ZyXEL

Best Practice for Smart Classroom Deployments

This deployment guide is designed to embody insights and lessons learned from real-world deployment experience to help maximizing the success designing, implementing and operating a ZyXEL Smart Classroom scenario with smooth wireless access. The guideline applies to ZyXEL Dual Band Concurrent 802.11n and 802.11ac Indoor Access Point series, including NWA3560-N, NWA5123-NI, WAC6502D-E, WAC6502D-S and WAC6503D-S.

INDEX

Planning Considerations

As access point throughput allocated to each user is being determined, a common mistake is using theoretical bitrates to estimate the throughput an AP can actually allocate to individual users. Take an 802.11n 2x2 dual-band AP as an example: the theoretical throughput is up to 300Mbps per band, which adds up to 600 Mbps (300Mbps x 2); in an application scenario of a classroom with 30 students, it would be mistakenly estimated as that each AP is capable of offering up to 20Mbps to each user (600Mbps/30 students).

However, several factors such as protocol/packet overhead, slow or weak signal client, channel interference or peer-to-peer applications would significantly reduce the actual AP throughput for 30% ~ 50% from the theoretical performance.

■ **Determining the baseline of bandwidth requirements**

In average, a typical wireless user consumes about 300 to 500 Kbps of bandwidth. For general purposes such as Internet surfing and data access, 1-2 Mbps per user is a reasonable assumption in AP capacity planning. In a smart classroom scenario, key applications could be voice, video and online testing systems; depending on video resolution, the throughput requirement varies from 2-4Mbps per user. As a result, a reasonable assumption for video applications is about 5-10Mbps per user, including the protocol/packet overhead buffer. Nevertheless, it is critical and highly recommended for administrators to understand the application type, bandwidth requirement for each application and target throughput available to each user.

■ **Determining wireless coverage**

As the 2.4GHz frequency is usually crowded and can be easily interfered by cordless phones, microwaves and adjacent APs, the rule of thumb is to use three non-overlapping frequencies, channels 1, 6 and 11, to prevent signal competition. In contrast, since the 5GHz has 23 non-overlapping frequencies (the actual number varies by country), it is always highly recommended to use dual-band concurrent access points (2.4GHz and 5 GHz) to maximize the available throughput for users, so the wireless network capacity can be truly increased and each AP would not interfere with its neighbors.

Guidelines for deploying a smooth, reliable wireless network in a high-density smart classroom environment

To ensure an instant, non-stop wireless access, two access points deployed in each classroom is fundamental and crucial for a digital curriculum. As students access digital materials in the class, the load-balancing feature distributes wireless traffic between two APs to relieve loading for the network. On the other hand, should one AP fails to function, the other would instantly take over the services to ensure a non-stop wireless access experience for smart classroom environments.

Physical Hardware Installation
- Two or more APs per classroom to ensure non-stop wireless services;
- Keep the distance between each pair of APs three meters or more to minimize RF interference;
- Ceiling mount is highly recommended for AP installation. The APs shall be fixed in the deployed environment without being moved around.

Design and Deployment Setup
- Application types and throughput requirements;
- Number of students covered by two or more APs per classroom;
- The number of APs deployed in each classroom based on the estimated total bandwidth per classroom against the baseline of AP performance;
- Advanced load-balancing feature is enabled to prevent unbalanced load sharing among APs;
- Optimization and constraint of traffic communications via the backhaul switch between two load-balancing APs in the same classroom.

Configuration Example
The following steps demonstrate how to configure the advanced load-balancing feature for optimized, balanced network performance.

Deployment Scenario

- With an assumed number of 20 students per classroom

- Total bandwidth requirement is about 40 to 60 Mbps per classroom

- Two APs per classroom and advanced load balancing is enabled between the two APs.

- One unified SSID for all APs in the campus, and students are expected to associate with their own APs in same classroom.

