

## 第四章無線網路規格

### 4.1 無線網路標準

國際上無線網路標準都是在 IEEE 802.11 項下，筆者在 1997 年即開始使用無線網路，當時的理論速率是 2Mbit/s，以下列出市面上常見的無線網路標準：

IEEE 802.11，1997 年，原始標準（2Mbit/s，播在 2.4GHz）。

IEEE 802.11a，1999 年，實體層補充（54Mbit/s，播在 5GHz）。

IEEE 802.11b，1999 年，實體層補充（11Mbit/s，播在 2.4GHz）。

IEEE 802.11g，2003 年，實體層補充（54Mbit/s，播在 2.4GHz）。

IEEE 802.11n，更高傳輸速率的改善，基礎速率提升到 72.2Mbit/s，可以使用雙倍頻寬 40MHz，此時速率提升到 150Mbit/s。支援多輸入多輸出技術（Multi-Input Multi-Output，MIMO）。

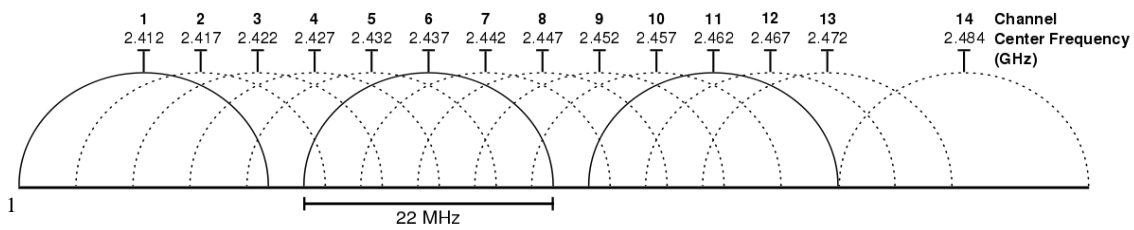
IEEE 802.11ac，2014 年，更高傳輸速率的改善，當使用多基站時將無線速率提高到至少 1Gbps，將單信道速率提高到至少 500Mbps。使用更高的無線頻寬（80MHz-160MHz，802.11n 只有 40MHz），更多的 MIMO 流（最多 8 條流），更好的調制方式（QAM256）。

802.11 無線網路標準							
802.11 協定	發行	頻段 (GHz)	頻寬 (MHz)	每條流速率 (Mbits/s)	MIMO 支援	距離(M)	
						室內	室外
-	1997.06	2.4	20	2	N/A	20	100
a	1999.09	5	20	54	N/A	35	120
b	1999.09	2.4	20	11	N/A	35	140
g	2003.06	2.4	20	54	N/A	38	140
n	2009.10	2.4/5	20	72.2	4	70	250
			40	150			
ac	2014.01	5	20	87.6	8	35	120
			40	200			
			80	433.3			
			160	866.7			

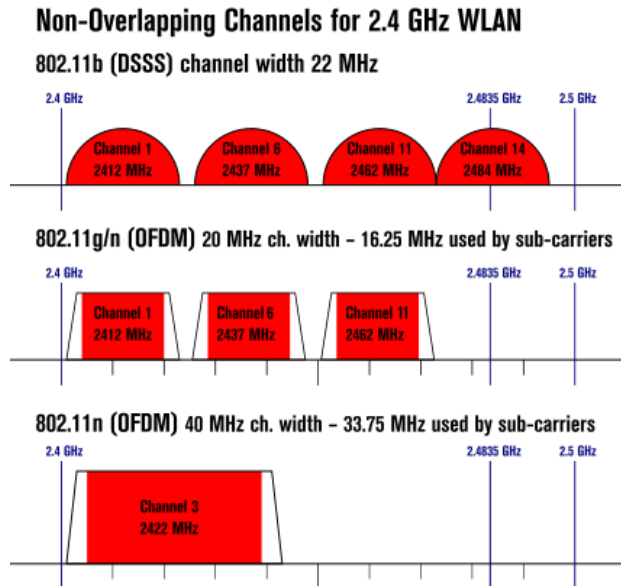
### 4.2 無線網路頻道

2.4GHz 部分：

這個部分共計有 14 個頻道，每個頻道使用 20MHz 的頻寬，另外需要 2MHz 的間隙，但每個頻道只間隔 5MHz，所以許多頻道是互相重疊的，因此 2.4GHz 14 個頻道最多就只有 1、6、11、14 等 4 個乾淨的頻道可用，如下圖所示。



目前台灣只開放頻道 1-11，所以在台灣只有 1、6、11 共 3 個乾淨的頻道可用。如果要用 802.11n 的 40 MHz 傳輸就只有 1 個頻道可用，如右圖<sup>2</sup>所示。



### 5GHz 部分：

國際上可以使用的 5G 的頻道有：

Band1:5150MHz~5250MHz，CH36、CH40、CH44、CH48。

Band2:5250MHz~5350MHz，CH52、CH56、CH60、CH64。

Band3:5470MHz~5725MHz，CH100、CH104、CH108、CH112、CH116、CH120、CH124、CH128、CH132、CH136、CH140。

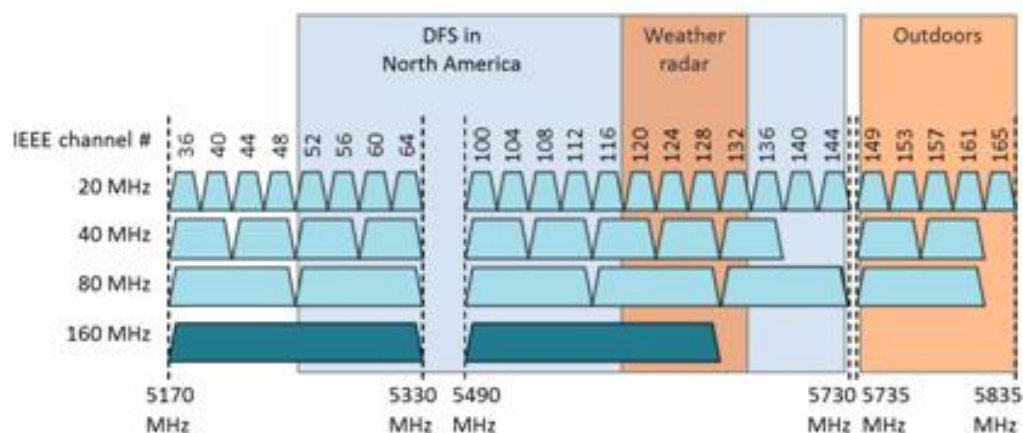
Band4:5725MHz~5850MHz，CH149、CH153、CH157、CH161、CH165。

每個頻道都具有不重疊的 20MHz 頻寬，所以 20MHz 頻寬的頻道共有 24 個，40MHz 頻寬的頻道共有 11 個，80MHz 頻寬的頻道共有 6 個，160MHz 頻寬的頻道共有 2 個。(如下圖<sup>3</sup>所示)

<sup>1</sup>"2.4 GHz Wi-Fi channels (802.11b,g WLAN)" 由 Michael Gauthier, Wireless Networking in the Developing World - I created this work based on Image:2.4\_GHz\_Wi-Fi\_channels\_(802.11b,g\_WLAN).png。使用來自維基共享資源 - [http://commons.wikimedia.org/wiki/File:2.4\\_GHz\\_Wi-Fi\\_channels\\_\(802.11b,g\\_WLAN\).svg#mediaviewer/File:2.4\\_GHz\\_Wi-Fi\\_channels\\_\(802.11b,g\\_WLAN\).svg](http://commons.wikimedia.org/wiki/File:2.4_GHz_Wi-Fi_channels_(802.11b,g_WLAN).svg#mediaviewer/File:2.4_GHz_Wi-Fi_channels_(802.11b,g_WLAN).svg) 的創用 CC 姓名標示-相同方式分享 3.0 條款授權。

<sup>2</sup> "NonOverlappingChannels2.4GHz802.11-en"由 Rbeede, Liebeskind (original)- <https://commons.wikimedia.org/wiki/File:NonOverlappingChannels2.4GHzWLAN-en.svg>。使用來自維基共享資源-<http://commons.wikimedia.org/wiki/File:NonOverlappingChannels2.4GHz802.11-en.svg#mediaviewer/File:NonOverlappingChannels2.4GHz802.11-en.svg> 的知識共享署名 3.0 條款授權

<sup>3</sup> 來源 <http://blog.merunetworks.com/blog/2013/07/why-other-vendors-are-recommending-deployment-of-802-11ac-in-40-mhz-channels/>



台灣地區根據 NCC 釋出的資料，台灣開放下列 4 個<sup>4</sup>5GHz 頻段(5.15-525 GHz, 5.25-5.35 GHz, 5.47-5.725 GHz, 5.725-5.85 GHz)：

1. Band1: CH36 5180MHz、CH40 5200MHz、CH44 5220MHz、CH48 5240MHz。
2. Band2: CH52 5260MHz、CH56 5280MHz、CH60 5300MHz、CH64 5320MHz
3. Band3: CH100 5500MHz、CH104 5520MHz、CH108 5540MHz、CH112 5560MHz、CH116 5580MHz、CH120 5600MHz、CH124 5620MHz、CH128 5640MHz、CH132 5660MHz、CH136 5680MHz、CH140 5700MHz
4. Band4: CH149 5745MHz、CH153 5765MHz、CH157 5785MHz、CH161 5805MHz、CH165 5825MHz

其中 5470~5725MHz 這個頻段與軍方和氣象用都普勒雷達頻率相衝突，在軍方優先民間次之的邏輯下，若是要使用這些頻率，就必須搭載 DFS 和 TPC (EIRP 值大於 500mW 之設備) 功能，當裝置感測到目前頻率有其它人在使用時，必須能夠跳開改採其它頻率；而 5250~5350MHz 不具備 DFS 時只能在室內使用。(台灣相關規範可上 NCC 搜尋「低功率射頻電機技術規範」)

### 4.3 無線網路接收靈敏度

2.4GHz:

- 11b 1Mbps: -99dBm
- 11b 11Mbps: -91dBm
- 11g 6Mbps: -94dBm
- 11g 54Mbps: -77dBm
- 11n HT20 MCS0: -95dBm
- 11n HT20 MCS7: -76dBm
- 11n HT40 MCS0: -92dBm
- 11n HT40 MCS7: -73dBm

<sup>4</sup> 中華民國無線電頻率分配表。 <http://motclaw.motc.gov.tw/s.aspx?soid=4907>。

5GHz :

MCS 索引	調變種類	編碼率	20MHz	40MHz	80MHz	160MHz
			800ns GI	800ns GI	800ns GI	800ns GI
0	BPSK	1/2	-82	-79	-76	-73
1	QPSK	1/2	-79	-76	-73	-70
2	QPSK	3/4	-77	-74	-71	-68
3	16-QAM	1/2	-74	-71	-68	-65
4	16-QAM	3/4	-70	-67	-64	-61
5	64-QAM	2/3	-66	-63	-60	-57
6	64-QAM	3/4	-65	-62	-59	-56
7	64-QAM	5/6	-64	-61	-58	-55
8	256-QAM	3/4	-59	-56	-53	-50
9	256-QAM	5/6	-57	-54	-51	-48

#### 4.4 無線網路速率

802.11g、802.11a :

20MHz : 6Mbps、9Mbps、11Mbps、12Mbps、18Mbps、24Mbps、36Mbps、48Mbps、54Mbps

802.11n、802.11ac :

MCS 索引	調變種類	編碼率	20MHz		40MHz		80MHz <sup>5</sup>		160MHz <sup>6</sup>	
			800ns	400ns	800ns	400ns	800ns	400ns	800ns	400ns
0	BPSK	1/2	6.5	7.2	13.5	15	29.3	32.5	58.5	65
1	QPSK	1/2	13	14.4	27	30	58.5	65	117	130
2	QPSK	3/4	19.5	21.7	40.5	45	87.8	97.5	175.5	195
3	16-QAM	1/2	26	28.9	54	60	117	130	234	260
4	16-QAM	3/4	39	43.3	81	90	175.5	192	351	390
5	64-QAM	2/3	52	57.8	108	120	234	260	468	520
6	64-QAM	3/4	58.5	65	121.5	135	263.3	292.5	526.5	585
7	64-QAM	5/6	65	72.2	135	150	292.5	325	585	650
8 <sup>7</sup>	256-QAM	3/4	78	86.7	162	180	351	390	702	780
9 <sup>8</sup>	256-QAM	5/6	N/A	N/A	180	200	390	433.3	780	866.7

#### 4.5 無線基地台傳輸原理<sup>9</sup>

Wi-Fi AP 係使用 CSMA(Carrier Sense Multiple Access)/ CA(Collision Avoidance)頻道偵測碰撞技術，來傳輸資料。即當裝置要以無線方式傳送資料前，會先偵測該頻道上是否有其他裝置傳出的訊號，如果頻道上沒有裝置使用時，便發出要求傳送訊息，等待並接收無線 AP 發出允許傳送訊息後，開始傳送資料，資料傳完，發出結束訊號，完成該次傳輸。

<sup>5</sup> 僅支援 802.11ac。

<sup>6</sup> 僅支援 802.11ac。

<sup>7</sup> 原始的 802.11n 並不支援，只有一些 802.11ac 的晶片支援。

<sup>8</sup> 原始的 802.11n 並不支援，只有一些 802.11ac 的晶片支援。

<sup>9</sup> 本段摘自 NCC，Wi-Fi 頻段使用及服務監理機制說明，第 9,10 頁

根據這個傳輸技術，在同一個地點如果有 2 個 Wi-Fi AP，且使用相同頻道 (CH) 時，各 Wi-Fi AP 加總之最大吞吐量與單一 Wi-Fi AP 使用之最大吞吐量相同，不致完全無法使用。如 2 個 Wi-Fi AP 置於相近位置，使用相鄰頻道 (CH) 時，因旁波帶干擾，Wi-Fi AP 之吞吐量約為無鄰頻使用時之吞吐量 73% 左右。

我國低功率電機技術規範規定之 2.4GHz 頻段 (2400-2483.5MHz)，共有 CH1 (中心頻率 2412MHz) 至 CH13 (中心頻率 2472MHz) 等 13 個通道 (CH)，每個通道中心頻率間隔 5MHz，因 Wi-Fi AP 使用頻寬為 20MHz，在終端設備接收靈敏度 -75dBm 範圍內，僅有 CH1、CH6 及 CH11 相互間有較少之鄰頻影響。

由於 Wi-Fi AP 佈建太密，可能會造成 Wi-Fi AP 訊號良好，但卻無法連線情形，為避免相互影響，在同一空間實際佈建 Wi-Fi AP 時，以使用 3 個 Wi-Fi AP 並分別使用 CH1、CH6、CH11 為宜，且 2 個 Wi-Fi AP 間至少相鄰 2 公尺以上，降低鄰頻影響。

綜上，Wi-Fi AP 若佈建太密，發生資料傳輸速率下降時，可利用空間分散佈建，增加 Wi-Fi AP 間之距離，或電信事業協調共用企業級 Wi-Fi AP，可減少佈建密度，有效提昇上網傳輸速率。

## 第五章現況分析

### 5.1 行動學習無線網路頻寬需求

隨著資訊科技的發展及網路世代的演進，目前主流的行動教學載具均已達到以下的規格：

- 1.螢幕解析度：720P 以上
- 2.無線網路：802.11ac 支援 MIMO

因此在教學上對畫面品質的要求上一定要達到 HD 畫質以上，在教學上才不致於讓學生覺得畫面難看影響學習。據此在教學上須傳輸 HD 畫質影像的就屬影片對頻寬要求最高<sup>10</sup>，以使用最普遍的 YOUTUBE 來說 HD 畫質影片頻寬需求約為 3000Kbits/s，以教育部目前國民中小學編班規定每班最高 30 人計算，再加上教師上課所需，一個班級進行動<sup>11</sup>學習所須頻寬約以 100Mbits/s 較為適當。據此標準現今的無線網路以理論速度來看必須是 802.11n 及 802.11ac 兩個規格才足以擔大任。目前主流無線網路基地台幾乎都是 802.11n 以上，市場預估今年(2015)年起 802.11ac 將會起飛，且目前市場上新發佈的行動裝置幾乎都是 802.11ac 支援 MIMO 的規格，所以將不進行 802.11 a/b/g 等規格的測試。

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<sup>10</sup> 均一教育平台所用的教學影片亦為 HD-720p 畫質影片。

<sup>11</sup> 少部分比較低階的機型除外。

## 5.2 大型學校-以名間國中為例

### 1. 學校概況

班級數：20 班。

學生數：557 人。

無線基地台：30 台以上。

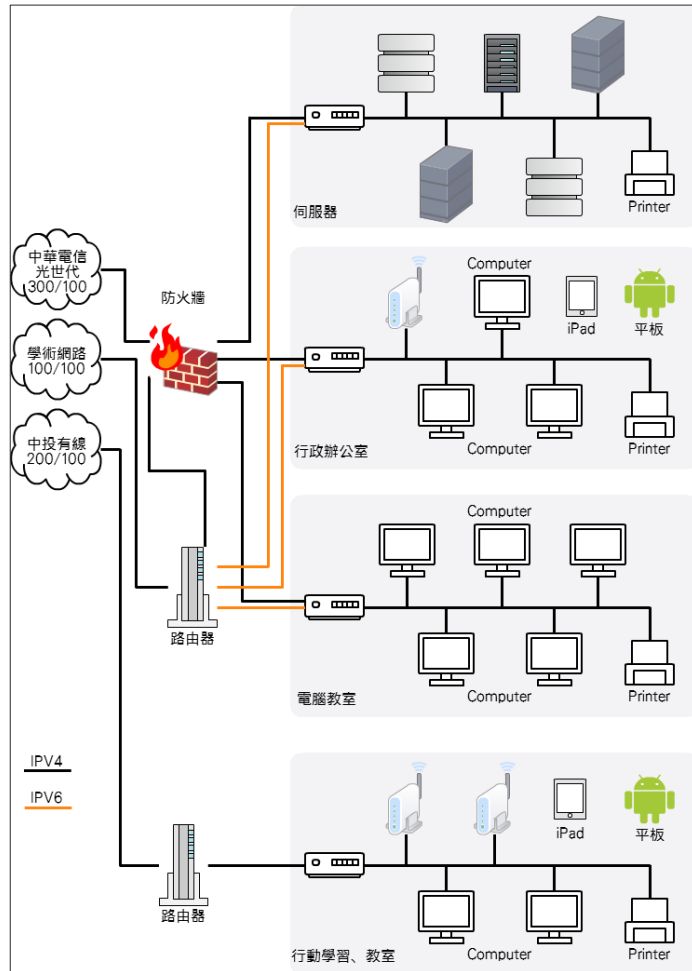
地址：南投縣名間鄉中山村彰  
南路 237 號。

周邊環境：四周 100 公尺內只  
有一兩戶住家。

對外頻寬：學術網路  
100M/100M，  
HiNet 光世代  
300M/100M，中  
投有線  
200M/100M。

### 2. 學校網路架構

學校網路架構如右圖所示。



### 3. 無線網路部分

無線網路基地台約 40 台，

WiFi 分析儀在電腦教室測得  
資料如下：



由圖可以得知只偵測到 2.4GHz 的無線電頻道，5GHz 的無線電頻道則偵測不到，在無線電頻道的使用上雖然沒有造成重疊而產生干擾，不過可以看到 1、6、11 三個無線電頻道均有多台無線基地台存在，而且在同一無線電頻道中電波的訊號強度在-76db(802.11n 規範下最高速率 65/72.2Mbit 接收靈敏度)以上者不止一個基地台，顯然他們只能共用這個無線電頻道的網路傳輸速率，甚至可能發生干擾導致網路傳輸速率下降。

以整個配置來看行動學習的班級所用的網路是與學校其他部門分隔開的，所有的行動裝置有可能在這兩個網路中切換，又因為使用 NAT 的機制故有可能出現無法連線到某些裝置的狀況或網路突然變慢等情形。

由於乾淨的 2.4GHz 無線電頻道最多只有 1、6、11 三個，所以在同一個地方依各種傳輸標準其理論最大資料傳輸速率如下：

802.11g 54 Mbits/s

802.11n 1xMIMO 72.2 Mbits/s

802.11n 2xMIMO 144.4 Mbits/s

另外一般來說無線網路實際的傳輸速度最佳狀況為理論值的 1/2，一般狀況約為理論值的 1/3，因此在一般的情形該校以一班 30 位學生來計算使用 802.11n 1xMIMO 的設備實施行動學習每位學生最高平均約可使用 800Kbits/s 的頻寬，使用 802.11n 2xMIMO 設備約 1600Kbits/s，然該校因無線基地台太多勢必存在許多干擾，無線網路的實際傳輸速率可能在上述推測值之下。



## 5.3 中型學校-以大成國小為例

### 1. 學校概況

班級數：17 班

學生數：391 人

無線基地台：30 台以上

地址：南投縣埔里鎮中山  
路三段 565 號。

周邊環境：四周不是住家  
就是商家。

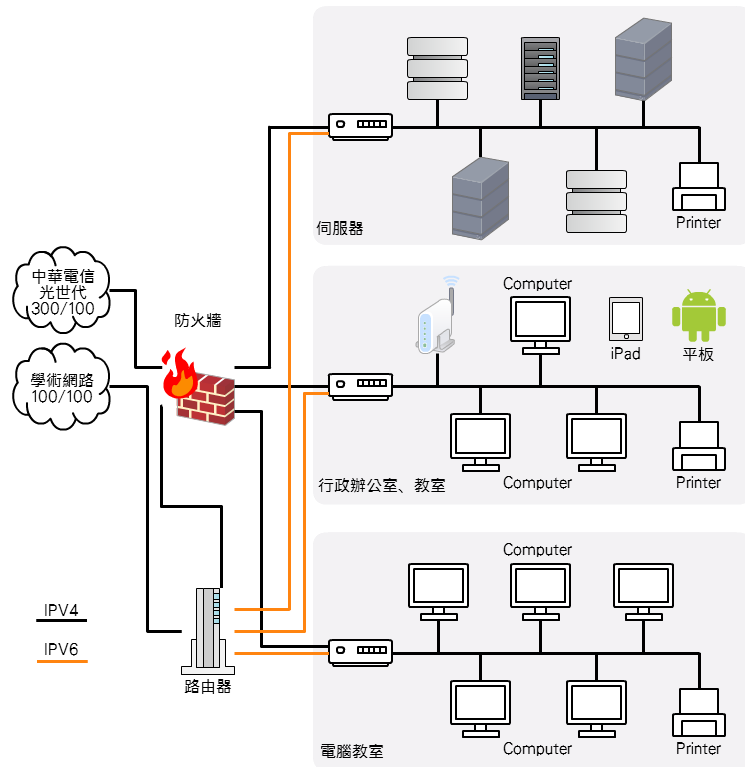
對外頻寬：學術網路  
100M/100M，  
HiNet 光世代  
300M/100M。

### 2. 學校網路架構

學校網路架構如右圖所  
示。

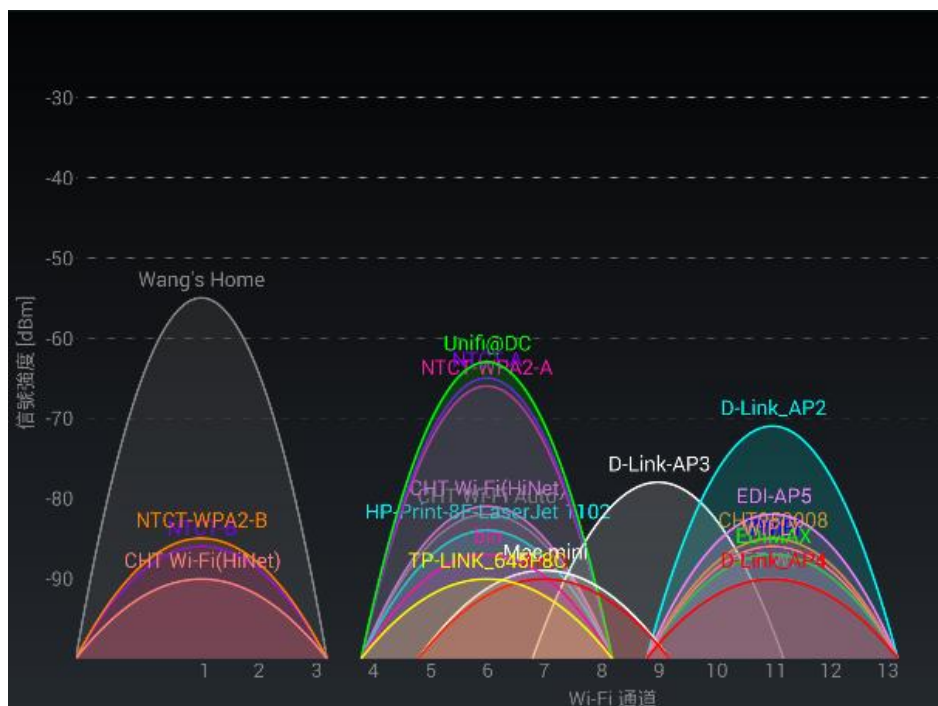
### 3. 無線網路部分

無線網路基地台約 20 台，  
WiFi 分析儀在本土語言中  
心走廊測得資料如右下  
圖。



2.4GHz 頻段：有非使 1、6、11 頻道的無線網路基地台，亦有來自校外的無線網路基地台訊號，而且訊號很強，很明顯地學校要在這個部分取得穩定的傳輸速率是可遇不可求，不宜用來作為行動學習教學使用。

5GHz 頻段：在這裏沒有測到訊號。



## 5.4 小型學校-以頭社國小為例

### 1. 學校概況

班級數：6 班

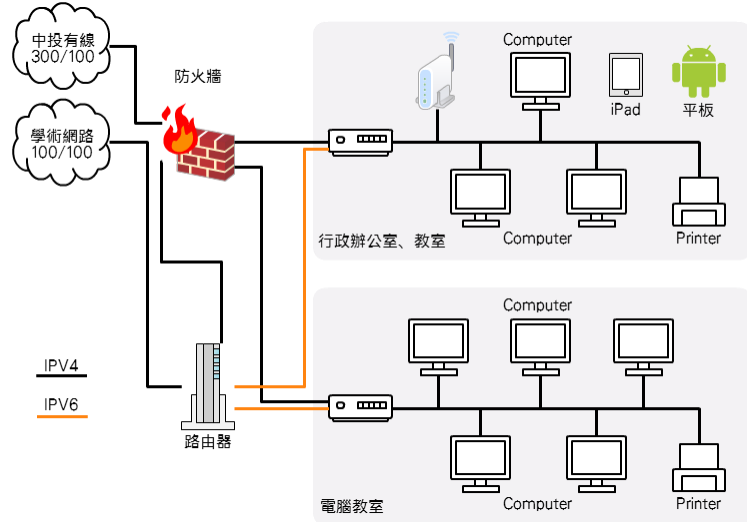
學生數：43 人

無線基地台：6 台以上

地址：南投縣魚池鄉頭社  
村平和巷 105 號

周邊環境：四周 100 公尺  
內無住家。

對外頻寬：學術網路  
100M/100M，  
中投有線  
200M/100M。



### 2. 學校網路架構

學校網路架構如右圖所示。

### 3. 無線網路部分

無線網路基地台約 10 台，WiFi 分析儀在電腦教室測得資料如下圖。

2.4GHz 頻段：有一台學校印表機使用頻道 10 造成干擾源，沒有來自校外的無線

網路基地台訊號，而且分佈良好，只要速率能滿足教學需求就沒問題。

5GHz 頻段：只有多台 AirPort 共用頻道 149，可以將其調至其他未使用頻道就是完美。



## 第六章網路傳輸速率測試

本計畫的目的是在尋求大、中、小型學校的無線網路環境架構，重點為無線網路的實際傳輸速率，而影響傳輸速率的因素至少有中央處理器、系統晶片組、作業系統、硬碟、無線基地台、無線網路卡、無線傳輸標準等，因此我們將中央處理器、系統晶片組、作業系統、無線網路卡四個因素固定為視窗作業系統-筆電、Android 平板、iOS 平板三種，硬碟部分我採用與硬碟無關的測試方法將其排除在外、無線基地台則固定為本縣採購的 A P，無線網路卡在筆電部分採用 Broadcom BCM94352HMB(AW-CE123H)，Android 平板、iOS 平板為平板內建。

### 6.1 測試軟體

Iperf 原是 NLANR/DAST 所開發用來測量 TCP 及 UDP 傳輸效能的軟體，現在則是廣泛使用在無線網裝置的網路效能測試上，且傳輸資料可以存放在記憶體上，因此測試結果可以與儲存裝置無關，本計劃採用本此軟體來測試網路效能。

由無線網路規格可知無線網路的效能與使用無線電波頻道有關(頻率及頻寬)，因此本計劃採用 Android 系統上的『Wifi 分析儀』來檢視所在環境無線頻道使用情形及訊號強度。

#### 1. Server 端：Iperf 2.0.5-2-DEB package，載點如下：

[https://iperf.fr/download/iperf\\_2.0.5/iperf\\_2.0.5-2\\_i386\\_debian.deb](https://iperf.fr/download/iperf_2.0.5/iperf_2.0.5-2_i386_debian.deb)

