSS of the STA	Frequency Band (GHz)	Bandwidth (MHz)	Byte Length (Byte)	Traffic Volume (Mbps/STA)	Average Downlink Latency (ms)	TP99 Latency (ms)
2	2.4	20	1500	7	≤ 15	≤ 20
2	5	40	1500	14	≤ 15	≤ 20
2	5	80	1500	30	≤ 15	≤ 20
2	5	160	1500	60	≤ 15	≤ 20

Table 11 lists the latency requirements of different service traffic volumes in a multi-STA interference environment.

Table 11 Latency requirements for a multi-STA interference environment

NSS of the STA	Frequency Band (GHz)	Bandwidth (MHz)	Byte Length (Byte)	Traffic Volume (Mbps/STA)	Average Downlink Latency (ms)	TP99 Latency (ms)
2	2.4	20	1500	6	≤ 40	≤ 80
2	5	40	1500	12	≤ 40	≤ 80
2	5	80	1500	25	≤ 40	≤ 80
2	5	160	1500	50	≤ 40	≤ 80

6.6 Security

6.6.1 Security Features and Network Security Protection

STAs on a WLAN are always exposed to network attacks. To defend against network attacks, network devices construct security mechanisms, which are classified into access security and system security. This document only describes requirements for device access security on a campus office network. The requirements of access security are described as follows:

Currently, a campus office network supports the following user access authentication and data encryption modes:

1. Wired Equivalent Privacy (WEP) authentication and encryption
2. Hybrid encryption, for example, Wi-Fi Protected Access (WPA) series + 802.1X authentication and encryption

   Note: For details about WPA, see normative reference document [2].
3. Portal authentication (web authentication)

6.6.2 Security Requirements

Table 12 lists the security requirements for APs.

Table 12 Security access requirements

Authentication Mode	Mandatory or Not
WPA	Yes
WPA2	Yes
WPA3	Yes
Portal	Yes

7 Typical Service Performance Requirements for a Campus Office Network

7.1 Performance Requirements for Multi-STA Concurrent Office Services

7.1.1 Scene Model for Multi-STA Concurrent Office Services

Multi-STA concurrent office services are the most typical application scenario of campus office services. The service model with the maximum number of concurrent STAs is used as the test and evaluation model. Figure 15 shows the scene model for multi-STA concurrent office services. APs are ceiling mounted at a height of 3 m. The distance between APs is 10 m to 12 m. The RSSI is greater than or equal to –65 dBm in 95% of the area. The distance between co-channel APs is 27 m on the 5 GHz frequency band with 40 MHz bandwidth. The main service types are as follows:

a. Wireless office services: video and voice conferencing, web browsing, email, etc.

b. Personal non-office services: video, gaming, instant messaging, etc.

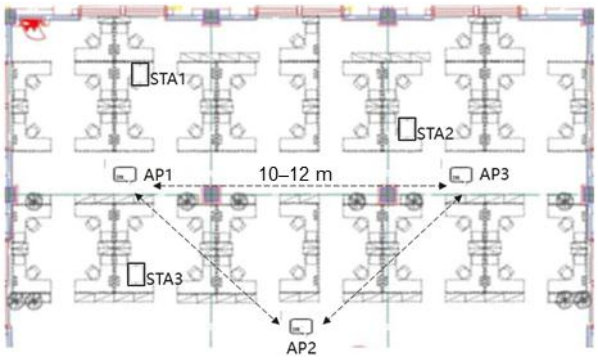

Figure 15 Multi- STA concurrent office environment

Based on the number of STAs within the coverage of a single device, there are light-load and heavy-load scenes.

