

網路設備採購規格及 機房網路規劃

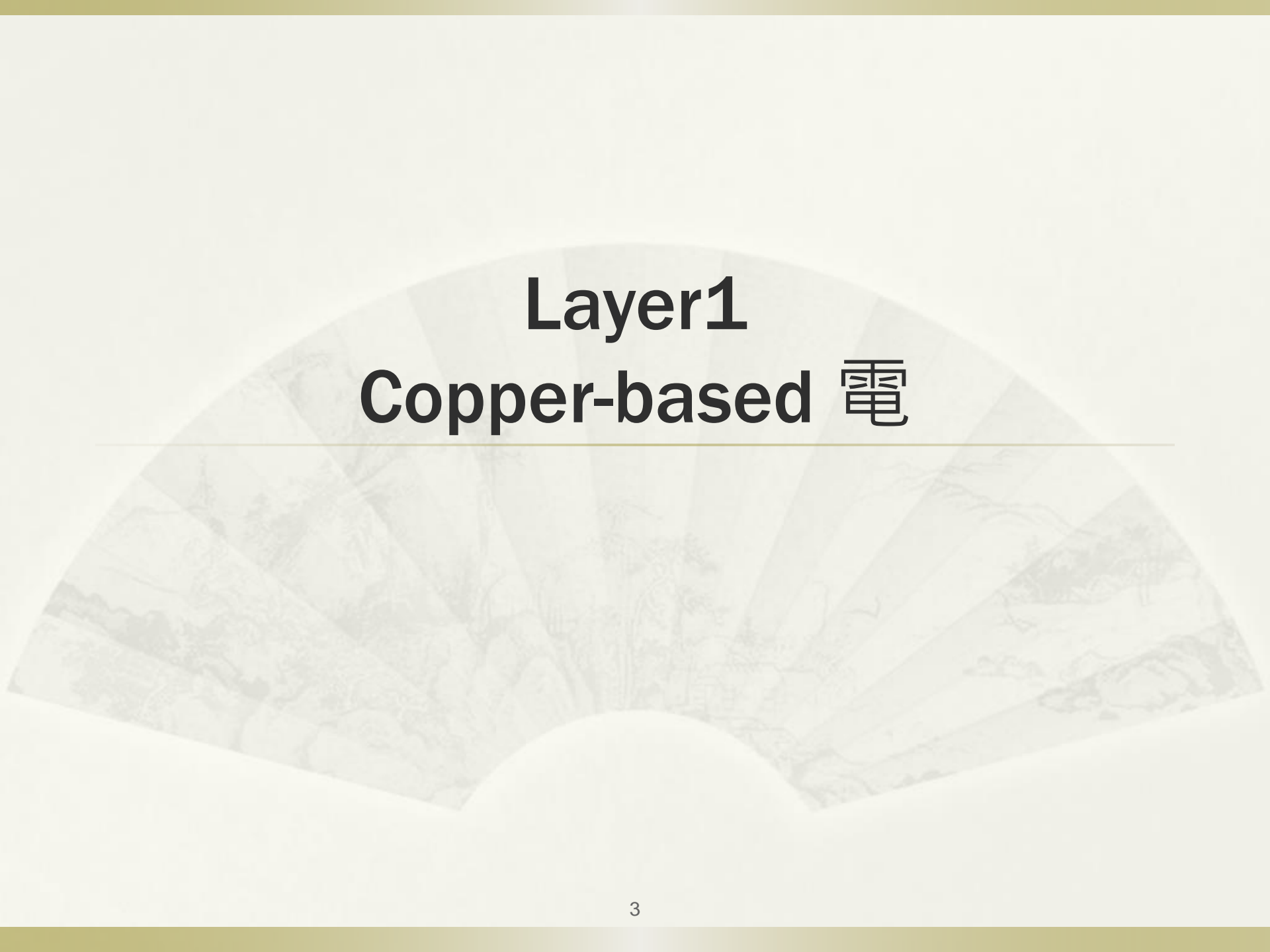
臺灣大學計資中心
游子興

davisyou@ntu.edu.tw
02-33665008

大綱

- * 通訊協定Layer1 - 電
- * 通訊協定Layer1 - 光
- * 通訊協定Layer1 - 無線
- * 通訊協定Layer2 - Switch
- * 通訊協定Layer3 - Router
- * 機房網路規劃經驗分享





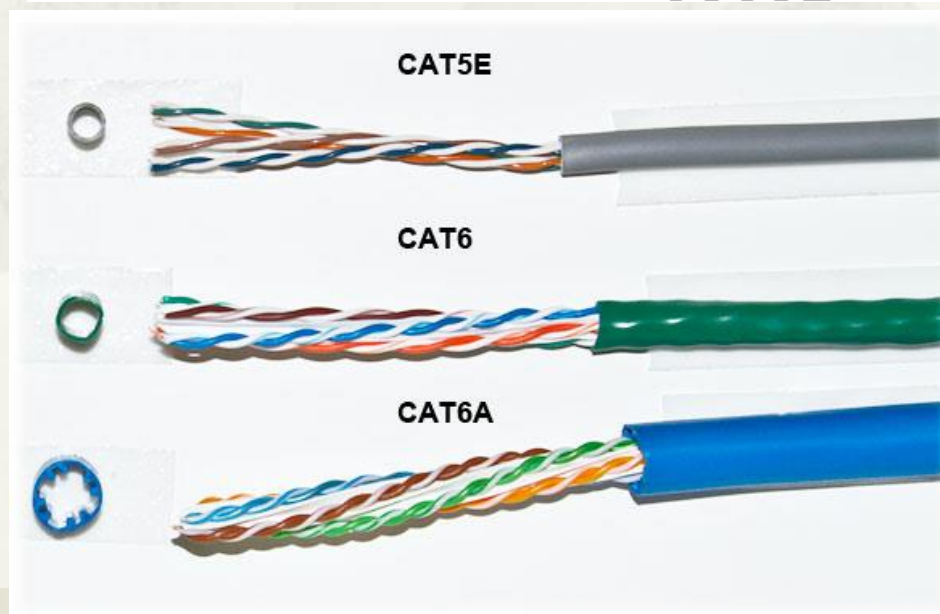
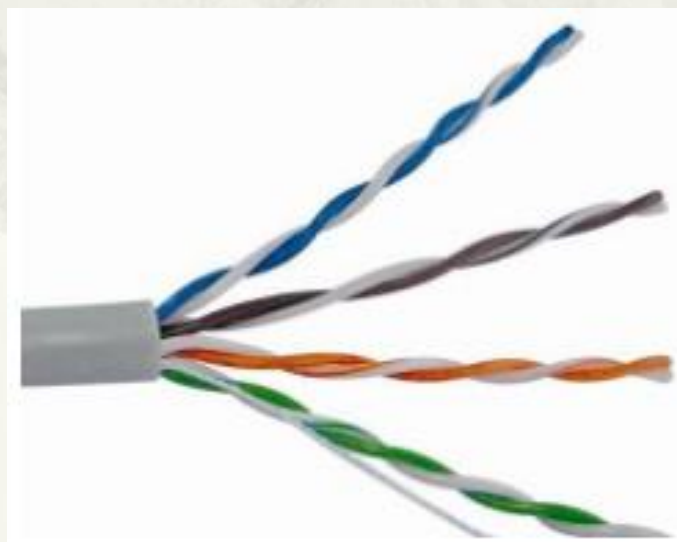
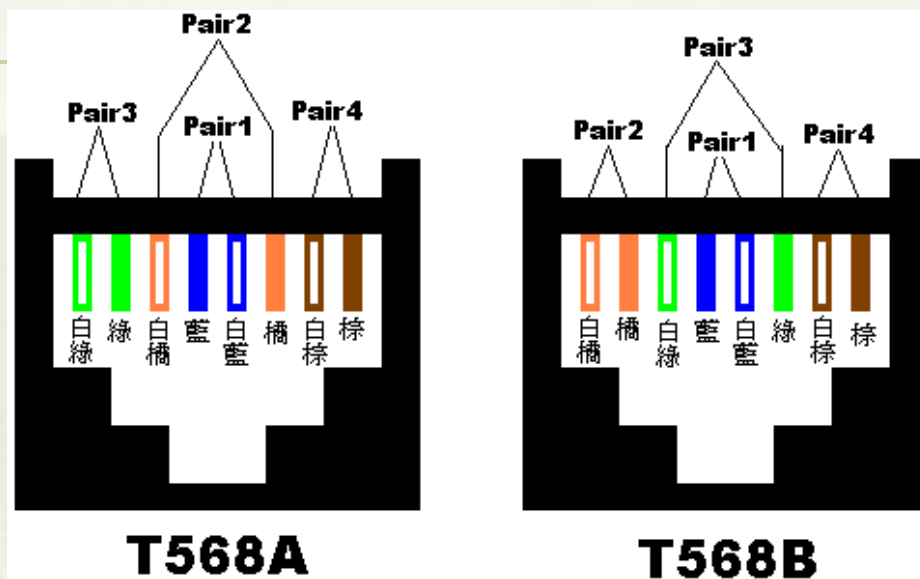
Layer1

Copper-based 電

網路線: 8P8C 雙絞線

8 Position: 8個凹槽

8 Contact: 8個金屬接點



水晶接頭壓線

二叉 vs. 三叉

鍍金三叉芯片

純銅鍍金三叉芯片，確保了芯片與線芯的充分接觸、充分發揮網路的效能。



PIN針比較

三叉設計
接觸面積大
傳輸效率佳

X

O

兩叉PIN針

三叉PIN針

壓線檢查



確認每條線
皆壓到底

此段需包含
外披覆

雙絞線線材標準 Category

TIA/EIA-568.2-D

* 傳輸距離: 100m

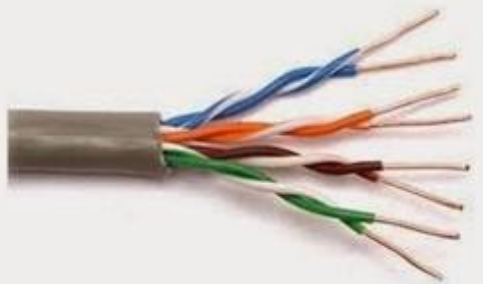
Category	頻率	頻寬
Cat 5	100MHz	100 Mbit/s
Cat 5e	125MHz	1000 Mbit/s
Cat 6	250MHz	1000 Mbit/s 10 Gbit/s (55m)
Cat 6a	500MHz	10 Gbit/s
Cat 7	600MHz	10 Gbit/s

如何辨別網路線線材 Category ?



UTP vs. STP

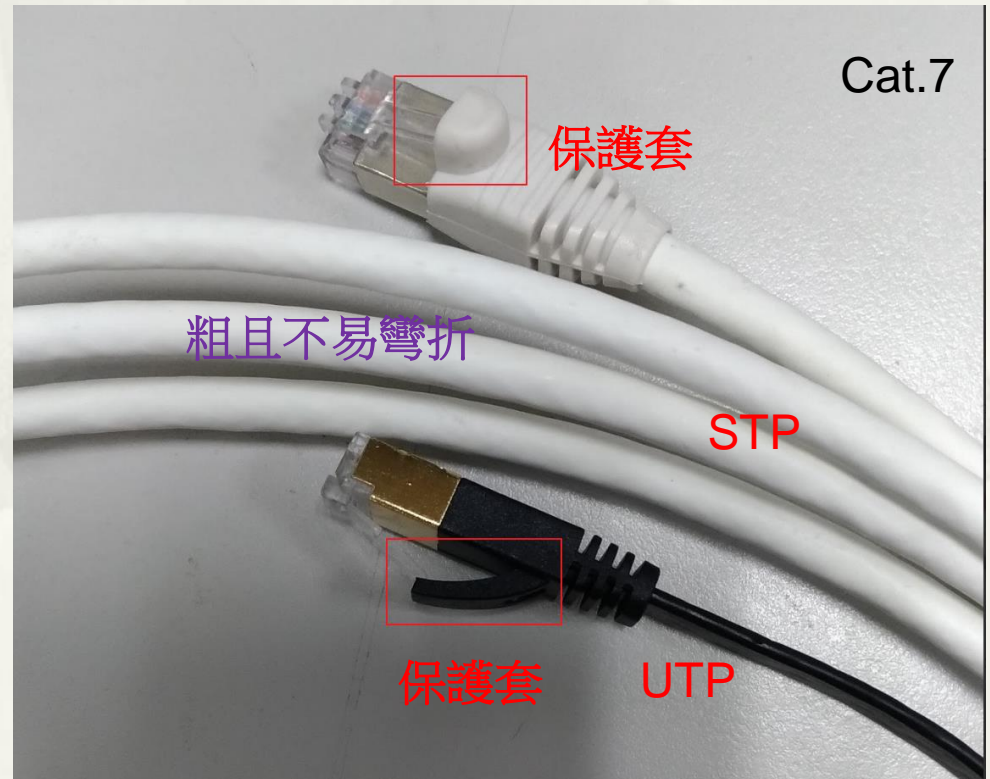
- * 無遮蔽式雙絞線 Unshielded Twisted Pair(UTP)
- * 有遮蔽式雙絞線 Shielded Twisted Pair(STP)
 - * Preventing Electromagnetic Interference (EMI)



UTP Cable



STP Cable



Cat.7

保護套

粗且不易彎折

STP

保護套

UTP

線材又粗又硬 過度彎折結果



網路線傳輸標準

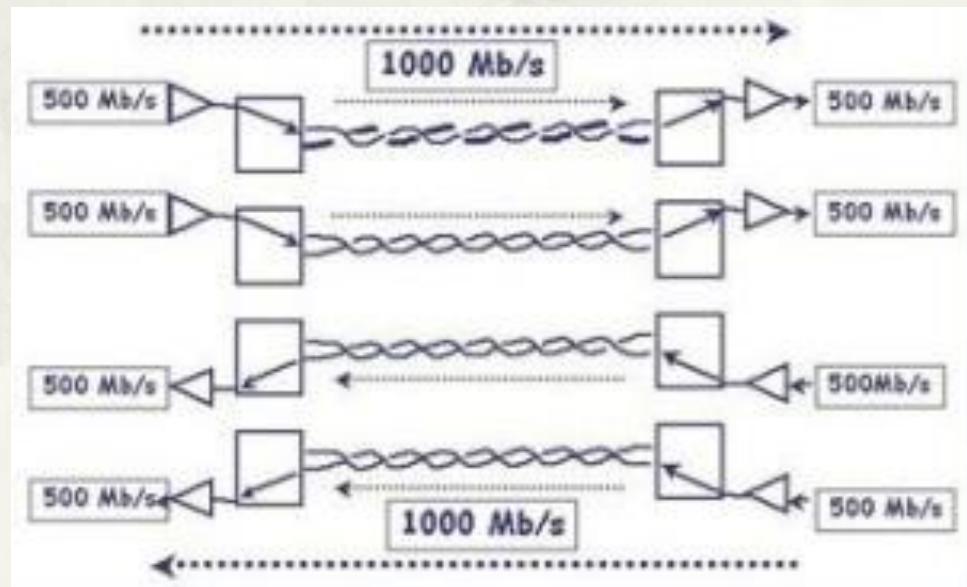
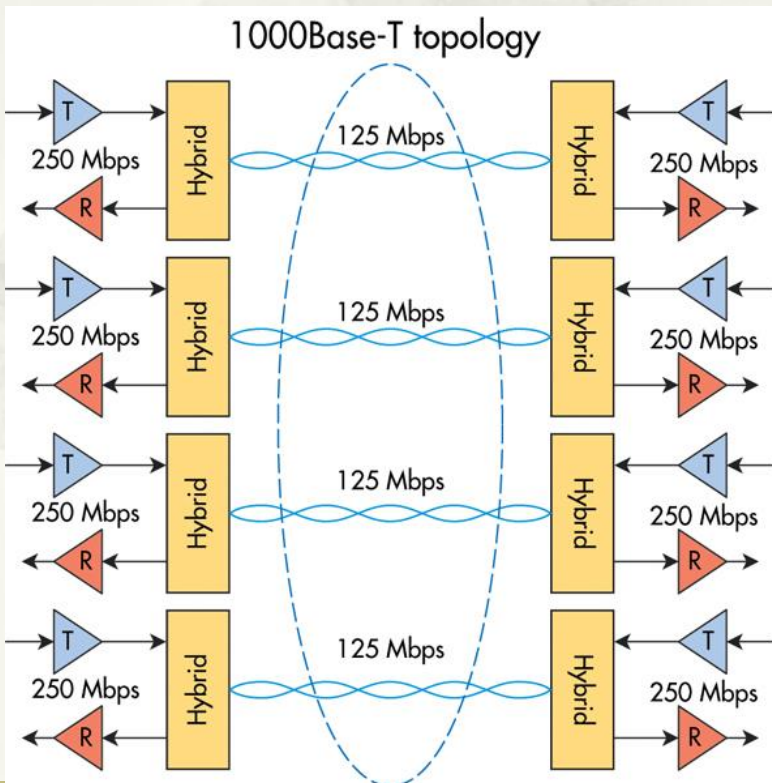
Type	標準	頻寬	使用蕊數	線材 (最低要求)
10BASE-T	IEEE 802.3	10 Mbit/s	2 pairs	Cat 3
100BASE-TX	IEEE 802.3u	100 Mbit/s	2 pairs (1 & 2, 3 & 6)	Cat 5
1000BASE-T	IEEE 802.3ab	1000 Mbit/s	4 pairs	Cat 5e
1000BASE-TX	TIA/EIA 854	1000 Mbit/s	4 pairs	Cat 6
10GBASE-T	IEEE 802.3an	10 Gbit/s	4 pairs	Cat 6 (55m) Cat 6a/7 (100m)

* “T” means Twisted-pair cable

1000BASE-T vs. 1000BASE-TX

- * 1000BASE-T (Popular)
 - * 4-pair UTP cable
 - * full-duplex

- * 1000BASE-TX (成本低)
 - * two pairs send
 - * two pairs receives



接線方式

- * 平行線 (Straight Cable) (90%)