- If there is high bandwidth requirement of more than 100 Mbps such as media classroom, WAC6500 Series is better choice especially for high density environments.
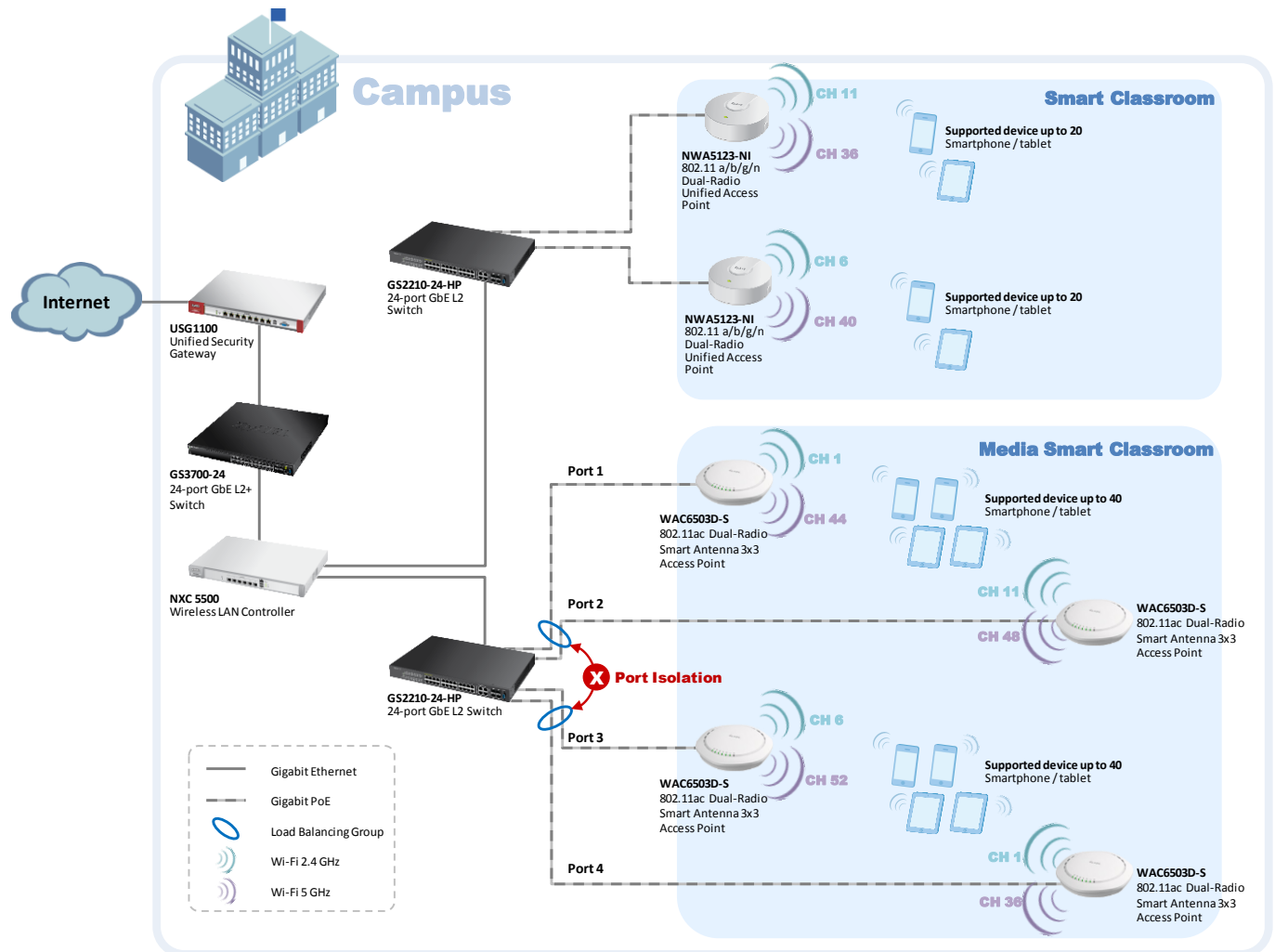
Configuration Steps

To limit the coverage of each AP for users to connect to the AP in their own classrooms, it is useful to decrease AP output power for 50-25% to restrain the range.