A. Light load: 40 STAs connected to a single device; concurrency rate of 30%; typical services including simultaneous upload/download on 3 STAs and simultaneous video conferencing on 15 STAs

B. Heavy load: 80 STAs connected to a single device; concurrency rate of 30%; typical services including simultaneous upload/download on 10 STAs and simultaneous video conferencing on 30 STAs

C. Heavy load: 80 STAs connected to a single device; concurrency rate of 30%; typical services including simultaneous upload/download on 25 STAs and simultaneous video services on 5 STAs

7.1.2 Performance Requirements for Multi-STA Concurrent Office Services

Multi-STA concurrent office services are the most common model of campus office services. Table 13 and Table 14 list the KPI experience requirements for concurrent services in this scene model (Table 14 applies to IEEE 802.11be).

Table 13 Performance requirements for multi- STA concurrent office services (A. light load; B. heavy load)

Network Requirements	Service Requirements	Parameter Item	NSS of the AP	Parameter
Frequency band: 5 GHz Bandwidth: 40 MHz NSS of the STA: 2	Light load: Three STAs simultaneously download files using FTP on a single radio.	Total FTP download rate (Mbps)	2	≥ 360
			4	≥ 420
	Light load: 15 STAs hold a video conference on a single radio, and 3 STAs simultaneously download files using FTP.	Average RTT (ms)	-	≤ 200
		Proportion of long RTTs (> 1000 ms)	-	≤ 3%
		Packet loss ratio	-	≤ 3%
		Total FTP download rate (Mbps)	-	≥ 250
	Heavy load: 10 STAs simultaneously download files using FTP on a single radio.	Total FTP download rate (Mbps)	2	≥ 300
			4	≥ 360
	Heavy load: 30 STAs hold a video conference on a single radio, and 3 STAs simultaneously download files using FTP.	Average RTT (ms)	-	≤ 200
		Proportion of long RTTs (> 1000 ms)	-	≤ 3%
		Packet loss ratio	-	≤ 3%
		Total FTP download rate (Mbps)	-	≥ 150
	The distance between co-channel interference APs is 24 m. Seven STAs hold a video conference on a single radio of each AP, and three STAs simultaneously download files using FTP.	Average RTT (ms)	-	≤ 200
		Proportion of long RTTs (> 1000 ms)	-	≤ 3%
		Packet loss ratio	-	≤ 3%
		Total FTP download rate (Mbps)	2	≥ 400
		Total FTP download rate (Mbps)	4	≥ 480

Table 14 Performance requirements for multi-STA concurrent office services (C. heavy load)

Network Requirements	Service Requirements	Parameter Item	Parameter
Frequency band: 5 GHz Bandwidth: 40	Heavy load: 5 STAs hold a video conference on a single radio, and 25 STAs simultaneously	Average RTT of STAs	≤ 200
		Proportion of long RTTs (> 1000 ms)	≤ 3%

Network Requirements	Service Requirements	Parameter Item	Parameter
MHz NSS of the STA: 2	upload or download files using FTP.	Packet loss ratio	≤ 3%
		Total FTP upload/download rate (Mbps)	≥ 250

7.2 Performance Requirements for Mobile Office Services

7.2.1 Mobile Office Service Scene Model

Mobile office is a common office scenario, for example, users move from conference room 1 to conference room 2 during a video or voice conference. This document uses the service model with the maximum number of concurrent STAs as the test and evaluation environment. Figure 16 shows the scene model. APs are ceiling-mounted at an interval of 10 m to 12 m. The RSSI is greater than or equal to –65 dBm in 95% of the area, the area per person is 4–5 m^2, a single device is connected to 40 STAs, the concurrency rate is 30%, and STAs move within the coverage of different APs in the office area. The main service types are as follows:

a. Wireless office: video and voice conferencing, web browsing, email, etc.

b. Personal non-office services: video, gaming, instant messaging, etc.