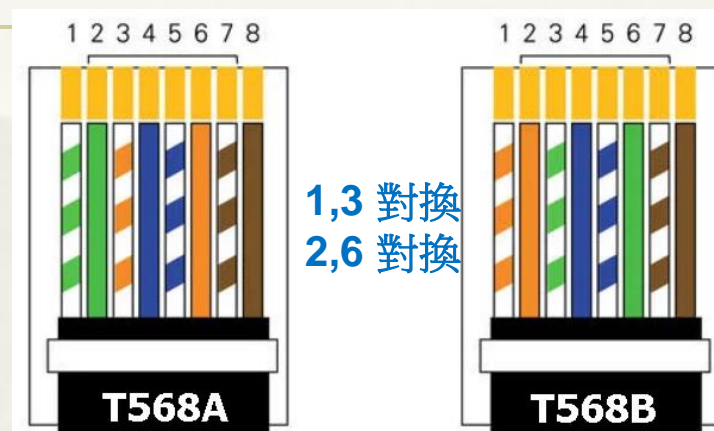
- * 兩端皆是 T568A or T568B(90%)

- * 跳線 (Crossover Cable) (10/100M)

- * 一端 T568A 另一端為 T568B

- * 接線方式

- * DCE (Data Circuit-terminating Equipment): Hub、Switch
- * DTE (Data Terminal Equipment): Router、PC
- * Crossover : 同設備相連、Straight: 不同設備相連

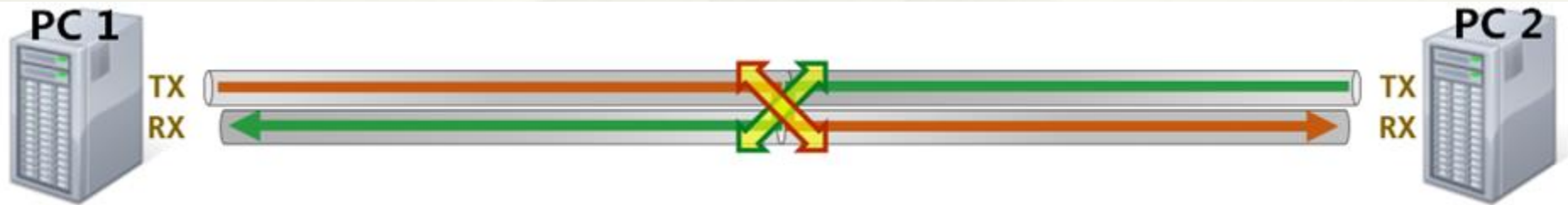


	Hub/Switch	Router	PC
Hub/Switch	Crossover	Straight	Straight
Router	Straight	Crossover	Crossover
PC	Straight	Crossover	Crossover

※新型設備會自動判斷並切換接線類型

Straight/Patch Cable vs Crossover Cable

* Crossover



* Straight



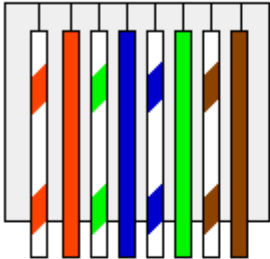
<https://community.fs.com/blog/patch-cable-vs-crossover-cable.html>

10/100Mbps Crossover

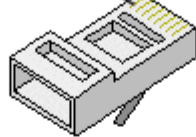
RJ-45 Color Code

T-568B Standard

1 2 3 4 5 6 7 8



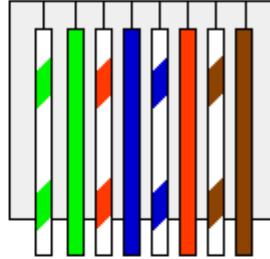
Pin #1



RJ-45
Male Plug

T-568A Standard

1 2 3 4 5 6 7 8

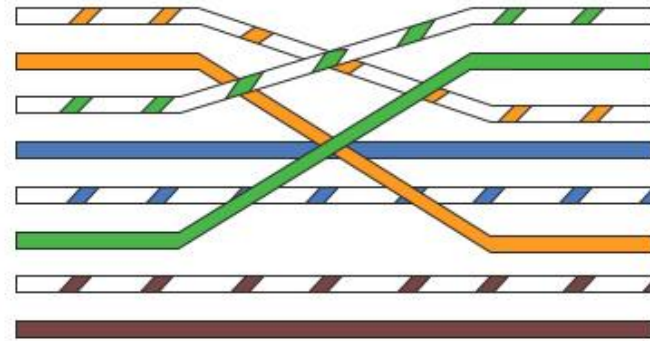


Pin #	Ethernet 10BASE-T 100BASE-TX	EIA/TIA 568A	EIA/TIA 568B or AT&T 258A
1	Transmit +	White with green stripe	White with orange stripe
2	Transmit -	Green with white stripe or solid green	Orange with white stripe or solid orange
3	Receive +	White with orange stripe	White with green stripe
4	N/A	Blue with white stripe or solid blue	Blue with white stripe or solid blue
5	N/A	White with blue stripe	White with blue stripe
6	Receive -	Orange with white stripe or solid orange	Green with white stripe or solid
7	N/A	White with brown strip or solid brown	White with brown strip or solid brown
8	N/A	Brown with white stripe or solid brown.	Brown with white stripe or solid brown.

Crossover Cable Wiring Scheme

Connector A

Pin 1
Pin 2
Pin 3
Pin 4
Pin 5
Pin 6
Pin 7
Pin 8



Connector B

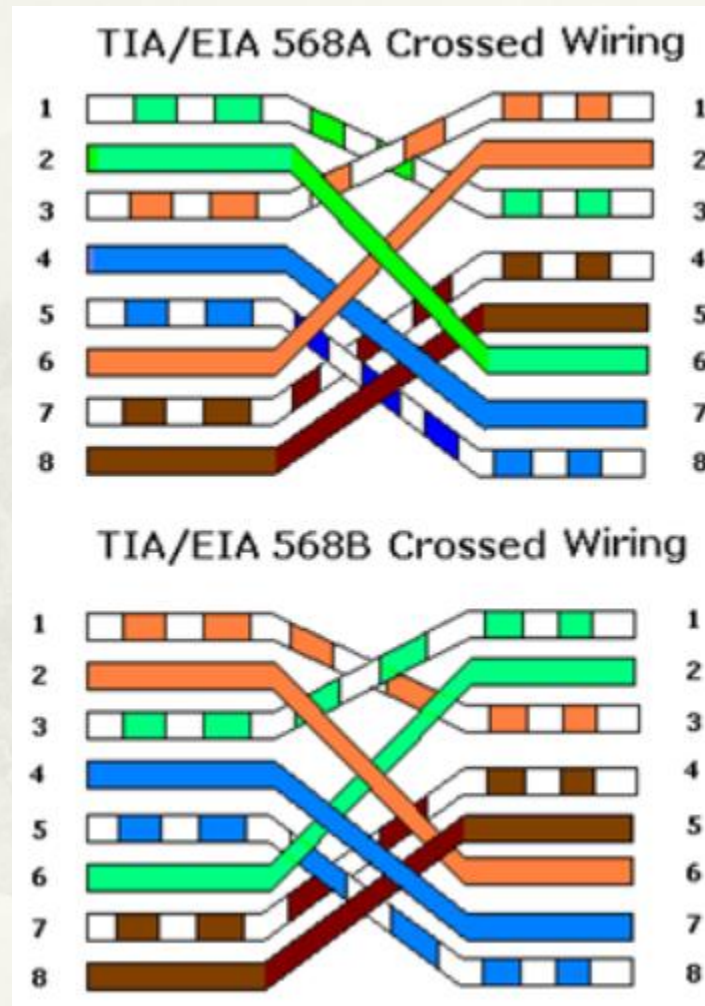
Pin 1
Pin 2
Pin 3
Pin 4
Pin 5
Pin 6
Pin 7
Pin 8

T568B

1,3 對換
2,6 對換

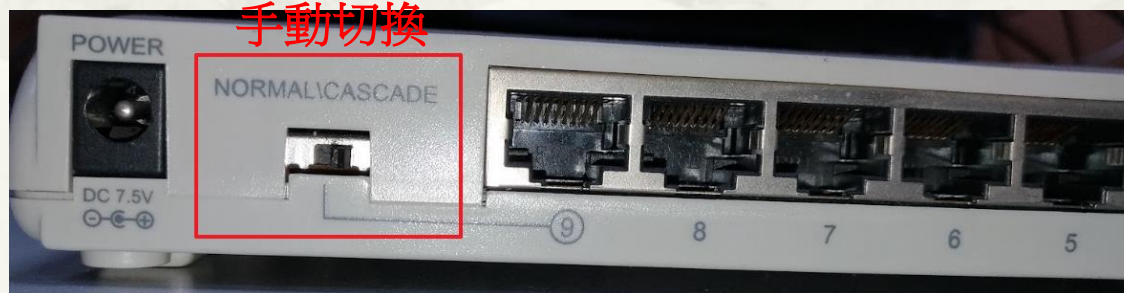
T568A

1000Mbps Crossover



舊型 Hub 10/100 Mbps 不支援自動切換 Crossover

- * 單獨 Uplink Port (已做好 Crossover)，可使用 Straight Cable 連接 Switch/Hub



反轉線 (Rollover Cable)

- * 一端採用568A或568B，另一端接線順序全部顛倒
- * 用途: 設備 Console Port

Layer1 Copper-based 電

優缺點

* 優點

- * 普及性

- * 耐用性、可靠度高 (耐彎曲、耐髒汙)

* 缺點

- * 重量、材積大

- * 傳輸距離短 100公尺

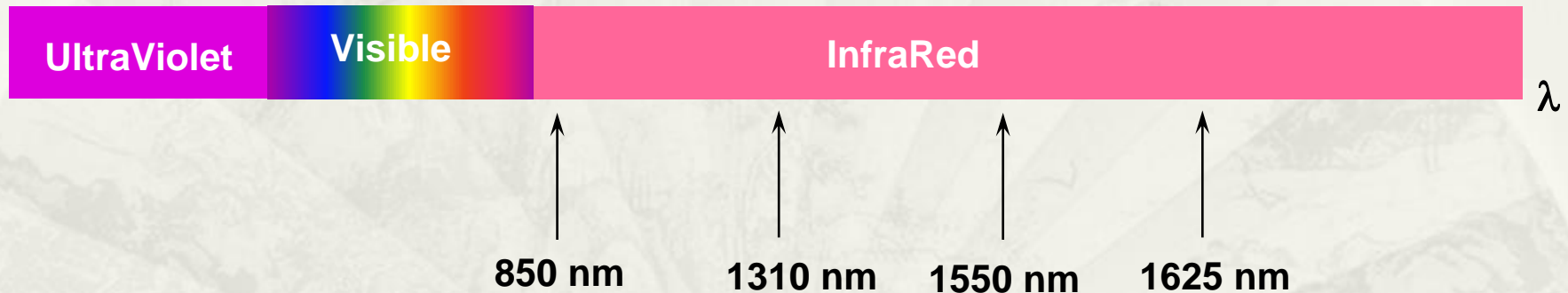


Layer1

Optical-based 光

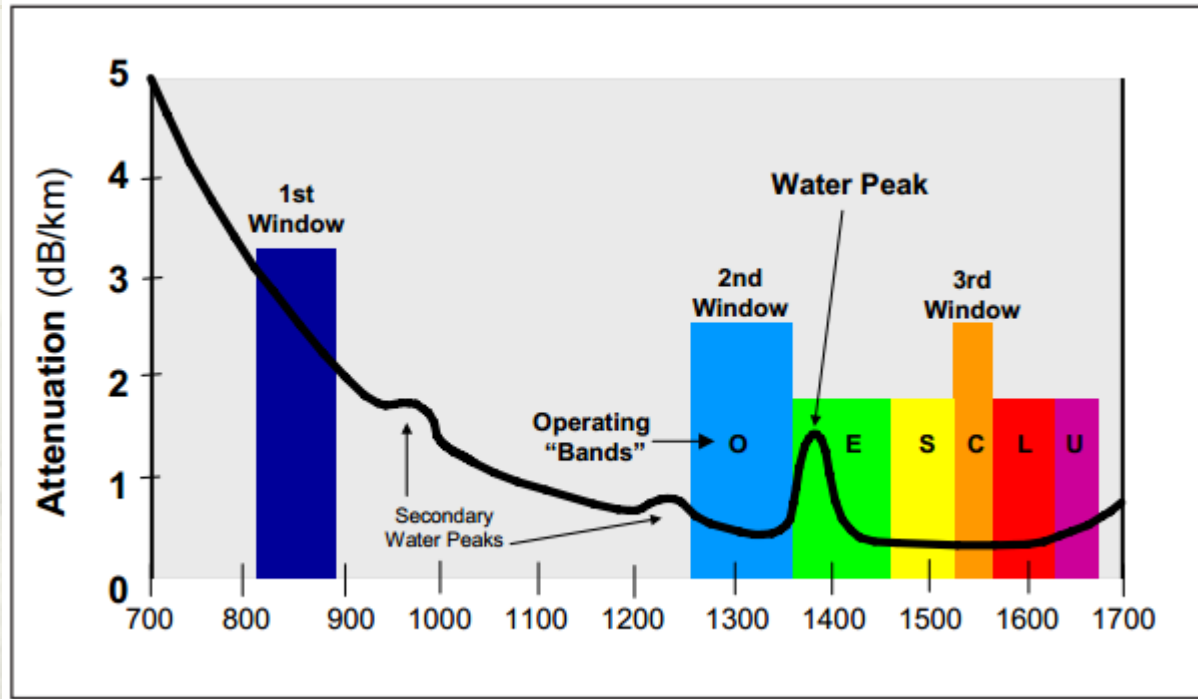
Optical Spectrum

- * Wavelength in the InfraRed(紅外線)
 - * 850 nm over Multi mode fiber
 - * 1310 nm over Single mode fiber
 - * 1550 nm over Single mode fiber
 - * 1625 nm over Single mode fiber



- * 波長越長、頻率約低，傳遞愈遠。
- * High Frequency、High Data Rate

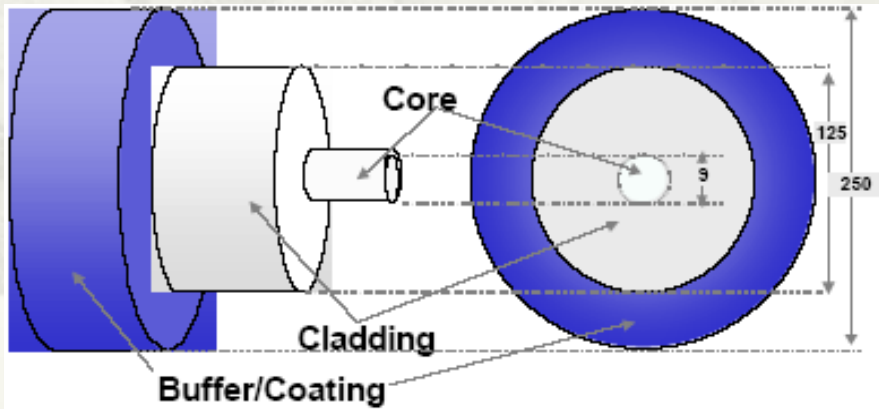
Optical Bands



- * O-band: 1260 - 1360 nm
- * S-band: 1460 - 1530 nm
- * C-band: 1530 - 1565 nm
- * L-band: 1565 - 1625 nm

Fiber Geometry and Dimensions

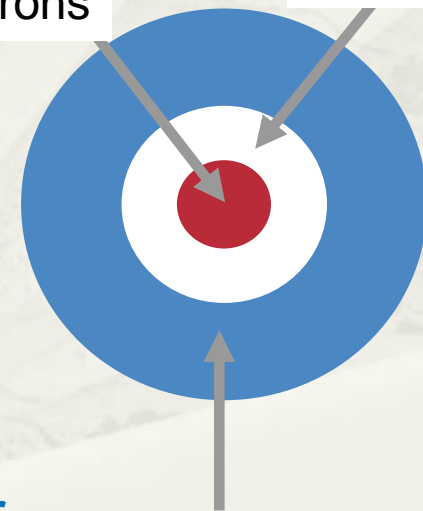
- * An optical fiber is comprised of three sections
 - * The core carries the light signals
 - * The refractive index(折射率) difference between core & cladding confines the light to the core
 - * The coating protects the glass



Single Mode Fiber

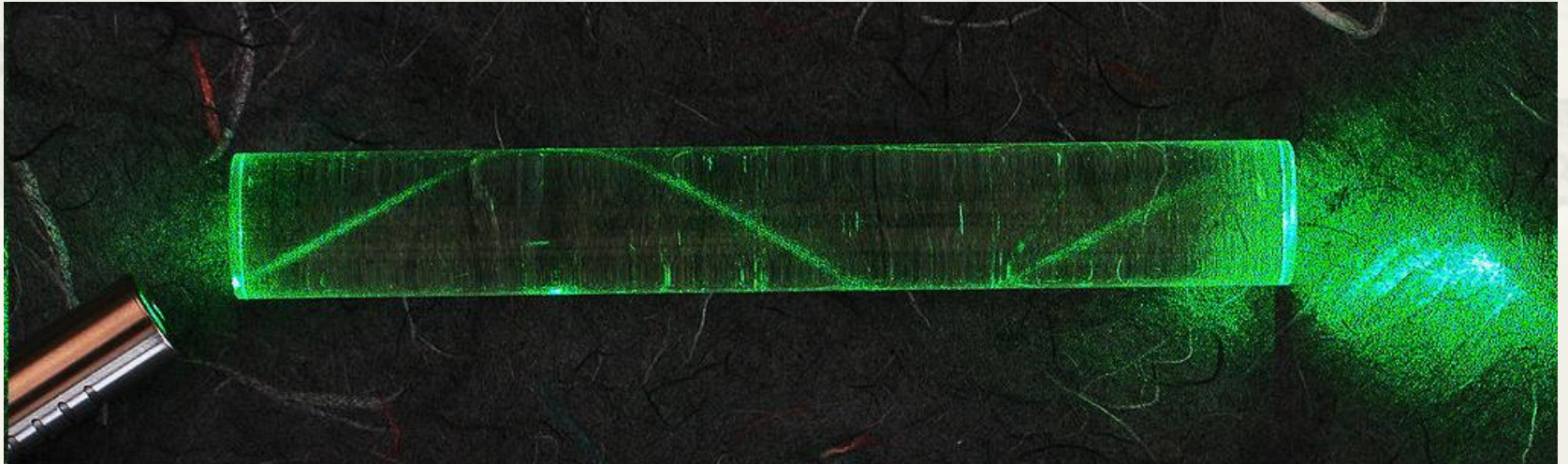
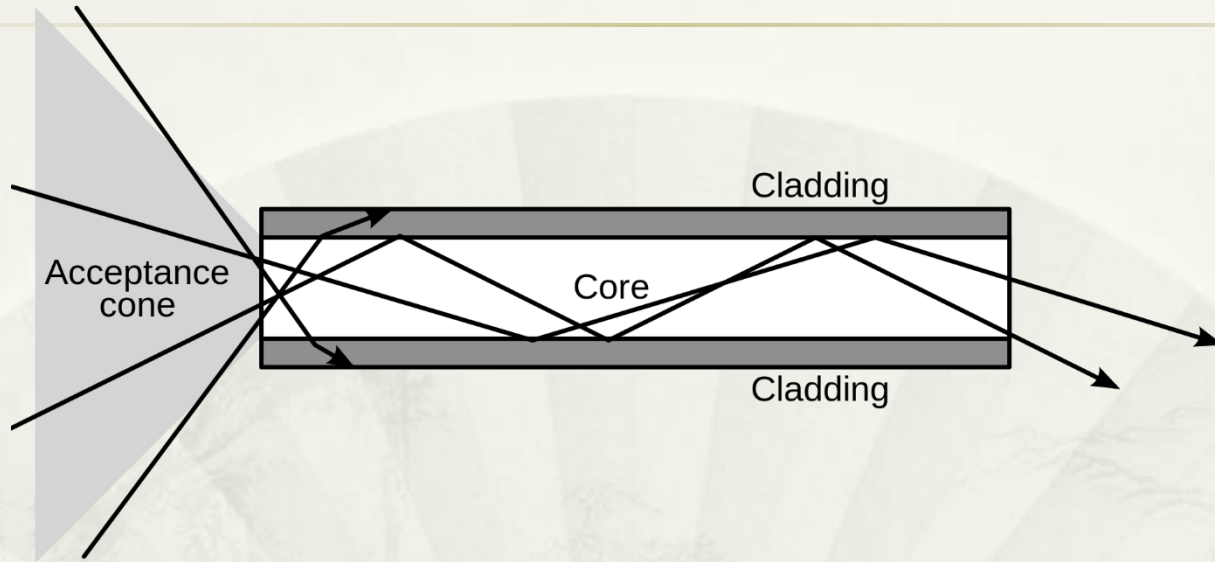
Core
9 microns