[https://iperf.fr/download/iperf\\_2.0.5/iperf\\_2.0.5-2\\_amd64\\_debian.deb](https://iperf.fr/download/iperf_2.0.5/iperf_2.0.5-2_amd64_debian.deb)

iperf-3.0.11.tar.gz 載點：

<http://downloads.es.net/pub/iperf/iperf-3.0.11.tar.gz>

然後用以下指令編譯：./configure;make;make install

#### 2.Client 端：

筆電-視窗作業系統：iperf-2.0.5-3-win32.zip。

載點：[https://iperf.fr/download/iperf\\_2.0.5/iperf-2.0.5-3-win32.zip](https://iperf.fr/download/iperf_2.0.5/iperf-2.0.5-3-win32.zip)

平板-Android：he.net - Network Tools(開發者：Hurricane Electric, LLC)內含的 iperf。

載點：<https://play.google.com/store/apps/details?id=net.he.networktools>

平板-iOS：HE.NET Network Tools(開發者：Hurricane Electric, LLC)內含的 iperf。

載點：<https://itunes.apple.com/us/app/he.net-network-tools/id858241710?mt=8>

## 6.2 測試載具硬體規格

### 1.Server 端

Lenove R60

作業系統：Debian GNU/Linux 6.0.10 (squeeze)

處理器：Intel(R) Celeron(R) M CPU 420 @ 1.60GHz

顯示晶片：Intel Corporation Mobile 945GM/GMS/GME, 943/940GML Express Integrated Graphics Controller

記憶體：4GB

硬碟：ATA 60.0 GB

螢幕：14.1-inch, XGA (1024 × 768 resolution) TFT color LCD

有線網卡：Broadcom Corporation NetXtreme BCM5751M Gigabit Ethernet PCI Express

無線網卡：Atheros Communications Inc. AR5BWB222 802.11abgn

### 2.Client 端

筆電：Acer ES1-111-C0A7

作業系統：Windows 8.1 x64

處理器：Intel Celeron N2940

顯示晶片：Intel HD Graphics

記憶體：8GB

硬碟：EZLINK Panzer IV-H 128G

螢幕：11.6" 霧面(LED 背光)(1366x768)

有線網卡：RealTek RTL8111

無線網卡：Broadcom BCM94352HMB(AW-CE123H) 2xMIMO

平板-Android：小米平板

作業系統：Android 4.4

處理器：NVIDIA Tegra K1 四核 2.2GHz

顯示晶片：192 顆 NVIDIA CUDA® 核心的 NVIDIA Kepler™架構 GPU

記憶體：2GB

ROM：16GB eMMC

螢幕：7.9" 2048x1536

無線網卡：802.11/b/g/n/ac 2x2MIMO

平板-iOS：iPad Air 2

作業系統：iOS 8.3

處理器：A8X

顯示晶片：PowerVR GXA6850

記憶體：2GB

ROM：64GB

螢幕：9.7" 2048x1536

無線網卡：Wi-Fi (802.11a/b/g/n/ac)；雙頻(2.4GHz 及 5GHz)；HT80 和 MIMO

## 6.3 無線 AP 規格

### **1.802.11n 雙頻 AP**

型號：UniFi AP-PRO

無線標準：802.11 a/b/g/n

使用頻率：2.4 GHz 及 5 GHz

訊號速率：2.4 GHz-最高 450Mbps，5 GHz-最高 300Mbps。

使用晶片：CPU-Atheros AR9344 (560 MHz)

WI1 chip-Atheros AR9344 802.11an

WI2 chip-Atheros AR9287 802.11bgn

FLASH：16 MiB

RAM：128 MiB

韌體版本：3.2.10.2886

### **2.802.11ac 雙頻 AP**

型號：UniFi AP-AC

無線標準：802.11 a/b/g/n/ac

使用頻率：2.4 GHz 及 5 GHz

訊號速率：2.4 GHz-最高 450Mbps，5 GHz-最高 1300Mbps。

使用晶片：CPU- Broadcom BCM4706

WI1 chip- Broadcom BCM4360 802.11an+ac

WI2 chip- Broadcom BCM4331 802.11bgn

FLASH：16 MiB

RAM：256 MiB

韌體版本：3.2.10.2886

## **6.4 大中小型學校無線網路測試方法**

iperf Server 端指令:iperf -s -w 2m

iperf Client 端指令:iperf -c [iperf server ip] -i 3 -t 60 -w 2m

**筆電、平板等裝置在測試時必須將省電功能關閉以免影響測試結果。**

在每一個地方先以『Wifi 分析儀』記錄無線頻道的使用情形，再進行下列 1~10 的測試，其中 1.是要確保 iperf Server 端有足够的的能力處理無線網路最高的傳輸速率(802.11ac 2XMIMO 866Mits/sec)。

- 1.筆電-有線-iperf Client<->iperf Server
- 2.筆電-無線 802.11n 2.4GHz-iperf Client<->iperf Server
- 3.筆電-無線 802.11n 5GHz-iperf Client<->iperf Server
- 4.筆電-無線 802.11ac 5GHz-iperf Client<->iperf Server
- 5.平板-Android 802.11n 2.4GHz-iperf Client<->iperf Server
- 6.平板-Android 802.11n 5GHz-iperf Client<->iperf Server
- 7.平板-Android 802.11ac 5GHz-iperf Client<->iperf Server
- 8.平板-iOS 802.11n 2.4GHz-iperf Client<->iperf Server
- 9.平板-iOS 802.11n 5GHz-iperf Client<->iperf Server
- 10.平板-iOS 802.11ac 5GHz-iperf Client<->iperf Server

## 6.5 大中小型學校無線網路測試記錄表格：

地點	行動裝置	連線方式	頻段	連線速率	實測速率	備註
國	筆電 視窗系統	有線				
		802.11n	2.4GHz			
		802.11n	5GHz			
	平板 Android	802.11ac	5GHz			
		802.11n	2.4GHz			
		802.11n	5GHz			
	平板 iOS	802.11ac	5GHz			
		802.11ac	5GHz			
		802.11n	2.4GHz			
		802.11n	5GHz			

## 6.6 無線電頻寬與無線網路速率測試

本測試主要目的是了解各設備在相同無線網路規範下使用 20MHz、40MHz 及 80MHz 無線電頻寬與網路傳輸速度的關係。因為使用 2.4GHz 的無線電頻段的設備眾多，要取得 40MHz 的乾淨頻道不易所以省略，只針對 5GHz 的 802.11n 及 802.11ac 進行測試。

為了排除無線網路基地台造成的影響，我們改用下列的無線網路基地台，其餘的設備、軟體及測試指令與前述一、二、四相同並在南投縣教育網路中心進行測試。

型號：ASUS RT-AC56U

網路 SoC：Broadcom BCM4708

無線網路晶片：Broadcom BCM4321、BCM4352

天線：內建式

有線網路：10/100/1000Mbps

無線網路：802.11 a/b/g/n/ac draft、2T2R

連接埠：RJ-45 x 5、USB 2.0 x 1、USB 3.0 x1

記憶體：256MB DDR3

使用頻率：2.4 GHz 及 5 GHz

韌體版本：3.0.0.4.378.4585

測試方法為分別使用筆電-視窗、平板-Android、平板-IOS 進行下列測試：

1.802.11n 5GHz@HT20-iperf Client<->iperf Server

2.802.11n 5GHz@HT40-iperf Client<->iperf Server

3.802.11ac 5GHz@HT20-iperf Client<->iperf Server

4.802.11ac 5GHz@HT40-iperf Client<->iperf Server

5.802.11ac 5GHz@HT80-iperf Client<->iperf Server

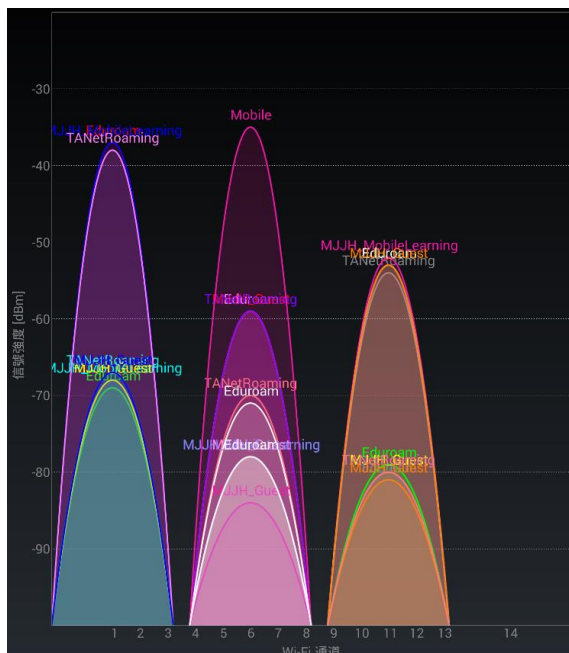
### 6.7 無線電頻寬與無線網路速率測試記錄表格：

行動裝置	使用頻段	使用頻寬	連線速率	實測速率	備註
筆電 視窗系統	802.11n 5GHz	HT20			
		HT40			
	802.11ac 5GHz	HT20			
		HT40			
		HT80			
平板 Android	802.11n 5GHz	HT20			
		HT40			
	802.11ac 5GHz	HT20			
		HT40			
		HT80			
平板 iOS	802.11n 5GHz	HT20			
		HT40			
	802.11ac 5GHz	HT20			
		HT40			
		HT80			

## 6.8 各項測試結果

### 6.8.1 大型學校-名間國中-會議室

測試時的無線 AP 訊號及裝置架設圖如下：



測試結果<sup>12</sup>：

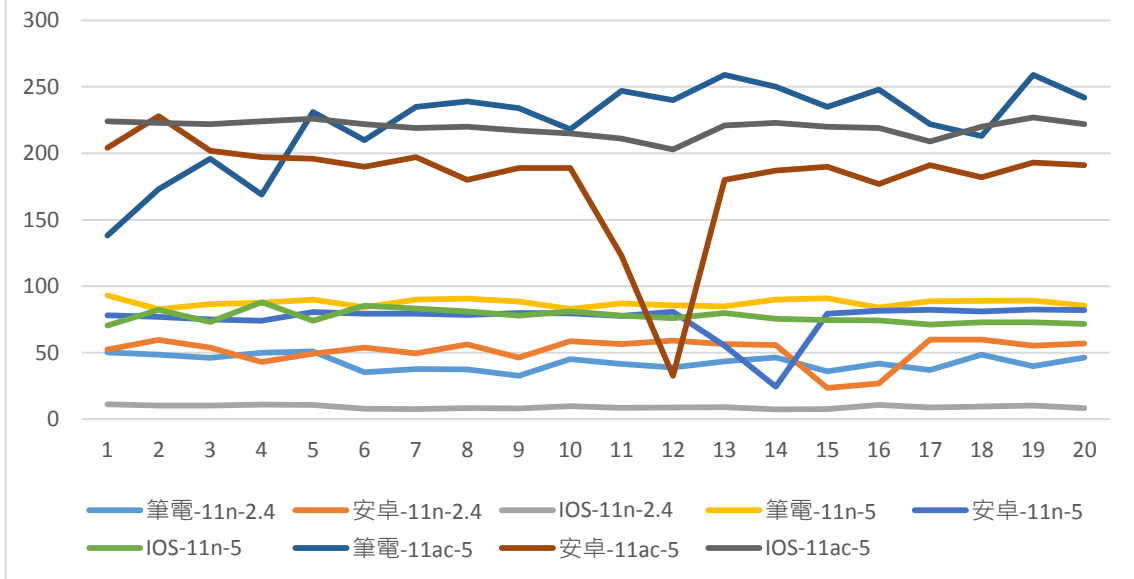
地點	行動裝置	連線方式	頻段	連線速率	實測速率	備註
名間國中	筆電 視窗系統	有線		1Gbps	937Mbps	
		802.11n	2.4GHz	144Mbps	42.7Mbps	
		802.11n	5GHz	300Mbps	87.5Mbps	
	平板 Android	802.11ac	5GHz	866Mbps	223Mbps	
		802.11n	2.4GHz	130Mbps	51.6Mbps	
		802.11n	5GHz	216Mbps	75.4Mbps	
	平板 iOS	802.11ac	5GHz	585Mbps	181Mbps	
		802.11n	2.4GHz	N/A	9.39Mbps	
		802.11n	5GHz	N/A	77.1Mbps	
		802.11ac	5GHz	N/A	219Mbps	

測試結果分析圖：

<sup>12</sup> 詳細資料如附件一名間國中無線網路無線電波強度、附件二名間國中測試結果。



名間國中無線網路實測速率分佈圖

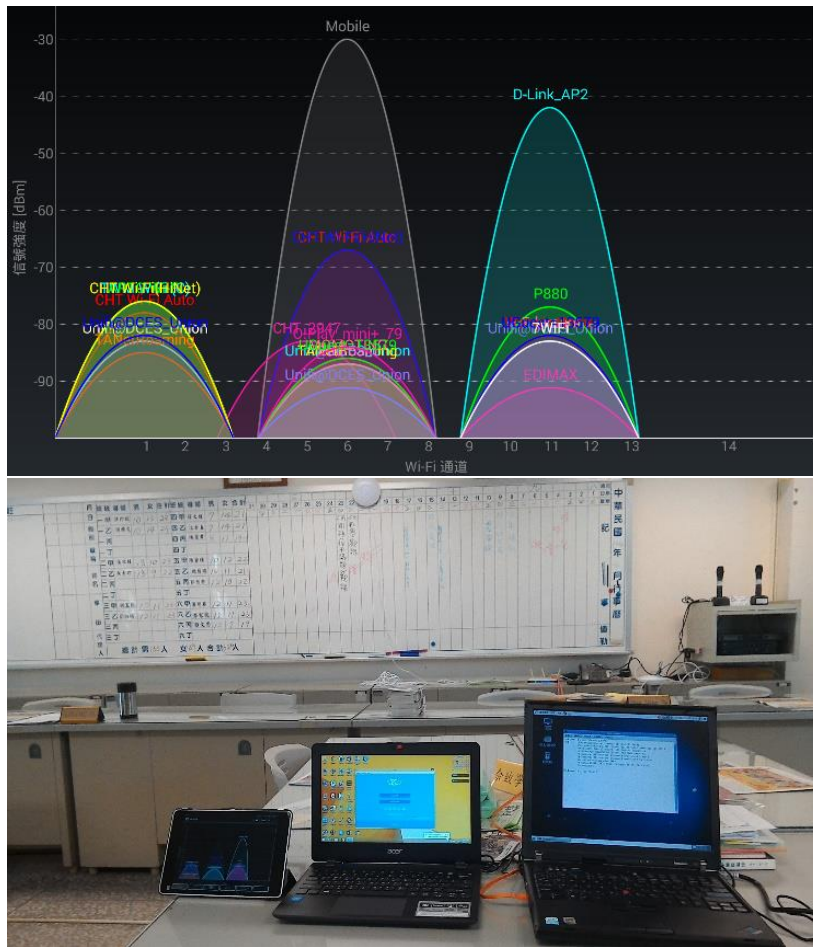


從結果可以歸納如下：

1. 無線網路傳輸速率不是很穩定，又以 802.11ac@5GHz 最為嚴重。
2. 三個平台都是在 802.11n@5GHz 的無線網路傳輸速率最為穩定。
3. 將結果對照附件一名間國中無線網路無線電波強度推測(2.4GHz 頻段有非常多的無線網路基地台)802.11n@2.4GHz 僅使用 20MHz 無線電頻寬，而 802.11n@5GHz 則使用 40MHz 無線電頻寬，所以最大相差約一倍與理論值相符。
4. 無線網路實測速率在 802.11ac@5GHz 時最快可達 223Mbps 以上。
5. 該校在 2.4GHz 頻段不僅有很多無線網路基地台使用相同頻道，在某此地方甚至還使會互相干擾的相鄰頻道，所以在這些地方無線網路的實際傳輸速率更是不理想。
6. 該校在 5GHz 頻段雖有無線網路基地台使用相同頻道的情形出現，但均僅有一台無線網路基地台的訊號在-80db 以上，根據無線網路接收靈敏度來看應該不會有任何影響。另外 5GHz 頻段還有一些未使用頻道可以使用，亦可調整頻道。

## 6.8.2 中型學校-大成國小-會議室

測試時的無線 AP 訊號及裝置架設圖如下：



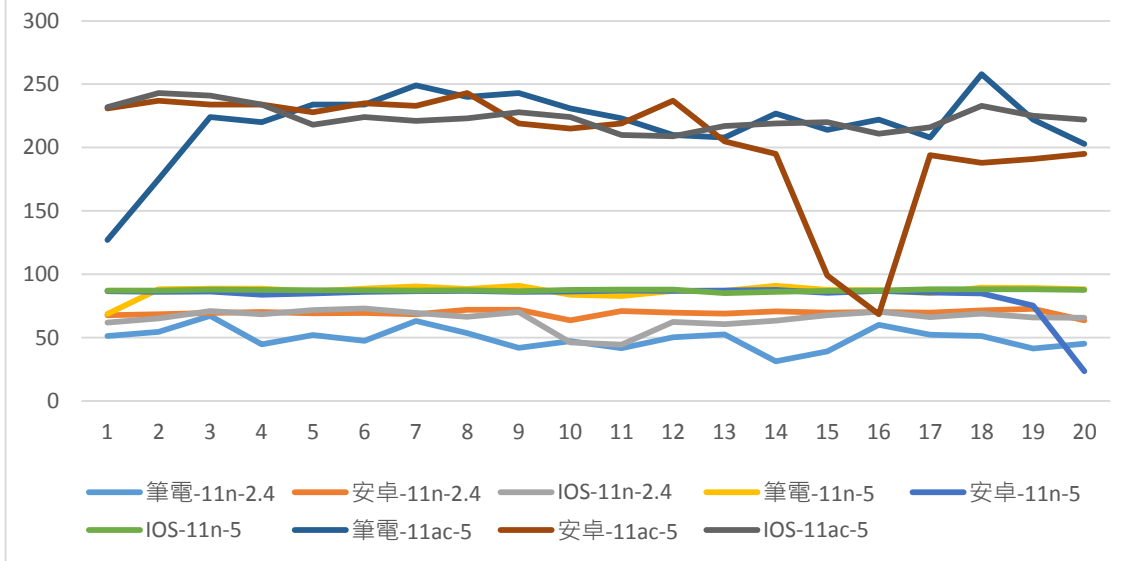
測試結果<sup>13</sup>：

地點	行動裝置	連線方式	頻段	連線速率	實測速率	備註
大成國小	筆電 視窗系統	有線		1Gbps	852Mbps	
		802.11n	2.4GHz	144Mbps	49.5Mbps	
		802.11n	5GHz	300Mbps	86.9Mbps	
	平板 Android	802.11ac	5GHz	866Mbps	219Mbps	
		802.11n	2.4GHz	144Mbps	69.5Mbps	
		802.11n	5GHz	243Mbps	82.5Mbps	
	平板 iOS	802.11ac	5GHz	533Mbps	205Mbps	
		802.11n	2.4GHz	N/A	60.9Mbps	
		802.11n	5GHz	N/A	87.4Mbps	
		802.11ac	5GHz	N/A	223Mbps	

測試結果分析圖：

<sup>13</sup> 詳細資料如附件三大成國小無線網路無線電波強度、附件四大成國小測試結果。

### 大成國小無線網路實測速率分佈圖

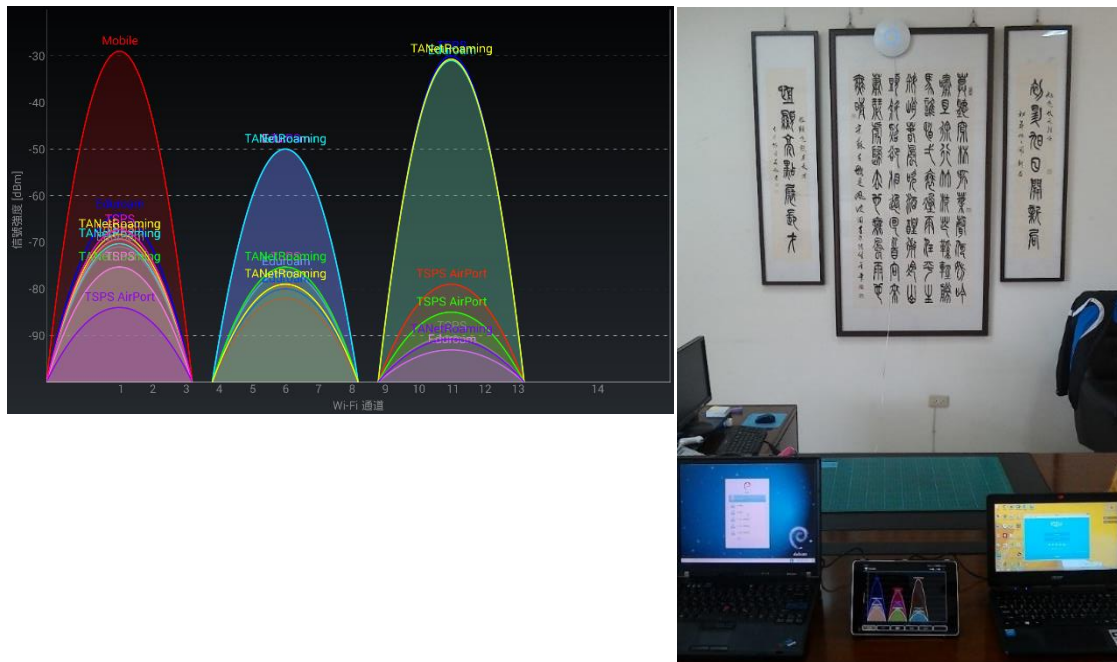


從結果可以歸納如下：

1. 無線網路傳輸速率不是很穩定，又以 802.11ac@5GHz 最為嚴重。
2. 三個平台都是在 802.11n@5GHz 的無線網路傳輸速率最為穩定。
3. 將結果對照附件三大成國小無線網路無線電波強度推測(2.4GHz 頻段有多台無線網路基地台)802.11n@2.4GHz 僅使用 20MHz 無線電頻寬，而 802.11n@5GHz 則使用 40MHz 無線電頻寬，所以 802.11n@5GHz 的傳輸速率比 802.11n@2.4GHz 大。
4. 無線網路實測速率在 802.11ac@5GHz 時最快可達 223Mbps 以上。
5. 該校在 2.4GHz 頻段不但有多台無線網路基地台使用相同頻道，而且有外面的無線網路基地台訊號及使用相鄰頻道的無線網路基地台，可是在三個學校中大成國小測得的無線網路速率並不是最低的。與有相似的名間國中相對照，可知只有設於超商的中華電信無線網路訊號較強約-70dBm，其他的均在-80dBm 以下，因此並無顯著影響。
6. 該校在 5GHz 頻段部分雖有設於超商的中華電信無線網路訊號，因僅有一個只須不要使用相同頻道即可。

### 6.8.3 小型學校-頭社國小-校長室

測試時的無線 AP 訊號及裝置架設圖如下：



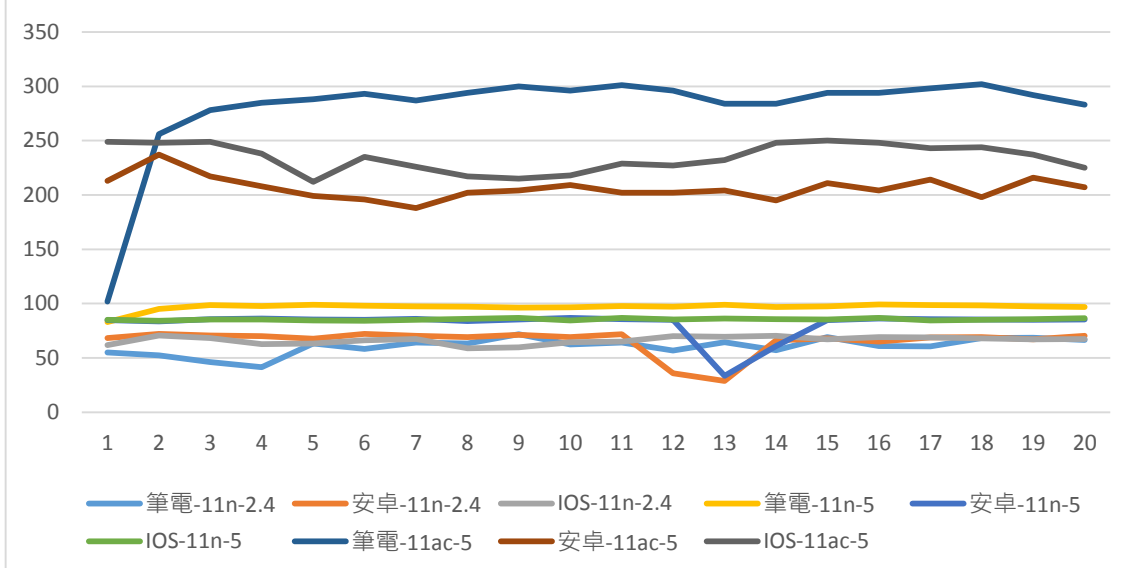
測試結果<sup>14</sup>：

地點	行動裝置	連線方式	頻段	連線速率	實測速率	備註
頭社國小	筆電 視窗系統	有線		1Gbps	946Mbps	
		802.11n	2.4GHz	144Mbps	61.0Mbps	
		802.11n	5GHz	300Mbps	96.9Mbps	
	平板 Android	802.11ac	5GHz	866Mbps	286Mbps	
		802.11n	2.4GHz	144Mbps	65.6Mbps	
		802.11n	5GHz	300Mbps	81.5Mbps	
	平板 iOS	802.11ac	5GHz	866Mbps	206Mbps	
		802.11n	2.4GHz	N/A	66.5Mbps	
		802.11n	5GHz	N/A	85.7Mbps	
		802.11ac	5GHz	N/A	234Mbps	

測試結果分析圖：

<sup>14</sup> 詳細資料如附件五頭社國小無線網路無線電波強度、附件六頭社國小測試結果。

### 頭社國小無線網路實測速率分佈圖



從結果可以歸納如下：

- 1.無線網路傳輸速率不是很穩定，又以 802.11ac@5GHz 最為嚴重。
- 2.三個平台都是在 802.11n@5GHz 的無線網路傳輸速率最為穩定。
- 3.將結果對照附件五頭社國小無線網路無線電波強度推測(2.4GHz 頻段有多台無線網路基地台)802.11n@2.4GHz 僅使用 20MHz 無線電頻寬，而 802.11n@5GHz 則使用 40MHz 無線電頻寬，所以 802.11n@5GHz 的傳輸速率比 802.11n@2.4GHz 大。
- 4.無線網路實測速率在 802.11ac@5GHz 時最快可達 234Mbps 以上。
- 5.該校在 2.4GHz 頻段雖有多台無線網路基地台使用相同頻道，可能學生少，使用量不高，再加上並無外部的無線基地台訊號，因此頭社國小是三個學校中所測得的無線網路平均速率最高的。
- 6.在我們測試前發現該校在 5GHz 頻段有無線網路基地台使用相同頻道的情形出現，因此我們將其調整為每台無線網路基地台均使用不同頻道，在這個部分頭社國小還是三個學校中所測得的無線網路平均速率最高的。