NXC5500

1. Create a radio profile and define the SSID profile for both 2.4G and 5G band.
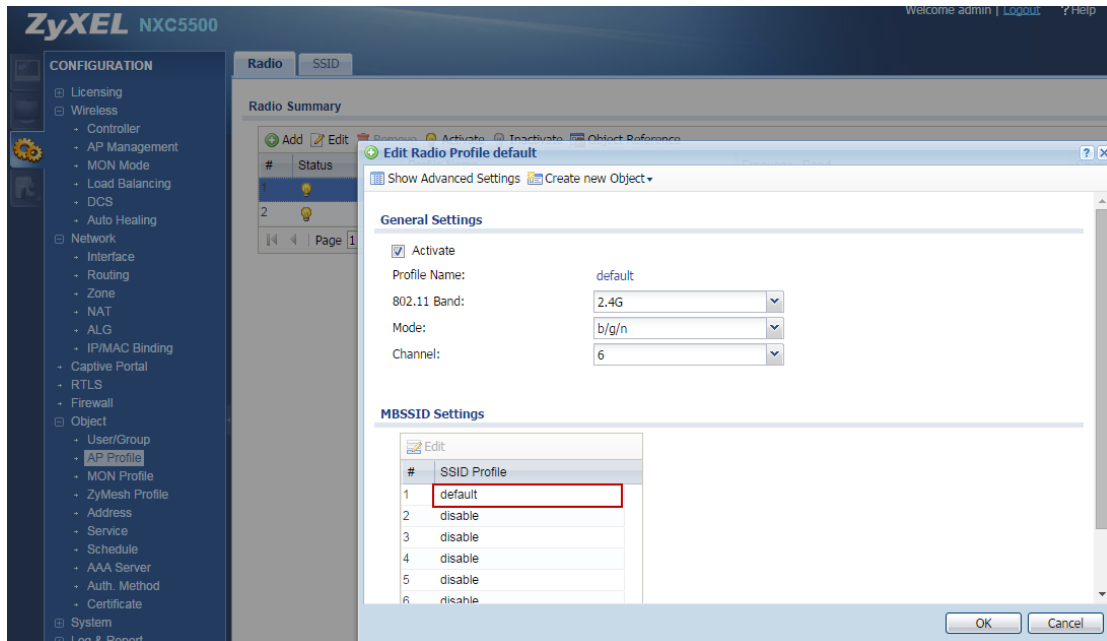
2. Apply the radio profile for AP.
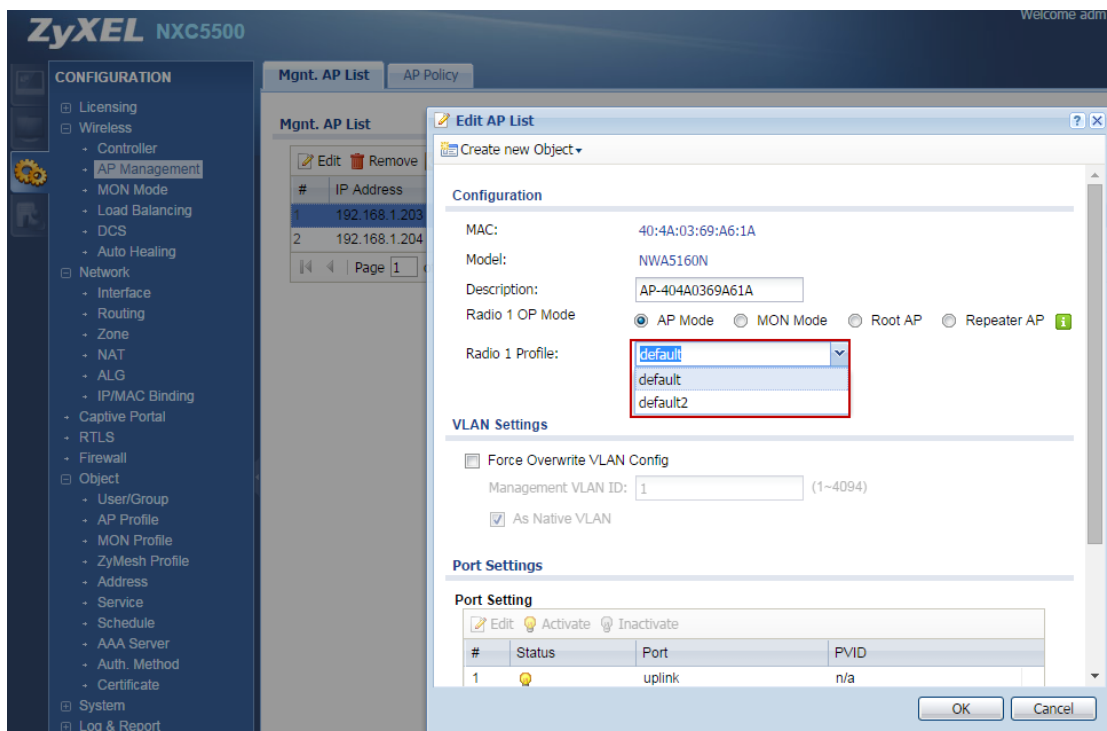
