

財團法人台灣網路資訊中心
台灣網路資訊中心委託執行計畫

「Native IPv6 連網環境建置及
IPv6 用戶安全防护研析」

受委託單位

國立中央大學

資訊工程學系

Native IPv6 連網試驗環境
測試報告

摘要

鑑於未來 Native IPv6 的發展需求，本計畫將建立 Native IPv6 連網試驗環境及進行 Native IPv6 網路環境測試。本測試報告詳述於 Native IPv6 連網試驗環境中的網路連通性，包含 NAT64/DNS64 與 464XLAT 連網環境，以校園網路作為 IPv4 與 IPv6 接取環境，並於實驗室自行架設 NAT64/DNS64 暨 464XLAT 轉換服務，以 JOOL 及 BIND9 開源軟體實現，提供 IPv6 -> NAT64/DNS64 -> IPv4 以及 IPv4 -> CLAT -> IPv6 PLAT -> IPv4 兩種連線情境。

測試項目包含 Windows10、Windows8、Android 及 iOS 四種作業系統，測試目標包含 Google、Youtube 等熱門網站及 skype、FTP、SFT 等熱門應用程式，測試標的包含 Ping、nslookup 及 WEB 瀏覽器等，並比較經過 NAT64、464XLAT、Native IPv6 及 Native IPv4 四種連網環境的連線差異。測試結果顯示，所有熱門網站皆可藉由 NAT64 暨 464XLAT 連網環境存取，且有無經過轉換機制的 response time 差距甚微，以使用者觀點的操作體驗完全不受影響。本測試報告結果可提供國內業者部署 IPv6-only 連線 IPv4-only 服務應用情境、優化與改善網路品質的參考依據。

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壹、前言

本測試報告系針對 NAT64/DNS64[1][2]及 464XLAT[3]連網環境進行連線測試，該環境乃以校園網路作為 IPv4 與 IPv6 接取環境，架設 NAT64/DNS64 暨 464XLAT 轉換服務於實驗室網路環境中，提供 IPv6 -> NAT64/DNS64 -> IPv4 以及 IPv4 -> CLAT -> IPv6 -> PLAT -> IPv4 兩種連線情境。建置軟體 JOOL 開源軟體[4]，建置方法於”Native IPv6 連網試驗環境建置手冊”中詳述。本測試報告主要敘述連網測試的方法、過程及結果。依照測試項目及測試方案，可將測試規劃成三個子部分—基本測試、連線測試及應用測試，如圖 1 所示。