Cladding
125 microns



Coating
250 microns

Reflection 反射



Multi Mode Fiber

多模光纖

規格	Core/Cladding	100Mbps 距離	1Gbps 距離	10Gbps 距離	線材顏色
OM1(淘汰)	62.5/125um	2km	275m	33m	橘色
OM2(淘汰)	50/125um	2km	550m	82m	橘色
OM3	50/125um		550m	300m	藍色
OM4	50/125um		550m	400m	紫色
OM5	50/125um		550m	400m	綠色



OM1
OM2



OM3 光纖跳線
從NT\$ 205 起



OM4 光纖跳線
從NT\$ 220 起



OM5 光纖跳線
從NT\$ 315 起

Single Mode Fiber (SMF)

單模光纖

規格	Core/Cladding	Attenuation 衰減	線材顏色
OS1 (淘汰)	9/125um	1 dB/km	黃色
OS2	9/125um	0.4 dB/km	黃色

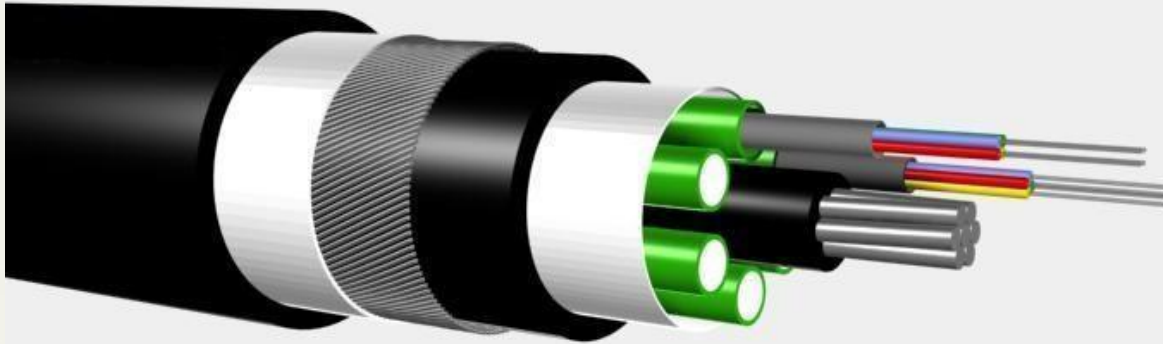
- * 傳輸距離
 - * 5km ~ 80km
- * 單模光纖規格
 - * ITU-T G.65x系列
 - * IEC 60793-2-50系列



OS 光纖跳線
從NT\$ 210 起

戶外光纜

24/48/96 蕊



24 蕊 62.5/125 um

光纖傳輸標準

Type	頻寬	標準	線材	波長	長度
100Base-FX	100Mbps	802.3u	Multi Mode (Single Mode)	850nm (1310nm)	2km (20km)
1000Base-SX	1000Mbps	802.3z	Multi Mode	850nm	550m
1000Base-LX (LH)	1000Mbps	802.3z	Multi Mode Single Mode	1310nm	550m 5km
1000Base-EX	1000Mbps	N/A	Single Mode	1310nm	40km
1000Base-ZX	1000Mbps	N/A	Single Mode	1550nm	70km
10GBase-SR	10 Gbps	802.3ae	Multi Mode	850nm	300m
10GBase-LR	10 Gbps	802.3ae	Single Mode	1310nm	10km
10GBase-ER	10 Gbps	802.3ae	Single Mode	1550nm	40km
10GBase-ZR	10 Gbps	N/A	Single Mode	1550nm	80km

X 結尾: 100Mbps/1 Gbps R 結尾: 10 Gbps

光纖傳輸標準

100Gbps

Type	頻寬 x Lanes	標準	Connector	Transceiver	長度
100GBASE-SR10 1st Gen	10Gbps x 10	802.3ba- 2010	MPO/MTP (MPO-24)	CFP	OM3:100m OM4:150m
100GBASE-SR4 2nd Gen	25Gbps x 4	802.3bm- 2015	MPO/MTP (MPO-12)	QSFP28	OM3:70m OM4:100m
100GBASE-SR2 3rd Gen	50Gbps x 2	802.3cd- 2018	MPO (MPO-8)	QSFP28	OM3:70m OM4:100m
100GBASE-SR1 4th Gen	100Gbps x1	802.3db- 2022	LC	QSFP28	OM3:60m OM4:100m

https://en.wikipedia.org/wiki/100_Gigabit_Ethernet

Connector

接頭形式

- * FC(Ferrule Connector) 圓型帶螺紋
- * ST(Straight Tip Connector) 圓頭
- * SC(Snap-in Connector) 卡接式方型 (大方頭)
- * LC(Little Connector/Local Connector) 小方頭
- * MPO (Multi-Fiber Push On)/MTP(Multi-Fiber Pull Off)
 - * MPO-8、MPO-12、MPO-24
 - * ※ MTP: Improved version of MPO

https://en.wikipedia.org/wiki/Optical_fiber_connector

光纖接頭 Connector



LC Connector



SC Connector



ST Connector



FC Connector

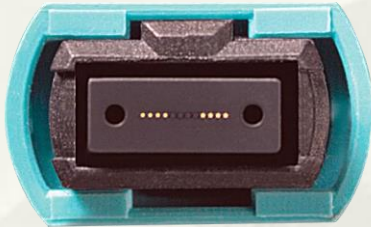


ST Connector

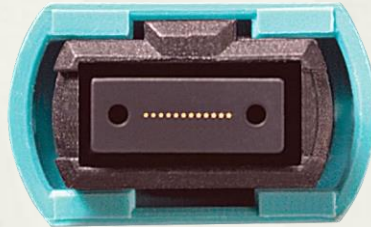


Connector MPO/MTP

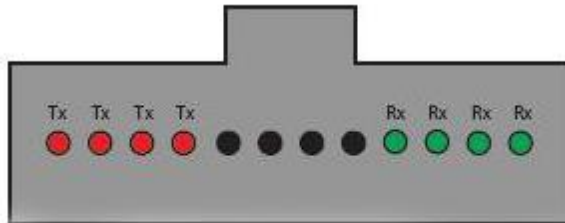
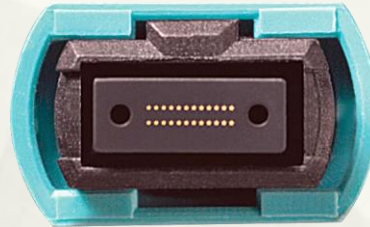
8 Fibers
MPO/MTP Connector



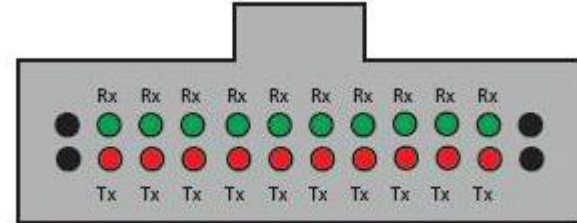
12 Fibers
MPO/MTP Connector



24 Fibers
MPO/MTP Connector



Lane assignments for 100GBASE-SR4, 12-fiber MPO/MTP



Lane assignments for 100GBASE-SR10, 24-fiber MPO/MTP

Connector MPO/MTP

Female MPO Connector



Male MPO Connector



線材接頭

- * 兩端相同
 - * LC + LC
 - * SC + SC
- * 兩端不同
 - * LC + SC
 - * ST + LC
 - * ...

Fiber Patch Panels

配線架/光纖盤

- * FC(Ferrule Connector)
圓型帶螺紋

- * ST(Straight Tip Connector) 圓頭

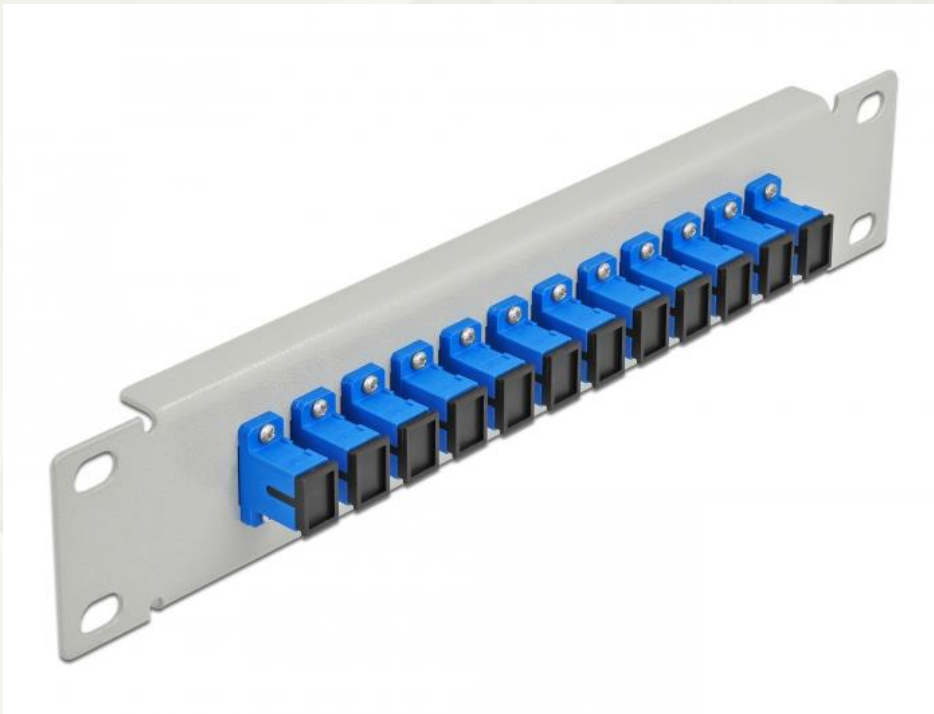


Fiber Patch Panels

配線架/光纖盤/光纖終端箱

* SC(Snap-in Connector)

* LC (Little Connector)



Optics Type/Transceiver Module

光纖收發器

Transceiver Module	Connector
GBIC(Gigabit Interface Converter): 1Gbps	SC、RJ-45
SFP(Small Form Pluggable): 1Gbps (MINI-GBIC) SFP+: 10 Gbps SFP28: 25 Gbps	LC、RJ-45
QSFP(Quad Small Form-factor Pluggable): 4Gbps (4xSFP) QSFP+: 40 Gbps QSFP28: 100 Gbps	LC MPO/MTP
XFP: 10 Gbps (淘汰)	LC
CFP(C Form-factor Pluggable) CFP2/CFP4/CFP8	MPO/MTP

Optics Type/Transceiver

光纖收發器



GBIC

SFP



SFP

XFP



SFP



XFP vs. SFP+



Optical Type	XFP	SFP+
Standard	IEE802.3ae; XFP MSA	IEE802.3ae; SFF-8431; SFF-8432
Publish Time	2002	2006
Size	Bigger	Smaller



SFP



SFP+



XFP



QSFP+

QSFP to 4 x SFP



Connector of QSFP



QSFP+ MTP/MPO :

QSFP-40G85-1M-xx
QSFP-40G85-4M-xx
QSFP-40G-PLRL4-xx
QSFP-40G-PIR4-xx
QSFP-40G-PLR4-xx

QSFP+ LC :

QSFP-40GUNIV-xx QSFP-40G-LR4-xx
QSFP-40G-LRL4-xx QSFP-40GE-ER4-xx
QSFP-40G-IR4-xx QSFP-40G-ER4-xx
QSFP-40GE-LR4-xx

Optics Type/Transceiver

GBIC



1000Base-LX

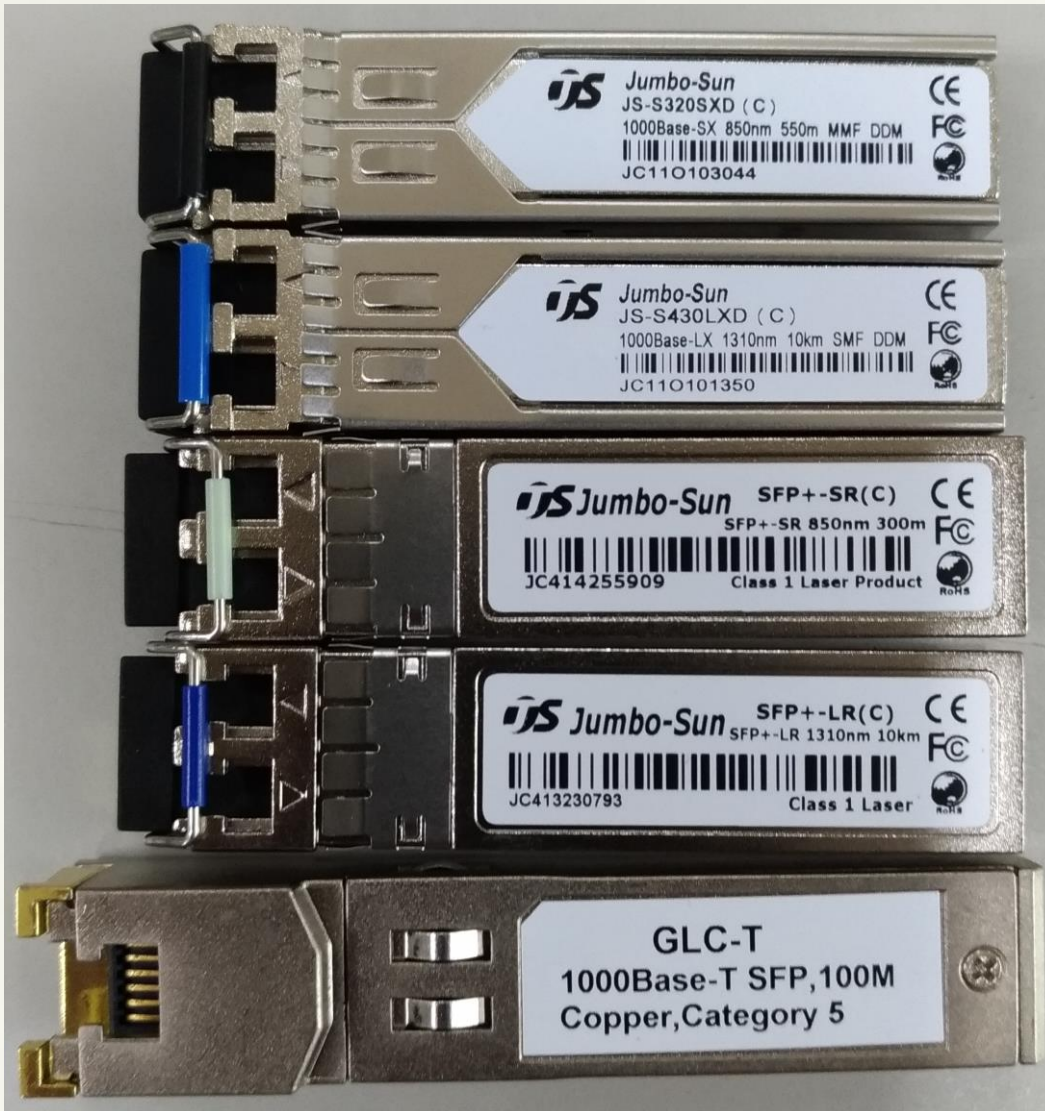
* 1G/1310nm: 淺藍

1000Base-SX

* 1G/850nm: 黑

Optics Type/Transceiver

SFP SFP+



1000Base-SX (SFP)

* 1G/850nm : 黑

1000Base-LX (SFP)

* 1G/1310nm: 淺藍

10GBase-SR (SFP+)

* 10G/850nm: 白

10GBase-LR (SFP+)

* 10G/1310nm: 深藍

1000Base-T (SFP)

* 1G/UTP

Optics Type/Transceiver

SFP SFP+



1000Base-SX (SFP)

* 1G/850nm : 黒

10GBase-LR (SFP+)

* 10G/1310nm: 深藍



特殊規格(高功率)

10GBase-(E)LR (SFP+)

* 10G/1310nm (40km)