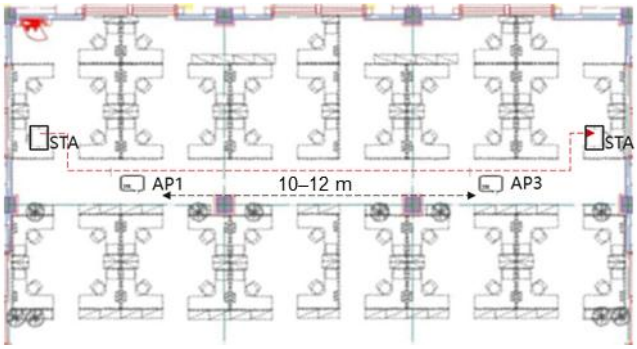

Figure 16 Mobile office environment

7.2.2 Performance Requirements for Mobile Office Services

Table 15 lists the performance requirements for mobile office services.

Table 15 Performance requirements for mobile office services

Network Requirements	Service Requirements	Parameter Item	NSS of the AP	Parameter
Frequency band: 5 GHz Bandwidth: 40 MHz	The distance between two APs is 12 m. On a single radio of each AP, 15 STAs run video conferencing and 1 STA downloads files	Average RTT (ms)	-	≤ 200
		Proportion of long RTTs (> 1000 ms)	-	≤ 3%
		Packet loss ratio	-	≤ 3%

Network Requirements	Service Requirements	Parameter Item	NSS of the AP	Parameter
NSS of the STA: 2	using FTP. The STAs move between the two APs at a speed of 0.5 m/s.	FTP download rate (Mbps)	-	≥ 120

7.3 Performance Requirements for Concurrent Access of Heavy-Load Video Services

7.3.1 Scene Model of Concurrent Access of Heavy-Load Video Services

In typical application environments (for example, canteens) of concurrent access of heavy-load video services, a large number of STAs run the same service (for example, watching videos) simultaneously. The network needs to provide a large amount of bandwidth and a low packet loss rate. This document uses the maximum number of concurrent STAs as the service model. Figure 17 shows the environment model. APs are ceiling-mounted at an interval of 15 m to 18 m. The RSSI is greater than or equal to –65 dBm in 95% of the area. The area per person is 4–5 m^2. A single device is connected to 60 STAs, and the concurrency rate is 50%. The main service types are web browsing, live broadcast, HD video, and instant messaging.

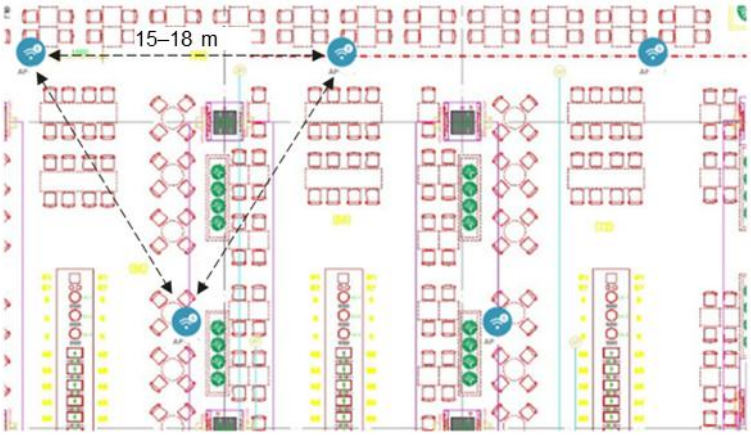

Figure 17 Environment for concurrent access of heavy-load video services

7.3.2 Performance Requirements for Concurrent Access of Heavy-Load Video Services

Table 16 lists the performance requirements for concurrent access of heavy-load video services.

Table 16 Performance requirements for concurrent access of heavy-load video services

Network Requirements	Service Requirements	Parameter Item	NSS of the AP	Parameter
Frequency band: 5 GHz Bandwidth: 40 MHz NSS of the STA: 2	Maximum number of video access STAs on a single radio	Average RTT (ms)	-	≤ 200
		Proportion of long RTTs (> 1000 ms)	-	≤ 0.5%
		Packet loss ratio	-	≤ 3%
		Number of access STAs	-	≥ 30

Appendix A (Normative): IEEE 802.11be Test Item Description in Technical Specification for Campus Office WLAN Performance and Experience (Based on IEEE 802.11be)

A.1 Optional/Mandatory Setting Requirements in Technical Specification for Campus Office WLAN Performance and Experience (Based on IEEE 802.11be)

See Table A.1.