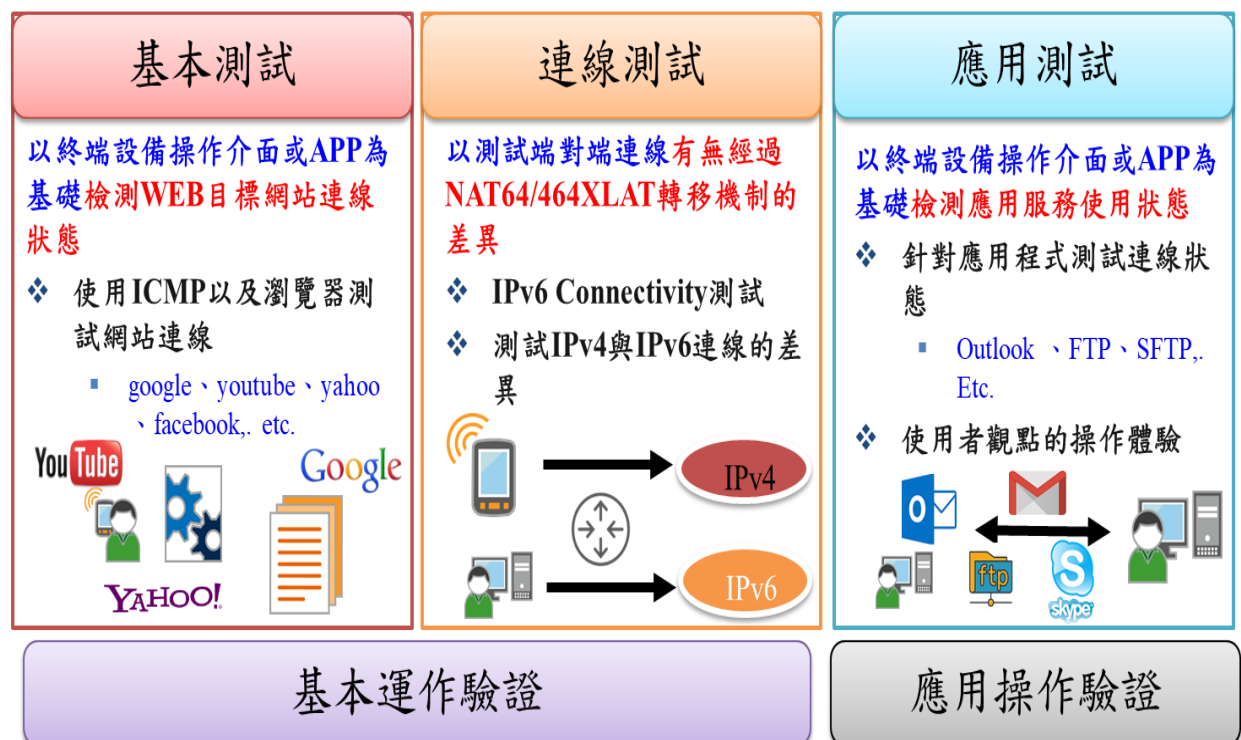


圖 1 NAT64/464XLAT 測試規劃

下面針對三個測試部分做說明：

➤ **連網測試**

以終端設備操作介面或應用程式為基礎，檢測 WEB 目標網站連線狀態，主要測試使用者介面配置 IPv6 參數與瀏覽器 IPv6 連網測試。測試方式係以 ICMP 及瀏覽器測試網站連線，測試網站包含：

- Google Search
- Youtube
- Yahoo Search
- Facebook
- Twitter
- Netflix

➤ **連線測試**

以測試與比較端對端連線有無經過 NAT64/464XLAT 轉移機制的差異，須測試 IPv6 Connectivity 連通性及 IPv4 與 IPv6 之連線差異。