100 Gbps CFP/QSFP28



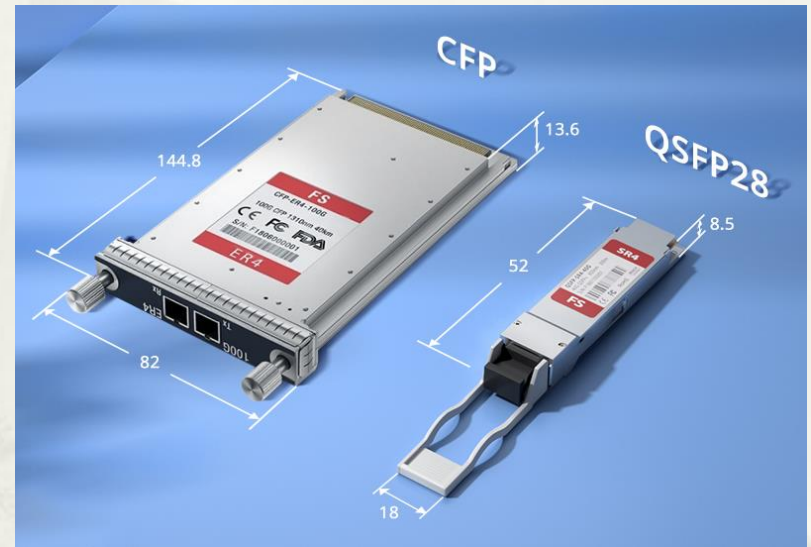
CFP

**10 x 10G lanes
(10Tx 10Rx)**

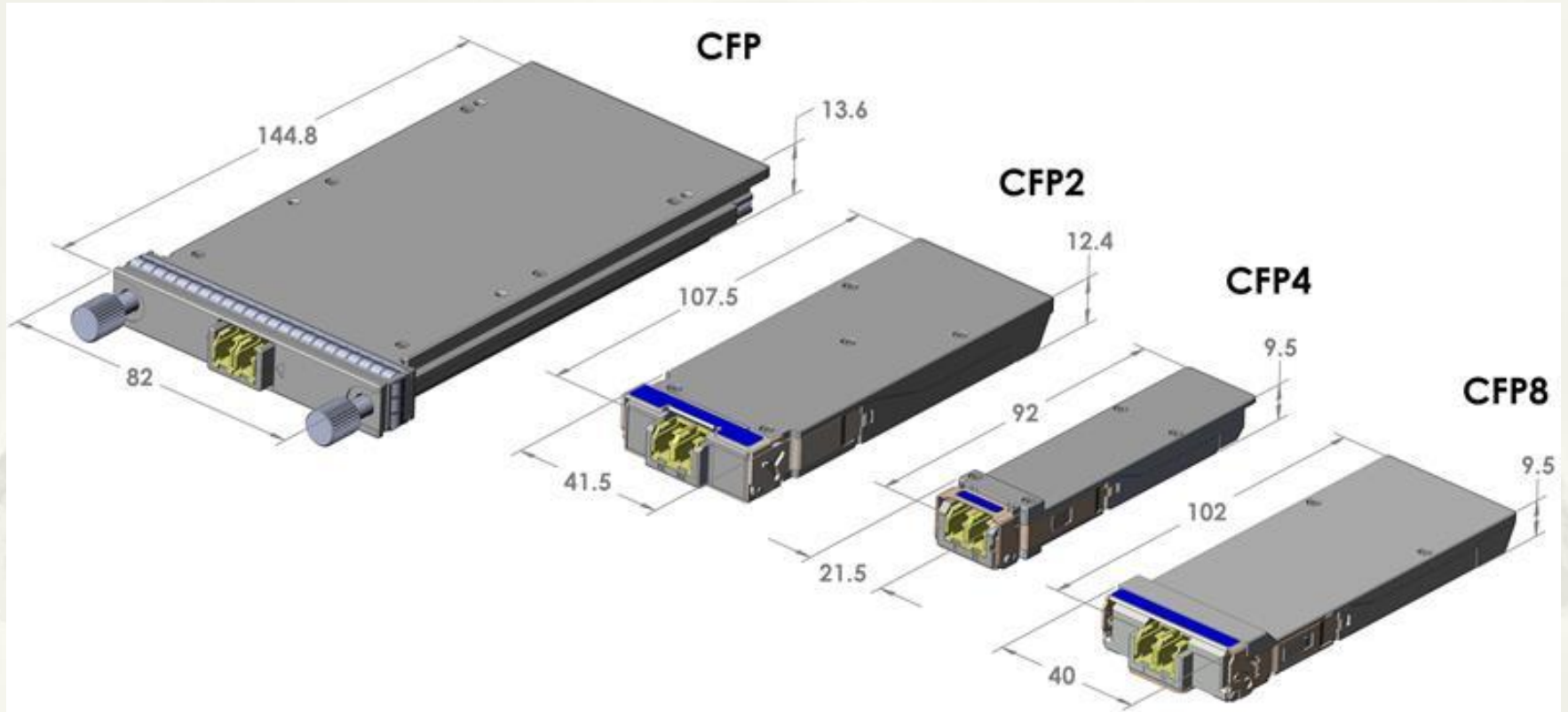


QSFP28

**4 x 25G lanes
(4Tx 4Rx)**



CFP Family



光纖收發器 Transceiver

單模/多模價格比較

2-pack

1000BASE-SX

1 Gbps 多模光纖模組

UACC-OM-MM-1G-D-2

1 Gbps 多模光纖模組是一款雙工光纖收發器，可在長達 550 公尺的距離內提供高達 1.25 Gbps 的傳輸速度。

TWD 599

含加值型營業稅: 約 TWD 29



2-pack

10GBASE-SR

10 Gbps 多模雙工光纖收發模組

UACC-OM-MM-10G-D-2

多模雙工光纖收發模組。

TWD 1,199

含加值型營業稅: 約 TWD 57



有現貨

2-pack

新

1000BASE-LX

1 Gbps 雙向單模光纖模組

UACC-OM-SM-1G-S-2

1 Gbps 雙向單模光纖模組是一款單工光纖收發器，可在長達 3 公里的距離內提供高達 1.25 Gbps 的傳輸速度。

TWD 799

含加值型營業稅: 約 TWD 38



2-pack

新

10GBASE-LR

10 Gbps 單模光纖模組

UACC-OM-SM-10G-D-2

10 Gbps 單模光纖模組是一款雙工光纖收發器，可在長達 10 公里的距離內提供高達 10 Gbps 的傳輸速度。

TWD 2,899

含加值型營業稅: 約 TWD 138



有現貨

<https://tw.store.ui.com/collections/unifi-accessories>

線材/接頭 選擇

- * 線材選擇 Multi-Mode vs. Single-Mode
 - * 傳輸距離: Single-Mode(優)
 - * 線材成本: 差異不大
 - * Transceiver 成本: Multi-Mode(優)
 - * 除非網路設備限制，建議統一使用 Single-Mode
- * Connector 接頭選擇
 - * LC(Little Connector)
 - * MPO/MTP

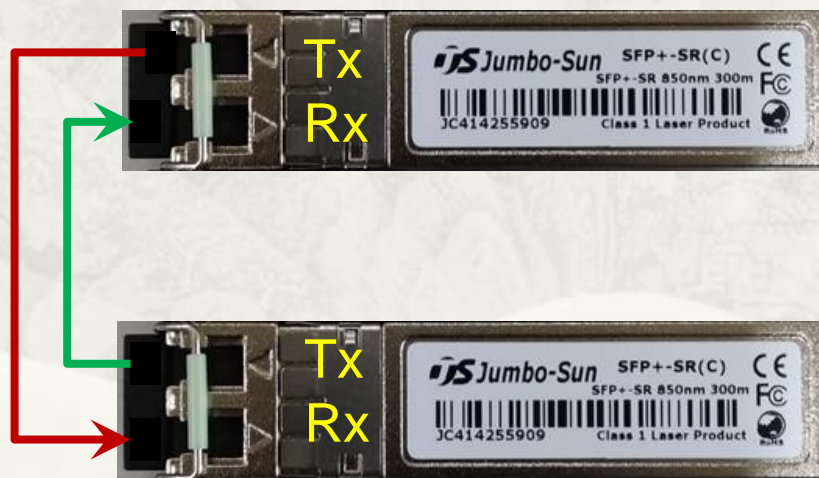
接線方式

- * 設備 to 設備

- * Tx → Rx

- * Rx → Tx

- * Crossover Cable



Patch Cord

A-to-A Fiber Patch Cable

Straight



A-to-B Fiber Patch Cable

Crossover (90%)



Patch Cord

A-A Duplex Patch Cord

Straight



A-B Duplex Patch Cord

Crossover

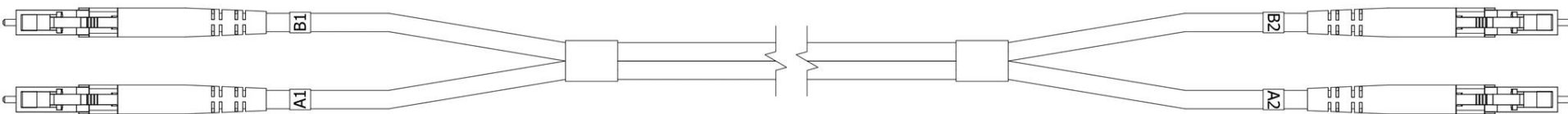


如何區分同一蕊

- * 線材、接頭顏色區分: 不準確

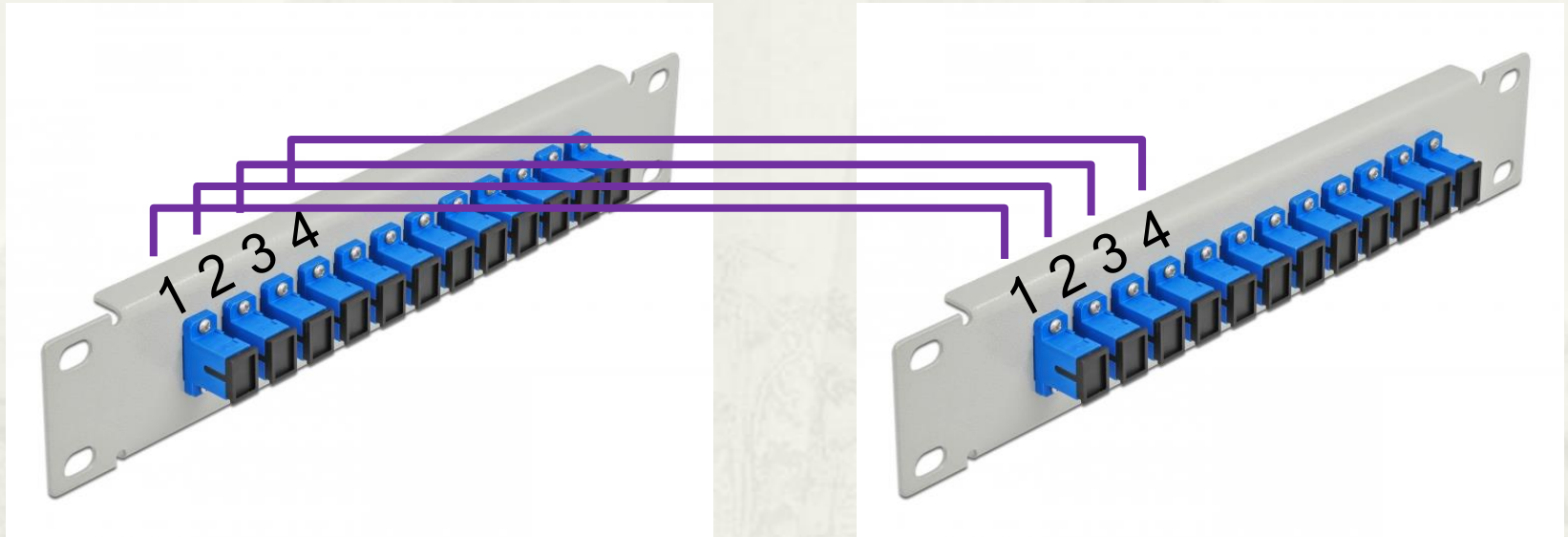


- * A<->A、B<->B、A1<->A2、B1<->B2: 不準確



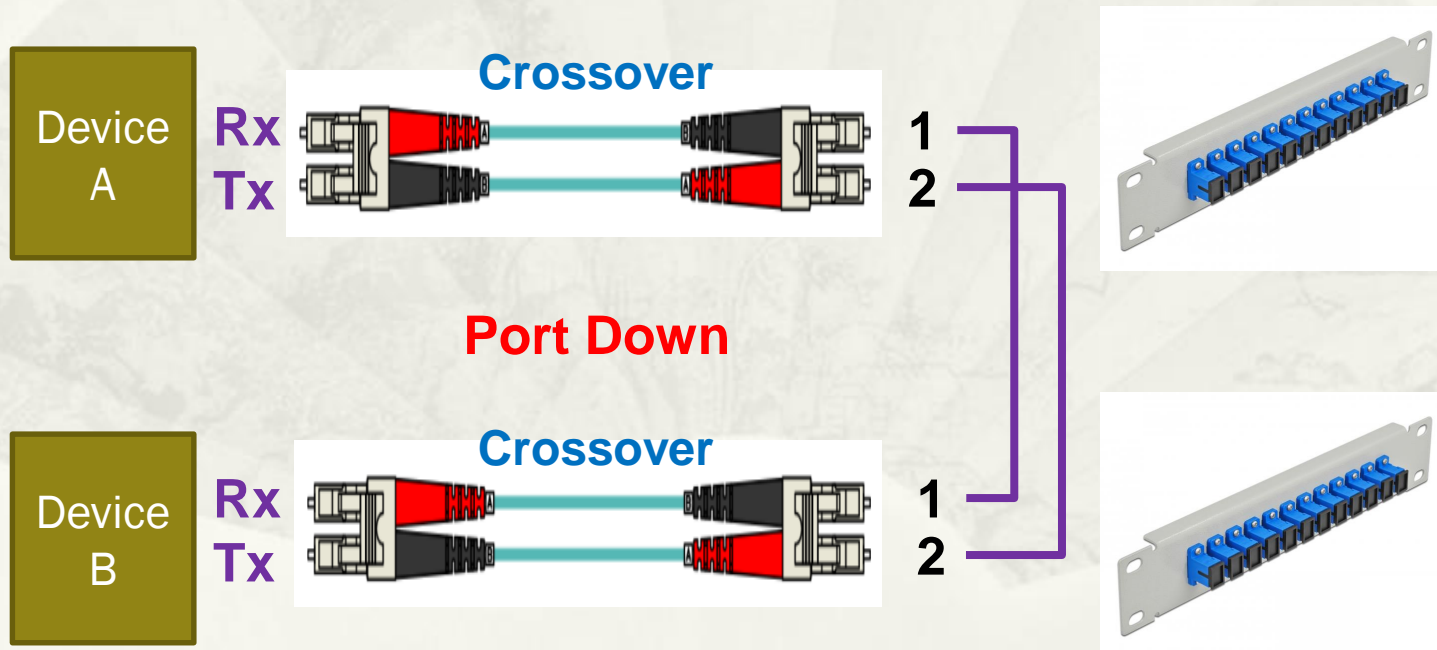
Patch Panel

- * Mapping the Same Number



Fiber Polarity

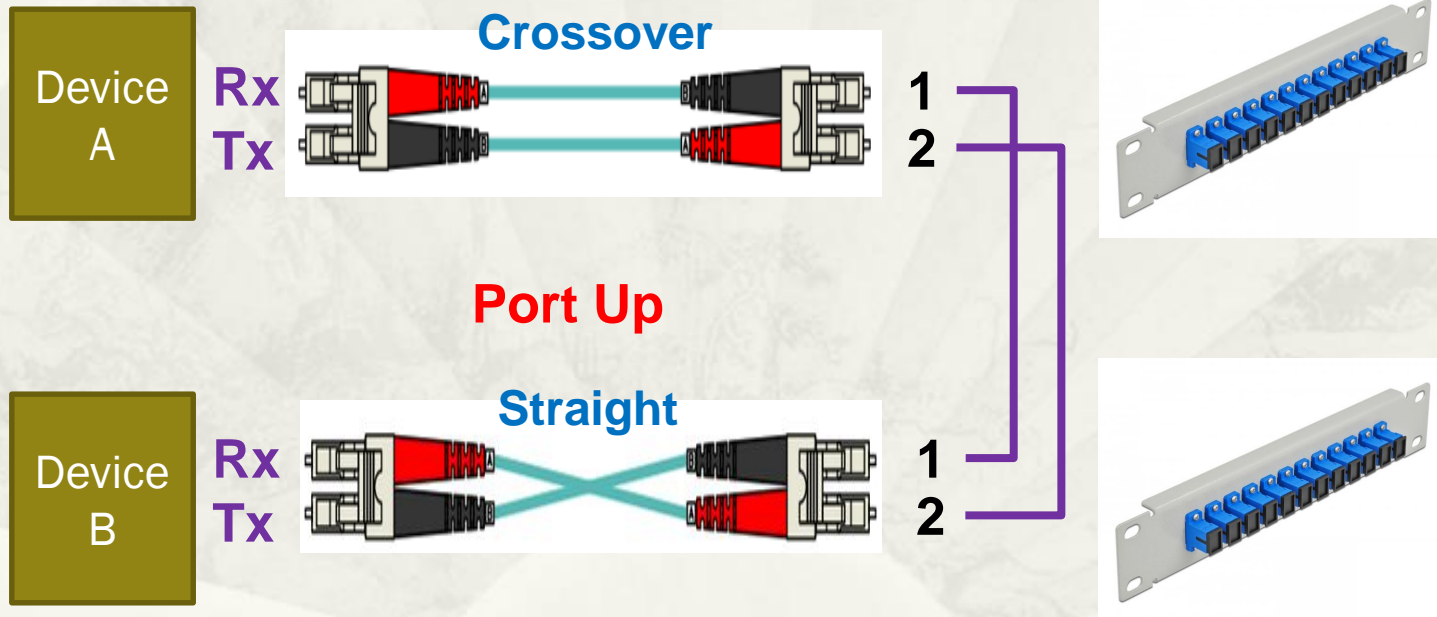
- * 兩台設備經過 Patch Panel 相連
 - * Rx → Rx
 - * Tx → Tx



Fiber Polarity

* Rx → Tx

* Tx → Rx



Type A

(Straight Through)



Side A: 1 2 3 4 5 6 7 8 9 10 11 12
 | | | | | | | | | | | |
 Side B: 1 2 3 4 5 6 7 8 9 10 11 12