### 6.8.4 使用無線電頻寬與無線網路速率-縣網

測試時的擺設情形：

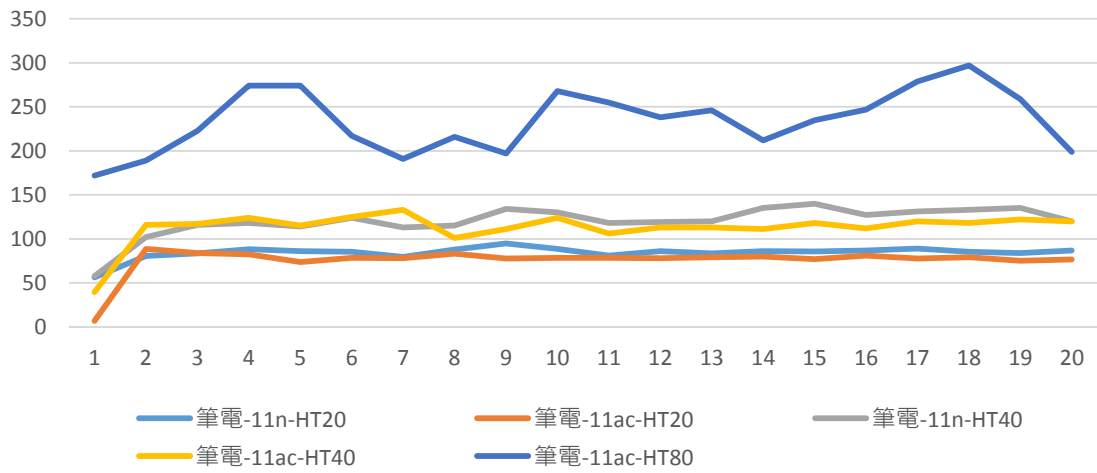


測試結果：

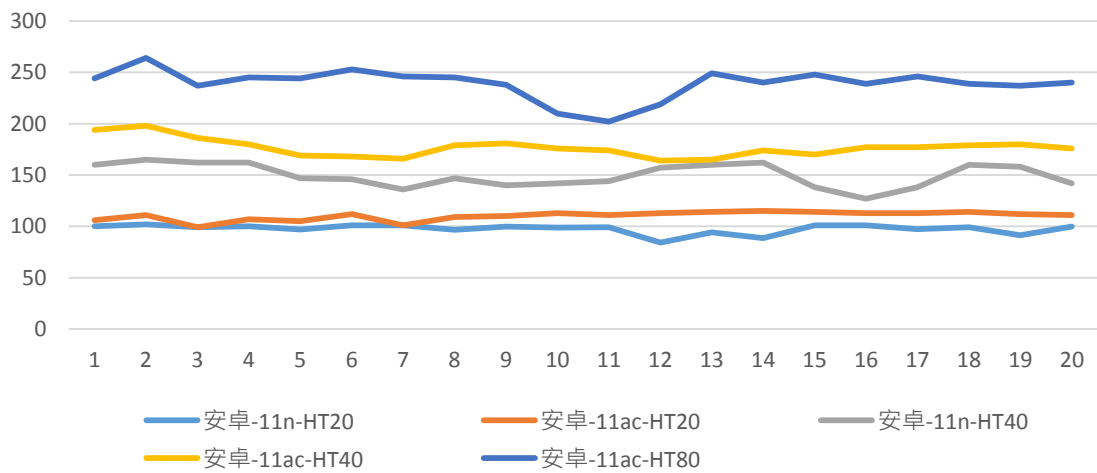
行動裝置	使用頻段	使用頻寬	連線速率	實測速率	備註
筆電 視窗系統	802.11n 5GHz	HT20	144 Mbps	84.2Mbps	
		HT40	300 Mbps	120Mbps	
	802.11ac 5GHz	HT20	173 Mbps	75.6Mbps	
		HT40	400 Mbps	113Mbps	
		HT80	866.5 Mbps	234Mbps	
平板 Android	802.11n 5GHz	HT20	144 Mbps	97.6Mbps	
		HT40	243 Mbps	150Mbps	
	802.11ac 5GHz	HT20	173 Mbps	110Mbps	
		HT40	400 Mbps	177Mbps	
		HT80	866 Mbps	239Mbps	
平板 iOS	802.11n 5GHz	HT20	N/A	101Mbps	
		HT40	N/A	160Mbps	
	802.11ac 5GHz	HT20	N/A	96.5Mbps	
		HT40	N/A	168Mbps	
		HT80	N/A	257Mbps	

下面為各平台測試結果的分佈圖：

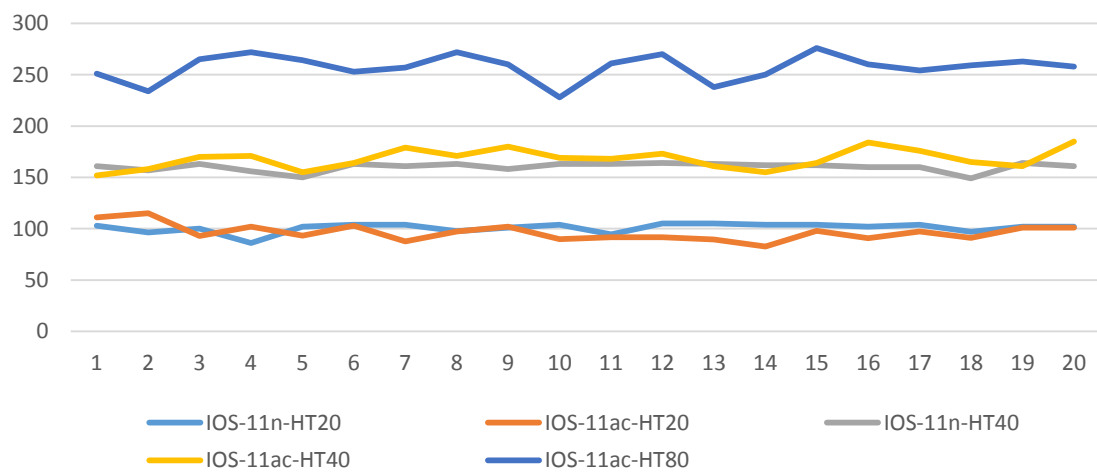
使用無線電頻寬與無線網路速率測試 - 筆電



使用無線電頻寬與無線網路速率測試 - 安卓



使用無線電頻寬與無線網路速率測試 - IOS



## 第七章各型學校行動學習無線網路最佳佈建建議方案

### 7.1 大型學校以名間國中為例

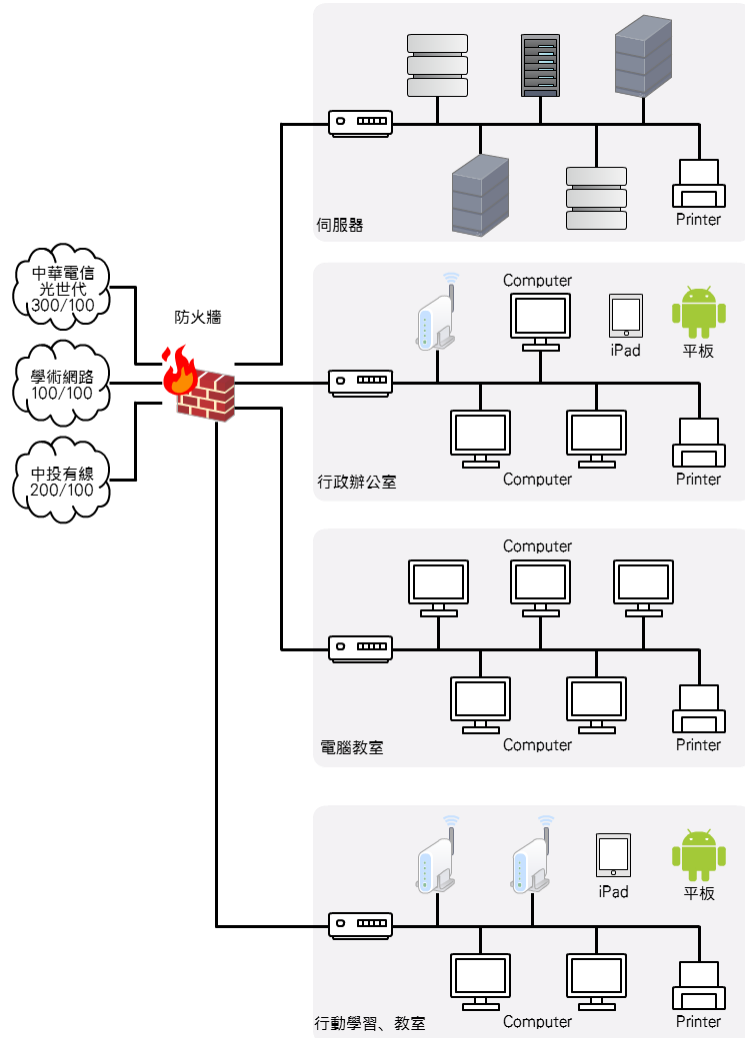
我們在測試的過程中發現竟然可以收到外面的無線訊號，使得原本就顯得擁塞的 2.4GHz 頻段更是雪上加霜。

根據測試結果及名間國中有 6 個行動學習專班，班級人數約 28 人，2.4GHz 頻段已經無法滿足學校的頻寬需求，建議學校未來應朝 802.11ac@5GHz 架構規畫，目前則配合學校現有設備使用 802.11n@5GHz 架構，採用具有 5GHz 頻段的無線網路基地台，剛好配上該校使用的雙頻平板。具體策略如下：

1. 行動學習均使用 5GHz 頻段上網，須注意在同一地方每個頻道只有一台無線基地台使用。
2. 調整使用 2.4GHz 頻段的無線網路基地台，讓每個地方使用 CH1、CH6、CH11 的無線網路基地台

只有 1 台，如果達不到此要求也應調整無線網路基地台發射功率，讓每個地方 **只有一台**無線網路基地台的訊號強度在 **-80db 以上**(-90db 最好)。

3. 當教師採用網路頻寬較高的行動學習教材時，如有頻寬不足之情形時可增置一台 5GHz 頻段無線網路基地台或調整幾位同學使用 2.4GHz 頻段上網。

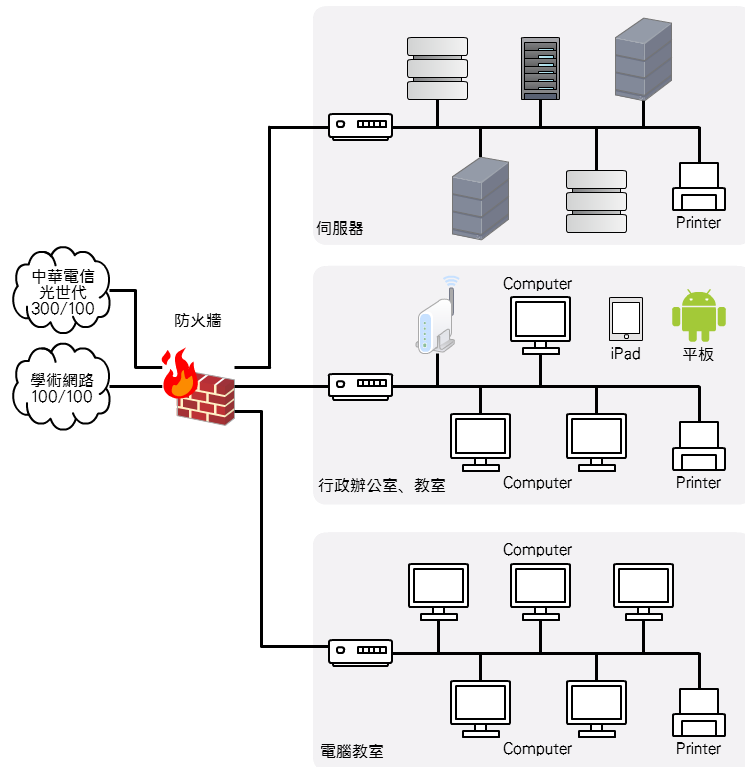




## 7.2 中型學校以大成國小為例

根據測試結果及大成國小  
有 1 個行動學習專班，班  
級人數約 23 人，2.4GHz  
頻段已經無法滿足學校的  
頻寬需求，因此學校至少  
應採用 802.11n@5GHz 方  
案方可順利進行教學。具  
體策略如下：

1. 行動學習均使用 5GHz  
頻段上網，須注意在同一  
地方每個頻道只有一台無  
線基地台使用。
2. 調整使用 2.4GHz 頻段的  
無線網路基地台，讓每個  
地方使用 CH1、CH6、  
CH11 的無線網路基地台  
只有 1 台，如果達不到此  
要求也應調整無線網路基  
地台發射功率，讓每個地  
方**只有一台**無線網路基地台的訊號強度在**-80db 以上**(-90db 最好)。



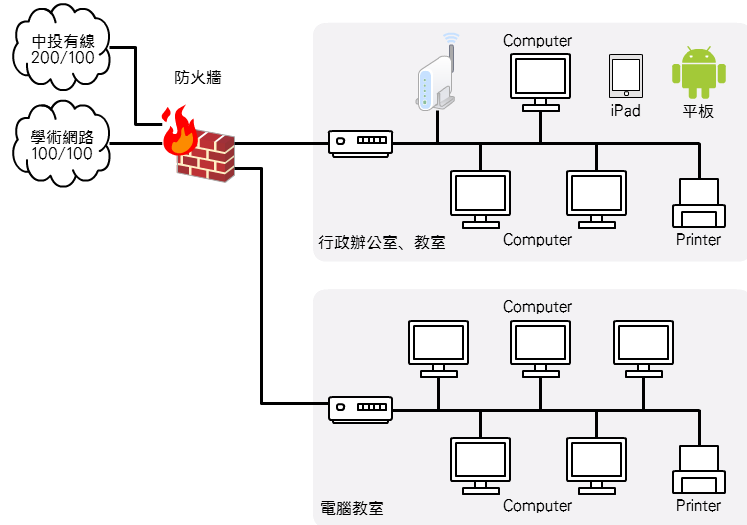
### 7.3 小型學校以頭社國小為例

該校四周環境單純只有學校的無線網路基地台，班級人數約 7 人，根據測試結果 2.4GHz 頻段已可滿足學校的頻寬需求，因此學校只要採用 802.11n 方案即可順利進行教學。具體策略如下：

1. 調整使用 2.4GHz 頻段的無線網路基地台，讓每個地方使用 CH1、CH6、CH11 的無線網路基地台只有 1 台，如果達不到此

要求也應調整無線網路基地台發射功率，讓每個地方**只有一台**無線網路基地台的訊號強度在**-80db 以上**(-90db 最好)。

2. 其實在測試過程中僅發現該校電腦教室有一台無線網路印表機造成干擾的現象，只須將該印表機的無線網路關閉即可。

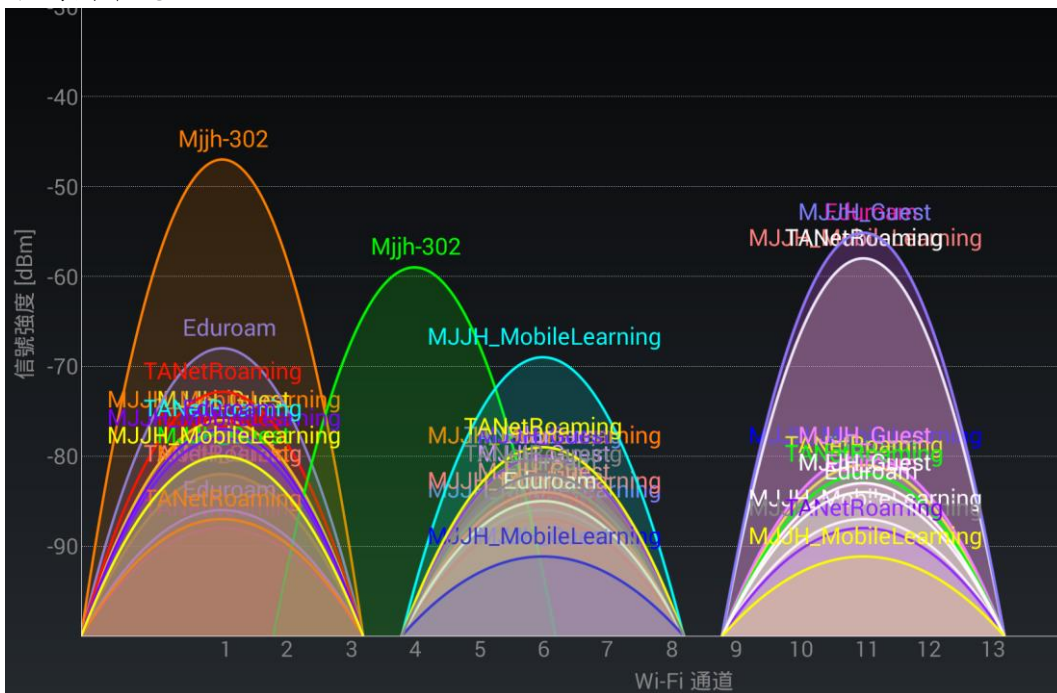


### 7.4 現況與建議方案速率對照表

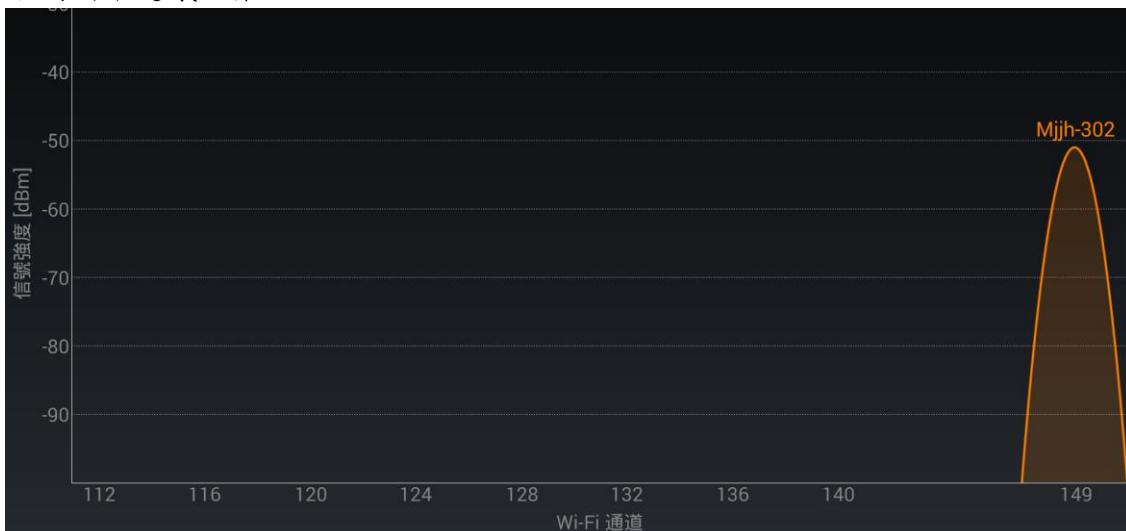
行動裝置	現況(Mbps)		建議方案(Mbps)	
	頻段@協定	實測速率	頻段@協定	實測速率
名間國中	11n@2.4GHz	9~42	現在 11n@5GHz 未來 11ac@5GHz	約>80 約>200
大成國小	11n@2.4GHz	50~70	11n@5GHz	約>85
頭社國小	11n@2.4GHz	<50	11n@2.4GHz 以上	約>65

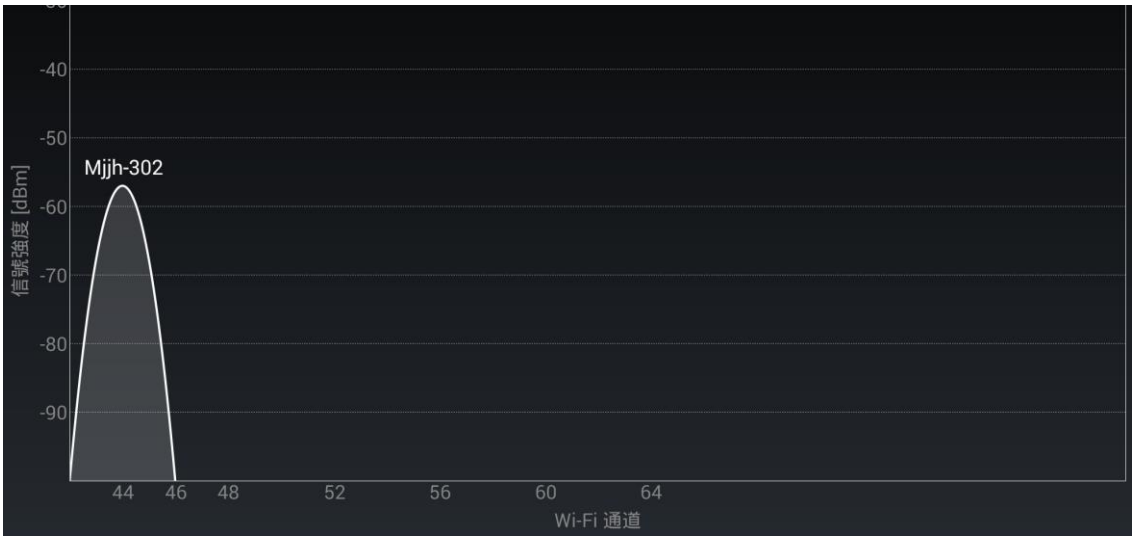
### 7.5 現況與建議方案無線電頻道使用對照

名間國中現況

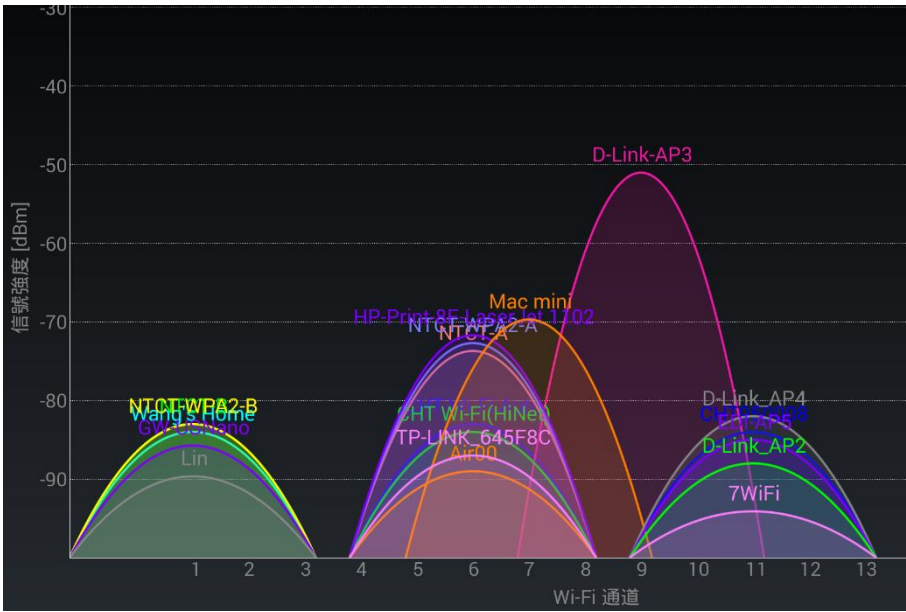


名間國中建議方案





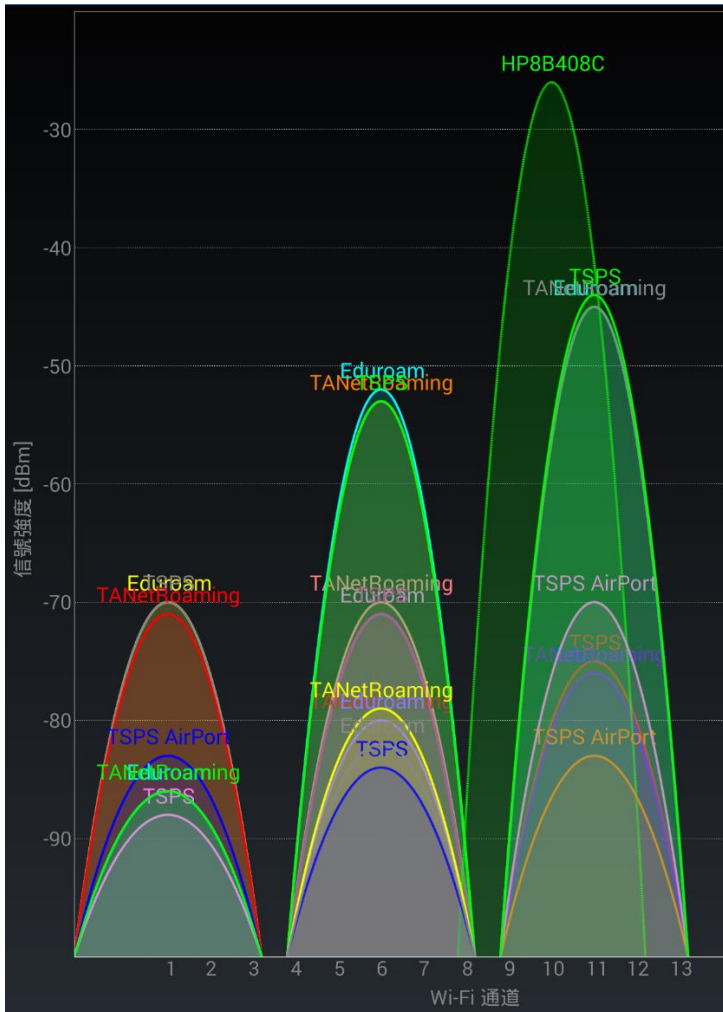
大成國小現況



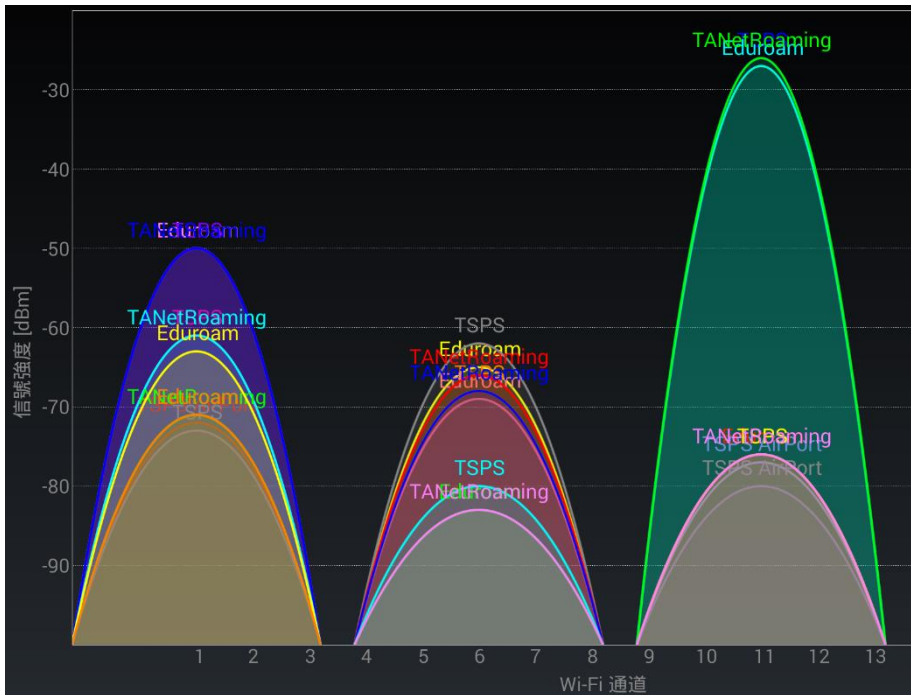
大成國小建議方案



頭社國小現況



頭社國小建議方案



## 結論

### 一.決定無線網路最高理論傳輸速率的因素是無線電波頻道的潔淨度與頻寬、無線網路傳輸標準

傳統上我們認為當一個地方的無線網路速率不足使用時只需增加無線網路基地台數量並分散使用者連線至不同的無線基地台即可，筆者在進行本計畫前也是這麼認為的，可是理論與事實告訴我們這是錯的，這也是為什麼那些 4G 營運商特別重視標得的無線電頻寬，因為無線電頻寬越大就可以提供越大的網路傳輸速率！所以正確的做法如下：

- 1.選用可以處理較多裝置連線的無線網路基地台。
- 2.每個無線電頻道只供一台無線網路基地台使用。
- 3.無線網路基地台與連線裝置使用相同的無線網路傳輸標準。

### 二.無線網路基地台的訊號強度不是越大越好

訊號越強唯一的好處就是覆蓋範圍越大，但是得到的壞處卻是降低無線網路的傳輸速率，原因如下：

- 1.無線電訊號越強對相鄰的無線電頻道干擾越大，另外 Ubiquiti Networks, Inc<sup>15</sup> 曾提到一般的無線基地台只對支援的無線電頻段進行濾波而非選用的無線電頻道，因此無線電波越強，溢波也越大，也就是說在相鄰頻道的電波越強，當然干擾就越大，其結果就是實際的無線網路傳輸速率下降。
- 2.對 2.4GHz 頻道來說乾淨的頻道最多就只有 3 個，覆蓋範圍越大代表的就是使用相同頻道的無線網路基地台也會越多<sup>16</sup>，相對的使用相同頻道的無線裝置就越多，每個裝置分配到的無線網路傳輸速率也越小。

### 三.無線電 2.4GHz 頻段無線網路傳輸速率較慢

根據測試資料 2.4GHz 頻段傳輸速率相對較慢，大約只有 5GHz 頻段 HT20 的傳輸速率，Apple iPad Air 2 在名間國中測得的速率更是偏低，而最有可能的原因應該是：

- 1.無線電 2.4GHz 頻段原來就只有 3 個乾淨無重疊的 20MHz 頻道，測試地點有多台無線基網路地台在使用無線電 2.4GHz 頻段，形成共用或干擾。
- 2.受到其他設備的干擾，這些設備包括帶有藍芽的任何裝置(如藍芽喇叭、手機、藍芽鍵盤、藍芽滑鼠.....)、無線鍵盤、無線滑鼠、遙控器.....等。