3. Enable load balancing by station number to utilize RF resource efficiently. (image)
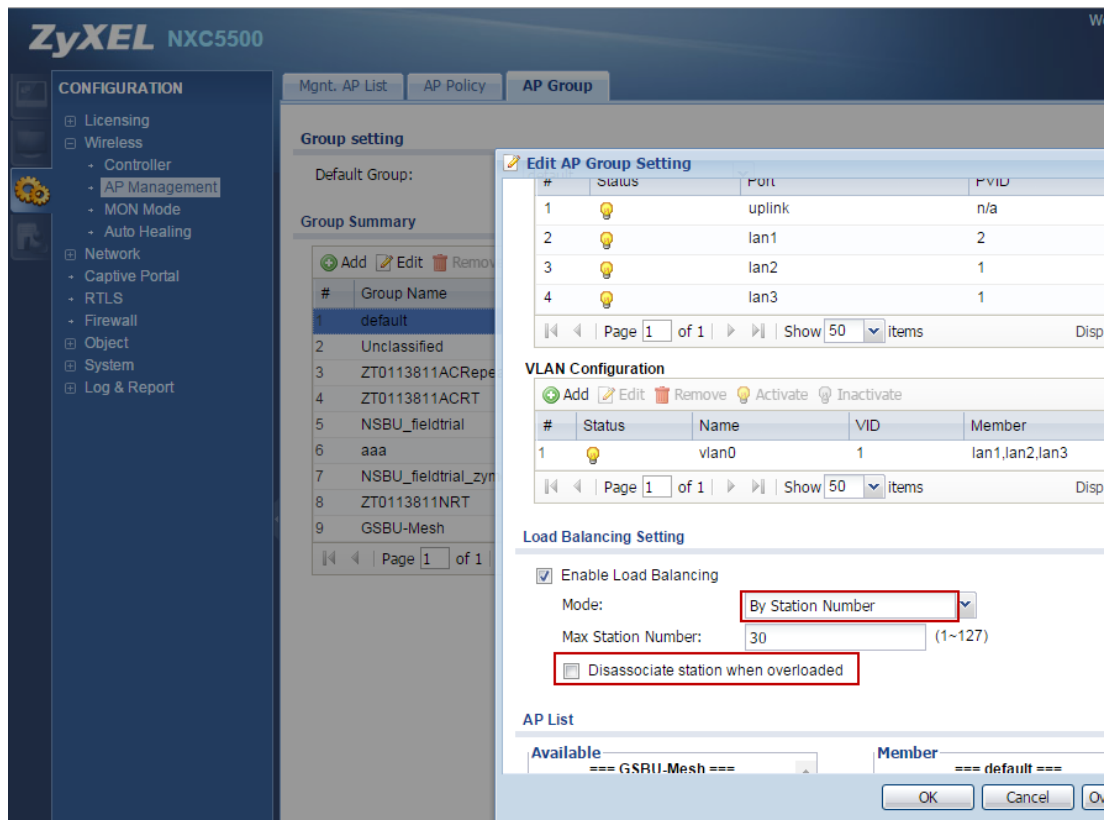
4. Enable DCS to select an available channel automatically.
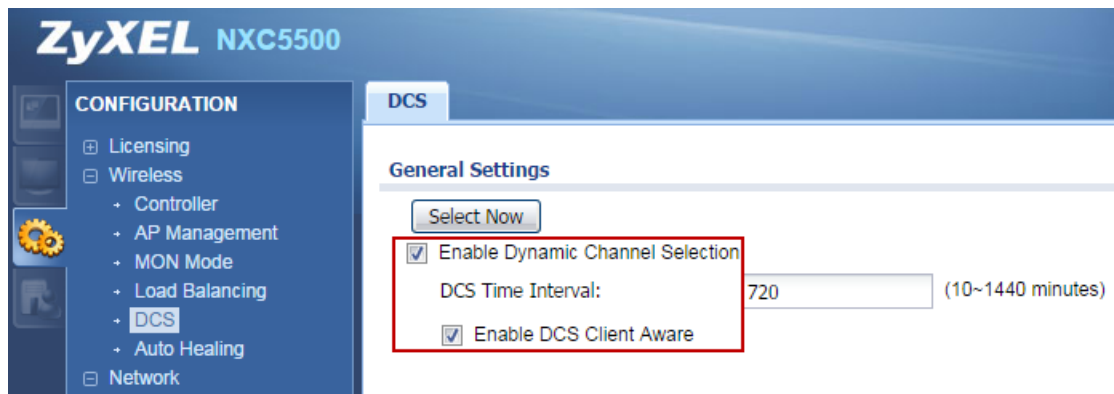
5. Adjust output power to 0~30 dBm