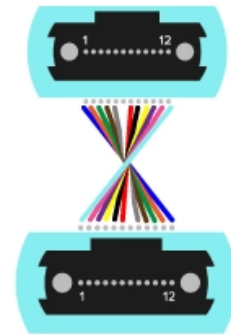


Type B

(Cross)



Side A: 1 2 3 4 5 6 7 8 9 10 11 12
 | | | | | | | | | | | |
 Side B: 12 11 10 9 8 7 6 5 4 3 2 1

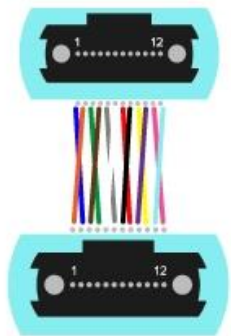



Type C

(Cross Pair)



Side A: 1 2 3 4 5 6 7 8 9 10 11 12
 | | | | | | | | | | | |
 Side B: 2 1 4 3 6 5 8 7 10 9 12 11



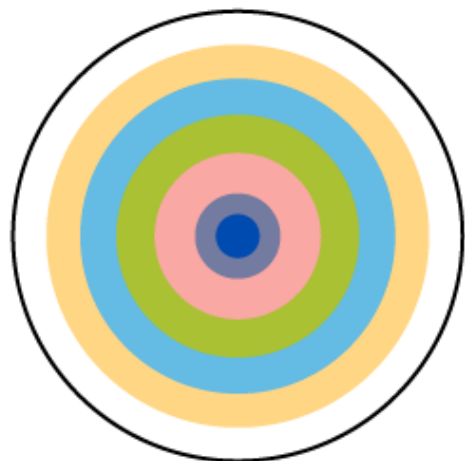


Layer1

Wi-Fi 無線網路

天線種類

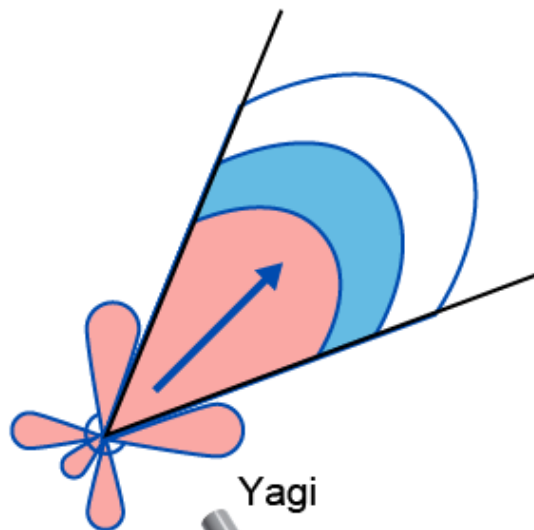
Omnidirectional



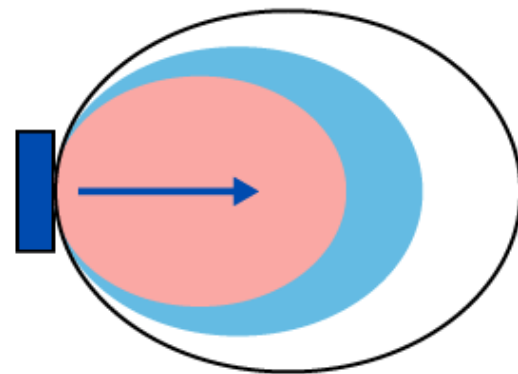
Dipole



Directional



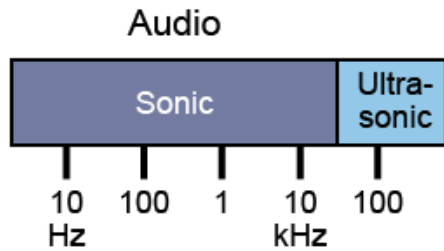
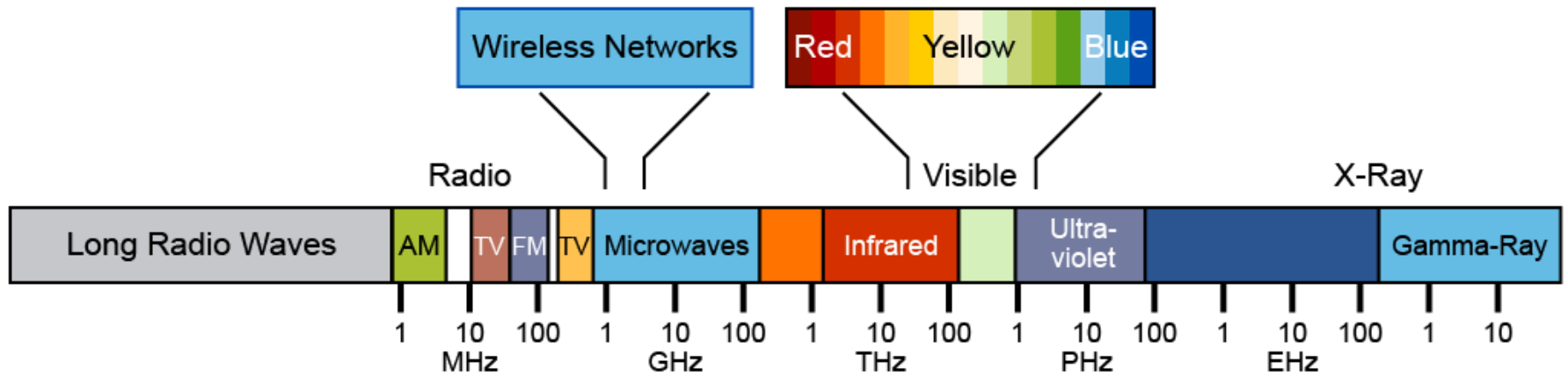
Yagi



Patch



頻譜圖



Wireless networks use RF signals creating electromagnetic waves.

Mechanical Waves

Wi-Fi 世代

Generation	IEEE標準	發佈年份	速率 Mbps	頻率 GHz
Wi-Fi 7	802.11be	(2024)	1376~46120	2.4/5/6
Wi-Fi 6E Wi-Fi 6	802.11ax	2020 2019	574~9608	6 2.4/5
Wi-Fi 5	802.11ac	2014	433~6933	5
Wi-Fi 4	802.11n	2008	72~600	2.4/5
Wi-Fi 3	802.11g	2003	6~54	2.4
Wi-Fi 2	802.11a	1999	6~54	5
Wi-Fi 1	802.11b	1999	1~11	2.4
Wi-Fi 0	802.11	1997	1~2	2.4

無線通訊協定

Wi-Fi 4 Wi-Fi 5 Wi-Fi 6

	802.11a/b/g (Legacy)	802.11n	802.11ac	802.11ax (Wi-Fi 6)
Year Ratified	802.11a/b--1999 802.11g--2003	2009	2013	Draft (Last time this table was updated in early June 2020 Draft was pending final ratification by IEEE).
Frequency band	802.11a--5 GHz 802.11b/g--2.4 GHz	2.4 GHz, 5 GHz	5 GHz	2.4 GHz, 5 GHz
Spatial Streams	N/A	4	8	8
Transmission	802.11b--DSSS 802.11a/g--OFDM	OFDM	OFDM	OFDMA (Orthogonal Frequency Division Multiple Access)
Data rates (Mbps)	802.11b--11 802.11a/g--54	Up to 600	1300—Wave 1 6930—Wave 2	4800—Wave 1 (4 Spatial Streams with 160 MHz channels or 8 Spatial Streams with 80MHz channels)

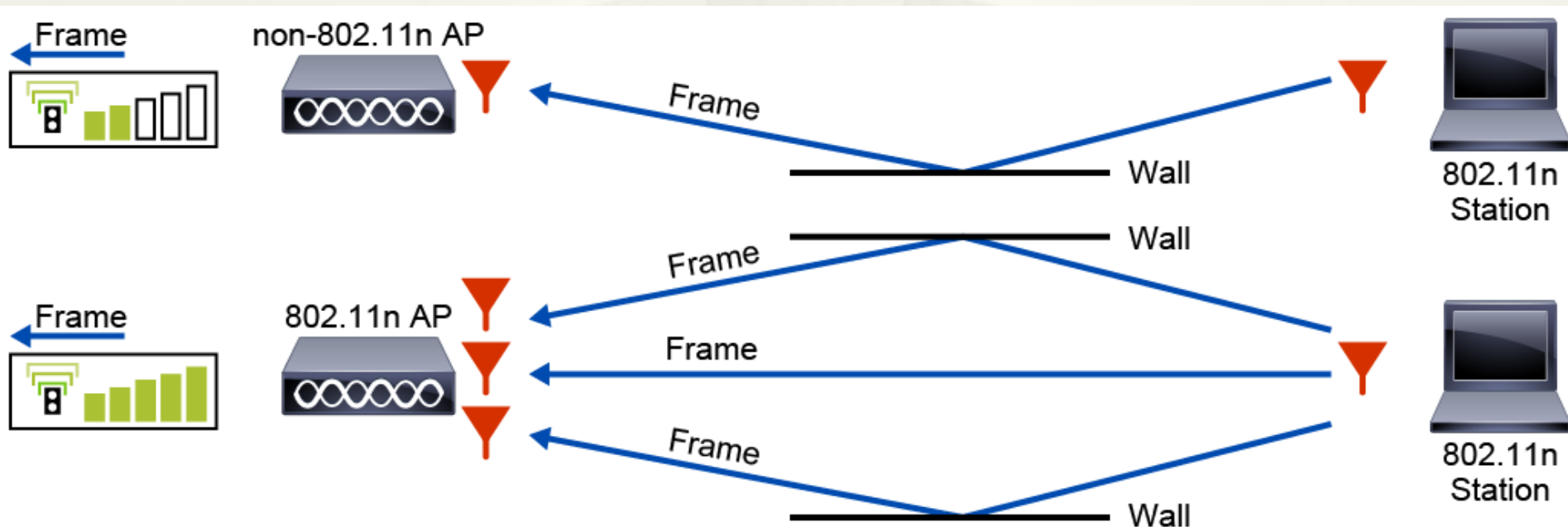
Wi-Fi

New Features

- * 802.11n
 - * MRC(Max Ratio Combine)
 - * Beamforming
 - * Spatial Multiplexing
- * 802.11ac
 - * MU-MIMO (Downlink only)
- * 802.11ax
 - * Uplink MU-MIMO
 - * OFDMA(Orthogonal Frequency Division Multiple Access)

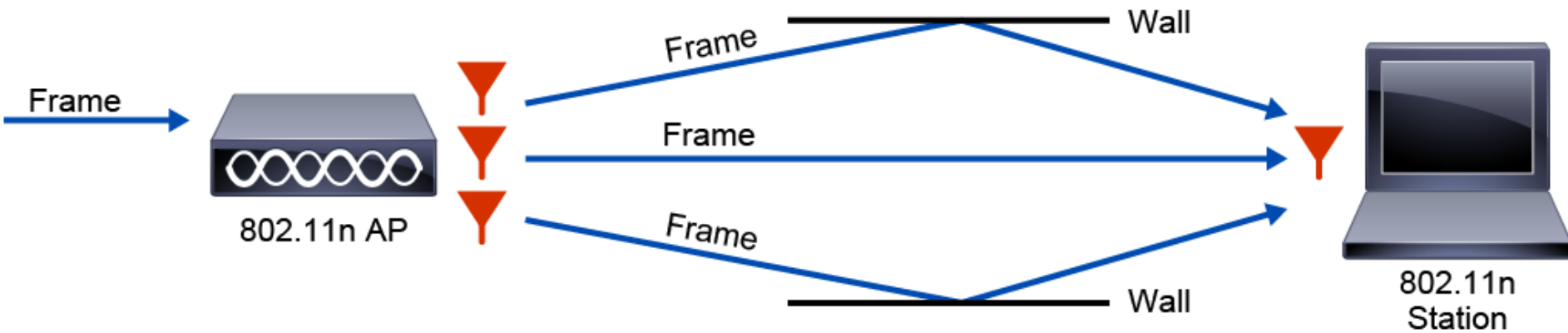
802.11n

MRC(Max Ratio Combine)



Combines energies on receiver side using multiple antennas.

802.11ac Beamforming

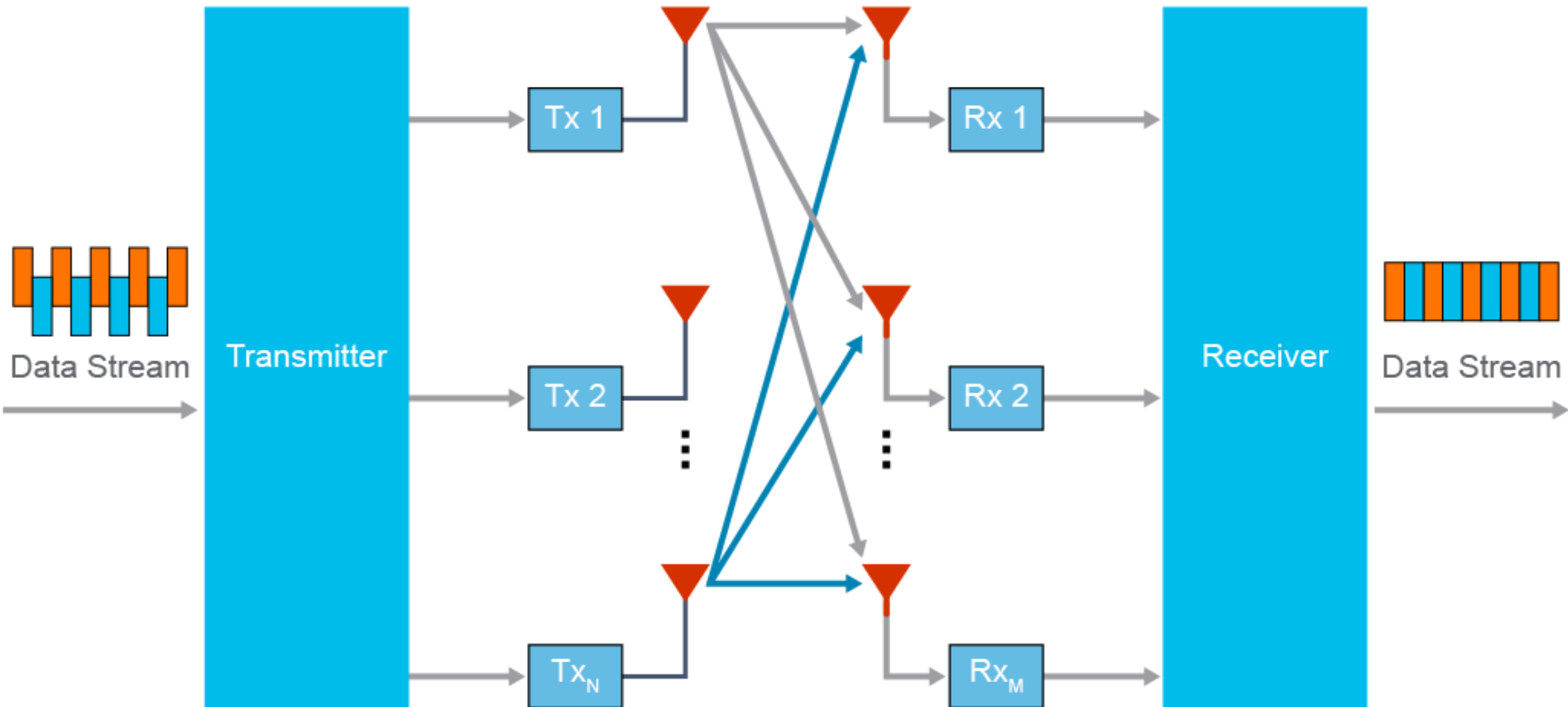


Separates energies on transmitter side using multiple antennas.

802.11n

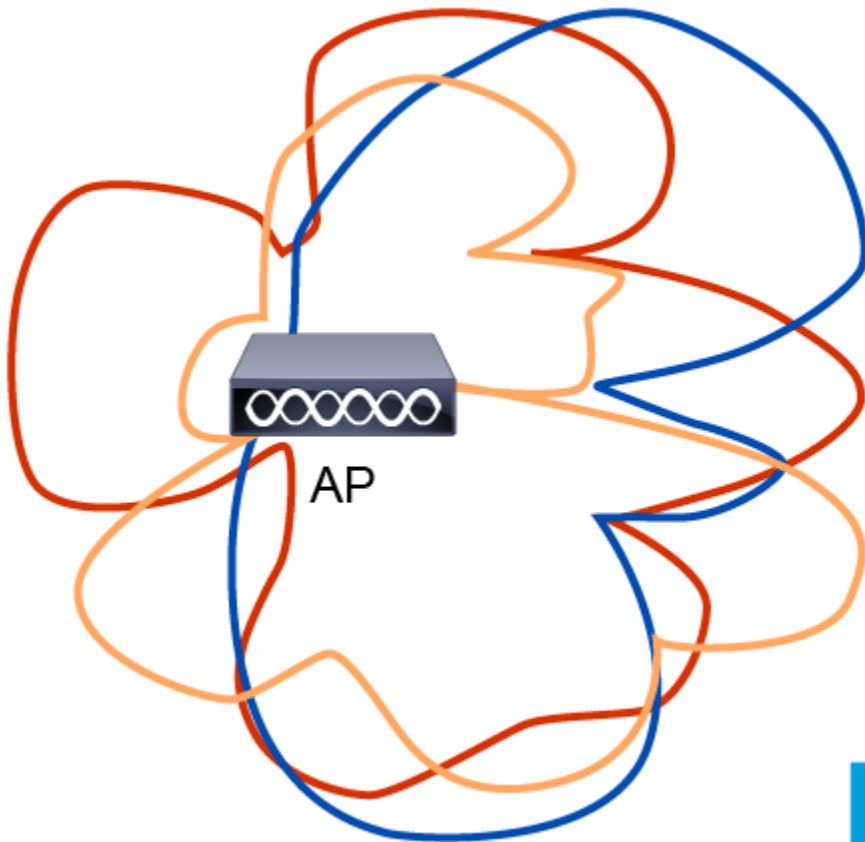
Spatial Multiplexing

* 收、發皆須多天線



802.11ac

MU(Multiple User)-MIMO



Multiple antennas transmit multiple frames to different clients.