### 四.應注意無線裝置 5GHz 頻段的相容性

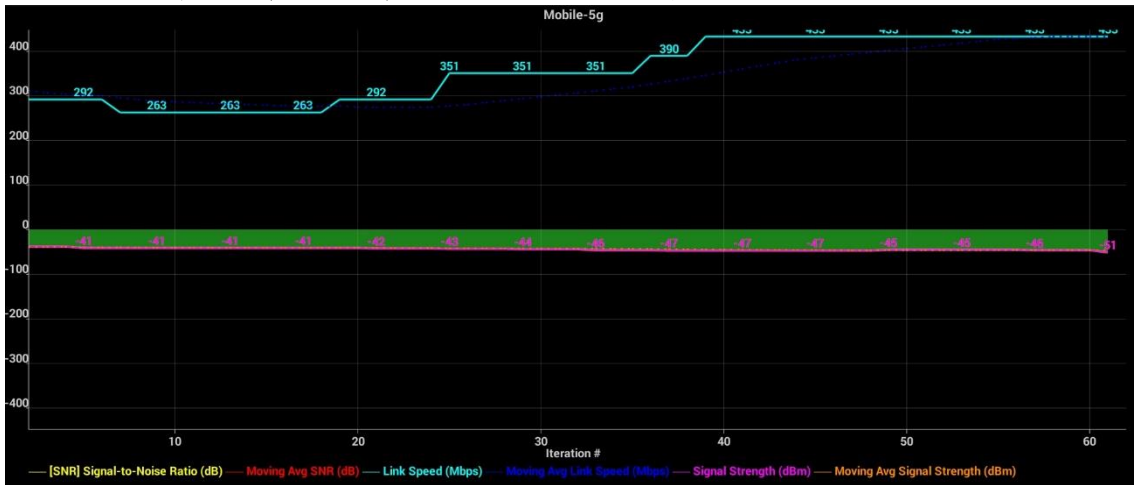
在我們的探討過程當中發現雖然台灣已經開放 5GHz 頻段的所有頻道，但市售無線裝置的支援度差異頗大，有的甚至只支援 BAND 4，所以就只有 2 個 40MHz 頻道或 1 個 80MHz 頻道可用，可用的無線網路傳輸速率容易受到限制。另一方面還會造成無法連線，因此最好選用支援 BAND 1~4 的無線裝置。

<sup>15</sup> <https://www.ubnt.com/enterprise/technology/>，最後瀏覽日期 20150330。

<sup>16</sup> 附件一名間國中無線網路無線電波強度就是如此。

## 五.無線網路比較不穩定有時會發生短暫延遲是正常的

如下圖所示不僅訊號非常穩定而且 SNR 也相當的低及穩定，但是連接速率的變化是非常的大(263~433)，與我們的測試數據相符。



## 六.本計畫測得各無線網路傳輸標準的實際網路傳輸速率

本計畫在三個學校測得各無線網路傳輸速率如下：

行動裝置	連線方式	頻段	連線速率(Mbps)			實測速率(Mbps)		
			名間國中	大成國小	頭社國小	名間國中	大成國小	頭社國小
筆電 視窗系統	有線		1000	1000	1000	937	852	946
	802.11n	2.4GHz	144	144	144	42.7	49.5	61.0
	802.11n	5GHz	300	300	300	87.5	86.9	96.9
	802.11ac	5GHz	866	866	866	223	219	286
平板 Android	802.11n	2.4GHz	130	144	144	51.6	69.5	65.6
	802.11n	5GHz	216	243	300	75.4	82.5	81.5
	802.11ac	5GHz	585	533	866	181.2	205	206
平板 iOS	802.11n	2.4GHz	N/A	N/A	N/A	9.39	60.9	66.5
	802.11n	5GHz	N/A	N/A	N/A	77.12	87.4	85.7
	802.11ac	5GHz	N/A	N/A	N/A	219	223	234

測得各無線網路傳輸標準下行動裝置最高網路傳輸速率如下：

使用頻段	使用頻寬	實測速率	備註
802.11n 2.4GHz	自動	73.1Mbps	2xMIMO
802.11n 5GHz	HT20	105Mbps	2xMIMO
	HT40	165Mbps	2xMIMO
802.11ac 5GHz	HT20	115Mbps	1xMIMO
	HT40	177Mbps	1xMIMO
	HT80	302Mbps	1xMIMO

2xMIMO 的部分若使用 1xMIMO 的設備時速率應減半。各校可以依據上表、班級學生數及周圍環境架設屬於符合需求的最佳無線網路環境。

## 建議

### 一.未來採購應以雙頻為主，2.4GHz 頻段用來提升覆蓋率，5GHz 頻段用來進行教學

充分利用 2.4GHz 及 5GHz 電波的特色，分配如下：

1.2.4GHz 頻段：具有傳得遠、穿透力強的特性，但因常受校外無線基地台的干擾無法確保網路傳輸速率，常會影響教學的順暢性，應做為提升校園無線網路覆蓋率之用。

2.5GHz 頻段：速率快、穿透力差，隔一層地板或一間教室就幾乎沒有訊號，因此可以確保網路傳輸速率，且頻道相對較多且寬，可確保教學的順暢，可做為教學之用。

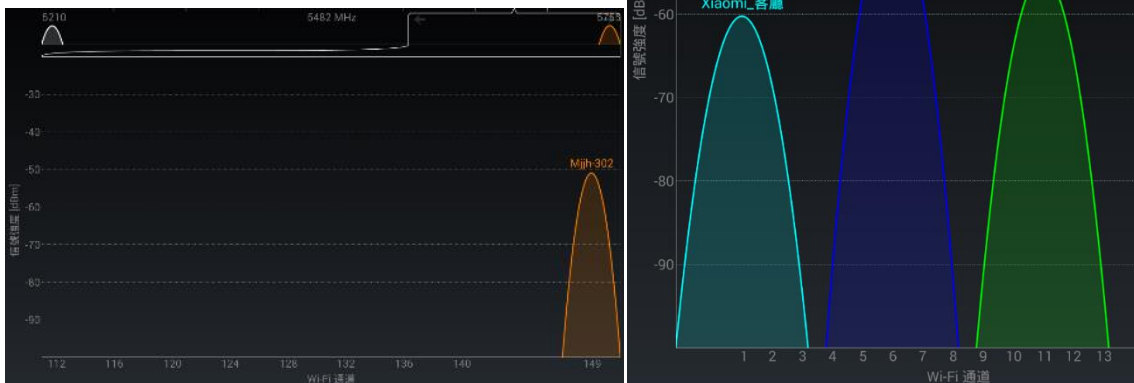
### 二.每個地方最佳的無線電波頻道分配

#### 1.2.4GHz 頻段

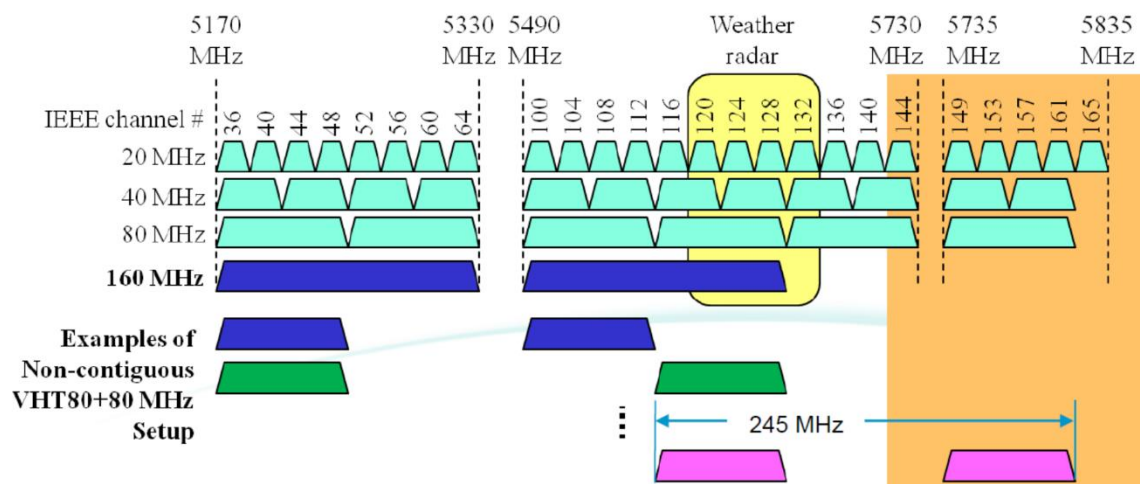
2.4GHz 的無線電波就只有 3 個乾淨的 20MHz 頻道可用，要有最佳的利用那麼看起來就應該像右圖。

#### 2.5GHz 頻段

5GHz 部分在 WiFi 分析儀看起來應該像下圖這個樣子才會有最佳的傳輸速率。



台灣目前已全部開放計有 CH36、CH40、CH44、CH48、CH52、CH56、CH60、CH64、CH100、CH104、CH108、CH112、CH116、CH120、CH124、CH128、CH132、CH136、CH140、CH149、CH153、CH157、CH161、CH165 共計 24 個頻寬 20MHz 的乾淨頻道，如下圖所示。





其中 CH100~CH140 共 11 個頻道必須具備 DFS(自動跳頻)，CH52~CH64 共 4 個頻道如具備 DFS(自動跳頻)則可在室外使用。

另外頻寬 40MHz 的頻道共有 11 個，頻寬 80MHz 的頻道共有 5 個。基本上 5GHz 部分因為穿透力不佳大約隔一間教室(兩道牆)或一層樓(樓地板比較厚)就沒有訊號了！因此為因應時代的趨勢，應選購至少支援 Band 2~4 的無線基地台才能調成任何一個地方同一頻道只有一台無線基地台使用 (802.11ac@80MHz)。

### 三.提昇學校有線網路佈建品質

本計畫所列學校機房有線網路建置情形如圖所示，不僅是維護不易、不够美觀.....等外在表現而已，更因線路的扭曲、彎折影響日後網路的傳輸速率，進而降低教學效率與順暢，建請教育部寬列經費至少提升至如右圖的佈建品質。



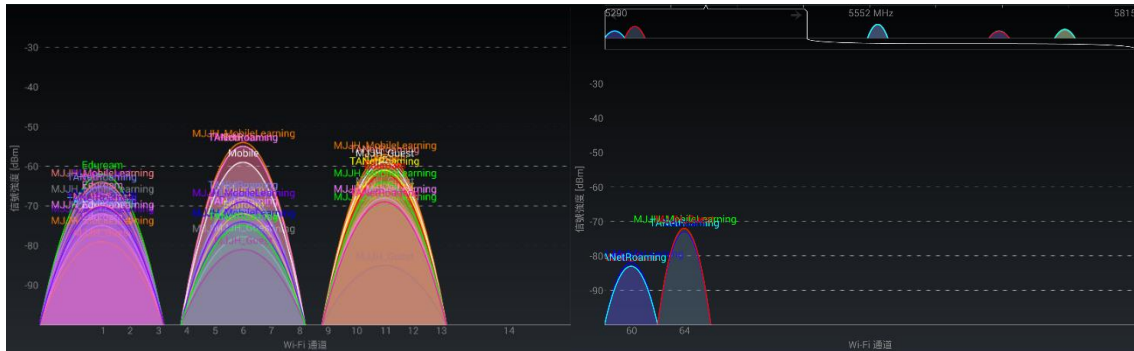
### 四.持續規畫校園行動教學無線網路架構與輔導

本計畫執行期間雖為一年，然實際進行行動學習無線網路最佳佈建建議方案探討時間不足，僅依目前市面上主流行動裝置進行各種無線網路標準下實際傳輸速度測試，並沒有進行下列各項實測：

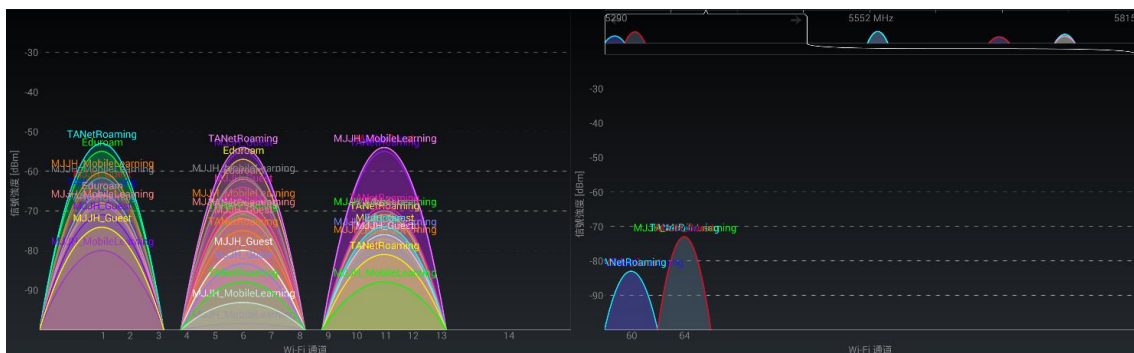
- 1.不同等級的行動裝置其網路傳輸速率。
- 2.行動學習學校採用設備實際傳輸速率測試。
- 3.以行動學習學校採用設備作為行動載具進行整班上網無線網路實際總頻寬測試-提供全班同時上網時無線網路可用總頻寬資訊。
- 4.以行動學習學校採用設備作為行動載具進行各型學校整班上網學術網路實際總頻寬測試-提供全班同時上網時各校學術網路可用總頻寬資訊，學校可以知道該申請多大的頻寬。
- 5.無線網路基地台等級。

建請教育部寬列經費進行上述各項測試並將成果與各校分享，各校如有須要最好能有專人協助，降低校園行動學習無線網路建置門檻，營造處處有教材，時時有學習，人人有成就的教育實境！

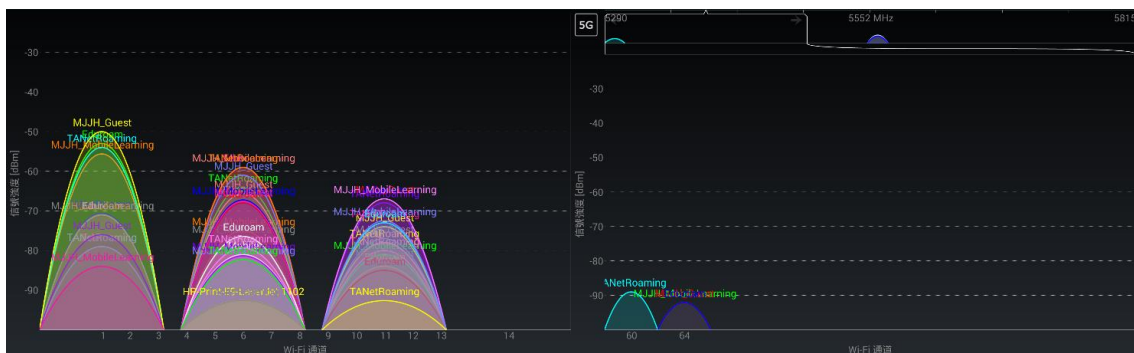
附件一名間國中無線網路無線電波強度  
校長室走廊



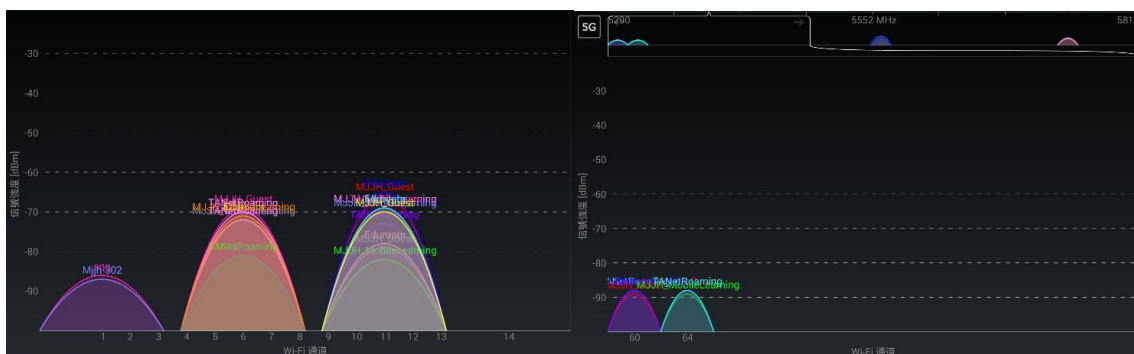
202 走廊

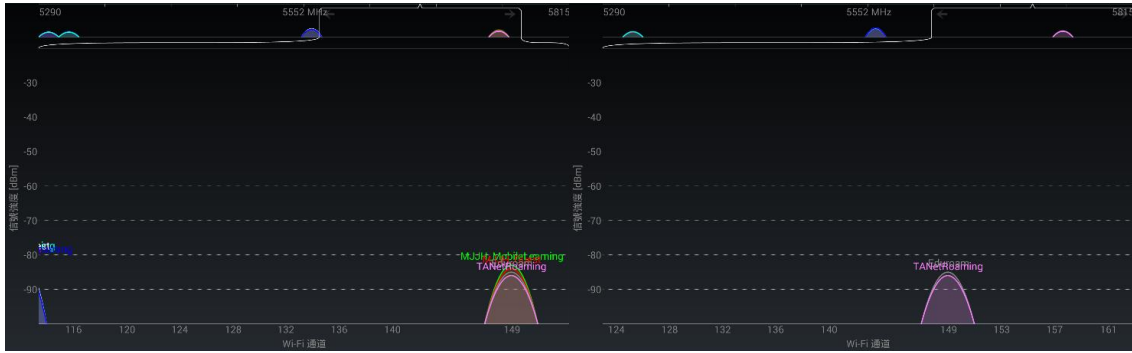


電腦教室走廊

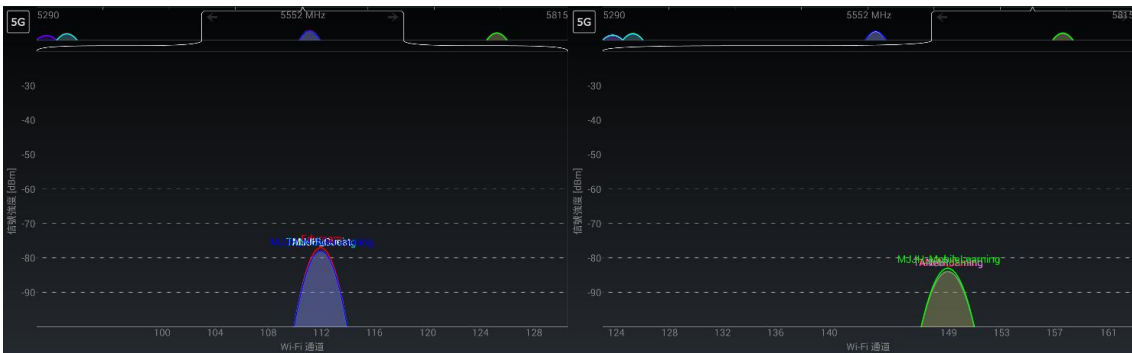
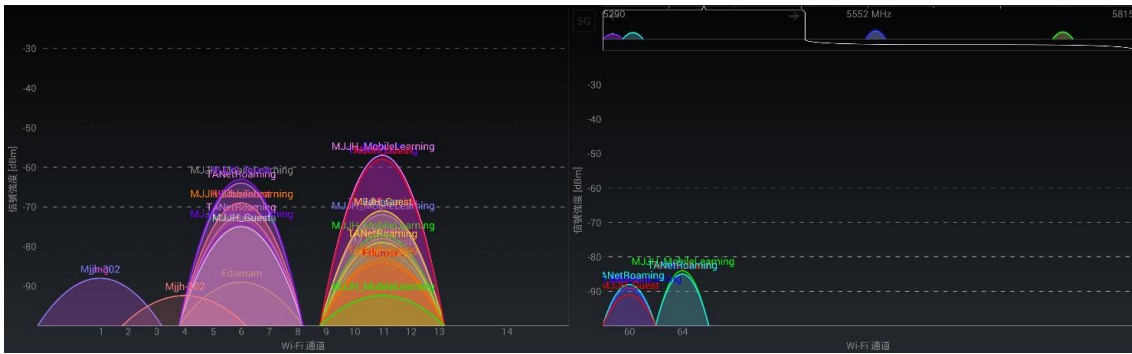


204 走廊

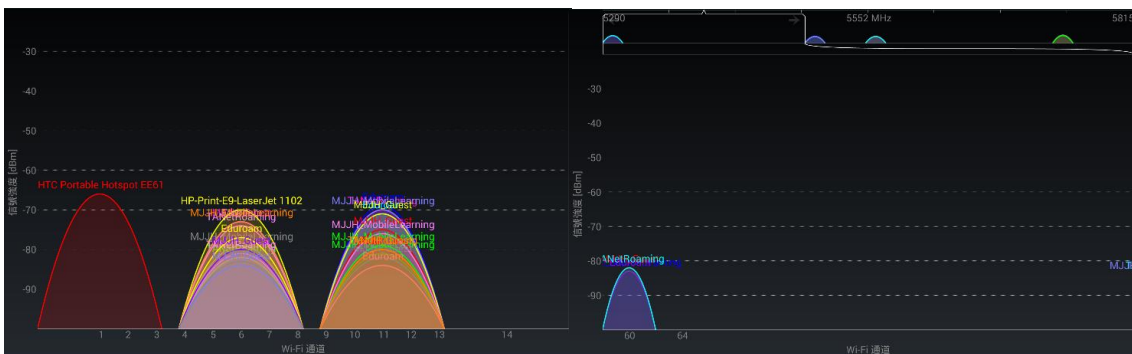


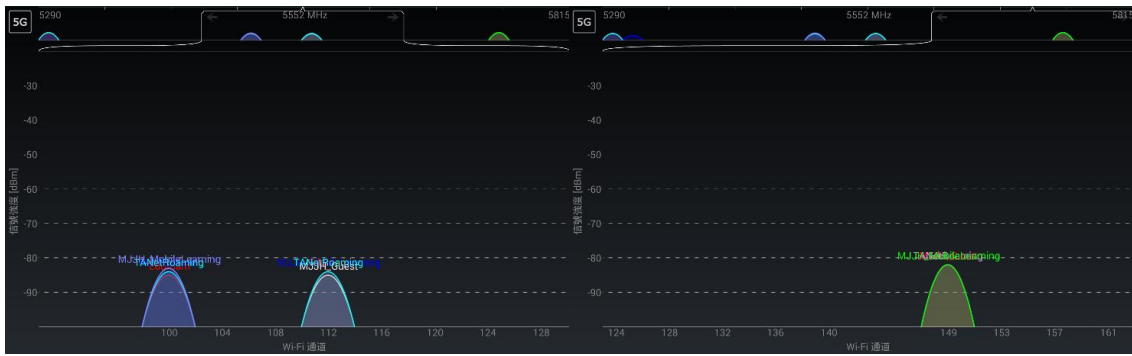


## 206 走廊

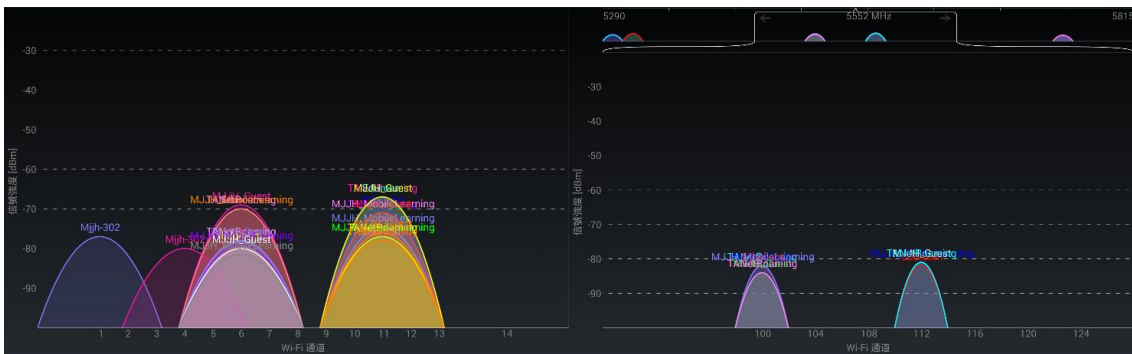


## 307 走廊





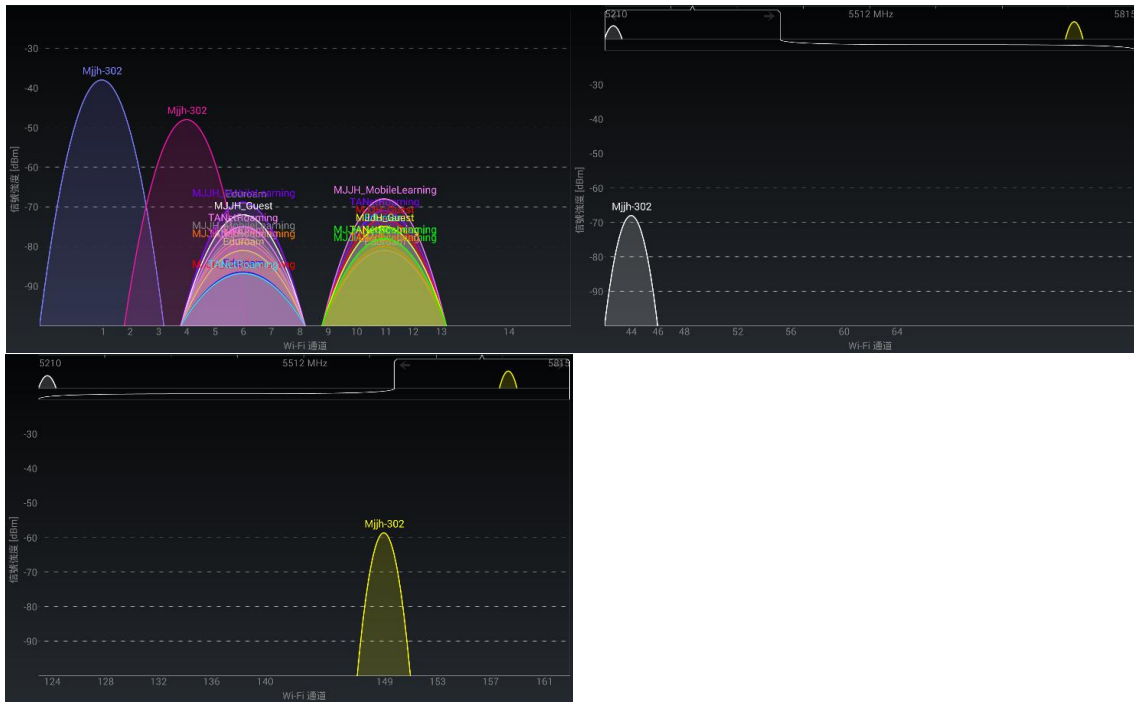
### 306 走廊



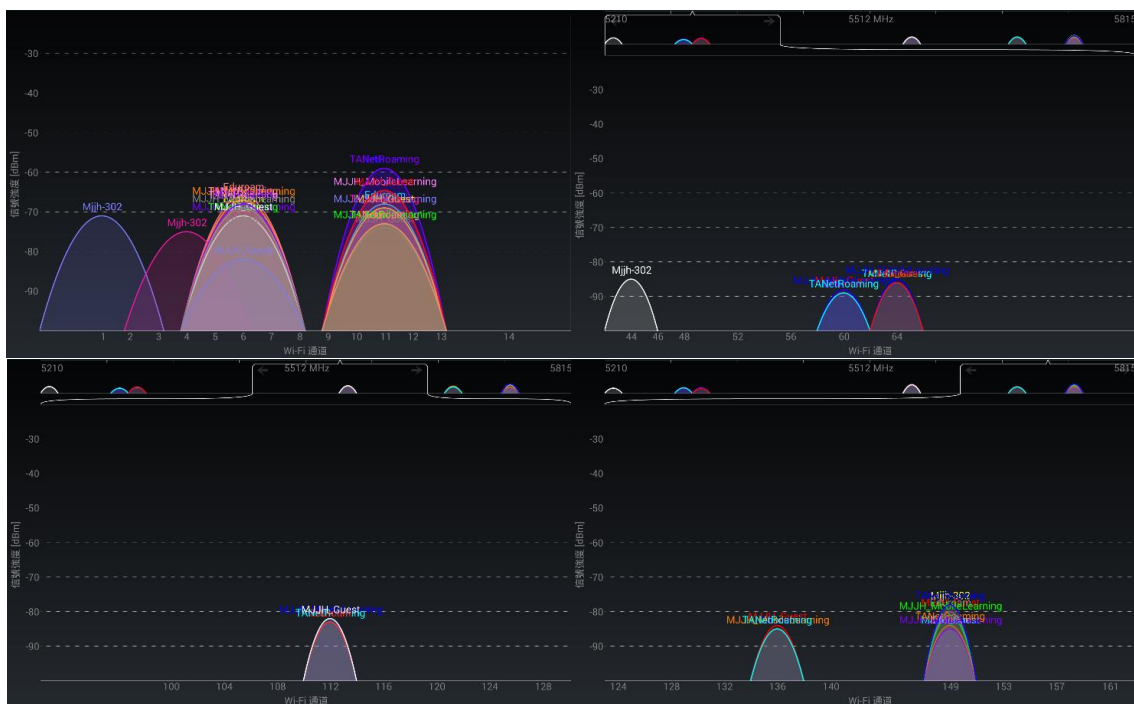
### 303 走廊



### 302 走廊



### 美術教室走廊



附件二名間國中測試結果

Server listening on TCP port 5001

TCP window size: 0.25 MByte (WARNING: requested 2.00 MByte)