Table A.1 IEEE 802.11be optional/mandatory setting requirements in this document

Chapter	Section	Category							
6 Basic Performance Requirements of Campus Office Network Devices	6.1.2 Bandwidth	Maximum performance requirements for a single-band single-STA scenario	NSS of the STA	Frequency Band (GHz)		Bandwidth (MHz)		DL Throughput (Mbps)	UL Throughput (Mbps)	Mandatory or Not
			2	2.4		20		≥ 260	≥ 260	No
			2	2.4		40		≥ 520	≥ 520	No
			2	5		40		≥ 520	≥ 520	Yes
			2	5		80		≥ 1040	≥ 1040	Yes
			2	5		160		≥ 2000	≥ 2000	Yes
		Maximum performance requirements for concurrent access of two STAs on multiple frequency bands	NSS of the STA	Band 1 (GHz)	Bandwidth 1 (MHz)	Band 2 (GHz)	Bandwidth 2 (MHz)	DL Throughput (Mbps)	UL Throughput (Mbps)	Mandatory or Not
			2	2.4	20	5	20	≥ 520	≥ 520	No
			2	2.4	20	5	40	≥ 780	≥ 780	No
			2	2.4	40	5	80	≥ 1520	≥ 1520	No
			2	2.4	40	5	160	≥ 2520	≥ 2520	No
		Maximum performance requirements for the single-band MU-MIMO scene model	NSS of the AP	NSS of the STA		Frequency Band (GHz)		Bandwidth (MHz)	DL Throughput (Mbps)	Mandatory or Not
			4	2		5		40	≥ 570	Yes
			4	2		5		80	≥ 1100	Yes

Chapter	Section	Category								
		Bandwidth performance requirements of the single-STA MLO scene model	NSS of the STA	Frequency Band (GHz)	Bandwidth (MHz)	Frequency Band (GHz)	Bandwidth (MHz)	DL Throughput (Mbps)		Mandatory or Not
			2	2.4	20	5	40	≥ 780		No
			2	2.4	40	5	80	≥ 1520		No
			2	5	40	5	40	≥ 1080		Yes
			2	5	80	5	160	≥ 3000		Yes
	6.2.2 Connection	Performance requirements of the single-band multi-STA concurrent throughput scene model	NSS of the AP	NSS of the STA	Frequency Band (GHz)	Bandwidth (MHz)	10 Concurrent STAs Total/Min Throughput	20 Concurrent STAs Total/Min Throughput	30 Concurrent STAs Total/Min Throughput	Mandatory or Not
			2	2	5	40	≥ 330/16	≥ 310/7	≥ 260/4	Yes
			2	2	5	80	≥ 660/33	≥ 620/15	≥ 520/8	Yes
			2	2	5	160	≥ 1280/64	≥ 1200/30	≥ 1000/16	Yes
			4	2	5	40	≥ 415/20	≥ 360/9	≥ 310/5	Yes
			4	2	5	80	≥ 830/41	≥ 720/18	≥ 620/10	Yes
			4	2	5	160	≥ 1600/80	≥ 1400/35	≥ 1200/20	Yes
	6.3.2 Coverage	Coverage performance requirements in scenarios of single-STA at an LOS distance of 10 m or 20 m without obstacles	NSS of the AP	NSS of the STA	Frequency Band (GHz)	Bandwidth (MHz)	Downlink Throughput @ 10 m LOS Coverage	Downlink Throughput @ 20 m LOS Coverage	Downlink Throughput @ 10 m Distance + Penetrating One Wall	Mandatory or Not
			2	2	2.4	20	≥ 230	≥ 195	≥ 130	No
			2	2	2.4	40	≥ 430	≥ 350	≥ 230	No
			2	2	5	40	≥ 390	≥ 310	≥ 180	Yes