802.11ax

- * Uplink MU-MIMO
 - * 802.11ac 僅支援 Download
 - * 802.11ax 支援 Upload/Download

802.11ax

OFDMA(Orthogonal Frequency Division Multiple Access)

802.11ac | without OFDMA



802.11ax | OFDMA

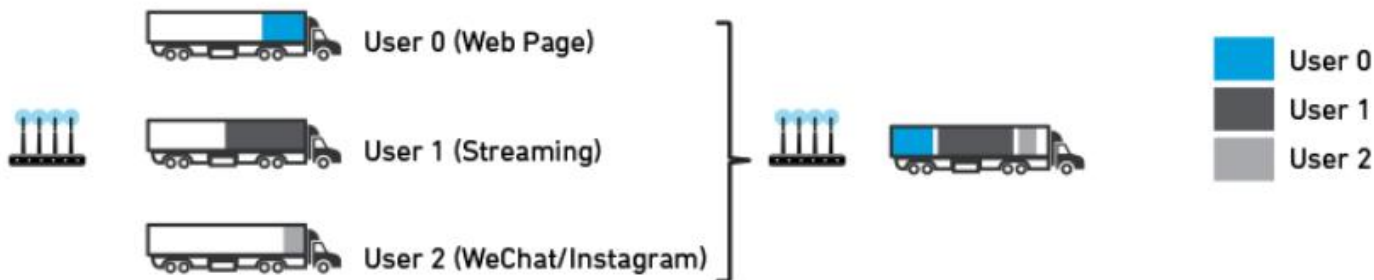
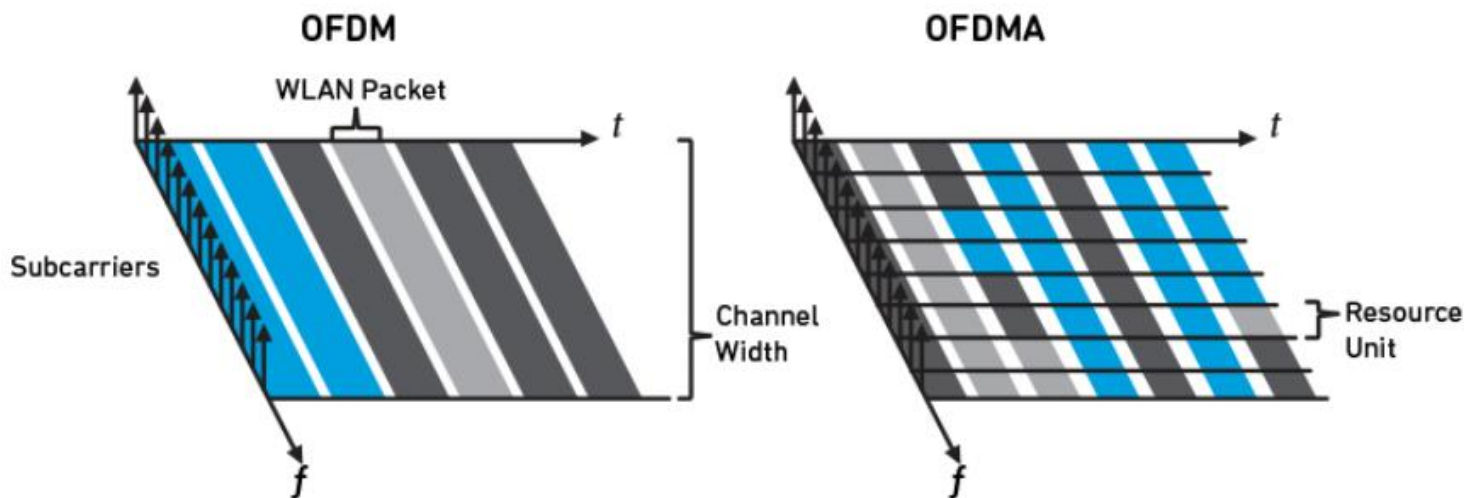


圖片來源: <https://www.tp-link.com/tw/blog/245/>

802.11ax

OFDMA(Orthogonal Frequency Division Multiple Access)

802.11ac vs. 802.11ax: Fixed Overhead vs. Efficient Payload Delivery



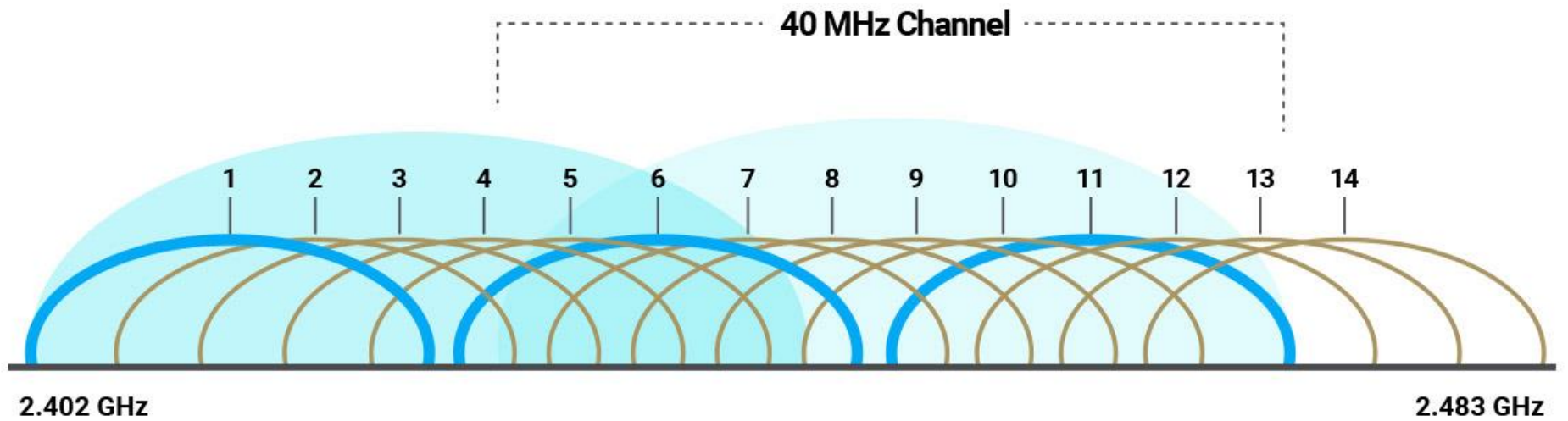
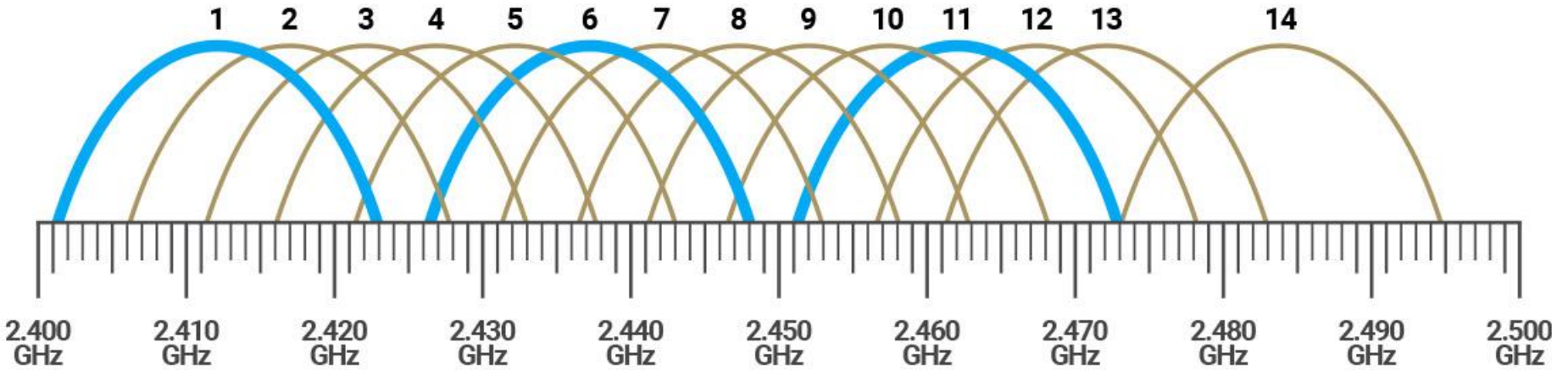
QORVO

Source: Qualcomm
©2017 Qorvo, Inc.

以往一輛貨車載不滿，但 OFDMA 就可在同一輛車載不同用戶的貨物，更善用資源。 Source : Qorvo / Qualcomm

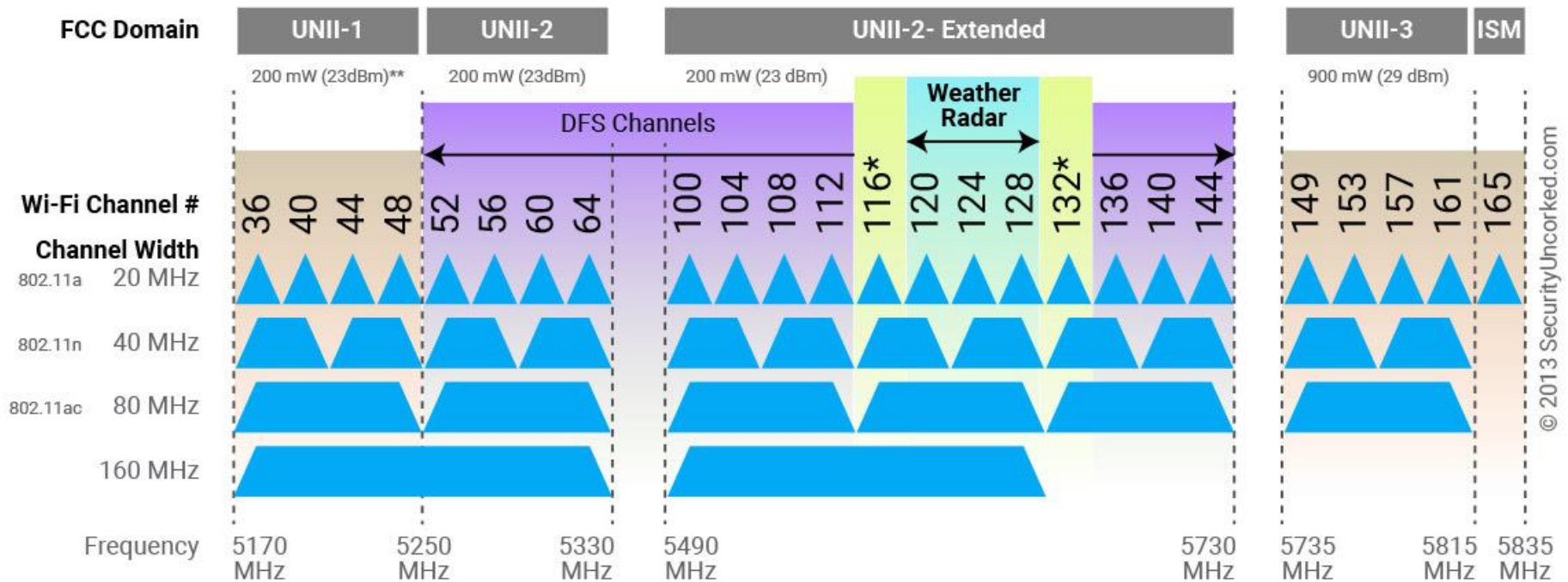
圖片來源 <https://www.wpgdadatong.com/tw/blog/detail/40617>

2.4G 頻寬



5G 頻寬

802.11ac Channel Allocation (N America)



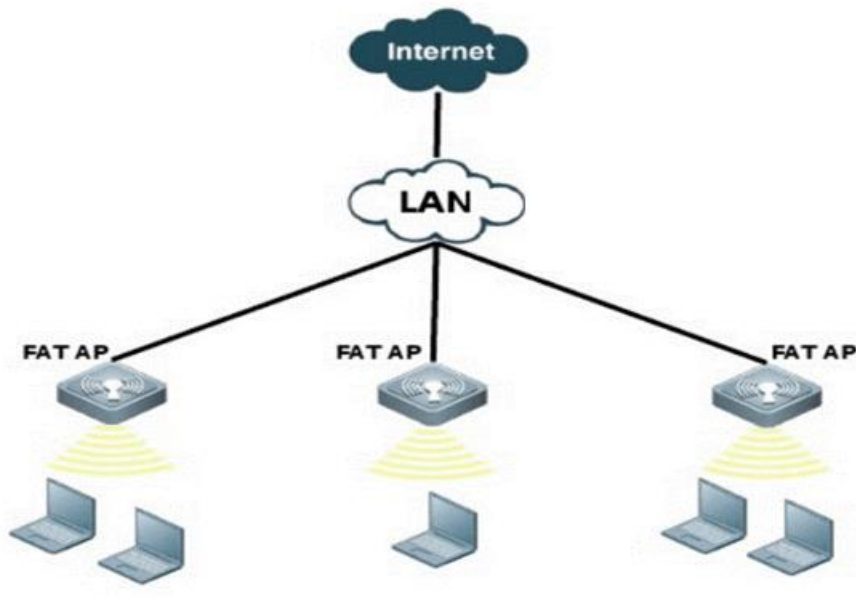
*Channels 116-144 used for Doppler radar. Channel 132-144 not yet available in USA
 **Allowed Power for UNII-1 band increased by FCC from 40 mW to 200 mW in 2014

© 2013 SecurityUncorked.com

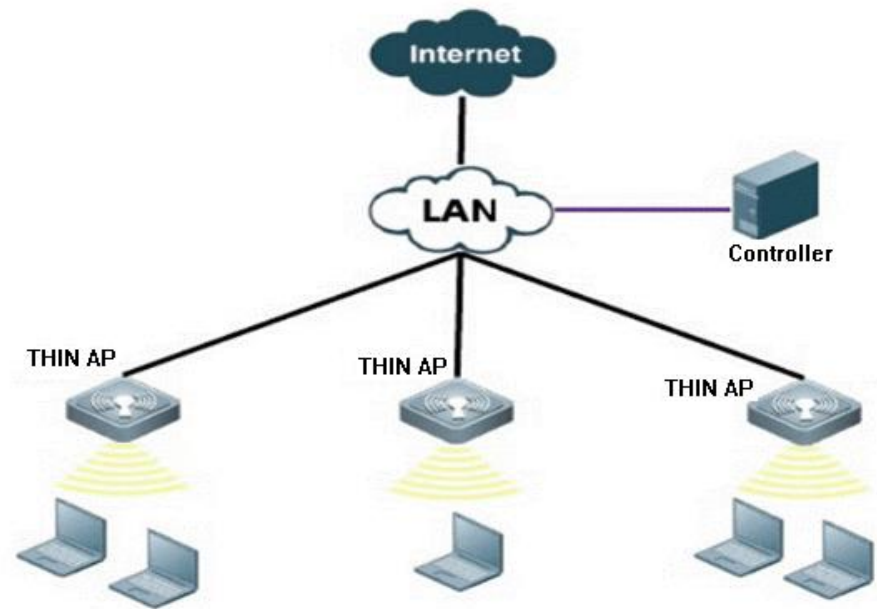
<https://www.engeniustech.com/go-guide-channel-transmit-power-wi-fi-networks-2/>

THIN AP vs. FAT AP

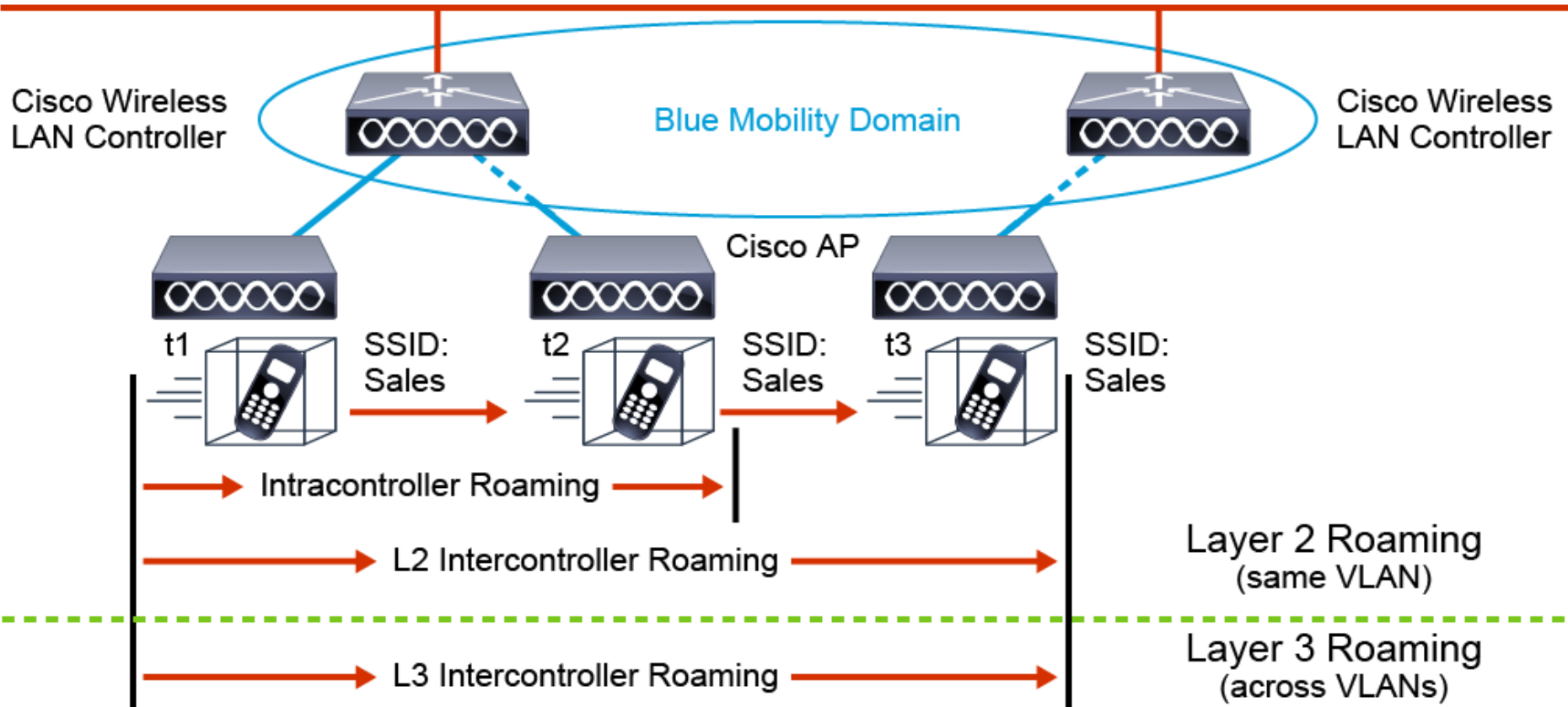
FAT AP
(No Controller)