[ ID] Interval            Transfer            Bandwidth

-----  
名間國中-筆電-視窗-有線

-----  
[ 4] local 192.168.12.65 port 5001 connected with 192.168.11.15 port 49851  
[ 4] 0.0- 3.0 sec    331 MBytes    926 Mbits/sec  
[ 4] 3.0- 6.0 sec    339 MBytes    948 Mbits/sec  
[ 4] 6.0- 9.0 sec    339 MBytes    947 Mbits/sec  
[ 4] 9.0-12.0 sec    338 MBytes    945 Mbits/sec  
[ 4] 12.0-15.0 sec   334 MBytes    933 Mbits/sec  
[ 4] 15.0-18.0 sec   338 MBytes    944 Mbits/sec  
[ 4] 18.0-21.0 sec   332 MBytes    928 Mbits/sec  
[ 4] 21.0-24.0 sec   328 MBytes    917 Mbits/sec  
[ 4] 24.0-27.0 sec   325 MBytes    909 Mbits/sec  
[ 4] 27.0-30.0 sec   327 MBytes    915 Mbits/sec  
[ 4] 30.0-33.0 sec   327 MBytes    915 Mbits/sec  
[ 4] 33.0-36.0 sec   329 MBytes    921 Mbits/sec  
[ 4] 36.0-39.0 sec   338 MBytes    946 Mbits/sec  
[ 4] 39.0-42.0 sec   332 MBytes    929 Mbits/sec  
[ 4] 42.0-45.0 sec   339 MBytes    947 Mbits/sec  
[ 4] 45.0-48.0 sec   338 MBytes    945 Mbits/sec  
[ 4] 48.0-51.0 sec   338 MBytes    946 Mbits/sec  
[ 4] 51.0-54.0 sec   339 MBytes    948 Mbits/sec  
[ 4] 54.0-57.0 sec   336 MBytes    940 Mbits/sec  
[ 4] 57.0-60.0 sec   327 MBytes    914 Mbits/sec  
[ 4] 0.0-60.0 sec   6674 MBytes   933 Mbits/sec  
-----

名間國中-筆電-視窗-802.11n-2.4GHz

-----  
[ 5] local 192.168.12.65 port 5001 connected with 192.168.11.12 port 50090  
[ 5] 0.0- 3.0 sec    17.9 MBytes   50.1 Mbits/sec  
[ 5] 3.0- 6.0 sec    17.4 MBytes   48.6 Mbits/sec  
[ 5] 6.0- 9.0 sec    16.5 MBytes   46.1 Mbits/sec  
[ 5] 9.0-12.0 sec    17.8 MBytes   49.9 Mbits/sec  
[ 5] 12.0-15.0 sec   18.2 MBytes   51.0 Mbits/sec  
[ 5] 15.0-18.0 sec   12.6 MBytes   35.2 Mbits/sec  
[ 5] 18.0-21.0 sec   13.5 MBytes   37.6 Mbits/sec  
[ 5] 21.0-24.0 sec   13.4 MBytes   37.5 Mbits/sec  
[ 5] 24.0-27.0 sec   11.6 MBytes   32.6 Mbits/sec  
[ 5] 27.0-30.0 sec   16.1 MBytes   45.0 Mbits/sec  
[ 5] 30.0-33.0 sec   14.9 MBytes   41.6 Mbits/sec  
[ 5] 33.0-36.0 sec   13.9 MBytes   38.9 Mbits/sec  
[ 5] 36.0-39.0 sec   15.6 MBytes   43.5 Mbits/sec  
[ 5] 39.0-42.0 sec   16.6 MBytes   46.3 Mbits/sec  
[ 5] 42.0-45.0 sec   12.9 MBytes   36.0 Mbits/sec  
[ 5] 45.0-48.0 sec   14.9 MBytes   41.7 Mbits/sec  
[ 5] 48.0-51.0 sec   13.2 MBytes   36.9 Mbits/sec  
[ 5] 51.0-54.0 sec   17.3 MBytes   48.5 Mbits/sec

```
[ 5] 54.0-57.0 sec 14.3 MBytes 39.9 Mbits/sec
[ 5] 57.0-60.0 sec 16.6 MBytes 46.4 Mbits/sec
[ 5] 0.0-60.0 sec 305 MBytes 42.7 Mbits/sec
```

---

名間國中-筆電-視窗-802.11n-5GHz

---

```
[ 6] local 192.168.12.65 port 5001 connected with 192.168.11.12 port 50090
[ 6] 0.0- 3.0 sec 33.2 MBytes 93.0 Mbits/sec
[ 6] 3.0- 6.0 sec 29.6 MBytes 82.8 Mbits/sec
[ 6] 6.0- 9.0 sec 30.9 MBytes 86.5 Mbits/sec
[ 6] 9.0-12.0 sec 31.3 MBytes 87.5 Mbits/sec
[ 6] 12.0-15.0 sec 32.1 MBytes 89.9 Mbits/sec
[ 6] 15.0-18.0 sec 30.1 MBytes 84.1 Mbits/sec
[ 6] 18.0-21.0 sec 32.2 MBytes 90.0 Mbits/sec
[ 6] 21.0-24.0 sec 32.4 MBytes 90.6 Mbits/sec
[ 6] 24.0-27.0 sec 31.6 MBytes 88.5 Mbits/sec
[ 6] 27.0-30.0 sec 29.6 MBytes 82.9 Mbits/sec
[ 6] 30.0-33.0 sec 31.1 MBytes 87.0 Mbits/sec
[ 6] 33.0-36.0 sec 30.6 MBytes 85.6 Mbits/sec
[ 6] 36.0-39.0 sec 30.3 MBytes 84.8 Mbits/sec
[ 6] 39.0-42.0 sec 32.2 MBytes 90.0 Mbits/sec
[ 6] 42.0-45.0 sec 32.5 MBytes 91.0 Mbits/sec
[ 6] 45.0-48.0 sec 30.0 MBytes 83.8 Mbits/sec
[ 6] 48.0-51.0 sec 31.7 MBytes 88.6 Mbits/sec
[ 6] 51.0-54.0 sec 31.8 MBytes 89.0 Mbits/sec
[ 6] 54.0-57.0 sec 31.9 MBytes 89.1 Mbits/sec
[ 6] 57.0-60.0 sec 30.5 MBytes 85.4 Mbits/sec
[ 6] 0.0-60.0 sec 626 MBytes 87.5 Mbits/sec
```

---

名間國中-筆電-視窗-802.11ac-5GHz

---

```
[ 7] local 192.168.12.65 port 5001 connected with 192.168.11.12 port 50554
[ 7] 0.0- 3.0 sec 49.5 MBytes 138 Mbits/sec
[ 7] 3.0- 6.0 sec 61.9 MBytes 173 Mbits/sec
[ 7] 6.0- 9.0 sec 70.2 MBytes 196 Mbits/sec
[ 7] 9.0-12.0 sec 60.4 MBytes 169 Mbits/sec
[ 7] 12.0-15.0 sec 82.5 MBytes 231 Mbits/sec
[ 7] 15.0-18.0 sec 75.0 MBytes 210 Mbits/sec
[ 7] 18.0-21.0 sec 84.0 MBytes 235 Mbits/sec
[ 7] 21.0-24.0 sec 85.4 MBytes 239 Mbits/sec
[ 7] 24.0-27.0 sec 83.6 MBytes 234 Mbits/sec
[ 7] 27.0-30.0 sec 78.0 MBytes 218 Mbits/sec
[ 7] 30.0-33.0 sec 88.3 MBytes 247 Mbits/sec
[ 7] 33.0-36.0 sec 86.0 MBytes 240 Mbits/sec
[ 7] 36.0-39.0 sec 92.7 MBytes 259 Mbits/sec
[ 7] 39.0-42.0 sec 89.3 MBytes 250 Mbits/sec
[ 7] 42.0-45.0 sec 84.1 MBytes 235 Mbits/sec
[ 7] 45.0-48.0 sec 88.8 MBytes 248 Mbits/sec
[ 7] 48.0-51.0 sec 79.3 MBytes 222 Mbits/sec
[ 7] 51.0-54.0 sec 76.2 MBytes 213 Mbits/sec
[ 7] 54.0-57.0 sec 92.8 MBytes 259 Mbits/sec
[ 7] 57.0-60.0 sec 86.4 MBytes 242 Mbits/sec
```

[ 7] 0.0-60.0 sec 1594 MBytes 223 Mbits/sec

-----  
名間國中-平板-Android-802.11n-2.4GHz  
-----

[ 8] local 192.168.12.65 port 5001 connected with 192.168.9.2 port 50834

[ 8] 0.0- 3.0 sec 18.7 MBytes 52.3 Mbits/sec  
[ 8] 3.0- 6.0 sec 21.3 MBytes 59.6 Mbits/sec  
[ 8] 6.0- 9.0 sec 19.3 MBytes 53.9 Mbits/sec  
[ 8] 9.0-12.0 sec 15.4 MBytes 43.0 Mbits/sec  
[ 8] 12.0-15.0 sec 17.6 MBytes 49.1 Mbits/sec  
[ 8] 15.0-18.0 sec 19.2 MBytes 53.7 Mbits/sec  
[ 8] 18.0-21.0 sec 17.7 MBytes 49.4 Mbits/sec  
[ 8] 21.0-24.0 sec 20.1 MBytes 56.2 Mbits/sec  
[ 8] 24.0-27.0 sec 16.6 MBytes 46.4 Mbits/sec  
[ 8] 27.0-30.0 sec 20.9 MBytes 58.6 Mbits/sec  
[ 8] 30.0-33.0 sec 20.2 MBytes 56.5 Mbits/sec  
[ 8] 33.0-36.0 sec 21.1 MBytes 59.0 Mbits/sec  
[ 8] 36.0-39.0 sec 20.2 MBytes 56.5 Mbits/sec  
[ 8] 39.0-42.0 sec 19.9 MBytes 55.7 Mbits/sec  
[ 8] 42.0-45.0 sec 8.42 MBytes 23.5 Mbits/sec  
[ 8] 45.0-48.0 sec 9.61 MBytes 26.9 Mbits/sec  
[ 8] 48.0-51.0 sec 21.4 MBytes 59.9 Mbits/sec  
[ 8] 51.0-54.0 sec 21.4 MBytes 59.9 Mbits/sec  
[ 8] 54.0-57.0 sec 19.8 MBytes 55.2 Mbits/sec  
[ 8] 57.0-60.0 sec 20.4 MBytes 56.9 Mbits/sec  
[ 8] 0.0-60.0 sec 369 MBytes 51.6 Mbits/sec

-----  
名間國中-平板-Android-802.11n-5GHz  
-----

[ 9] local 192.168.12.65 port 5001 connected with 192.168.9.2 port 50835

[ 9] 0.0- 3.0 sec 27.9 MBytes 78.1 Mbits/sec  
[ 9] 3.0- 6.0 sec 27.5 MBytes 77.0 Mbits/sec  
[ 9] 6.0- 9.0 sec 26.9 MBytes 75.1 Mbits/sec  
[ 9] 9.0-12.0 sec 26.4 MBytes 73.9 Mbits/sec  
[ 9] 12.0-15.0 sec 28.8 MBytes 80.5 Mbits/sec  
[ 9] 15.0-18.0 sec 28.4 MBytes 79.4 Mbits/sec  
[ 9] 18.0-21.0 sec 28.4 MBytes 79.4 Mbits/sec  
[ 9] 21.0-24.0 sec 28.0 MBytes 78.4 Mbits/sec  
[ 9] 24.0-27.0 sec 28.5 MBytes 79.7 Mbits/sec  
[ 9] 27.0-30.0 sec 28.5 MBytes 79.6 Mbits/sec  
[ 9] 30.0-33.0 sec 27.8 MBytes 77.7 Mbits/sec  
[ 9] 33.0-36.0 sec 28.9 MBytes 80.8 Mbits/sec  
[ 9] 36.0-39.0 sec 19.8 MBytes 55.3 Mbits/sec  
[ 9] 39.0-42.0 sec 8.71 MBytes 24.4 Mbits/sec  
[ 9] 42.0-45.0 sec 28.4 MBytes 79.4 Mbits/sec  
[ 9] 45.0-48.0 sec 29.2 MBytes 81.5 Mbits/sec  
[ 9] 48.0-51.0 sec 29.4 MBytes 82.2 Mbits/sec  
[ 9] 51.0-54.0 sec 28.9 MBytes 80.9 Mbits/sec  
[ 9] 54.0-57.0 sec 29.5 MBytes 82.4 Mbits/sec  
[ 9] 57.0-60.0 sec 29.3 MBytes 81.9 Mbits/sec  
[ 9] 0.0-60.0 sec 539 MBytes 75.4 Mbits/sec



名間國中-平板-Android-802.11ac-5GHz

---

```
[ 10] local 192.168.12.65 port 5001 connected with 192.168.9.2 port 52422
[ 10] 0.0- 3.0 sec 73.1 MBytes 204 Mbits/sec
[ 10] 3.0- 6.0 sec 81.6 MBytes 228 Mbits/sec
[ 10] 6.0- 9.0 sec 72.2 MBytes 202 Mbits/sec
[ 10] 9.0-12.0 sec 70.6 MBytes 197 Mbits/sec
[ 10] 12.0-15.0 sec 70.1 MBytes 196 Mbits/sec
[ 10] 15.0-18.0 sec 67.9 MBytes 190 Mbits/sec
[ 10] 18.0-21.0 sec 70.6 MBytes 197 Mbits/sec
[ 10] 21.0-24.0 sec 64.4 MBytes 180 Mbits/sec
[ 10] 24.0-27.0 sec 67.5 MBytes 189 Mbits/sec
[ 10] 27.0-30.0 sec 67.5 MBytes 189 Mbits/sec
[ 10] 30.0-33.0 sec 44.0 MBytes 123 Mbits/sec
[ 10] 33.0-36.0 sec 11.6 MBytes 32.5 Mbits/sec
[ 10] 36.0-39.0 sec 64.3 MBytes 180 Mbits/sec
[ 10] 39.0-42.0 sec 66.9 MBytes 187 Mbits/sec
[ 10] 42.0-45.0 sec 68.0 MBytes 190 Mbits/sec
[ 10] 45.0-48.0 sec 63.3 MBytes 177 Mbits/sec
[ 10] 48.0-51.0 sec 68.2 MBytes 191 Mbits/sec
[ 10] 51.0-54.0 sec 65.1 MBytes 182 Mbits/sec
[ 10] 54.0-57.0 sec 69.0 MBytes 193 Mbits/sec
[ 10] 57.0-60.0 sec 68.3 MBytes 191 Mbits/sec
[ 10] 0.0-60.0 sec 1294 MBytes 181 Mbits/sec
```

---

名間國中-平板-IOS-802.11n-2.4GHz

---

```
[ 11] local 192.168.12.65 port 5001 connected with 192.168.12.60 port 50696
[ 11] 0.0- 3.0 sec 4.01 MBytes 11.2 Mbits/sec
[ 11] 3.0- 6.0 sec 3.68 MBytes 10.3 Mbits/sec
[ 11] 6.0- 9.0 sec 3.68 MBytes 10.3 Mbits/sec
[ 11] 9.0-12.0 sec 3.86 MBytes 10.8 Mbits/sec
[ 11] 12.0-15.0 sec 3.81 MBytes 10.7 Mbits/sec
[ 11] 15.0-18.0 sec 2.77 MBytes 7.74 Mbits/sec
[ 11] 18.0-21.0 sec 2.68 MBytes 7.49 Mbits/sec
[ 11] 21.0-24.0 sec 2.96 MBytes 8.29 Mbits/sec
[ 11] 24.0-27.0 sec 2.84 MBytes 7.94 Mbits/sec
[ 11] 27.0-30.0 sec 3.50 MBytes 9.80 Mbits/sec
[ 11] 30.0-33.0 sec 3.03 MBytes 8.47 Mbits/sec
[ 11] 33.0-36.0 sec 3.12 MBytes 8.73 Mbits/sec
[ 11] 36.0-39.0 sec 3.17 MBytes 8.87 Mbits/sec
[ 11] 39.0-42.0 sec 2.58 MBytes 7.20 Mbits/sec
[ 11] 42.0-45.0 sec 2.67 MBytes 7.45 Mbits/sec
[ 11] 45.0-48.0 sec 3.80 MBytes 10.6 Mbits/sec
[ 11] 48.0-51.0 sec 3.12 MBytes 8.73 Mbits/sec
[ 11] 51.0-54.0 sec 3.42 MBytes 9.57 Mbits/sec
[ 11] 54.0-57.0 sec 3.61 MBytes 10.1 Mbits/sec
[ 11] 57.0-60.0 sec 2.93 MBytes 8.21 Mbits/sec
[ 11] 0.0-61.5 sec 67.2 MBytes 9.17 Mbits/sec
```

---

名間國中-平板-IOS-802.11n-5GHz

---

```

[ 12] local 192.168.12.65 port 5001 connected with 192.168.12.60 port 50742
[ 12] 0.0- 3.0 sec 25.2 MBytes 70.5 Mbits/sec
[ 12] 3.0- 6.0 sec 29.4 MBytes 82.1 Mbits/sec
[ 12] 6.0- 9.0 sec 26.1 MBytes 73.0 Mbits/sec
[ 12] 9.0-12.0 sec 31.5 MBytes 88.1 Mbits/sec
[ 12] 12.0-15.0 sec 26.5 MBytes 74.1 Mbits/sec
[ 12] 15.0-18.0 sec 30.5 MBytes 85.3 Mbits/sec
[ 12] 18.0-21.0 sec 29.7 MBytes 83.1 Mbits/sec
[ 12] 21.0-24.0 sec 28.9 MBytes 80.9 Mbits/sec
[ 12] 24.0-27.0 sec 27.8 MBytes 77.8 Mbits/sec
[ 12] 27.0-30.0 sec 29.0 MBytes 81.0 Mbits/sec
[ 12] 30.0-33.0 sec 27.8 MBytes 77.8 Mbits/sec
[ 12] 33.0-36.0 sec 27.1 MBytes 75.9 Mbits/sec
[ 12] 36.0-39.0 sec 28.5 MBytes 79.8 Mbits/sec
[ 12] 39.0-42.0 sec 27.0 MBytes 75.5 Mbits/sec
[ 12] 42.0-45.0 sec 26.7 MBytes 74.6 Mbits/sec
[ 12] 45.0-48.0 sec 26.5 MBytes 74.2 Mbits/sec
[ 12] 48.0-51.0 sec 25.5 MBytes 71.2 Mbits/sec
[ 12] 51.0-54.0 sec 26.0 MBytes 72.7 Mbits/sec
[ 12] 54.0-57.0 sec 26.0 MBytes 72.7 Mbits/sec
[ 12] 57.0-60.0 sec 25.6 MBytes 71.5 Mbits/sec
[ 12] 0.0-60.1 sec 552 MBytes 77.1 Mbits/sec

```

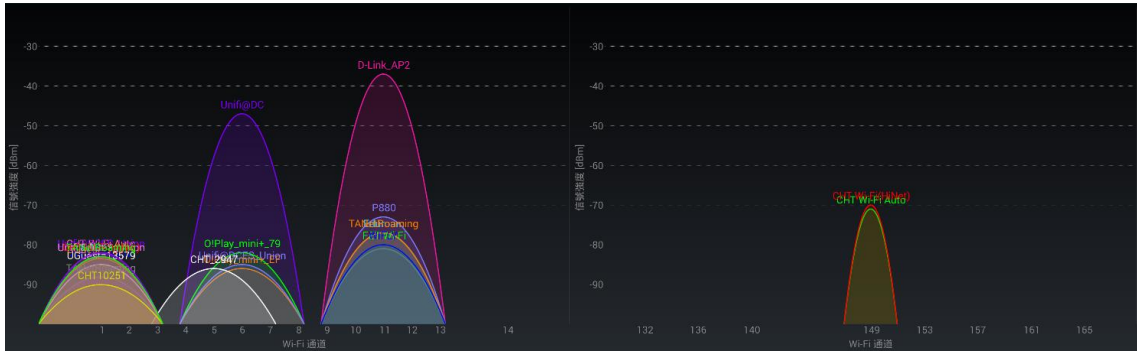
-----  
名間國中-平板-IOS-802.11ac-5GHz  
-----

```

[ 13] local 192.168.12.65 port 5001 connected with 192.168.12.60 port 50760
[ 13] 0.0- 3.0 sec 80.0 MBytes 224 Mbits/sec
[ 13] 3.0- 6.0 sec 79.8 MBytes 223 Mbits/sec
[ 13] 6.0- 9.0 sec 79.3 MBytes 222 Mbits/sec
[ 13] 9.0-12.0 sec 80.2 MBytes 224 Mbits/sec
[ 13] 12.0-15.0 sec 80.9 MBytes 226 Mbits/sec
[ 13] 15.0-18.0 sec 79.5 MBytes 222 Mbits/sec
[ 13] 18.0-21.0 sec 78.2 MBytes 219 Mbits/sec
[ 13] 21.0-24.0 sec 78.8 MBytes 220 Mbits/sec
[ 13] 24.0-27.0 sec 77.5 MBytes 217 Mbits/sec
[ 13] 27.0-30.0 sec 76.9 MBytes 215 Mbits/sec
[ 13] 30.0-33.0 sec 75.4 MBytes 211 Mbits/sec
[ 13] 33.0-36.0 sec 72.5 MBytes 203 Mbits/sec
[ 13] 36.0-39.0 sec 79.0 MBytes 221 Mbits/sec
[ 13] 39.0-42.0 sec 79.7 MBytes 223 Mbits/sec
[ 13] 42.0-45.0 sec 78.5 MBytes 220 Mbits/sec
[ 13] 45.0-48.0 sec 78.4 MBytes 219 Mbits/sec
[ 13] 48.0-51.0 sec 74.6 MBytes 209 Mbits/sec
[ 13] 51.0-54.0 sec 78.8 MBytes 220 Mbits/sec
[ 13] 54.0-57.0 sec 81.2 MBytes 227 Mbits/sec
[ 13] 57.0-60.0 sec 79.2 MBytes 222 Mbits/sec
[ 13] 0.0-60.1 sec 1570 MBytes 219 Mbits/sec