Chapter	Section	Category							
		and single-STA wall-penetration	2	2	5	80	≥ 720	≥ 540	≥ 270	Yes
			2	2	5	160	≥ 1300	≥ 970	≥ 340	Yes
			4	2	2.4	20	≥ 260	≥ 215	≥ 150	No
			4	2	2.4	40	≥ 460	≥ 390	≥ 260	No
			4	2	5	40	≥ 430	≥ 350	≥ 220	Yes
			4	2	5	80	≥ 810	≥ 650	≥ 380	Yes
			4	2	5	160	≥ 1440	≥ 1080	≥ 540	Yes
		Coverage performance requirements of single-STA at an LOS distance of 5 m without obstacle	NSS of the AP	NSS of the STA		Frequency Band (GHz)		Bandwidth (MHz)	Downlink Throughput @ 5 m LOS Coverage	Mandatory or Not
			2	2		5		80	≥ 900	Yes
			2	2		5		160	≥ 1620	Yes
			4	2		5		80	≥ 970	Yes
			4	2		5		160	≥ 1800	Yes
	6.4.2 Roaming	Roaming performance requirements	NSS of the AP	NSS of the STA		Frequency Band (GHz)	Bandwidth (MHz)	Minimum Throughput During Roaming	Average Throughput During Roaming	Mandatory or Not
			2	2		2.4	20	≥ 20	≥ 120	No
			2	2		2.4	40	≥ 35	≥ 210	No
			2	2		5	40	≥ 35	≥ 21	Yes
			2	2		5	80	≥ 60	≥ 350	Yes
			2	2		5	160	≥ 100	≥ 610	Yes
			4	2		2.4	20	≥ 25	≥ 140	No
			4	2		2.4	40	≥ 40	≥ 240	No
			4	2		5	40	≥ 40	≥ 240	Yes
			4	2		5	80	≥ 70	≥ 400	Yes
			4	2		5	160	≥ 120	≥ 660	Yes

Chapter	Section	Category							
	6.5.2 Latency	Latency requirements for a single STA without interference	NSS of the STA	Frequency Band (GHz)		Bandwidth (MHz)	Byte Length (Byte)	Traffic Volume (Mbps)	Average Downlink Latency (ms)	Mandatory or Not
			2	2.4		20	1500	145	≤ 6	No
			2	2.4		40	1500	290	≤ 6	No
			2	5		40	1500	290	≤ 6	Yes
			2	5		80	1500	600	≤ 6	No
			2	5		160	1500	1200	≤ 6	No
		Latency requirements for a multi-STA interference-free environment	NSS of the STA	Frequency Band (GHz)	Bandwidth (MHz)	Byte Length (Byte)	Traffic Volume (Mbps/STA)	Average Downlink Latency (ms)	TP99 Latency (ms)	Mandatory or Not
			2	2.4	20	1500	7	≤ 15	≤ 20	No
			2	5	40	1500	14	≤ 15	≤ 20	Yes
			2	5	80	1500	30	≤ 15	≤ 20	Yes
			2	5	160	1500	60	≤ 15	≤ 20	Yes
		Latency requirements for a multi-STA interference environment	NSS of the STA	Frequency Band (GHz)	Bandwidth (MHz)	Byte Length (Byte)	Traffic Volume (Mbps/STA)	Average Downlink Latency (ms)	TP99 Latency (ms)	Mandatory or Not
			2	2.4	20	1500	6	≤ 40	≤ 80	No
			2	5	40	1500	12	≤ 40	≤ 80	Yes
			2	5	80	1500	25	≤ 40	≤ 80	Yes
			2	5	160	1500	50	≤ 40	≤ 80	Yes
7 Typical Service Performance Requirements for a Campus Office Network	7.1.2 Multi-STA concurrent office	All test cases are mandatory.								
	7.2.2 Mobile office	All test cases are mandatory.								