Other Consideration:

To prevent bandwidth abuse by clients using peer-to-peer downloading applications under some circumstances, it is highly recommended to enable the rate limit function on the network gateway. If the function is not available, rate limitation can be enabled on the NXC controller per SSID as an alternative.

The following screenshot illustrates the 2Mbps Internet access rate limitation for each student.

Enable rate limiting (GUI > configuration > Object > SSID) to restrain the throughput per station associated on the same SSID.
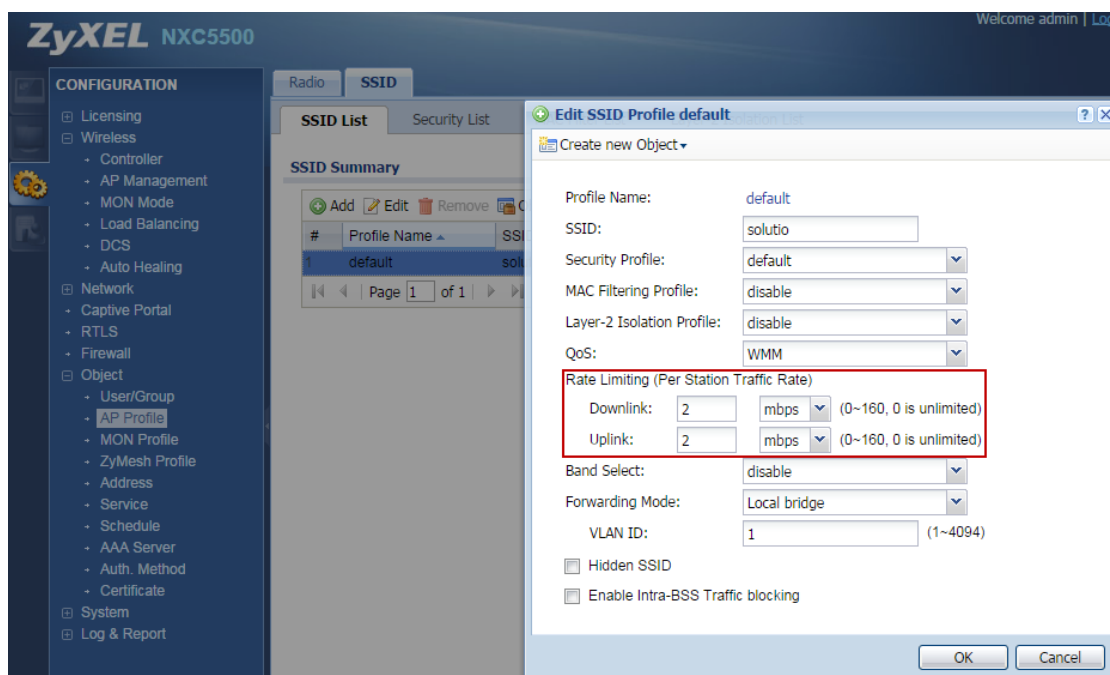
PoE switch

1. Port isolation configuration on switch

   GUI > basic setting > switch setup, select "Port Based".

2. GUI > advanced application > VLAN

   Configure port isolation, assuming Port 11 and 12 are in the same group and port 1 is reserved for the application server while Port 24 is reserved for uplink traffics.


With this method, user can flexibly decide which areas need to have load-balancing group applied, and those don't, through switch setting.

Test Report

Scenario A

In Smart Classroom deployment, typically there are two APs enabling load balancing feature. Thus, the test results based on single AP is able to provide a performance overview for Smart Classroom scenario. Taking the scenario of a classroom with 30 students, one AP serves for 15 students, the performance data of "1AP*15 tablets w/5G" can be as a reference. Depending on the file size of e-learning materials and tablet capability for wireless band support, the download speed will vary. If the tablet is 802.11ac capable, ZyXEL WAC6500 series AP is recommended to use and customers can benefit more than 50% faster download time compared to 802.11n AP models.