```

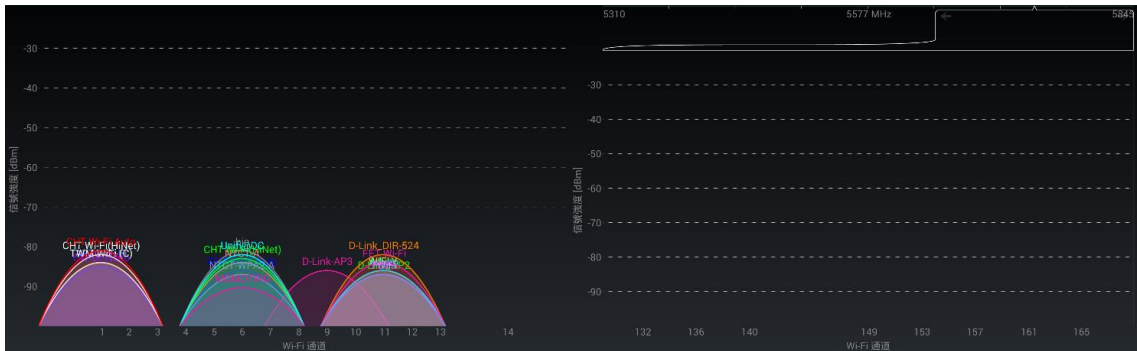
附件三大成國小無線網路無線電波強度  
電腦教室門口



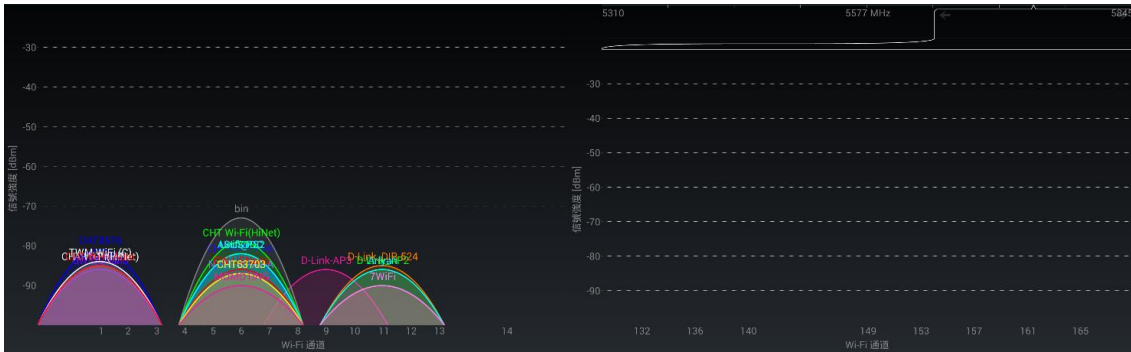
會議室



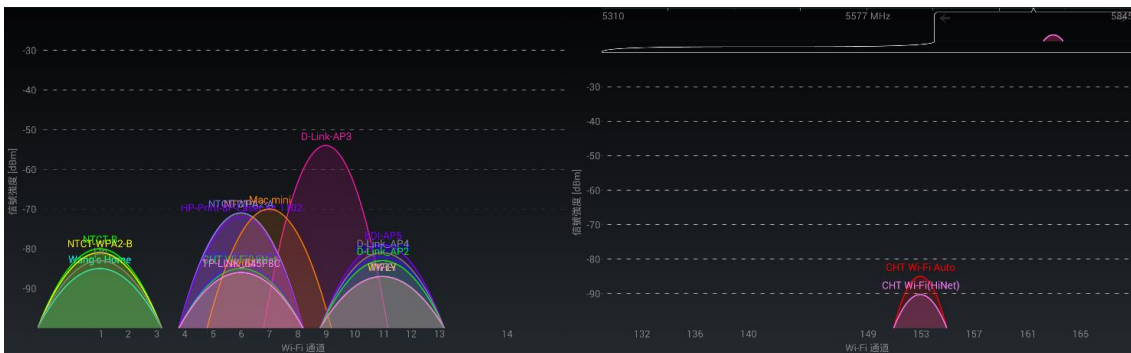
一年甲班



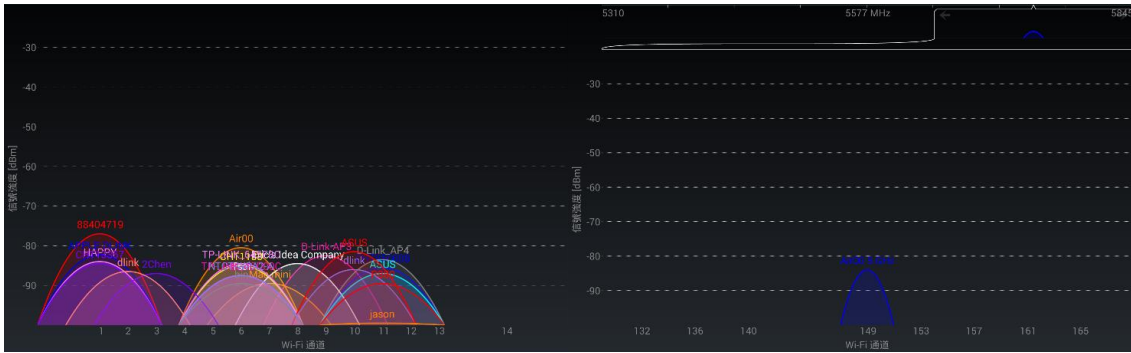
### 一年丙班旁廁所



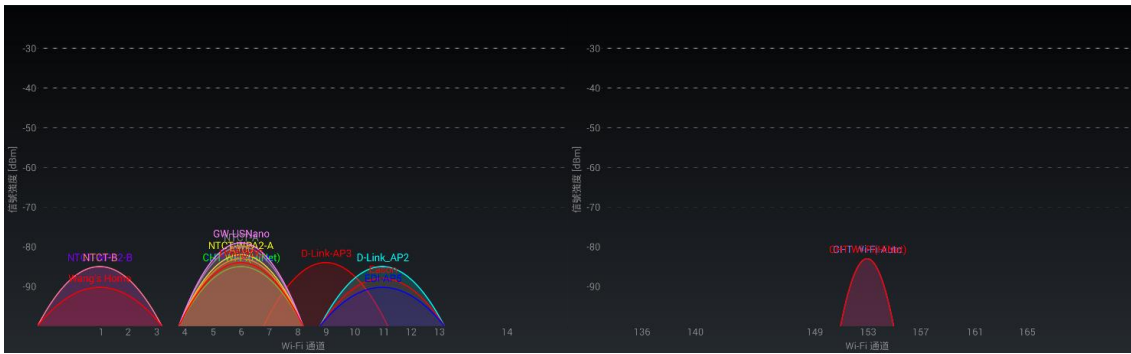
### 教務學務處



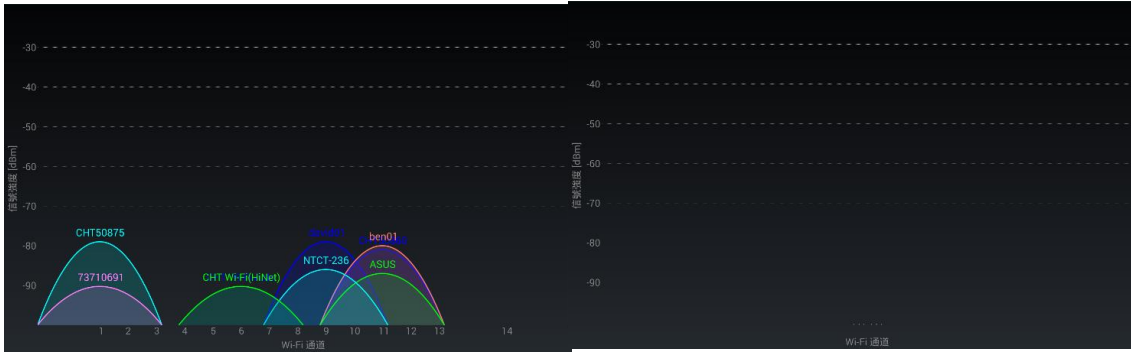
### 司令台



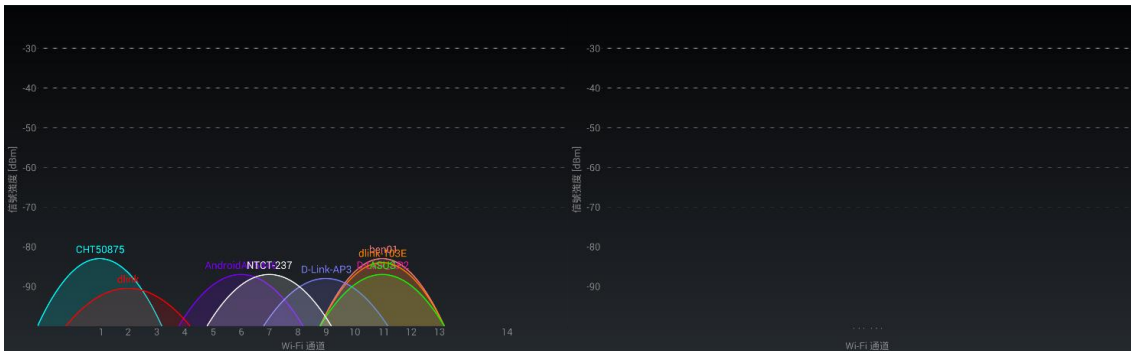
### 二年乙班



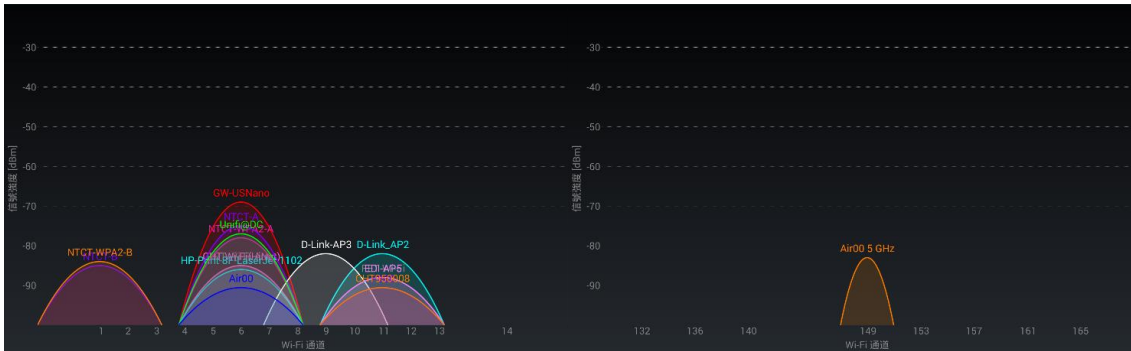
### 午餐廚房



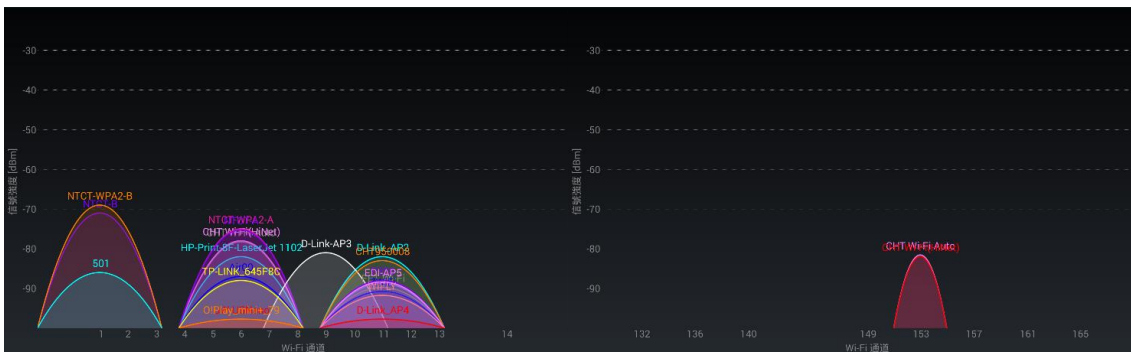
### 體育器材室



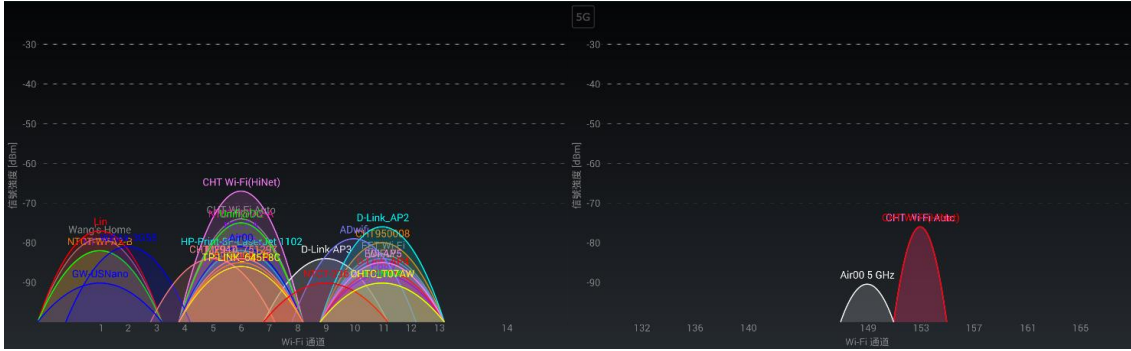
### 自然教室 2



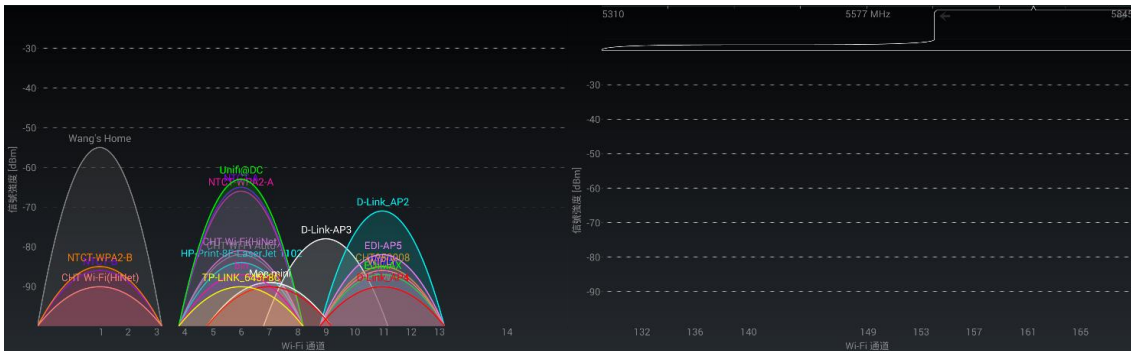
### 自然教室 1 廁所



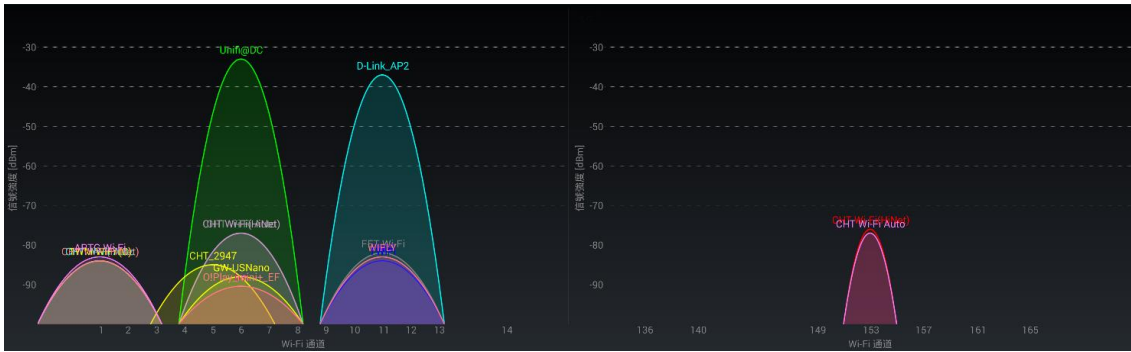
## 音樂教室



## 本土語言中心



## 值日室



附件四大成國小測試結果

Server listening on TCP port 5001

TCP window size: 0.25 MByte (WARNING: requested 2.00 MByte)

[ ID] Interval            Transfer            Bandwidth

-----  
筆電-視窗系統-有線

-----  
[ 4] local 192.168.2.157 port 5001 connected with 192.168.2.155 port 53425  
[ 4] 0.0- 3.0 sec    285 MBytes    798 Mbits/sec  
[ 4] 3.0- 6.0 sec    290 MBytes    812 Mbits/sec  
[ 4] 6.0- 9.0 sec    304 MBytes    850 Mbits/sec  
[ 4] 9.0-12.0 sec    298 MBytes    833 Mbits/sec  
[ 4] 12.0-15.0 sec   302 MBytes    845 Mbits/sec  
[ 4] 15.0-18.0 sec   304 MBytes    849 Mbits/sec  
[ 4] 18.0-21.0 sec   317 MBytes    886 Mbits/sec  
[ 4] 21.0-24.0 sec   294 MBytes    822 Mbits/sec  
[ 4] 24.0-27.0 sec   307 MBytes    858 Mbits/sec  
[ 4] 27.0-30.0 sec   284 MBytes    795 Mbits/sec  
[ 4] 30.0-33.0 sec   300 MBytes    839 Mbits/sec  
[ 4] 33.0-36.0 sec   318 MBytes    890 Mbits/sec  
[ 4] 36.0-39.0 sec   314 MBytes    877 Mbits/sec  
[ 4] 39.0-42.0 sec   323 MBytes    902 Mbits/sec  
[ 4] 42.0-45.0 sec   300 MBytes    840 Mbits/sec  
[ 4] 45.0-48.0 sec   291 MBytes    814 Mbits/sec  
[ 4] 48.0-51.0 sec   310 MBytes    868 Mbits/sec  
[ 4] 51.0-54.0 sec   313 MBytes    876 Mbits/sec  
[ 4] 54.0-57.0 sec   328 MBytes    917 Mbits/sec  
[ 4] 57.0-60.0 sec   314 MBytes    878 Mbits/sec  
[ 4] 0.0-60.0 sec   6098 MBytes   852 Mbits/sec  
-----

筆電-視窗系統-802.11n 2.4GHz

-----  
[ 5] local 192.168.2.157 port 5001 connected with 192.168.2.156 port 53455  
[ 5] 0.0- 3.0 sec    18.4 MBytes   51.3 Mbits/sec  
[ 5] 3.0- 6.0 sec    19.5 MBytes   54.5 Mbits/sec  
[ 5] 6.0- 9.0 sec    24.0 MBytes   67.2 Mbits/sec  
[ 5] 9.0-12.0 sec    16.0 MBytes   44.7 Mbits/sec  
[ 5] 12.0-15.0 sec   18.7 MBytes   52.2 Mbits/sec  
[ 5] 15.0-18.0 sec   17.0 MBytes   47.6 Mbits/sec  
[ 5] 18.0-21.0 sec   22.6 MBytes   63.3 Mbits/sec  
[ 5] 21.0-24.0 sec   19.2 MBytes   53.7 Mbits/sec  
[ 5] 24.0-27.0 sec   15.1 MBytes   42.1 Mbits/sec  
[ 5] 27.0-30.0 sec   17.0 MBytes   47.4 Mbits/sec  
[ 5] 30.0-33.0 sec   14.9 MBytes   41.8 Mbits/sec  
[ 5] 33.0-36.0 sec   18.0 MBytes   50.3 Mbits/sec  
[ 5] 36.0-39.0 sec   18.8 MBytes   52.5 Mbits/sec  
[ 5] 39.0-42.0 sec   11.2 MBytes   31.4 Mbits/sec  
[ 5] 42.0-45.0 sec   14.0 MBytes   39.1 Mbits/sec  
[ 5] 45.0-48.0 sec   21.5 MBytes   60.2 Mbits/sec  
[ 5] 48.0-51.0 sec   18.7 MBytes   52.4 Mbits/sec  
[ 5] 51.0-54.0 sec   18.3 MBytes   51.3 Mbits/sec

```
[ 5] 54.0-57.0 sec 14.8 MBytes 41.4 Mbits/sec
[ 5] 57.0-60.0 sec 16.2 MBytes 45.3 Mbits/sec
[ 5] 0.0-60.0 sec 354 MBytes 49.5 Mbits/sec
```

---

筆電-視窗系統-802.11n 5GHz

---

```
[ 6] local 192.168.2.157 port 5001 connected with 192.168.2.156 port 53616
[ 6] 0.0- 3.0 sec 24.6 MBytes 68.8 Mbits/sec
[ 6] 3.0- 6.0 sec 31.5 MBytes 88.1 Mbits/sec
[ 6] 6.0- 9.0 sec 31.7 MBytes 88.6 Mbits/sec
[ 6] 9.0-12.0 sec 31.7 MBytes 88.6 Mbits/sec
[ 6] 12.0-15.0 sec 30.9 MBytes 86.5 Mbits/sec
[ 6] 15.0-18.0 sec 31.8 MBytes 88.8 Mbits/sec
[ 6] 18.0-21.0 sec 32.4 MBytes 90.6 Mbits/sec
[ 6] 21.0-24.0 sec 31.6 MBytes 88.4 Mbits/sec
[ 6] 24.0-27.0 sec 32.5 MBytes 91.0 Mbits/sec
[ 6] 27.0-30.0 sec 30.0 MBytes 83.9 Mbits/sec
[ 6] 30.0-33.0 sec 29.7 MBytes 83.0 Mbits/sec
[ 6] 33.0-36.0 sec 31.1 MBytes 86.9 Mbits/sec
[ 6] 36.0-39.0 sec 31.1 MBytes 87.0 Mbits/sec
[ 6] 39.0-42.0 sec 32.5 MBytes 90.9 Mbits/sec
[ 6] 42.0-45.0 sec 31.3 MBytes 87.6 Mbits/sec
[ 6] 45.0-48.0 sec 31.3 MBytes 87.4 Mbits/sec
[ 6] 48.0-51.0 sec 30.4 MBytes 85.1 Mbits/sec
[ 6] 51.0-54.0 sec 32.0 MBytes 89.6 Mbits/sec
[ 6] 54.0-57.0 sec 31.9 MBytes 89.2 Mbits/sec
[ 6] 57.0-60.0 sec 31.6 MBytes 88.3 Mbits/sec
[ 6] 0.0-60.0 sec 622 MBytes 86.9 Mbits/sec
```

---

筆電-視窗系統-802.11ac 5GHz

---

```
[ 7] local 192.168.2.157 port 5001 connected with 192.168.2.156 port 53617
[ 7] 0.0- 3.0 sec 45.4 MBytes 127 Mbits/sec
[ 7] 3.0- 6.0 sec 62.7 MBytes 175 Mbits/sec
[ 7] 6.0- 9.0 sec 80.0 MBytes 224 Mbits/sec
[ 7] 9.0-12.0 sec 78.5 MBytes 220 Mbits/sec
[ 7] 12.0-15.0 sec 83.7 MBytes 234 Mbits/sec
[ 7] 15.0-18.0 sec 83.8 MBytes 234 Mbits/sec
[ 7] 18.0-21.0 sec 89.2 MBytes 249 Mbits/sec
[ 7] 21.0-24.0 sec 86.0 MBytes 240 Mbits/sec
[ 7] 24.0-27.0 sec 86.9 MBytes 243 Mbits/sec
[ 7] 27.0-30.0 sec 82.6 MBytes 231 Mbits/sec
[ 7] 30.0-33.0 sec 79.6 MBytes 223 Mbits/sec
[ 7] 33.0-36.0 sec 75.0 MBytes 210 Mbits/sec
[ 7] 36.0-39.0 sec 74.5 MBytes 208 Mbits/sec
[ 7] 39.0-42.0 sec 81.1 MBytes 227 Mbits/sec
[ 7] 42.0-45.0 sec 76.5 MBytes 214 Mbits/sec
[ 7] 45.0-48.0 sec 79.5 MBytes 222 Mbits/sec
[ 7] 48.0-51.0 sec 74.2 MBytes 208 Mbits/sec
[ 7] 51.0-54.0 sec 92.4 MBytes 258 Mbits/sec
[ 7] 54.0-57.0 sec 79.3 MBytes 222 Mbits/sec
[ 7] 57.0-60.0 sec 72.7 MBytes 203 Mbits/sec
```



[ 7] 0.0-60.0 sec 1564 MBytes 219 Mbits/sec

---

平板-Android-802.11n 2.4GHz

---

[ 8] local 192.168.2.157 port 5001 connected with 192.168.2.158 port 37041  
[ 8] 0.0- 3.0 sec 24.2 MBytes 67.8 Mbits/sec  
[ 8] 3.0- 6.0 sec 24.5 MBytes 68.5 Mbits/sec  
[ 8] 6.0- 9.0 sec 24.9 MBytes 69.5 Mbits/sec  
[ 8] 9.0-12.0 sec 25.2 MBytes 70.4 Mbits/sec  
[ 8] 12.0-15.0 sec 24.8 MBytes 69.3 Mbits/sec  
[ 8] 15.0-18.0 sec 24.9 MBytes 69.5 Mbits/sec  
[ 8] 18.0-21.0 sec 24.5 MBytes 68.5 Mbits/sec  
[ 8] 21.0-24.0 sec 25.8 MBytes 72.1 Mbits/sec  
[ 8] 24.0-27.0 sec 25.8 MBytes 72.0 Mbits/sec  
[ 8] 27.0-30.0 sec 22.8 MBytes 63.7 Mbits/sec  
[ 8] 30.0-33.0 sec 25.4 MBytes 71.1 Mbits/sec  
[ 8] 33.0-36.0 sec 25.0 MBytes 69.9 Mbits/sec  
[ 8] 36.0-39.0 sec 24.6 MBytes 68.9 Mbits/sec  
[ 8] 39.0-42.0 sec 25.3 MBytes 70.9 Mbits/sec  
[ 8] 42.0-45.0 sec 24.9 MBytes 69.7 Mbits/sec  
[ 8] 45.0-48.0 sec 25.2 MBytes 70.4 Mbits/sec  
[ 8] 48.0-51.0 sec 24.9 MBytes 69.7 Mbits/sec  
[ 8] 51.0-54.0 sec 25.6 MBytes 71.6 Mbits/sec  
[ 8] 54.0-57.0 sec 26.0 MBytes 72.7 Mbits/sec  
[ 8] 57.0-60.0 sec 22.8 MBytes 63.7 Mbits/sec  
[ 8] 0.0-60.0 sec 497 MBytes 69.5 Mbits/sec

---

平板-Android-802.11n 5GHz

---

[ 9] local 192.168.2.157 port 5001 connected with 192.168.2.158 port 37042  
[ 9] 0.0- 3.0 sec 31.0 MBytes 86.7 Mbits/sec  
[ 9] 3.0- 6.0 sec 30.8 MBytes 86.2 Mbits/sec  
[ 9] 6.0- 9.0 sec 30.9 MBytes 86.4 Mbits/sec  
[ 9] 9.0-12.0 sec 30.0 MBytes 83.9 Mbits/sec  
[ 9] 12.0-15.0 sec 30.4 MBytes 85.0 Mbits/sec  
[ 9] 15.0-18.0 sec 30.8 MBytes 86.2 Mbits/sec  
[ 9] 18.0-21.0 sec 31.0 MBytes 86.8 Mbits/sec  
[ 9] 21.0-24.0 sec 31.1 MBytes 87.0 Mbits/sec  
[ 9] 24.0-27.0 sec 30.8 MBytes 86.2 Mbits/sec  
[ 9] 27.0-30.0 sec 30.9 MBytes 86.4 Mbits/sec  
[ 9] 30.0-33.0 sec 31.2 MBytes 87.3 Mbits/sec  
[ 9] 33.0-36.0 sec 31.1 MBytes 87.0 Mbits/sec  
[ 9] 36.0-39.0 sec 31.2 MBytes 87.3 Mbits/sec  
[ 9] 39.0-42.0 sec 31.4 MBytes 87.8 Mbits/sec  
[ 9] 42.0-45.0 sec 30.6 MBytes 85.5 Mbits/sec  
[ 9] 45.0-48.0 sec 31.1 MBytes 86.9 Mbits/sec  
[ 9] 48.0-51.0 sec 30.6 MBytes 85.6 Mbits/sec  
[ 9] 51.0-54.0 sec 30.4 MBytes 85.0 Mbits/sec  
[ 9] 54.0-57.0 sec 26.9 MBytes 75.3 Mbits/sec  
[ 9] 57.0-60.0 sec 8.40 MBytes 23.5 Mbits/sec  
[ 9] 0.0-60.1 sec 591 MBytes 82.5 Mbits/sec

---

平板-Android-802.11ac 5GHz

---

```
[ 10] local 192.168.2.157 port 5001 connected with 192.168.2.158 port 37045
[ 10] 0.0- 3.0 sec 82.7 MBytes 231 Mbits/sec
[ 10] 3.0- 6.0 sec 84.8 MBytes 237 Mbits/sec
[ 10] 6.0- 9.0 sec 83.6 MBytes 234 Mbits/sec
[ 10] 9.0-12.0 sec 83.5 MBytes 234 Mbits/sec
[ 10] 12.0-15.0 sec 81.5 MBytes 228 Mbits/sec
[ 10] 15.0-18.0 sec 84.1 MBytes 235 Mbits/sec
[ 10] 18.0-21.0 sec 83.4 MBytes 233 Mbits/sec
[ 10] 21.0-24.0 sec 87.0 MBytes 243 Mbits/sec
[ 10] 24.0-27.0 sec 78.2 MBytes 219 Mbits/sec
[ 10] 27.0-30.0 sec 76.8 MBytes 215 Mbits/sec
[ 10] 30.0-33.0 sec 78.2 MBytes 219 Mbits/sec
[ 10] 33.0-36.0 sec 84.7 MBytes 237 Mbits/sec
[ 10] 36.0-39.0 sec 73.4 MBytes 205 Mbits/sec
[ 10] 39.0-42.0 sec 69.6 MBytes 195 Mbits/sec
[ 10] 42.0-45.0 sec 35.5 MBytes 99.1 Mbits/sec
[ 10] 45.0-48.0 sec 24.5 MBytes 68.6 Mbits/sec
[ 10] 48.0-51.0 sec 69.4 MBytes 194 Mbits/sec
[ 10] 51.0-54.0 sec 67.3 MBytes 188 Mbits/sec
[ 10] 54.0-57.0 sec 68.4 MBytes 191 Mbits/sec
[ 10] 57.0-60.0 sec 69.6 MBytes 195 Mbits/sec
[ 10] 0.0-60.1 sec 1466 MBytes 205 Mbits/sec
```

---

平板-IOS-802.11n 2.4GHz

---

```
[ 11] local 192.168.2.157 port 5001 connected with 192.168.2.152 port 37375
[ 11] 0.0- 3.0 sec 22.2 MBytes 62.0 Mbits/sec
[ 11] 3.0- 6.0 sec 23.3 MBytes 65.2 Mbits/sec
[ 11] 6.0- 9.0 sec 25.4 MBytes 71.1 Mbits/sec
[ 11] 9.0-12.0 sec 24.5 MBytes 68.5 Mbits/sec
[ 11] 12.0-15.0 sec 25.7 MBytes 71.8 Mbits/sec
[ 11] 15.0-18.0 sec 26.2 MBytes 73.1 Mbits/sec
[ 11] 18.0-21.0 sec 24.8 MBytes 69.4 Mbits/sec
[ 11] 21.0-24.0 sec 23.7 MBytes 66.4 Mbits/sec
[ 11] 24.0-27.0 sec 25.1 MBytes 70.2 Mbits/sec
[ 11] 27.0-30.0 sec 16.6 MBytes 46.4 Mbits/sec
[ 11] 30.0-33.0 sec 15.9 MBytes 44.4 Mbits/sec
[ 11] 33.0-36.0 sec 22.3 MBytes 62.4 Mbits/sec
[ 11] 36.0-39.0 sec 21.7 MBytes 60.6 Mbits/sec
[ 11] 39.0-42.0 sec 22.7 MBytes 63.5 Mbits/sec
[ 11] 42.0-45.0 sec 24.2 MBytes 67.7 Mbits/sec
[ 11] 45.0-48.0 sec 25.2 MBytes 70.6 Mbits/sec
[ 11] 48.0-51.0 sec 23.7 MBytes 66.2 Mbits/sec
[ 11] 51.0-54.0 sec 24.7 MBytes 69.1 Mbits/sec
[ 11] 54.0-57.0 sec 23.6 MBytes 66.1 Mbits/sec
[ 11] 57.0-60.0 sec 23.5 MBytes 65.8 Mbits/sec
[ 11] 0.0-64.3 sec 467 MBytes 60.9 Mbits/sec
```

---

平板-IOS-802.11n 5GHz

```

[ 12] local 192.168.2.157 port 5001 connected with 192.168.2.152 port 37378
[ 12] 0.0- 3.0 sec 31.2 MBytes 87.3 Mbits/sec
[ 12] 3.0- 6.0 sec 31.2 MBytes 87.3 Mbits/sec
[ 12] 6.0- 9.0 sec 31.5 MBytes 88.0 Mbits/sec
[ 12] 9.0-12.0 sec 31.3 MBytes 87.7 Mbits/sec
[ 12] 12.0-15.0 sec 31.2 MBytes 87.4 Mbits/sec
[ 12] 15.0-18.0 sec 31.3 MBytes 87.5 Mbits/sec
[ 12] 18.0-21.0 sec 31.2 MBytes 87.1 Mbits/sec
[ 12] 21.0-24.0 sec 31.3 MBytes 87.5 Mbits/sec
[ 12] 24.0-27.0 sec 31.0 MBytes 86.7 Mbits/sec
[ 12] 27.0-30.0 sec 31.3 MBytes 87.6 Mbits/sec
[ 12] 30.0-33.0 sec 31.5 MBytes 88.0 Mbits/sec
[ 12] 33.0-36.0 sec 31.5 MBytes 88.0 Mbits/sec
[ 12] 36.0-39.0 sec 30.4 MBytes 85.1 Mbits/sec
[ 12] 39.0-42.0 sec 30.8 MBytes 86.3 Mbits/sec
[ 12] 42.0-45.0 sec 31.1 MBytes 87.0 Mbits/sec
[ 12] 45.0-48.0 sec 31.2 MBytes 87.2 Mbits/sec
[ 12] 48.0-51.0 sec 31.5 MBytes 88.1 Mbits/sec
[ 12] 51.0-54.0 sec 31.6 MBytes 88.3 Mbits/sec
[ 12] 54.0-57.0 sec 31.5 MBytes 88.1 Mbits/sec
[ 12] 57.0-60.0 sec 31.4 MBytes 87.7 Mbits/sec
[ 12] 0.0-60.2 sec 627 MBytes 87.4 Mbits/sec