THIN AP

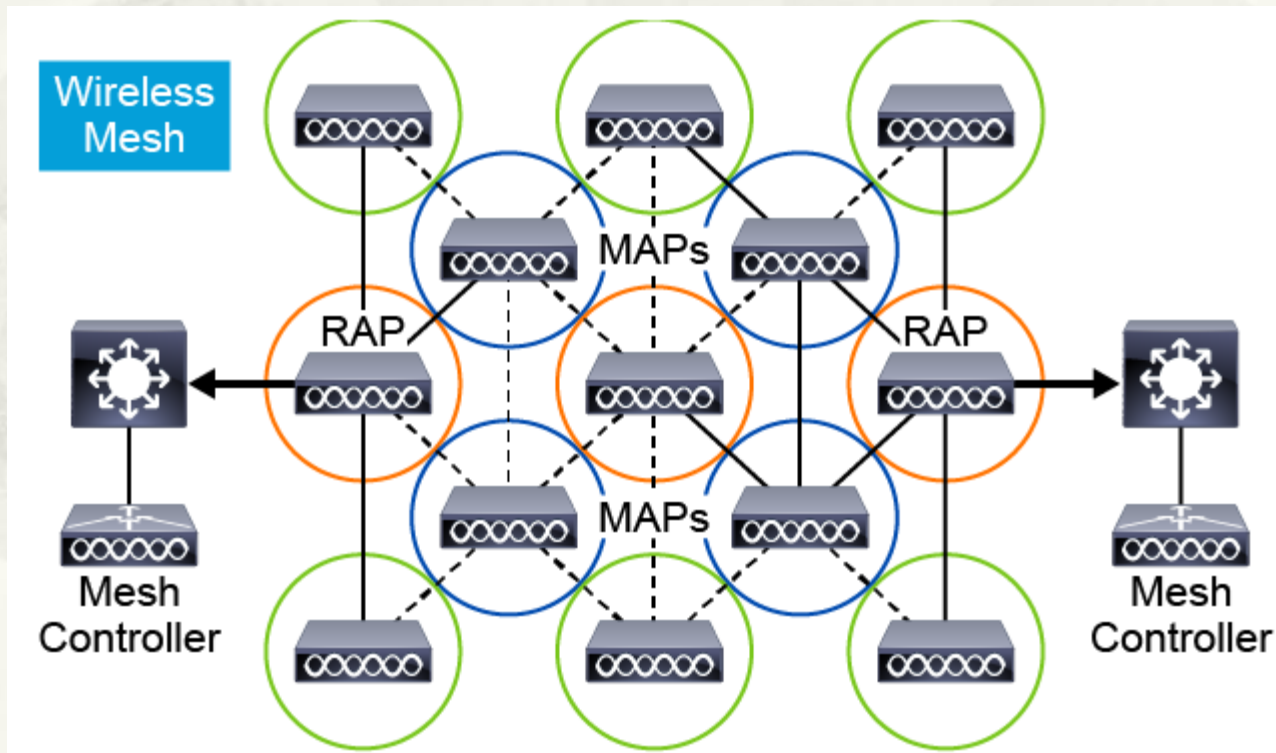


無線漫遊 Roaming



Mesh

- * RAP: Root AP (Wired)
- * MAP: Mesh AP (Non-wired)



TANet 漫遊中心認證服務

- * TANetRoaming 分別由國家高速網路中心以及資訊策進會介接教育單位、非營利組織和政府組織帳號，與漫遊中心建立帳號交換漫遊認證機制，讓所有使用TANet 網路單位的老師、研究員、學生和政府官員都可以持單一帳號，以跨區認證方式享受與所屬單位相同的上網環境。後來統一名稱為TANetRoaming，主要認證方式是網頁認證。
- * eduroam 為建立國際教育及科研機構間無線區域網路漫遊體系的計畫，意在推動全球教育及科研單位之間的無線區域網路服務共享。主要認證方式是EAP-802.1X認證。

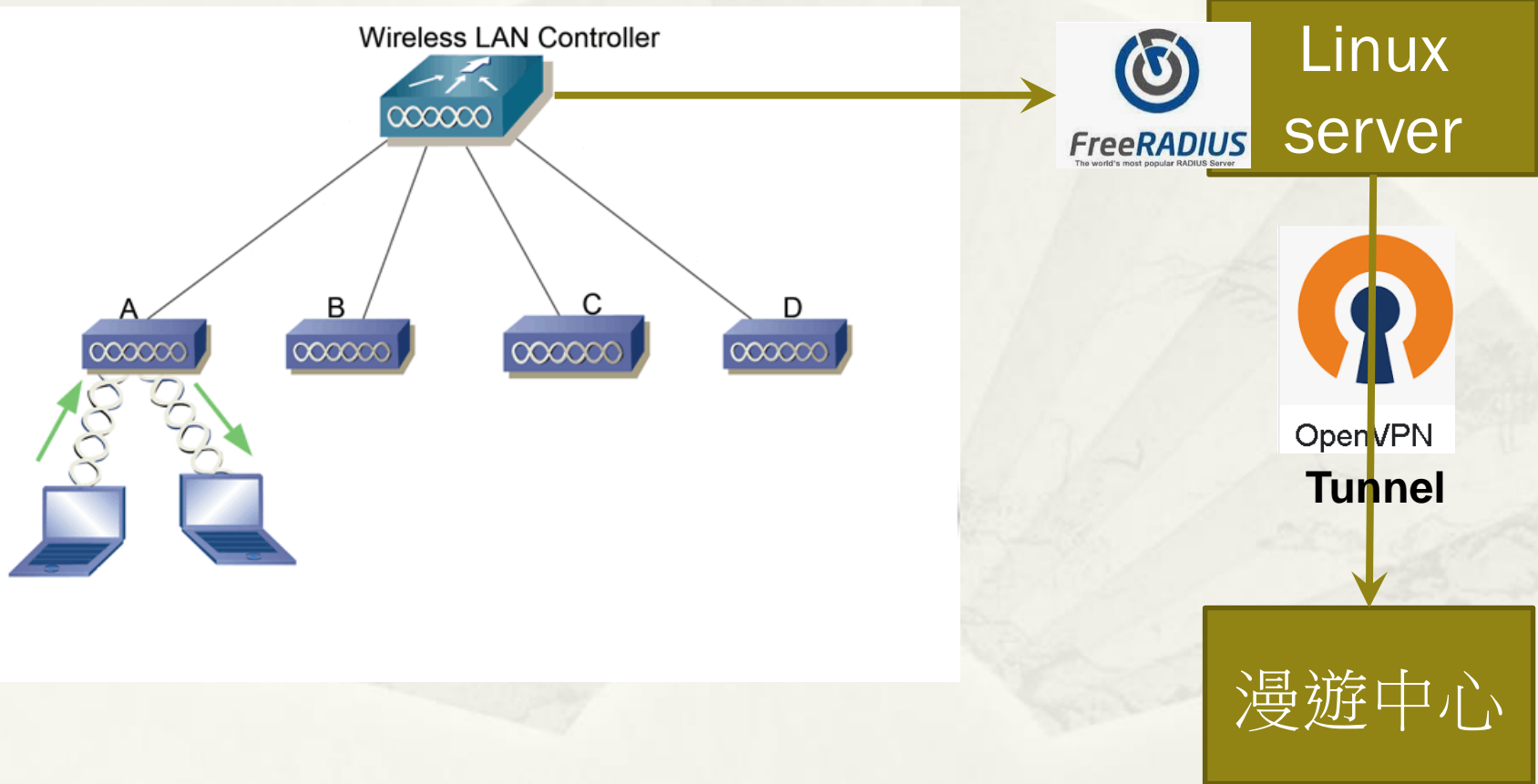
TANetRoaming 明碼傳輸(不安全)

```
Auth: Login OK: [0932363049@itw/38[REDACTED]55] (from client hccvs port 0 cli  
Auth: Login OK: [0975522750@itw/j[REDACTED]51] (from client cyut port 0 cli 40  
Auth: Login OK: [REDACTED]@eduroam.ntnu.edu.tw/<via Auth-Type = Accept>] (fr  
Auth: Login OK: [REDACTED]@eduroam.sinica.edu.tw/<via Auth-Type = Accept>] (  
Auth: Login OK: [0901090339@itw/as[REDACTED]3] (from client chna port 0 cli D  
Auth: Login OK: [0976423308@itw/i[REDACTED]5] (from client tp port 0 cli 04-C  
Auth: Login OK: [0978239845@itw/lo[REDACTED]45] (from client ccivs port  
Auth: Login OK: [0978708542@itw/lo[REDACTED]42] (from client ccivs port 0 c  
Auth: Login OK: [0975636482@itw/s[REDACTED]3] (from client ccivs port 9 cli  
Auth: Login OK: [0903413155@itw/a[REDACTED]40] (from client ccivs port 13  
Auth: Login OK: [0980897684@itw/mn[REDACTED]78] (from client ccivs port 2 cl  
Auth: Login OK: [0989245966@itw/q[REDACTED]9] (from client ccivs port 8 cli  
Auth: Login OK: [0905128061@itw/a[REDACTED]3] (from client ccivs port 4 cli 9  
Auth: Login OK: [0975395252@itw/Q[REDACTED]30] (from client ccivs port 5 cl  
Auth: Login OK: [0965493024@itw/l[REDACTED]2] (from client ccivs port 6 cli  
Auth: Login OK: [0975622239@itw/qw[REDACTED]009] (from client ccivs port  
Auth: Login OK: [0968322341@itw/a0[REDACTED]3] (from client ccivs port 11  
Auth: Login OK: [0920308817@itw/B[REDACTED]7] (from client tp port 0 cli D4-
```


TANetRoaming 淘汰時程

- * 依照「第96次技術小組會議」建議
- * 報告事項第二點：
- * (二) 臺灣學術網路(TANet)無線網路漫遊服務及全面改用 eduroam 為認證機制進度報告。
- * 決定
 - * 考量 TANetRoaming 以明碼儲存密碼且左空位刪除，系統連線與密碼收發均無加密，請各單位儘速將認證服務升級至 eduroam。目前結束TANetRoaming尚未訂出時程
區網中心期中或期末會議討論 預計大專院校民國111年底要完成100%
預計高中職民國112年底要完成100%
 - * TANetRoaming 將俟全國各級學校完成eduroam，可以保留TANetRoaming服務
惟學校或縣市教育網路中心若完成eduroam，可以移除TANetRoaming服務
 - * 請各區網中心、縣市教育網路中心協助無線漫遊中心推動eduroam，並調查轄下各大專院校、高中職無線網路升級eduroam意願及系統架構，於彙整後提供無線漫遊中心。
 - * 請無線漫遊中心持續更新eduroam相關建置指引及辦理教育訓練，協助各區網中心了解eduroam 技術，俾利區網中心輔導轄下各校解決 eduroam 問題。另請無線漫遊中心參加 ISAC 所辦理之交流會議，宣導 eduroam 建置事宜。

漫遊中心認證網路架構

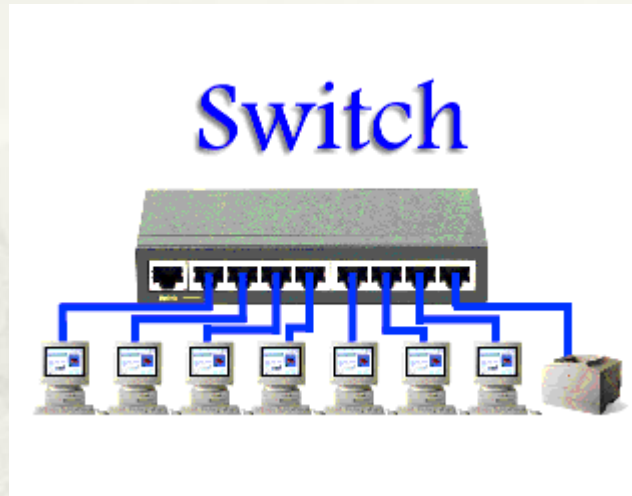


Layer2 Switch 交換器

Forwarding Packets
(不更改封包)

Switch vs. Hub

* Switch



MAC addr Table

```
R1G_3750#sh mac address-table
Mac Address Table
-----
```

Vlan	Mac Address	Type	Ports
1	0007.1d11.0d2c	DYNAMIC	Gi2/0/4
1	000b.ab88.bfbe	DYNAMIC	Gi2/0/24
1	000e.e300.3fd7	DYNAMIC	Gi2/0/14
1	000e.e306.0a97	DYNAMIC	Gi2/0/14
1	0011.140d.c7f7	DYNAMIC	Gi2/0/24
1	0011.1411.c5e9	DYNAMIC	Gi2/0/24
1	0017.42c9.ee5a	DYNAMIC	Gi2/0/5
1	0017.4f13.ee7b	DYNAMIC	Gi2/0/15
1	0017.4f14.dc68	DYNAMIC	Gi2/0/15
1	0019.067a.c002	DYNAMIC	Gi2/0/2
1	0019.067a.c040	DYNAMIC	Gi2/0/2
1	0019.067a.cf02	DYNAMIC	Gi2/0/3

* Hub



no MAC addr Table

* Ref <http://www.fiber-optic-solutions.com/buy-ethernet-switch-hub.html>

無網管 vs. 有網管 Switch

* 無網管 Switch



- * 一般家用
- * Plug & Play

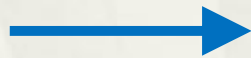
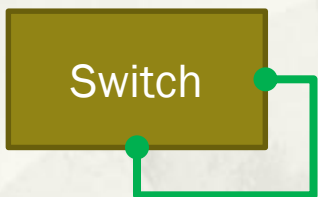
* 有網管 Switch



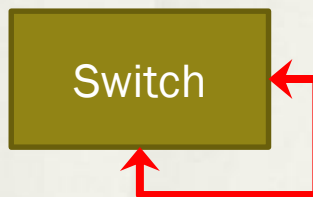
- * 提供設定畫面
 - * CLI or Web
- * 功能
 - * Spanning-tree
 - * VLAN & Trunk
 - * SNMP

Spanning-Tree 防止 Loop

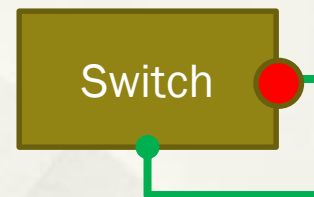
* Loop Case1



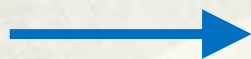
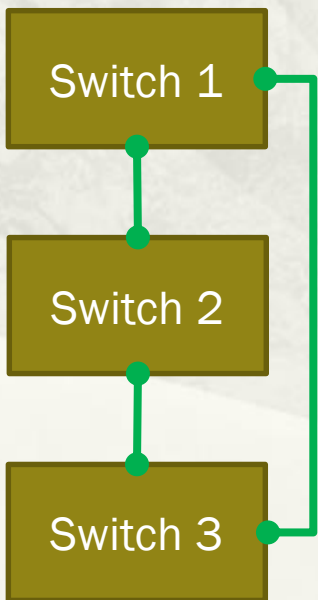
無網管