Topology:
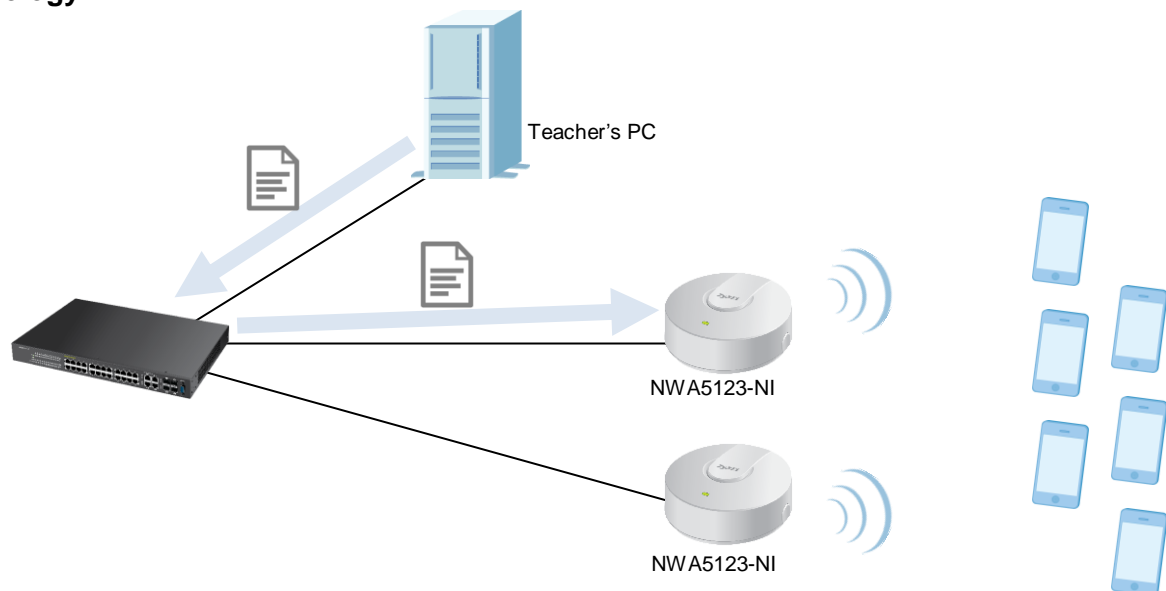
Test Results:

Test Condition	Download 50MB file	Download 100MB file	Download 150MB file	Download 200MB file
1AP*15 tablets w/5G	4m15s	8m	12m40s	16m30s
1AP*20 tablets w/5G	5m20s	10m50s	17m50s	22m30s
1AP*30 tablets w/5G	8m10s	19m30s	26m40s	31m50s

Scenario B

20 tablet computers play YouTube video streams in a 2.4G environment. The video quality level that can be downloaded successfully and completely on all tablets is observed.

Topology:
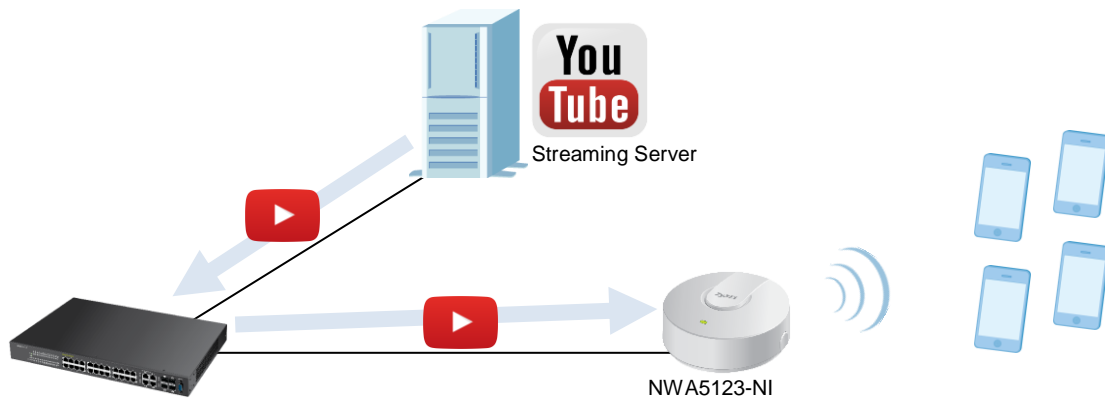
Test Results:

Test Environment	Video Bitrates	Test Results
1AP*20PAD	800kbps	Pass
	1.3Mbps	Pass
	2.1Mbps	Fail
	3.9Mbps	Fail

Pass: all tablets play video completely.

Fail: download on any of the tablets gets stuck.

YouTube video quality reference table:

YouTube suggested bitrates	
Quality	**Video bitrates**
1080p	8,000 kbps
720p	5,000 kbps
480p	2,500 kbps
360p	1,000 kbps

Source:

YouTube : https://support.google.com/youtube/answer/1722171?hl=en