```

-----

平板-IOS-802.11ac 5GHz

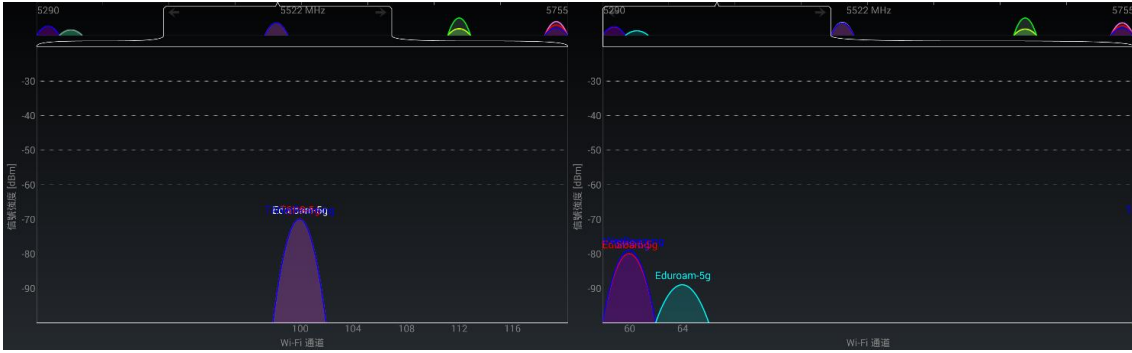
-----

```

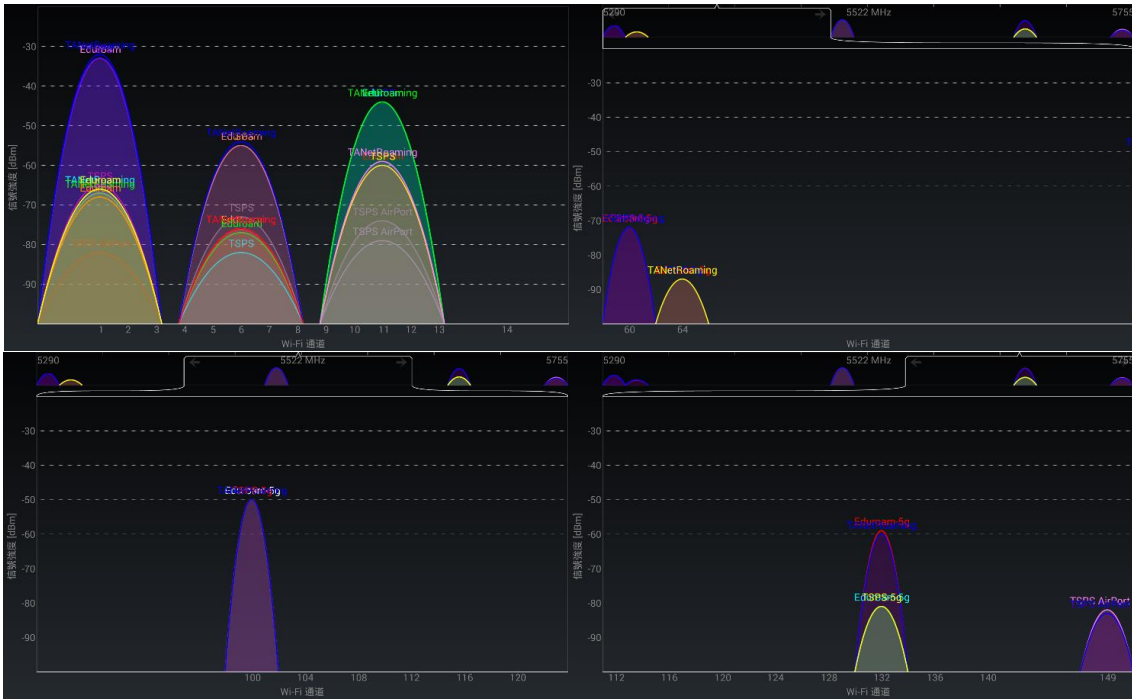
[ 13] local 192.168.2.157 port 5001 connected with 192.168.2.152 port 37396
[ 13] 0.0- 3.0 sec 82.8 MBytes 232 Mbits/sec
[ 13] 3.0- 6.0 sec 87.0 MBytes 243 Mbits/sec
[ 13] 6.0- 9.0 sec 86.2 MBytes 241 Mbits/sec
[ 13] 9.0-12.0 sec 83.7 MBytes 234 Mbits/sec
[ 13] 12.0-15.0 sec 78.1 MBytes 218 Mbits/sec
[ 13] 15.0-18.0 sec 80.0 MBytes 224 Mbits/sec
[ 13] 18.0-21.0 sec 79.0 MBytes 221 Mbits/sec
[ 13] 21.0-24.0 sec 79.8 MBytes 223 Mbits/sec
[ 13] 24.0-27.0 sec 81.7 MBytes 228 Mbits/sec
[ 13] 27.0-30.0 sec 80.1 MBytes 224 Mbits/sec
[ 13] 30.0-33.0 sec 75.3 MBytes 210 Mbits/sec
[ 13] 33.0-36.0 sec 74.6 MBytes 209 Mbits/sec
[ 13] 36.0-39.0 sec 77.5 MBytes 217 Mbits/sec
[ 13] 39.0-42.0 sec 78.4 MBytes 219 Mbits/sec
[ 13] 42.0-45.0 sec 78.7 MBytes 220 Mbits/sec
[ 13] 45.0-48.0 sec 75.5 MBytes 211 Mbits/sec
[ 13] 48.0-51.0 sec 77.1 MBytes 216 Mbits/sec
[ 13] 51.0-54.0 sec 83.3 MBytes 233 Mbits/sec
[ 13] 54.0-57.0 sec 80.4 MBytes 225 Mbits/sec
[ 13] 57.0-60.0 sec 79.4 MBytes 222 Mbits/sec
[ 13] 0.0-60.1 sec 1600 MBytes 223 Mbits/sec

```

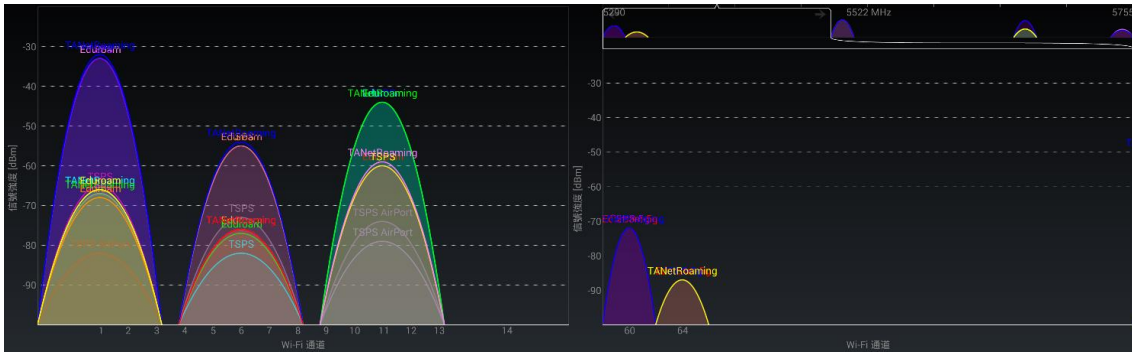


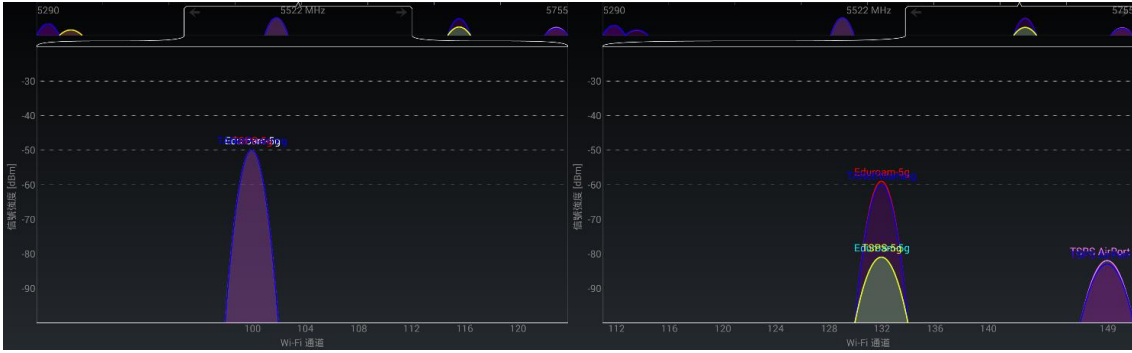


五年智班走廊



辦公室走廊





語言教室前門走廊



附件六頭社國小測試結果

Server listening on TCP port 5001

TCP window size: 0.25 MByte (WARNING: requested 2.00 MByte)

[ ID] Interval            Transfer        Bandwidth

頭社國小-筆電-視窗-有線

```
[ 4] local 192.168.1.99 port 5001 connected with 192.168.1.97 port 54289
[ 4] 0.0- 3.0 sec 333 MBytes 931 Mbits/sec
[ 4] 3.0- 6.0 sec 338 MBytes 944 Mbits/sec
[ 4] 6.0- 9.0 sec 338 MBytes 946 Mbits/sec
[ 4] 9.0-12.0 sec 338 MBytes 946 Mbits/sec
[ 4] 12.0-15.0 sec 339 MBytes 949 Mbits/sec
[ 4] 15.0-18.0 sec 336 MBytes 941 Mbits/sec
[ 4] 18.0-21.0 sec 338 MBytes 946 Mbits/sec
[ 4] 21.0-24.0 sec 339 MBytes 947 Mbits/sec
[ 4] 24.0-27.0 sec 334 MBytes 934 Mbits/sec
[ 4] 27.0-30.0 sec 339 MBytes 947 Mbits/sec
[ 4] 30.0-33.0 sec 339 MBytes 948 Mbits/sec
[ 4] 33.0-36.0 sec 338 MBytes 946 Mbits/sec
[ 4] 36.0-39.0 sec 339 MBytes 948 Mbits/sec
[ 4] 39.0-42.0 sec 339 MBytes 949 Mbits/sec
[ 4] 42.0-45.0 sec 339 MBytes 949 Mbits/sec
[ 4] 45.0-48.0 sec 339 MBytes 949 Mbits/sec
[ 4] 48.0-51.0 sec 339 MBytes 949 Mbits/sec
[ 4] 51.0-54.0 sec 339 MBytes 949 Mbits/sec
[ 4] 54.0-57.0 sec 339 MBytes 948 Mbits/sec
[ 4] 57.0-60.0 sec 339 MBytes 949 Mbits/sec
[ 4] 0.0-60.0 sec 6766 MBytes 946 Mbits/sec
```

頭社國小-筆電-視窗-802.11n-2.4GHz

```
[ 5] local 192.168.1.99 port 5001 connected with 192.168.1.55 port 54191
[ 5] 0.0- 3.0 sec 19.7 MBytes 55.0 Mbits/sec
[ 5] 3.0- 6.0 sec 18.7 MBytes 52.4 Mbits/sec
[ 5] 6.0- 9.0 sec 16.5 MBytes 46.1 Mbits/sec
[ 5] 9.0-12.0 sec 14.8 MBytes 41.5 Mbits/sec
[ 5] 12.0-15.0 sec 22.7 MBytes 63.4 Mbits/sec
[ 5] 15.0-18.0 sec 20.8 MBytes 58.3 Mbits/sec
[ 5] 18.0-21.0 sec 22.9 MBytes 64.1 Mbits/sec
[ 5] 21.0-24.0 sec 22.6 MBytes 63.3 Mbits/sec
[ 5] 24.0-27.0 sec 25.7 MBytes 71.9 Mbits/sec
[ 5] 27.0-30.0 sec 22.3 MBytes 62.3 Mbits/sec
[ 5] 30.0-33.0 sec 22.9 MBytes 64.1 Mbits/sec
[ 5] 33.0-36.0 sec 20.3 MBytes 56.9 Mbits/sec
[ 5] 36.0-39.0 sec 23.0 MBytes 64.4 Mbits/sec
[ 5] 39.0-42.0 sec 20.4 MBytes 57.2 Mbits/sec
[ 5] 42.0-45.0 sec 24.8 MBytes 69.3 Mbits/sec
[ 5] 45.0-48.0 sec 21.8 MBytes 60.9 Mbits/sec
[ 5] 48.0-51.0 sec 21.7 MBytes 60.6 Mbits/sec
[ 5] 51.0-54.0 sec 24.4 MBytes 68.3 Mbits/sec
```

```
[ 5] 54.0-57.0 sec 24.5 MBytes 68.5 Mbits/sec
[ 5] 57.0-60.0 sec 23.8 MBytes 66.5 Mbits/sec
[ 5] 0.0-60.0 sec 434 MBytes 60.8 Mbits/sec
```

---

頭社國小-筆電-視窗-802.11n-5GHz

```
[ 6] local 192.168.1.99 port 5001 connected with 192.168.1.55 port 50090
[ 6] 0.0- 3.0 sec 29.6 MBytes 82.9 Mbits/sec
[ 6] 3.0- 6.0 sec 34.0 MBytes 95.1 Mbits/sec
[ 6] 6.0- 9.0 sec 35.3 MBytes 98.6 Mbits/sec
[ 6] 9.0-12.0 sec 34.9 MBytes 97.6 Mbits/sec
[ 6] 12.0-15.0 sec 35.4 MBytes 99.0 Mbits/sec
[ 6] 15.0-18.0 sec 35.0 MBytes 97.9 Mbits/sec
[ 6] 18.0-21.0 sec 34.9 MBytes 97.5 Mbits/sec
[ 6] 21.0-24.0 sec 34.7 MBytes 97.1 Mbits/sec
[ 6] 24.0-27.0 sec 34.5 MBytes 96.4 Mbits/sec
[ 6] 27.0-30.0 sec 34.5 MBytes 96.5 Mbits/sec
[ 6] 30.0-33.0 sec 34.9 MBytes 97.6 Mbits/sec
[ 6] 33.0-36.0 sec 34.8 MBytes 97.2 Mbits/sec
[ 6] 36.0-39.0 sec 35.4 MBytes 99.0 Mbits/sec
[ 6] 39.0-42.0 sec 34.6 MBytes 96.9 Mbits/sec
[ 6] 42.0-45.0 sec 34.8 MBytes 97.3 Mbits/sec
[ 6] 45.0-48.0 sec 35.4 MBytes 99.1 Mbits/sec
[ 6] 48.0-51.0 sec 35.3 MBytes 98.6 Mbits/sec
[ 6] 51.0-54.0 sec 35.1 MBytes 98.2 Mbits/sec
[ 6] 54.0-57.0 sec 34.8 MBytes 97.4 Mbits/sec
[ 6] 57.0-60.0 sec 34.7 MBytes 96.9 Mbits/sec
[ 6] 0.0-60.0 sec 693 MBytes 96.7 Mbits/sec
```

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頭社國小-筆電-視窗-802.11ac-5GHz

```
[ 7] local 192.168.1.99 port 5001 connected with 192.168.1.55 port 50554
[ 7] 0.0- 3.0 sec 36.6 MBytes 102 Mbits/sec
[ 7] 3.0- 6.0 sec 91.4 MBytes 256 Mbits/sec
[ 7] 6.0- 9.0 sec 99.5 MBytes 278 Mbits/sec
[ 7] 9.0-12.0 sec 102 MBytes 285 Mbits/sec
[ 7] 12.0-15.0 sec 103 MBytes 288 Mbits/sec
[ 7] 15.0-18.0 sec 105 MBytes 293 Mbits/sec
[ 7] 18.0-21.0 sec 103 MBytes 287 Mbits/sec
[ 7] 21.0-24.0 sec 105 MBytes 294 Mbits/sec
[ 7] 24.0-27.0 sec 107 MBytes 300 Mbits/sec
[ 7] 27.0-30.0 sec 106 MBytes 296 Mbits/sec
[ 7] 30.0-33.0 sec 108 MBytes 301 Mbits/sec
[ 7] 33.0-36.0 sec 106 MBytes 296 Mbits/sec
[ 7] 36.0-39.0 sec 102 MBytes 284 Mbits/sec
[ 7] 39.0-42.0 sec 102 MBytes 284 Mbits/sec
[ 7] 42.0-45.0 sec 105 MBytes 294 Mbits/sec
[ 7] 45.0-48.0 sec 105 MBytes 294 Mbits/sec
[ 7] 48.0-51.0 sec 107 MBytes 298 Mbits/sec
[ 7] 51.0-54.0 sec 108 MBytes 302 Mbits/sec
[ 7] 54.0-57.0 sec 104 MBytes 292 Mbits/sec
[ 7] 57.0-60.0 sec 101 MBytes 283 Mbits/sec
```



[ 7] 0.0-60.0 sec 2007 MBytes 280 Mbits/sec

---

頭社國小-平板-Android-802.11n-2.4GHz

---

[ 8] local 192.168.1.99 port 5001 connected with 192.168.1.89 port 34102  
[ 8] 0.0- 3.0 sec 24.4 MBytes 68.2 Mbits/sec  
[ 8] 3.0- 6.0 sec 25.8 MBytes 72.1 Mbits/sec  
[ 8] 6.0- 9.0 sec 25.3 MBytes 70.7 Mbits/sec  
[ 8] 9.0-12.0 sec 25.0 MBytes 69.9 Mbits/sec  
[ 8] 12.0-15.0 sec 24.2 MBytes 67.7 Mbits/sec  
[ 8] 15.0-18.0 sec 25.7 MBytes 72.0 Mbits/sec  
[ 8] 18.0-21.0 sec 25.1 MBytes 70.3 Mbits/sec  
[ 8] 21.0-24.0 sec 24.8 MBytes 69.2 Mbits/sec  
[ 8] 24.0-27.0 sec 25.4 MBytes 71.1 Mbits/sec  
[ 8] 27.0-30.0 sec 24.8 MBytes 69.3 Mbits/sec  
[ 8] 30.0-33.0 sec 25.6 MBytes 71.7 Mbits/sec  
[ 8] 33.0-36.0 sec 12.8 MBytes 35.8 Mbits/sec  
[ 8] 36.0-39.0 sec 10.2 MBytes 28.7 Mbits/sec  
[ 8] 39.0-42.0 sec 23.6 MBytes 66.1 Mbits/sec  
[ 8] 42.0-45.0 sec 24.4 MBytes 68.1 Mbits/sec  
[ 8] 45.0-48.0 sec 23.2 MBytes 64.9 Mbits/sec  
[ 8] 48.0-51.0 sec 24.7 MBytes 69.0 Mbits/sec  
[ 8] 51.0-54.0 sec 24.8 MBytes 69.2 Mbits/sec  
[ 8] 54.0-57.0 sec 24.0 MBytes 67.0 Mbits/sec  
[ 8] 57.0-60.0 sec 25.2 MBytes 70.4 Mbits/sec  
[ 8] 0.0-60.0 sec 469 MBytes 65.6 Mbits/sec

---

頭社國小-平板-Android-802.11n-5GHz

---

[ 9] local 192.168.1.99 port 5001 connected with 192.168.1.89 port 34104  
[ 9] 0.0- 3.0 sec 30.3 MBytes 84.7 Mbits/sec  
[ 9] 3.0- 6.0 sec 29.9 MBytes 83.5 Mbits/sec  
[ 9] 6.0- 9.0 sec 30.6 MBytes 85.6 Mbits/sec  
[ 9] 9.0-12.0 sec 30.8 MBytes 86.1 Mbits/sec  
[ 9] 12.0-15.0 sec 30.6 MBytes 85.5 Mbits/sec  
[ 9] 15.0-18.0 sec 30.5 MBytes 85.2 Mbits/sec  
[ 9] 18.0-21.0 sec 30.7 MBytes 86.0 Mbits/sec  
[ 9] 21.0-24.0 sec 30.0 MBytes 83.9 Mbits/sec  
[ 9] 24.0-27.0 sec 30.5 MBytes 85.3 Mbits/sec  
[ 9] 27.0-30.0 sec 31.1 MBytes 86.9 Mbits/sec  
[ 9] 30.0-33.0 sec 30.7 MBytes 85.7 Mbits/sec  
[ 9] 33.0-36.0 sec 30.5 MBytes 85.2 Mbits/sec  
[ 9] 36.0-39.0 sec 12.0 MBytes 33.6 Mbits/sec  
[ 9] 39.0-42.0 sec 21.7 MBytes 60.8 Mbits/sec  
[ 9] 42.0-45.0 sec 30.3 MBytes 84.8 Mbits/sec  
[ 9] 45.0-48.0 sec 30.8 MBytes 86.1 Mbits/sec  
[ 9] 48.0-51.0 sec 30.7 MBytes 85.7 Mbits/sec  
[ 9] 51.0-54.0 sec 30.5 MBytes 85.3 Mbits/sec  
[ 9] 54.0-57.0 sec 30.4 MBytes 85.1 Mbits/sec  
[ 9] 57.0-60.0 sec 30.5 MBytes 85.3 Mbits/sec  
[ 9] 0.0-60.0 sec 583 MBytes 81.5 Mbits/sec

---

頭社國小-平板-Android-802.11ac-5GHz

---

```
[ 10] local 192.168.1.99 port 5001 connected with 192.168.1.89 port 34106
[ 10] 0.0- 3.0 sec 76.2 MBytes 213 Mbits/sec
[ 10] 3.0- 6.0 sec 84.6 MBytes 237 Mbits/sec
[ 10] 6.0- 9.0 sec 77.6 MBytes 217 Mbits/sec
[ 10] 9.0-12.0 sec 74.4 MBytes 208 Mbits/sec
[ 10] 12.0-15.0 sec 71.1 MBytes 199 Mbits/sec
[ 10] 15.0-18.0 sec 69.9 MBytes 196 Mbits/sec
[ 10] 18.0-21.0 sec 67.1 MBytes 188 Mbits/sec
[ 10] 21.0-24.0 sec 72.2 MBytes 202 Mbits/sec
[ 10] 24.0-27.0 sec 72.9 MBytes 204 Mbits/sec
[ 10] 27.0-30.0 sec 74.7 MBytes 209 Mbits/sec
[ 10] 30.0-33.0 sec 72.1 MBytes 202 Mbits/sec
[ 10] 33.0-36.0 sec 72.3 MBytes 202 Mbits/sec
[ 10] 36.0-39.0 sec 73.1 MBytes 204 Mbits/sec
[ 10] 39.0-42.0 sec 69.6 MBytes 195 Mbits/sec
[ 10] 42.0-45.0 sec 75.5 MBytes 211 Mbits/sec
[ 10] 45.0-48.0 sec 72.9 MBytes 204 Mbits/sec
[ 10] 48.0-51.0 sec 76.5 MBytes 214 Mbits/sec
[ 10] 51.0-54.0 sec 70.9 MBytes 198 Mbits/sec
[ 10] 54.0-57.0 sec 77.2 MBytes 216 Mbits/sec
[ 10] 57.0-60.0 sec 74.2 MBytes 207 Mbits/sec
[ 10] 0.0-60.0 sec 1475 MBytes 206 Mbits/sec
```

---

頭社國小-平板-IOS-802.11n-2.4GHz

---

```
[ 11] local 192.168.1.99 port 5001 connected with 192.168.1.238 port 64640
[ 11] 0.0- 3.0 sec 22.1 MBytes 61.7 Mbits/sec
[ 11] 3.0- 6.0 sec 25.3 MBytes 70.7 Mbits/sec
[ 11] 6.0- 9.0 sec 24.4 MBytes 68.3 Mbits/sec
[ 11] 9.0-12.0 sec 22.4 MBytes 62.8 Mbits/sec
[ 11] 12.0-15.0 sec 22.6 MBytes 63.3 Mbits/sec
[ 11] 15.0-18.0 sec 23.6 MBytes 66.1 Mbits/sec
[ 11] 18.0-21.0 sec 24.1 MBytes 67.3 Mbits/sec
[ 11] 21.0-24.0 sec 21.0 MBytes 58.7 Mbits/sec
[ 11] 24.0-27.0 sec 21.3 MBytes 59.6 Mbits/sec
[ 11] 27.0-30.0 sec 23.0 MBytes 64.3 Mbits/sec
[ 11] 30.0-33.0 sec 23.3 MBytes 65.0 Mbits/sec
[ 11] 33.0-36.0 sec 25.0 MBytes 70.0 Mbits/sec
[ 11] 36.0-39.0 sec 24.8 MBytes 69.4 Mbits/sec
[ 11] 39.0-42.0 sec 25.2 MBytes 70.4 Mbits/sec
[ 11] 42.0-45.0 sec 23.9 MBytes 67.0 Mbits/sec
[ 11] 45.0-48.0 sec 24.8 MBytes 69.3 Mbits/sec
[ 11] 48.0-51.0 sec 24.7 MBytes 69.0 Mbits/sec
[ 11] 51.0-54.0 sec 24.3 MBytes 67.9 Mbits/sec
[ 11] 54.0-57.0 sec 24.0 MBytes 67.2 Mbits/sec
[ 11] 57.0-60.0 sec 24.1 MBytes 67.4 Mbits/sec
[ 11] 0.0-60.2 sec 476 MBytes 66.3 Mbits/sec
```

---

頭社國小-平板-IOS-802.11n-5GHz

---

```

[ 12] local 192.168.1.99 port 5001 connected with 192.168.1.238 port 64649
[ 12] 0.0- 3.0 sec 30.4 MBytes 85.1 Mbits/sec
[ 12] 3.0- 6.0 sec 30.1 MBytes 84.1 Mbits/sec
[ 12] 6.0- 9.0 sec 30.6 MBytes 85.4 Mbits/sec
[ 12] 9.0-12.0 sec 30.5 MBytes 85.3 Mbits/sec
[ 12] 12.0-15.0 sec 30.2 MBytes 84.5 Mbits/sec
[ 12] 15.0-18.0 sec 30.1 MBytes 84.2 Mbits/sec
[ 12] 18.0-21.0 sec 30.5 MBytes 85.2 Mbits/sec
[ 12] 21.0-24.0 sec 30.7 MBytes 86.0 Mbits/sec
[ 12] 24.0-27.0 sec 31.0 MBytes 86.8 Mbits/sec
[ 12] 27.0-30.0 sec 30.2 MBytes 84.4 Mbits/sec
[ 12] 30.0-33.0 sec 31.1 MBytes 86.9 Mbits/sec
[ 12] 33.0-36.0 sec 30.6 MBytes 85.5 Mbits/sec
[ 12] 36.0-39.0 sec 30.8 MBytes 86.1 Mbits/sec
[ 12] 39.0-42.0 sec 30.6 MBytes 85.6 Mbits/sec
[ 12] 42.0-45.0 sec 30.6 MBytes 85.5 Mbits/sec
[ 12] 45.0-48.0 sec 31.0 MBytes 86.7 Mbits/sec
[ 12] 48.0-51.0 sec 30.2 MBytes 84.4 Mbits/sec
[ 12] 51.0-54.0 sec 30.5 MBytes 85.2 Mbits/sec
[ 12] 54.0-57.0 sec 30.7 MBytes 85.8 Mbits/sec
[ 12] 57.0-60.0 sec 30.9 MBytes 86.4 Mbits/sec
[ 12] 0.0-60.2 sec 613 MBytes 85.5 Mbits/sec

```

---

頭社國小-平板-IOS-802.11ac-5GHz

---

```

[ 13] local 192.168.1.99 port 5001 connected with 192.168.1.238 port 64665
[ 13] 0.0- 3.0 sec 89.2 MBytes 249 Mbits/sec
[ 13] 3.0- 6.0 sec 88.8 MBytes 248 Mbits/sec
[ 13] 6.0- 9.0 sec 88.9 MBytes 249 Mbits/sec
[ 13] 9.0-12.0 sec 85.0 MBytes 238 Mbits/sec
[ 13] 12.0-15.0 sec 75.8 MBytes 212 Mbits/sec
[ 13] 15.0-18.0 sec 84.0 MBytes 235 Mbits/sec
[ 13] 18.0-21.0 sec 80.7 MBytes 226 Mbits/sec
[ 13] 21.0-24.0 sec 77.5 MBytes 217 Mbits/sec
[ 13] 24.0-27.0 sec 77.0 MBytes 215 Mbits/sec
[ 13] 27.0-30.0 sec 78.1 MBytes 218 Mbits/sec
[ 13] 30.0-33.0 sec 81.9 MBytes 229 Mbits/sec
[ 13] 33.0-36.0 sec 81.0 MBytes 227 Mbits/sec
[ 13] 36.0-39.0 sec 82.8 MBytes 232 Mbits/sec
[ 13] 39.0-42.0 sec 88.6 MBytes 248 Mbits/sec
[ 13] 42.0-45.0 sec 89.2 MBytes 250 Mbits/sec
[ 13] 45.0-48.0 sec 88.7 MBytes 248 Mbits/sec
[ 13] 48.0-51.0 sec 86.8 MBytes 243 Mbits/sec
[ 13] 51.0-54.0 sec 87.2 MBytes 244 Mbits/sec
[ 13] 54.0-57.0 sec 84.9 MBytes 237 Mbits/sec
[ 13] 57.0-60.0 sec 80.3 MBytes 225 Mbits/sec
[ 13] 0.0-60.1 sec 1678 MBytes 234 Mbits/sec

```

附件七使用無線電頻寬與無線網路速率測試結果

Server listening on TCP port 5001

TCP window size: 0.25 MByte (WARNING: requested 2.00 MByte)

[ ID] Interval            Transfer            Bandwidth

-----  
筆電-視窗系統-802.11n 5GHz@HT20  
-----

```
[ 13] local 192.168.1.91 port 5001 connected with 192.168.1.37 port 52755
[ 13] 1854.0-1857.0 sec  20.1 MBytes  56.2 Mbites/sec
[ 13] 1857.0-1860.0 sec  28.8 MBytes  80.6 Mbites/sec
[ 13] 1860.0-1863.0 sec  29.9 MBytes  83.5 Mbites/sec
[ 13] 1863.0-1866.0 sec  31.6 MBytes  88.3 Mbites/sec
[ 13] 1866.0-1869.0 sec  30.7 MBytes  85.9 Mbites/sec
[ 13] 1869.0-1872.0 sec  30.5 MBytes  85.3 Mbites/sec
[ 13] 1872.0-1875.0 sec  28.4 MBytes  79.4 Mbites/sec
[ 13] 1875.0-1878.0 sec  31.4 MBytes  87.9 Mbites/sec
[ 13] 1878.0-1881.0 sec  33.9 MBytes  94.7 Mbites/sec
[ 13] 1881.0-1884.0 sec  31.6 MBytes  88.5 Mbites/sec
[ 13] 1884.0-1887.0 sec  28.9 MBytes  80.9 Mbites/sec
[ 13] 1887.0-1890.0 sec  30.7 MBytes  85.9 Mbites/sec
[ 13] 1890.0-1893.0 sec  29.9 MBytes  83.5 Mbites/sec
[ 13] 1893.0-1896.0 sec  30.8 MBytes  86.2 Mbites/sec
[ 13] 1896.0-1899.0 sec  30.7 MBytes  85.8 Mbites/sec
[ 13] 1899.0-1902.0 sec  31.0 MBytes  86.7 Mbites/sec
[ 13] 1902.0-1905.0 sec  31.7 MBytes  88.8 Mbites/sec
[ 13] 1905.0-1908.0 sec  30.5 MBytes  85.3 Mbites/sec
[ 13] 1908.0-1911.0 sec  30.0 MBytes  83.8 Mbites/sec
[ 13] 1911.0-1914.0 sec  31.0 MBytes  86.7 Mbites/sec
[ 13]  0.0-60.0 sec   602 MBytes  84.2 Mbites/sec
```