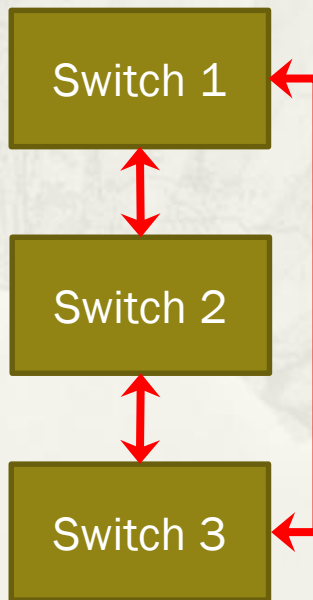
有網管



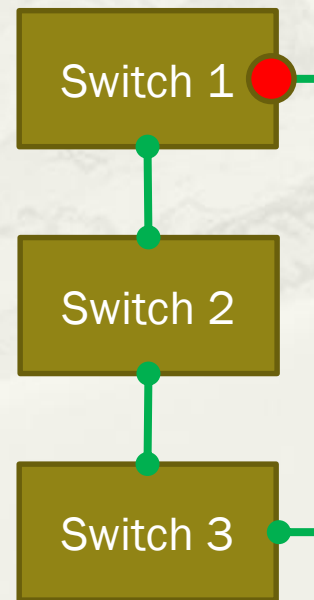
* Loop Case2



Loop 網路癱瘓

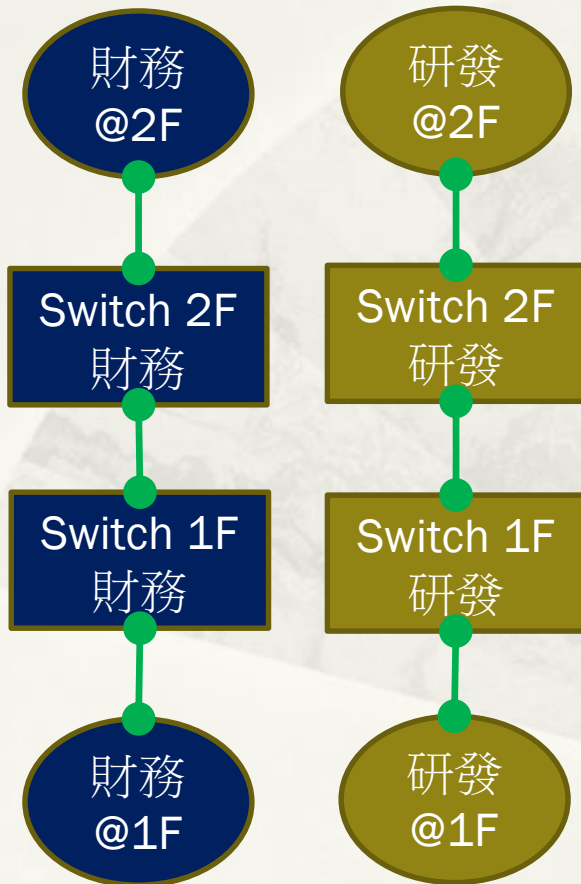


自動 Block 網路正常

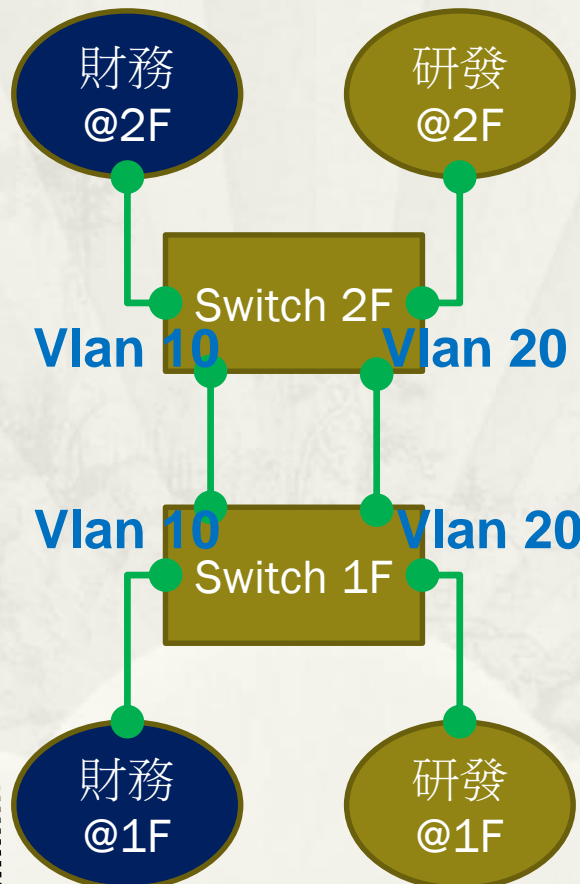


VLAN & Trunk

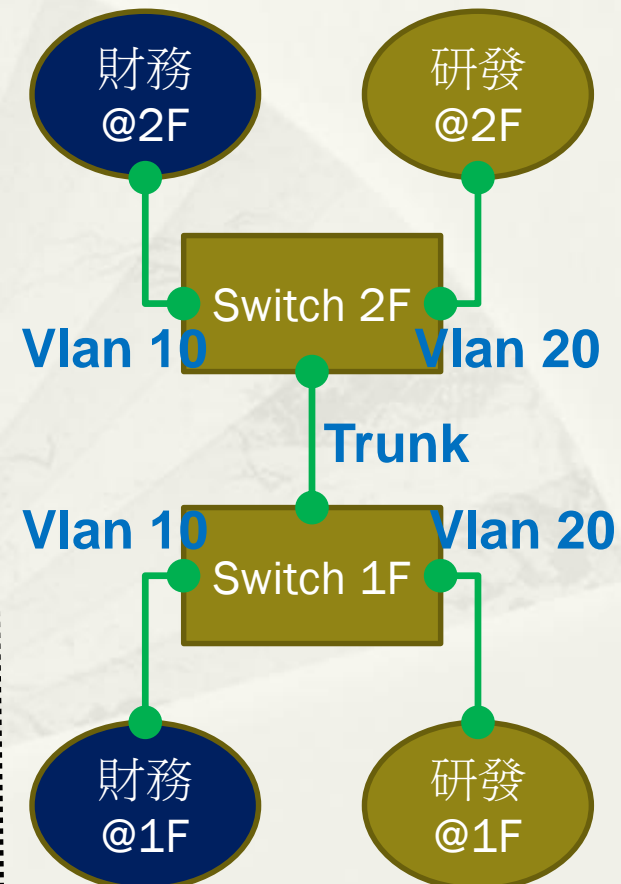
無網管 Switch



有網管 Switch



有網管 Switch



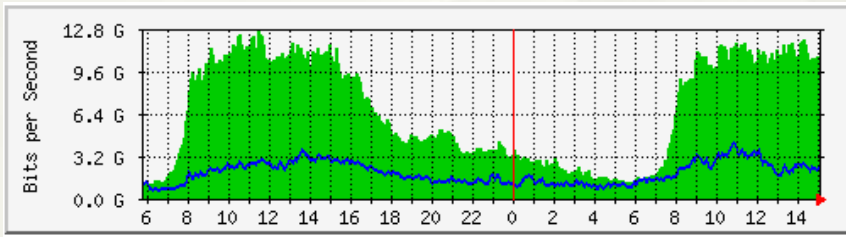
SNMP Protocol

- * 用於收集網路設備之網管資訊，例如各裝置的資料傳輸率、例外事件等
- * 版本
 - * v1: 32bit counters
 - * v2c: 64bit counters, get-bulk, inform
 - * v3: 支援用戶登入的安全機制
- * UDP port:
 - * 161: 監聽，等待接受管理者發送之查詢請求。
 - * 162: SNMP Trap，設備主動發送異常事件。

SNMP 監控圖表

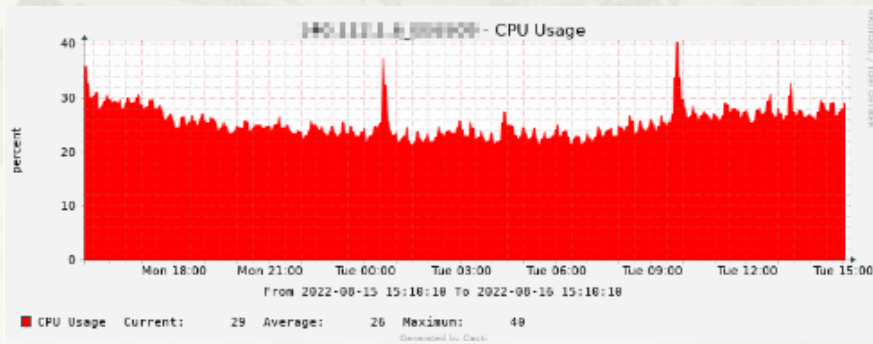
* MRTG

流量監控

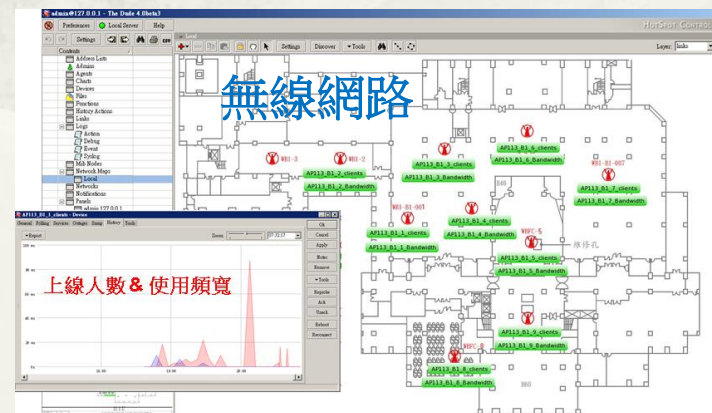
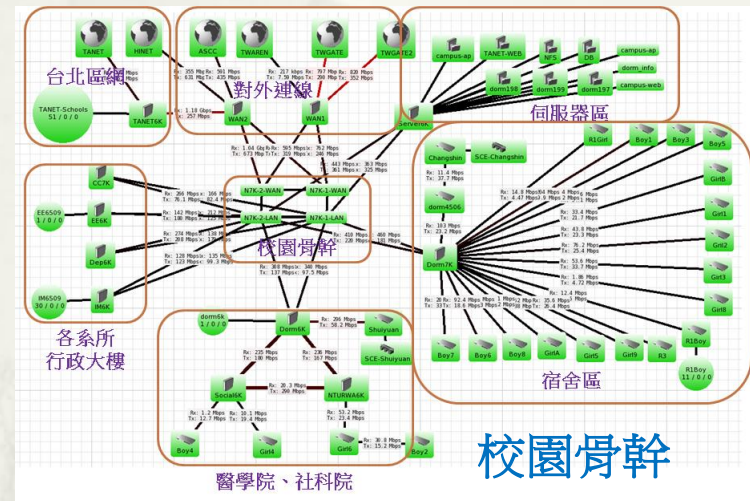


* Cacti

CPU 監控



* The Dude



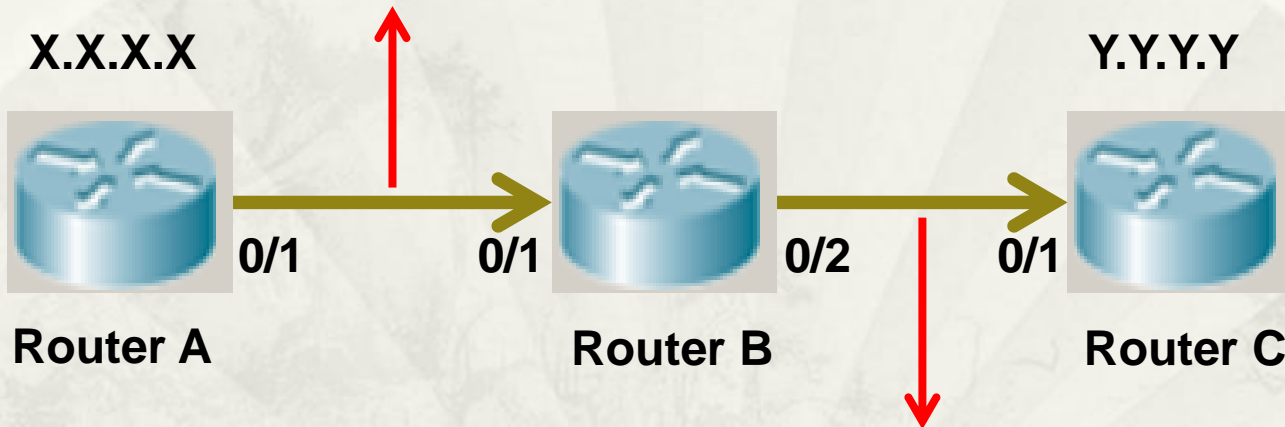
Layer3 Router 路由器

Routing
(會更改封包)

Routing

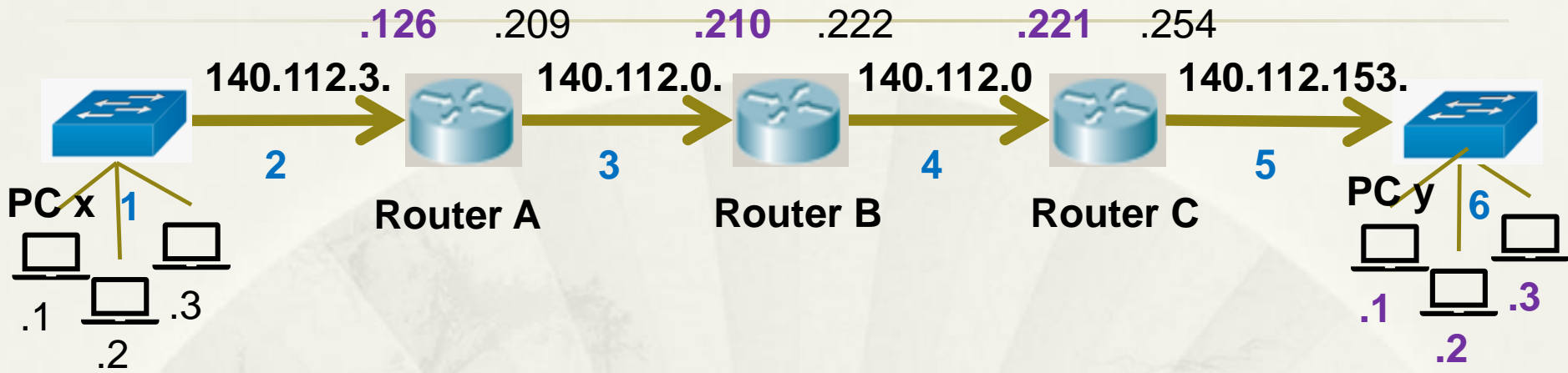
會更改封包

Src IP	Dest IP	Src Mac	Dest Mac	Time to Live
X.X.X.X	Y.Y.Y.Y	RouterA G0/1	RouterB G0/1	125




Src IP	Dest IP	Src Mac	Dest Mac	Time to Live
X.X.X.X	Y.Y.Y.Y	RouterB G0/2	RouterC G0/1	124

Routing & Switching 封包變化

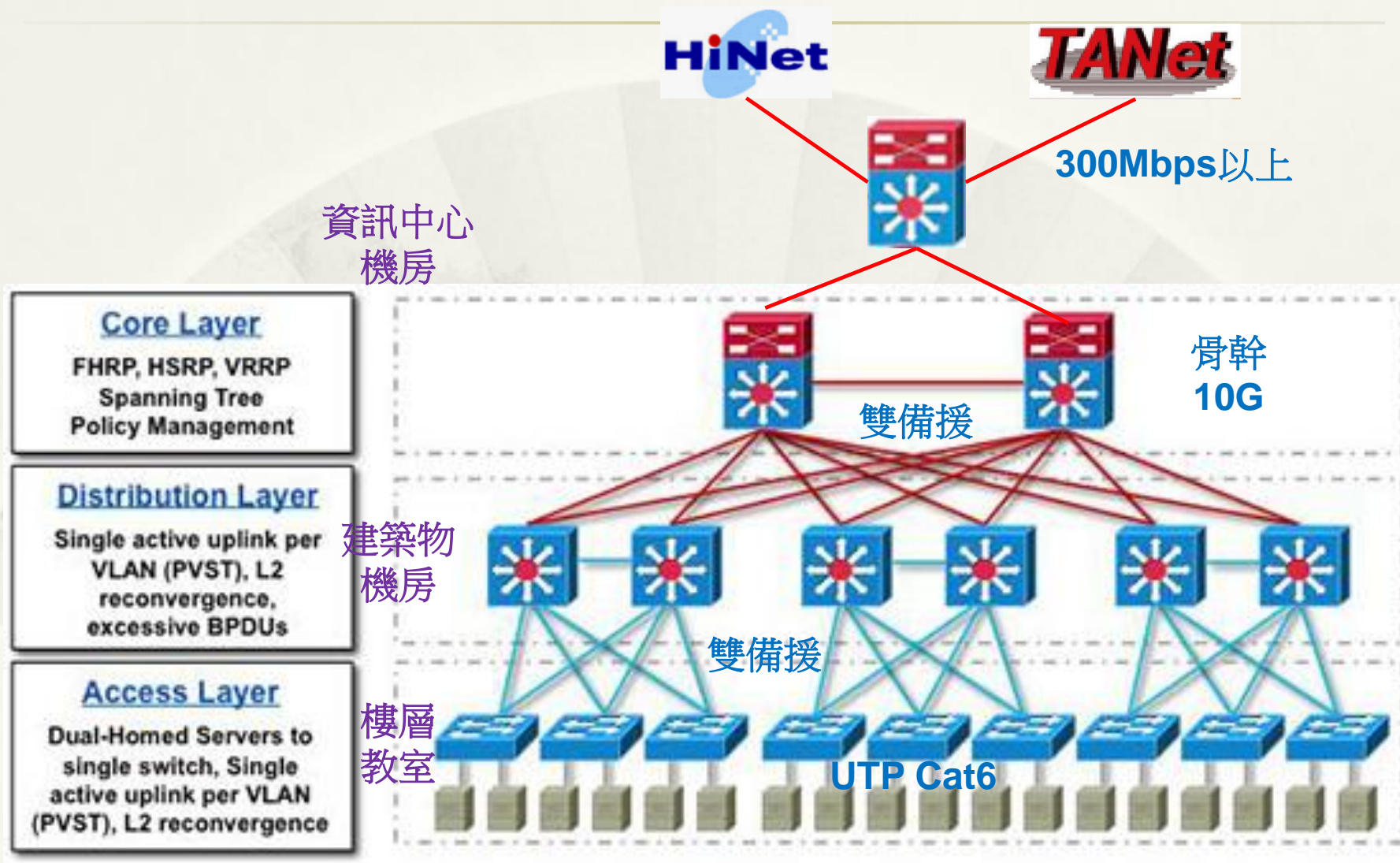


1 2	Src IP	Dest IP	Src Mac	Dest Mac	Time to Live
	PC x	PC y	PC x	RouterA .126	128
3	Src IP	Dest IP	Src Mac	Dest Mac	Time to Live
	PC x	PC y	RouterA .209	RouterB .210	127
4	Src IP	Dest IP	Src Mac	Dest Mac	Time to Live
	PC x	PC y	RouterB .222	RouterC .221	126
5 6	Src IP	Dest IP	Src Mac	Dest Mac	Time to Live
	PC x	PC y	RouterC .254	PC y	125



機房網路規劃 經驗分享

網路架構



Vertical vs. Horizontal Slot

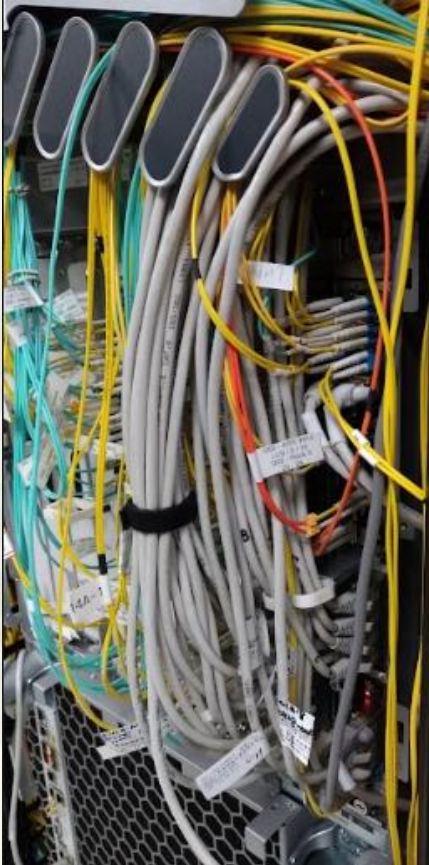
Vertical Slot



Horizontal Slot



Vertical Slot Issues



- * 當線路太多
- * 改接困難

線長 Issue

* 理線槽



* 線長留剛好就好



結論與建議

- * 通訊協定Layer1 - 電
 - * Cat 6 , 6a 以上
- * 通訊協定Layer1 - 光
 - * 線材: Single Mode
 - * 介面: LC
- * 通訊協定Layer1 - 無線
 - * WiFi 6 以上
- * 通訊協定Layer2 - Switch
 - * 支援網管功能 Switch
- * 通訊協定Layer3 - Router
 - * Multilayer Switch
- * 機房網路規劃
 - * 挑選適合的設備型號與規格
 - * 線材剛好就好