➤ **應用測試**

以終端設備操作介面或應用程式為基礎，檢測應用服務使用狀態，從使用者角度與觀點來檢測操作或使用上是否會發生

錯誤中斷情況。此項測試會針對以下應用程式做連線狀態之測試：

- Skype
- FTP
- SFTP
- Windows Outlook
- Gmail

測試流程則可分為準備測試、實際測試及測試報告三階段（如圖

2），各階段測試須知如下所述：

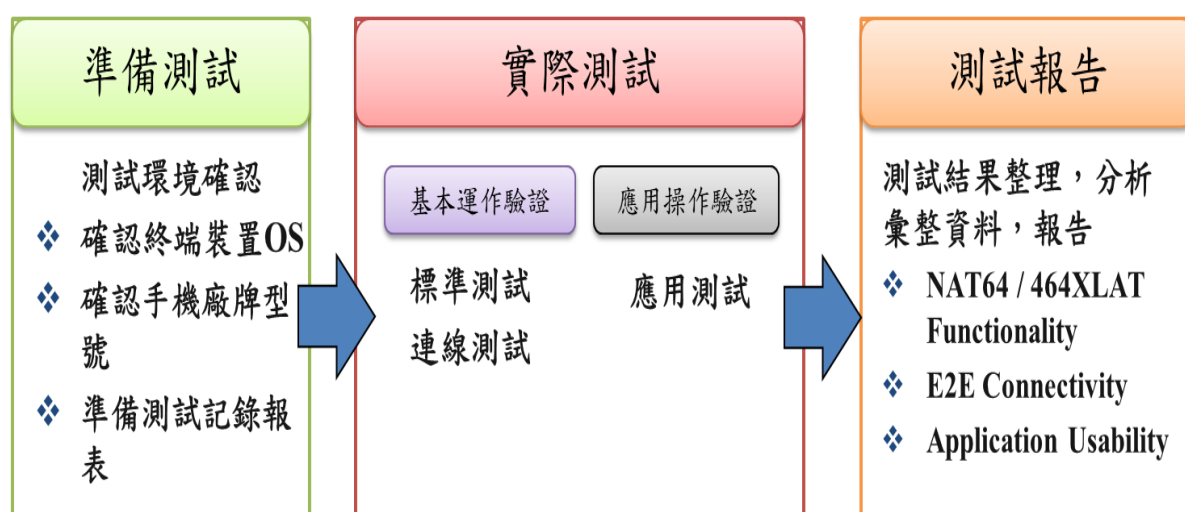


圖 2 NAT64/464XLAT 連網測試流程

一、準備測試

此階段屬於整個測試環節的前置階段，是為了之後實際測試環節做準備。準備測試環節如下：

- 測試環境確認

包含確認終端裝置故障與否、NAT64/464XLAT 轉換伺服器運作是否正常及網路連線是否通暢等。

➤ **確認終端裝置 OS**

確認終端裝置作業系統版本是否符合要求，有線裝置須以 Windows 8.x 及 Windows 10.x 版本之作業系統進行測試；行動裝置則須以 Android 10.x 及 iOS 13.x 來測試。

➤ **確認手機廠牌型號**

確認手機廠牌型號並記錄於測試報表中。

➤ **準備測試紀錄報表**

備妥測試紀錄報表，於測試過程中隨時記錄測試所得結果、途中遭遇問題、觀察與發現。

二、 實際測試

實際測試包含基本運用驗證的基本測試與連線測試，以及應用操作驗證的應用測試，其中測試規劃之實際執行詳細說明如表 1。

表 1 NAT64/464XLAT 測試規劃

測試大項	編號	功能	說明	附註
基本測試 (A)	A-1	IPv4/IPv6 位址取得	檢視終端裝置 IPv4/IPv6 位址	1. 查看手機 IPv6 位 址（以 Android 為例） ➤ 設定> 關於> 手機 識 別 or ➤ 設定> 關於 手機> 狀態 2. Ifconfig for windows
	A-2	使用 DNS	使用	安裝 ping&DNS

		指令查詢網站 IP	nslookup 指令檢測	APP
	A-3	使用瀏覽器連線目標網站	使用 chrome 瀏覽器檢測	
	A-4	使用 ICMP 進行連線測試	使用 ping or traceroute 指令檢測	紀錄 TTL 時間
功能測試 (B)	B-1	TTL 反應時間測試	端對端連線測試有無經過 NAT64 / 464XLAT 的差異	安裝 ping&DNS APP
	B-2	有無經過轉換機制 TTL 比較		
應用測試 (C)	C-1	針對應用程式測試連線狀態	針對 SKYPE、FTP、SFTP、Gmail 等進行連線測試	測試服務連線狀態與記錄使用者觀點的操作體驗

三、 測試報告

測試報告階段須將測試結果整理，分析並彙整資料，報告包含：

- NAT64 / 464XLAT Functionality
- E2E Connectivity
- Application Usability

測試報表須包含測試項次、測試網址、網站名稱、網站類型以及測試裝置（含有線裝置及無線裝置）等。須紀錄測試結果並截圖佐證。

測試作業系統共分為 Windows10、Windows8、Android 及 iOS 四個測項，分別以 ASUS MD750、ASUS S300CA、Sony z1 及 iPhone 11 終端設備進行測試，以 Google Chrome 為預設瀏覽器，應用測試採用的應用程式包含 Skype、Outlook 及 Gmail 等。Windows10、Windows8 皆採用 Windows 內建 CLI 介面作為基本測試工具，Android 採用 Ping & Net，而 iOS 則採用 iNetTools，此兩項應用程式皆支援無線裝置的 ping、nslookup 及 traceroute 等命令。而為因應 STP 及 SFTP 之測試要求，需架設 FTP 的 Server 端及 Client 端，有線裝置皆以 FileZilla 軟體架設 Server 及 Client，Android 和 iOS 裝置則分別以 File Manager+ 及 FTPManager APP 架設 FTP Client，對 FileZilla 的 Server 進行檔案