-----  
筆電-視窗系統-802.11n 5GHz@HT40  
-----

```
[ 16] local 192.168.1.91 port 5001 connected with 192.168.1.37 port 52893
[ 16] 2262.0-2265.0 sec  20.6 MBytes  57.6 Mbites/sec
[ 16] 2265.0-2268.0 sec  36.3 MBytes  102 Mbites/sec
[ 16] 2268.0-2271.0 sec  41.5 MBytes  116 Mbites/sec
[ 16] 2271.0-2274.0 sec  42.2 MBytes  118 Mbites/sec
[ 16] 2274.0-2277.0 sec  40.6 MBytes  114 Mbites/sec
[ 16] 2277.0-2280.0 sec  44.5 MBytes  124 Mbites/sec
[ 16] 2280.0-2283.0 sec  40.3 MBytes  113 Mbites/sec
[ 16] 2283.0-2286.0 sec  41.0 MBytes  115 Mbites/sec
[ 16] 2286.0-2289.0 sec  47.8 MBytes  134 Mbites/sec
[ 16] 2289.0-2292.0 sec  46.3 MBytes  130 Mbites/sec
[ 16] 2292.0-2295.0 sec  42.3 MBytes  118 Mbites/sec
[ 16] 2295.0-2298.0 sec  42.6 MBytes  119 Mbites/sec
[ 16] 2298.0-2301.0 sec  43.0 MBytes  120 Mbites/sec
[ 16] 2301.0-2304.0 sec  48.3 MBytes  135 Mbites/sec
[ 16] 2304.0-2307.0 sec  50.1 MBytes  140 Mbites/sec
[ 16] 2307.0-2310.0 sec  45.3 MBytes  127 Mbites/sec
[ 16] 2310.0-2313.0 sec  47.0 MBytes  131 Mbites/sec
[ 16] 2313.0-2316.0 sec  47.5 MBytes  133 Mbites/sec
```

```
[ 16] 2316.0-2319.0 sec 48.4 MBytes 135 Mbits/sec
[ 16] 2319.0-2322.0 sec 43.0 MBytes 120 Mbits/sec
[ 16] 0.0-60.0 sec 858 MBytes 120 Mbits/sec
```

---

筆電-視窗系統-802.11ac 5GHz@HT20

---

```
[ 10] local 192.168.1.91 port 5001 connected with 192.168.1.37 port 52618
[ 10] 0.0- 3.0 sec 2.36 MBytes 6.60 Mbits/sec
[ 10] 3.0- 6.0 sec 31.7 MBytes 88.7 Mbits/sec
[ 10] 6.0- 9.0 sec 30.1 MBytes 84.0 Mbits/sec
[ 10] 9.0-12.0 sec 29.4 MBytes 82.3 Mbits/sec
[ 10] 12.0-15.0 sec 26.4 MBytes 73.7 Mbits/sec
[ 10] 15.0-18.0 sec 28.0 MBytes 78.4 Mbits/sec
[ 10] 18.0-21.0 sec 27.9 MBytes 78.0 Mbits/sec
[ 10] 21.0-24.0 sec 29.7 MBytes 83.1 Mbits/sec
[ 10] 24.0-27.0 sec 27.8 MBytes 77.6 Mbits/sec
[ 10] 27.0-30.0 sec 28.0 MBytes 78.3 Mbits/sec
[ 10] 30.0-33.0 sec 28.0 MBytes 78.4 Mbits/sec
[ 10] 33.0-36.0 sec 28.0 MBytes 78.2 Mbits/sec
[ 10] 36.0-39.0 sec 28.3 MBytes 79.0 Mbits/sec
[ 10] 39.0-42.0 sec 28.6 MBytes 79.9 Mbits/sec
[ 10] 42.0-45.0 sec 27.6 MBytes 77.1 Mbits/sec
[ 10] 45.0-48.0 sec 29.0 MBytes 81.0 Mbits/sec
[ 10] 48.0-51.0 sec 27.8 MBytes 77.7 Mbits/sec
[ 10] 51.0-54.0 sec 28.3 MBytes 79.0 Mbits/sec
[ 10] 54.0-57.0 sec 26.9 MBytes 75.2 Mbits/sec
[ 10] 57.0-60.0 sec 27.4 MBytes 76.6 Mbits/sec
[ 10] 0.0-60.0 sec 541 MBytes 75.6 Mbits/sec
```

---

筆電-視窗系統-802.11ac 5GHz@HT40

---

```
[ 7] local 192.168.1.91 port 5001 connected with 192.168.1.37 port 52429
[ 7] 0.0- 3.0 sec 14.1 MBytes 39.4 Mbits/sec
[ 7] 3.0- 6.0 sec 41.6 MBytes 116 Mbits/sec
[ 7] 6.0- 9.0 sec 41.8 MBytes 117 Mbits/sec
[ 7] 9.0-12.0 sec 44.2 MBytes 124 Mbits/sec
[ 7] 12.0-15.0 sec 41.2 MBytes 115 Mbits/sec
[ 7] 15.0-18.0 sec 44.7 MBytes 125 Mbits/sec
[ 7] 18.0-21.0 sec 47.5 MBytes 133 Mbits/sec
[ 7] 21.0-24.0 sec 36.0 MBytes 101 Mbits/sec
[ 7] 24.0-27.0 sec 39.8 MBytes 111 Mbits/sec
[ 7] 27.0-30.0 sec 44.4 MBytes 124 Mbits/sec
[ 7] 30.0-33.0 sec 38.0 MBytes 106 Mbits/sec
[ 7] 33.0-36.0 sec 40.3 MBytes 113 Mbits/sec
[ 7] 36.0-39.0 sec 40.6 MBytes 113 Mbits/sec
[ 7] 39.0-42.0 sec 39.7 MBytes 111 Mbits/sec
[ 7] 42.0-45.0 sec 42.2 MBytes 118 Mbits/sec
[ 7] 45.0-48.0 sec 40.1 MBytes 112 Mbits/sec
[ 7] 48.0-51.0 sec 42.9 MBytes 120 Mbits/sec
[ 7] 51.0-54.0 sec 42.3 MBytes 118 Mbits/sec
[ 7] 54.0-57.0 sec 43.5 MBytes 122 Mbits/sec
[ 7] 57.0-60.0 sec 42.9 MBytes 120 Mbits/sec
```

[ 7] 0.0-60.0 sec 808 MBytes 113 Mbits/sec

---

筆電-視窗系統-802.11ac 5GHz@HT80

---

[ 4] local 192.168.1.91 port 5001 connected with 192.168.1.37 port 52156  
[ 4] 0.0- 3.0 sec 61.4 MBytes 172 Mbits/sec  
[ 4] 3.0- 6.0 sec 67.5 MBytes 189 Mbits/sec  
[ 4] 6.0- 9.0 sec 79.7 MBytes 223 Mbits/sec  
[ 4] 9.0-12.0 sec 98.1 MBytes 274 Mbits/sec  
[ 4] 12.0-15.0 sec 98.0 MBytes 274 Mbits/sec  
[ 4] 15.0-18.0 sec 77.8 MBytes 217 Mbits/sec  
[ 4] 18.0-21.0 sec 68.3 MBytes 191 Mbits/sec  
[ 4] 21.0-24.0 sec 77.4 MBytes 216 Mbits/sec  
[ 4] 24.0-27.0 sec 70.5 MBytes 197 Mbits/sec  
[ 4] 27.0-30.0 sec 95.8 MBytes 268 Mbits/sec  
[ 4] 30.0-33.0 sec 91.3 MBytes 255 Mbits/sec  
[ 4] 33.0-36.0 sec 85.0 MBytes 238 Mbits/sec  
[ 4] 36.0-39.0 sec 88.1 MBytes 246 Mbits/sec  
[ 4] 39.0-42.0 sec 75.8 MBytes 212 Mbits/sec  
[ 4] 42.0-45.0 sec 84.1 MBytes 235 Mbits/sec  
[ 4] 45.0-48.0 sec 88.2 MBytes 247 Mbits/sec  
[ 4] 48.0-51.0 sec 99.7 MBytes 279 Mbits/sec  
[ 4] 51.0-54.0 sec 106 MBytes 297 Mbits/sec  
[ 4] 54.0-57.0 sec 92.8 MBytes 259 Mbits/sec  
[ 4] 57.0-60.0 sec 71.2 MBytes 199 Mbits/sec  
[ 4] 0.0-60.0 sec 1676 MBytes 234 Mbits/sec

---

平板-Android-802.11n 5GHz@HT20

---

[ 14] local 192.168.1.91 port 5001 connected with 192.168.1.243 port 38040  
[ 14] 0.0- 3.0 sec 35.9 MBytes 100 Mbits/sec  
[ 14] 3.0- 6.0 sec 36.5 MBytes 102 Mbits/sec  
[ 14] 6.0- 9.0 sec 35.5 MBytes 99.2 Mbits/sec  
[ 14] 9.0-12.0 sec 35.8 MBytes 100 Mbits/sec  
[ 14] 12.0-15.0 sec 34.7 MBytes 97.1 Mbits/sec  
[ 14] 15.0-18.0 sec 35.9 MBytes 101 Mbits/sec  
[ 14] 18.0-21.0 sec 36.0 MBytes 101 Mbits/sec  
[ 14] 21.0-24.0 sec 34.6 MBytes 96.7 Mbits/sec  
[ 14] 24.0-27.0 sec 35.7 MBytes 99.9 Mbits/sec  
[ 14] 27.0-30.0 sec 35.4 MBytes 98.9 Mbits/sec  
[ 14] 30.0-33.0 sec 35.4 MBytes 99.1 Mbits/sec  
[ 14] 33.0-36.0 sec 30.2 MBytes 84.3 Mbits/sec  
[ 14] 36.0-39.0 sec 33.7 MBytes 94.3 Mbits/sec  
[ 14] 39.0-42.0 sec 31.7 MBytes 88.6 Mbits/sec  
[ 14] 42.0-45.0 sec 36.1 MBytes 101 Mbits/sec  
[ 14] 45.0-48.0 sec 36.0 MBytes 101 Mbits/sec  
[ 14] 48.0-51.0 sec 34.8 MBytes 97.3 Mbits/sec  
[ 14] 51.0-54.0 sec 35.4 MBytes 99.1 Mbits/sec  
[ 14] 54.0-57.0 sec 32.7 MBytes 91.5 Mbits/sec  
[ 14] 57.0-60.0 sec 35.7 MBytes 99.8 Mbits/sec  
[ 14] 0.0-60.0 sec 698 MBytes 97.6 Mbits/sec

---

平板-Android-802.11n 5GHz@HT40

---

```
[ 17] local 192.168.1.91 port 5001 connected with 192.168.1.243 port 38043
[ 17] 0.0- 3.0 sec 57.3 MBytes 160 Mbits/sec
[ 17] 3.0- 6.0 sec 59.1 MBytes 165 Mbits/sec
[ 17] 6.0- 9.0 sec 58.1 MBytes 162 Mbits/sec
[ 17] 9.0-12.0 sec 57.9 MBytes 162 Mbits/sec
[ 17] 12.0-15.0 sec 52.6 MBytes 147 Mbits/sec
[ 17] 15.0-18.0 sec 52.2 MBytes 146 Mbits/sec
[ 17] 18.0-21.0 sec 48.5 MBytes 136 Mbits/sec
[ 17] 21.0-24.0 sec 52.7 MBytes 147 Mbits/sec
[ 17] 24.0-27.0 sec 50.2 MBytes 140 Mbits/sec
[ 17] 27.0-30.0 sec 50.9 MBytes 142 Mbits/sec
[ 17] 30.0-33.0 sec 51.6 MBytes 144 Mbits/sec
[ 17] 33.0-36.0 sec 56.3 MBytes 157 Mbits/sec
[ 17] 36.0-39.0 sec 57.2 MBytes 160 Mbits/sec
[ 17] 39.0-42.0 sec 57.8 MBytes 162 Mbits/sec
[ 17] 42.0-45.0 sec 49.5 MBytes 138 Mbits/sec
[ 17] 45.0-48.0 sec 45.4 MBytes 127 Mbits/sec
[ 17] 48.0-51.0 sec 49.5 MBytes 138 Mbits/sec
[ 17] 51.0-54.0 sec 57.3 MBytes 160 Mbits/sec
[ 17] 54.0-57.0 sec 56.6 MBytes 158 Mbits/sec
[ 17] 57.0-60.0 sec 50.8 MBytes 142 Mbits/sec
[ 17] 0.0-60.0 sec 1072 MBytes 150 Mbits/sec
```

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平板-Android-802.11ac 5GHz@HT20

---

```
[ 11] local 192.168.1.91 port 5001 connected with 192.168.1.243 port 38039
[ 11] 0.0- 3.0 sec 38.0 MBytes 106 Mbits/sec
[ 11] 3.0- 6.0 sec 39.7 MBytes 111 Mbits/sec
[ 11] 6.0- 9.0 sec 35.5 MBytes 99.3 Mbits/sec
[ 11] 9.0-12.0 sec 38.3 MBytes 107 Mbits/sec
[ 11] 12.0-15.0 sec 37.7 MBytes 105 Mbits/sec
[ 11] 15.0-18.0 sec 40.1 MBytes 112 Mbits/sec
[ 11] 18.0-21.0 sec 36.0 MBytes 101 Mbits/sec
[ 11] 21.0-24.0 sec 39.1 MBytes 109 Mbits/sec
[ 11] 24.0-27.0 sec 39.4 MBytes 110 Mbits/sec
[ 11] 27.0-30.0 sec 40.4 MBytes 113 Mbits/sec
[ 11] 30.0-33.0 sec 39.5 MBytes 111 Mbits/sec
[ 11] 33.0-36.0 sec 40.2 MBytes 113 Mbits/sec
[ 11] 36.0-39.0 sec 40.7 MBytes 114 Mbits/sec
[ 11] 39.0-42.0 sec 41.0 MBytes 115 Mbits/sec
[ 11] 42.0-45.0 sec 40.7 MBytes 114 Mbits/sec
[ 11] 45.0-48.0 sec 40.3 MBytes 113 Mbits/sec
[ 11] 48.0-51.0 sec 40.4 MBytes 113 Mbits/sec
[ 11] 51.0-54.0 sec 40.9 MBytes 114 Mbits/sec
[ 11] 54.0-57.0 sec 40.2 MBytes 112 Mbits/sec
[ 11] 57.0-60.0 sec 39.6 MBytes 111 Mbits/sec
[ 11] 0.0-60.0 sec 788 MBytes 110 Mbits/sec
```

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平板-Android-802.11ac 5GHz@HT40

---

```

[ 8] local 192.168.1.91 port 5001 connected with 192.168.1.243 port 38038
[ 8] 0.0- 3.0 sec 69.4 MBytes 194 Mbits/sec
[ 8] 3.0- 6.0 sec 70.7 MBytes 198 Mbits/sec
[ 8] 6.0- 9.0 sec 66.5 MBytes 186 Mbits/sec
[ 8] 9.0-12.0 sec 64.2 MBytes 180 Mbits/sec
[ 8] 12.0-15.0 sec 60.4 MBytes 169 Mbits/sec
[ 8] 15.0-18.0 sec 60.0 MBytes 168 Mbits/sec
[ 8] 18.0-21.0 sec 59.5 MBytes 166 Mbits/sec
[ 8] 21.0-24.0 sec 64.2 MBytes 179 Mbits/sec
[ 8] 24.0-27.0 sec 64.6 MBytes 181 Mbits/sec
[ 8] 27.0-30.0 sec 63.0 MBytes 176 Mbits/sec
[ 8] 30.0-33.0 sec 62.1 MBytes 174 Mbits/sec
[ 8] 33.0-36.0 sec 58.6 MBytes 164 Mbits/sec
[ 8] 36.0-39.0 sec 59.2 MBytes 165 Mbits/sec
[ 8] 39.0-42.0 sec 62.2 MBytes 174 Mbits/sec
[ 8] 42.0-45.0 sec 60.7 MBytes 170 Mbits/sec
[ 8] 45.0-48.0 sec 63.2 MBytes 177 Mbits/sec
[ 8] 48.0-51.0 sec 63.2 MBytes 177 Mbits/sec
[ 8] 51.0-54.0 sec 64.1 MBytes 179 Mbits/sec
[ 8] 54.0-57.0 sec 64.5 MBytes 180 Mbits/sec
[ 8] 57.0-60.0 sec 62.8 MBytes 176 Mbits/sec
[ 8] 0.0-60.0 sec 1263 MBytes 177 Mbits/sec

```

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平板-Android-802.11ac 5GHz@HT80

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```

[ 5] local 192.168.1.91 port 5001 connected with 192.168.1.243 port 38036
[ 5] 0.0- 3.0 sec 87.2 MBytes 244 Mbits/sec
[ 5] 3.0- 6.0 sec 94.5 MBytes 264 Mbits/sec
[ 5] 6.0- 9.0 sec 84.6 MBytes 237 Mbits/sec
[ 5] 9.0-12.0 sec 87.7 MBytes 245 Mbits/sec
[ 5] 12.0-15.0 sec 87.2 MBytes 244 Mbits/sec
[ 5] 15.0-18.0 sec 90.6 MBytes 253 Mbits/sec
[ 5] 18.0-21.0 sec 88.2 MBytes 246 Mbits/sec
[ 5] 21.0-24.0 sec 87.5 MBytes 245 Mbits/sec
[ 5] 24.0-27.0 sec 85.1 MBytes 238 Mbits/sec
[ 5] 27.0-30.0 sec 75.0 MBytes 210 Mbits/sec
[ 5] 30.0-33.0 sec 72.2 MBytes 202 Mbits/sec
[ 5] 33.0-36.0 sec 78.4 MBytes 219 Mbits/sec
[ 5] 36.0-39.0 sec 89.1 MBytes 249 Mbits/sec
[ 5] 39.0-42.0 sec 85.7 MBytes 240 Mbits/sec
[ 5] 42.0-45.0 sec 88.6 MBytes 248 Mbits/sec
[ 5] 45.0-48.0 sec 85.5 MBytes 239 Mbits/sec
[ 5] 48.0-51.0 sec 87.9 MBytes 246 Mbits/sec
[ 5] 51.0-54.0 sec 85.3 MBytes 239 Mbits/sec
[ 5] 54.0-57.0 sec 84.9 MBytes 237 Mbits/sec
[ 5] 57.0-60.0 sec 85.8 MBytes 240 Mbits/sec
[ 5] 0.0-60.0 sec 1711 MBytes 239 Mbits/sec

```

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平板-IOS-802.11n 5GHz@HT20

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```

[ 15] local 192.168.1.91 port 5001 connected with 192.168.1.29 port 54050
[ 15] 0.0- 3.0 sec 37.0 MBytes 103 Mbits/sec

```



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[ 15] 3.0- 6.0 sec 34.5 MBytes 96.5 Mbits/sec
[ 15] 6.0- 9.0 sec 35.8 MBytes 100 Mbits/sec
[ 15] 9.0-12.0 sec 30.8 MBytes 86.2 Mbits/sec
[ 15] 12.0-15.0 sec 36.3 MBytes 102 Mbits/sec
[ 15] 15.0-18.0 sec 37.1 MBytes 104 Mbits/sec
[ 15] 18.0-21.0 sec 37.2 MBytes 104 Mbits/sec
[ 15] 21.0-24.0 sec 34.9 MBytes 97.6 Mbits/sec
[ 15] 24.0-27.0 sec 36.2 MBytes 101 Mbits/sec
[ 15] 27.0-30.0 sec 37.1 MBytes 104 Mbits/sec
[ 15] 30.0-33.0 sec 33.8 MBytes 94.4 Mbits/sec
[ 15] 33.0-36.0 sec 37.5 MBytes 105 Mbits/sec
[ 15] 36.0-39.0 sec 37.4 MBytes 105 Mbits/sec
[ 15] 39.0-42.0 sec 37.2 MBytes 104 Mbits/sec
[ 15] 42.0-45.0 sec 37.1 MBytes 104 Mbits/sec
[ 15] 45.0-48.0 sec 36.5 MBytes 102 Mbits/sec
[ 15] 48.0-51.0 sec 37.1 MBytes 104 Mbits/sec
[ 15] 51.0-54.0 sec 34.7 MBytes 97.1 Mbits/sec
[ 15] 54.0-57.0 sec 36.6 MBytes 102 Mbits/sec
[ 15] 57.0-60.0 sec 36.6 MBytes 102 Mbits/sec
[ 15] 0.0-60.0 sec 724 MBytes 101 Mbits/sec

```

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平板-IOS-802.11n 5GHz@HT40  
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```

[ 18] local 192.168.1.91 port 5001 connected with 192.168.1.29 port 54066
[ 18] 0.0- 3.0 sec 57.7 MBytes 161 Mbits/sec
[ 18] 3.0- 6.0 sec 56.1 MBytes 157 Mbits/sec
[ 18] 6.0- 9.0 sec 58.2 MBytes 163 Mbits/sec
[ 18] 9.0-12.0 sec 56.0 MBytes 156 Mbits/sec
[ 18] 12.0-15.0 sec 53.5 MBytes 150 Mbits/sec
[ 18] 15.0-18.0 sec 58.2 MBytes 163 Mbits/sec
[ 18] 18.0-21.0 sec 57.4 MBytes 161 Mbits/sec
[ 18] 21.0-24.0 sec 58.1 MBytes 163 Mbits/sec
[ 18] 24.0-27.0 sec 56.4 MBytes 158 Mbits/sec
[ 18] 27.0-30.0 sec 58.1 MBytes 163 Mbits/sec
[ 18] 30.0-33.0 sec 58.4 MBytes 163 Mbits/sec
[ 18] 33.0-36.0 sec 58.5 MBytes 164 Mbits/sec
[ 18] 36.0-39.0 sec 58.3 MBytes 163 Mbits/sec
[ 18] 39.0-42.0 sec 57.9 MBytes 162 Mbits/sec
[ 18] 42.0-45.0 sec 57.9 MBytes 162 Mbits/sec
[ 18] 45.0-48.0 sec 57.4 MBytes 160 Mbits/sec
[ 18] 48.0-51.0 sec 57.2 MBytes 160 Mbits/sec
[ 18] 51.0-54.0 sec 53.2 MBytes 149 Mbits/sec
[ 18] 54.0-57.0 sec 58.5 MBytes 164 Mbits/sec
[ 18] 57.0-60.0 sec 57.7 MBytes 161 Mbits/sec
[ 18] 0.0-60.0 sec 1147 MBytes 160 Mbits/sec

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平板-IOS-802.11ac GHz@HT20  
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```

[ 12] local 192.168.1.91 port 5001 connected with 192.168.1.29 port 54041
[ 12] 0.0- 3.0 sec 39.6 MBytes 111 Mbits/sec
[ 12] 3.0- 6.0 sec 41.0 MBytes 115 Mbits/sec
[ 12] 6.0- 9.0 sec 33.2 MBytes 92.8 Mbits/sec

```

```

[ 12] 9.0-12.0 sec 36.6 MBytes 102 Mbits/sec
[ 12] 12.0-15.0 sec 33.4 MBytes 93.3 Mbits/sec
[ 12] 15.0-18.0 sec 36.8 MBytes 103 Mbits/sec
[ 12] 18.0-21.0 sec 31.4 MBytes 87.7 Mbits/sec
[ 12] 21.0-24.0 sec 34.8 MBytes 97.4 Mbits/sec
[ 12] 24.0-27.0 sec 36.6 MBytes 102 Mbits/sec
[ 12] 27.0-30.0 sec 32.1 MBytes 89.7 Mbits/sec
[ 12] 30.0-33.0 sec 32.8 MBytes 91.6 Mbits/sec
[ 12] 33.0-36.0 sec 32.8 MBytes 91.7 Mbits/sec
[ 12] 36.0-39.0 sec 32.0 MBytes 89.5 Mbits/sec
[ 12] 39.0-42.0 sec 29.5 MBytes 82.5 Mbits/sec
[ 12] 42.0-45.0 sec 35.0 MBytes 97.9 Mbits/sec
[ 12] 45.0-48.0 sec 32.5 MBytes 90.8 Mbits/sec
[ 12] 48.0-51.0 sec 34.8 MBytes 97.4 Mbits/sec
[ 12] 51.0-54.0 sec 32.5 MBytes 91.0 Mbits/sec
[ 12] 54.0-57.0 sec 36.1 MBytes 101 Mbits/sec
[ 12] 57.0-60.0 sec 36.3 MBytes 101 Mbits/sec
[ 12] 0.0-60.0 sec 692 MBytes 96.5 Mbits/sec

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平板-IOS-802.11ac 5GHz@HT40

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```

[ 9] local 192.168.1.91 port 5001 connected with 192.168.1.29 port 54030
[ 9] 0.0- 3.0 sec 54.4 MBytes 152 Mbits/sec
[ 9] 3.0- 6.0 sec 56.5 MBytes 158 Mbits/sec
[ 9] 6.0- 9.0 sec 60.7 MBytes 170 Mbits/sec
[ 9] 9.0-12.0 sec 61.1 MBytes 171 Mbits/sec
[ 9] 12.0-15.0 sec 55.3 MBytes 155 Mbits/sec
[ 9] 15.0-18.0 sec 58.6 MBytes 164 Mbits/sec
[ 9] 18.0-21.0 sec 64.1 MBytes 179 Mbits/sec
[ 9] 21.0-24.0 sec 61.1 MBytes 171 Mbits/sec
[ 9] 24.0-27.0 sec 64.4 MBytes 180 Mbits/sec
[ 9] 27.0-30.0 sec 60.3 MBytes 169 Mbits/sec
[ 9] 30.0-33.0 sec 59.9 MBytes 168 Mbits/sec
[ 9] 33.0-36.0 sec 62.0 MBytes 173 Mbits/sec
[ 9] 36.0-39.0 sec 57.5 MBytes 161 Mbits/sec
[ 9] 39.0-42.0 sec 55.6 MBytes 155 Mbits/sec
[ 9] 42.0-45.0 sec 58.7 MBytes 164 Mbits/sec
[ 9] 45.0-48.0 sec 65.9 MBytes 184 Mbits/sec
[ 9] 48.0-51.0 sec 62.9 MBytes 176 Mbits/sec
[ 9] 51.0-54.0 sec 59.1 MBytes 165 Mbits/sec
[ 9] 54.0-57.0 sec 57.7 MBytes 161 Mbits/sec
[ 9] 57.0-60.0 sec 66.1 MBytes 185 Mbits/sec
[ 9] 0.0-60.0 sec 1204 MBytes 168 Mbits/sec

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平板-IOS-802.11ac 5GHz@HT80

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```

[ 6] local 192.168.1.91 port 5001 connected with 192.168.1.29 port 54022
[ 6] 0.0- 3.0 sec 89.8 MBytes 251 Mbits/sec
[ 6] 3.0- 6.0 sec 83.8 MBytes 234 Mbits/sec
[ 6] 6.0- 9.0 sec 94.8 MBytes 265 Mbits/sec
[ 6] 9.0-12.0 sec 97.3 MBytes 272 Mbits/sec
[ 6] 12.0-15.0 sec 94.5 MBytes 264 Mbits/sec

```

[ 6]	15.0-18.0	sec	90.3	MBytes	253	Mbits/sec
[ 6]	18.0-21.0	sec	91.8	MBytes	257	Mbits/sec
[ 6]	21.0-24.0	sec	97.4	MBytes	272	Mbits/sec
[ 6]	24.0-27.0	sec	93.1	MBytes	260	Mbits/sec
[ 6]	27.0-30.0	sec	81.4	MBytes	228	Mbits/sec
[ 6]	30.0-33.0	sec	93.3	MBytes	261	Mbits/sec
[ 6]	33.0-36.0	sec	96.4	MBytes	270	Mbits/sec
[ 6]	36.0-39.0	sec	84.9	MBytes	238	Mbits/sec
[ 6]	39.0-42.0	sec	89.5	MBytes	250	Mbits/sec
[ 6]	42.0-45.0	sec	98.9	MBytes	276	Mbits/sec
[ 6]	45.0-48.0	sec	92.9	MBytes	260	Mbits/sec
[ 6]	48.0-51.0	sec	90.7	MBytes	254	Mbits/sec
[ 6]	51.0-54.0	sec	92.7	MBytes	259	Mbits/sec
[ 6]	54.0-57.0	sec	94.1	MBytes	263	Mbits/sec
[ 6]	57.0-60.0	sec	92.1	MBytes	258	Mbits/sec
[ 6]	0.0-60.0	sec	1842	MBytes	257	Mbits/sec

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