Chapter	Section	Category	
	7.3.2 Concurrent access of heavy-load video services	All test cases are mandatory.	

Appendix B (Informative): Reference Values of Signal Attenuation Caused by Common Obstacles

B.1 Reference Values of Signal Attenuation Caused by Common Obstacles

See Table B.1.

Table B.1 Reference values of signal attenuation caused by common obstacles

No.	Common Obstacle	Thickness (mm)	2.4 GHz Signal Attenuation (dB)	5 GHz Signal Attenuation (dB)
1	Common brick wall	120	10	20
2	Thick brick wall	240	15	25
3	Concrete	240	25	30
4	Asbestos	8	3	4
5	Foam materials	8	3	4
6	Hollow wood	20	2	3
7	Common wooden door	40	3	4
8	Solid wooden door	40	10	15
9	Common glass	8	4	7
10	Thick glass	12	8	10
11	Armored glass	30	25	35
12	Load-bearing pillar	500	25	30
13	Shutter door	10	15	20
14	Steel plate	80	30	35
15	Elevator	80	30	35

Appendix C (Informative): Common Services and Service Proportions in Campus Office Scenarios

C.1 Common Services and Service Proportions in Campus Office Scenarios

See Table C.1.

Table C.1 Description and proportions of common services in campus office scenarios

Service Type	**Single-Service Baseline Rate (Mbps)**	**Proportion of Services in Office Scenarios**						
		High-Density Office Area	**Common Office Area**	**Conference room**	**High-Density Office Area**	**Exhibition hall**	**Restaurant**	**High-Density Office Area**
HD video	16	10%	10%	0%	40%	0%	50%	20%
Video conferencing	4	30%	30%	0%	0%	0%	0%	0%
E-whiteboard (wireless projection)	8	10%	10%	30%	0%	10%	0%	0%
Email	16	10%	10%	30%	0%	30%	0%	10%
Web browsing	4	10%	10%	20%	20%	30%	20%	20%
Gaming	1	0%	0%	0%	10%	0%	0%	20%
Instant messaging	0.5	20%	20%	20%	20%	30%	20%	20%
VoIP	0.5	10%	10%	0%	10%	0%	10%	10%

Appendix D (Informative): New Content Description in Technical Specification for Campus Office WLAN Performance and Experience (Based on IEEE 802.11be)

D.1 Definitions and Technical Requirements of New Scene Models in Technical Specification for Campus Office WLAN Performance and Experience (Based on IEEE 802.11be)

See Table D.1.

Table D.1 New content in this specification

New Content Description	Position
Added the abbreviation MLO, short for multi-link operation.	4. Acronyms and Abbreviations
Added the bandwidth scene model: interference-free single-STA MLO.	6.1.1.5
Added the bandwidth requirement: single-STA MLO bandwidth performance requirement.	Table 4
Added the coverage scene model: single-STA at an LOS distance of 5 m without obstacles.	6.3.1.4
Added the coverage requirement: single-STA at an LOS distance of 5 m without obstacle.	Table 7
Added the multi-STA concurrent office service scenario: C. heavy load.	7.1.1
Added the performance requirement for multi-STA concurrent office service scenario: C. heavy load.	Table 14

References

[1] IEEE 802.11ax-2021 - IEEE Standard for Information Technology--Telecommunications and Information Exchange between Systems Local and Metropolitan Area Networks--Specific Requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 1: Enhancements for High-Efficiency WLAN

[2] IEEE P802.11be™/D6.0 Draft Standard for Information technology Telecommunications and information exchange between systems Local and metropolitan area networks— Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 2: Enhancements for extremely high throughput (EHT)