傳輸測試。測試環境資訊可參考表 2。

表 2 NAT64/DNS64 測試環境資訊

連線方式	作業系統	測試終端	分享器型號	瀏覽器
有線	Windows10	ASUS MD750		Chrome
	Windows8	ASUS S300CA		Chrome
無線(WiFi)	Android	Sony z1	D-link dir-2680	Chrome
	iOS	iPhone 11	D-link dir-2680	Chrome
作業系統	基本測試應用程式	FTP&SFTP 應用程式		應用測試
		Client	Server	應用程式
Windows10	Windows CLI	FileZilla	FileZilla	Skype、Outlook
Windows8	Windows CLI	FileZilla	FileZilla	Skype、Outlook
Android	Ping & Net	File Manager+	FileZilla	Gmail、Skype、Outlook
iOS	iNetTools	FTPManager	FileZilla	Gmail、Skype、Outlook

貳、目的及應用範圍

雖然 IPv6 成長快速，但仍存在一些議題須持續關注，特別是 IPv6 與 IPv4 互通性問題急需解決。未來 IPv6 網路的發展方向將朝向 Native IPv6 方面演進，因此如何在 IPv4 與 IPv6 共存下連線成為一門重要課題。鑑於未來 Native IPv6 的發展需求，本計畫將建立 Native IPv6 連網試驗環境一套。具體如下：

- 464XLAT CLAT(For NAT46 功能)，以 JOOL 開源軟體建置
- 464XLAT PLAT(For NAT64 功能)，以 JOOL 開源軟體建置
- DNS64 Server(搭配 PLAT NAT64 使用)，須用 BIND DNS Server 軟體建置

本測試報告詳述 Native IPv6 連網試驗環境的測試步驟，包含測試流程、測試須知、測試項目、測試工具、測試遭遇困難以及測試的發現。測試測項包含用戶熱門使用網站如 Google、Youtube 等；熱門應用程式如 Gmail、Outlook 等；檔案傳輸 FTP、SFTP 等，測試項目以囊括大部分網路基本使用目的及範圍。本測試會將 NAT64、464XLAT、Native IPv6 及 Native IPv4 連網環境進行比較，驗證有無經過轉換機制之差異，所得成果可不僅可讓用戶了解哪些熱門應用程式支援 Native IPv6 環境，有無經過轉換機制的差異及其影響，亦可作為台灣 ISP 業者部署 Native IPv6 環境之參考。

參、測試成果

一、 NAT64/DNS64 測試成果

NAT64/DNS64 測試結果摘要如表 3 所示。分為基本測試、連線測試及應用測試，測試結果如下說明：

表 3 NAT64 測試摘要

項次	網站名稱	網站類型	有線裝置		無線裝置	
			Win8	Win10	Android	iOS
1	Google	入口網站	v	v	v	v
2	Youtube	影音網站	v	v	v	v
3	Facebook	社群網站	v	v	v	v
4	Yahoo	入口網站	v	v	v	v
5	Netflix	影音網站	v	v	v	v
6	Twitter	社群網站	v	v	v	v
項次	服務	名稱	有線裝置		無線裝置	
			Win8	Win10	Android	iOS
7	SKYPE	通訊服務	v	v	v	v
8	FTP	下載服務	v	v	v	v
9	SFTP	傳輸服務	v	v	v	v
10	Outlook	郵件服務	v	v	v	v
11	Gmail	郵件服務	v	v	v	v

項次	網站名稱	網站支援	訊務是否 會經過 NAT64	Response Time	Ping	Web
1	Google	DualStack	否	4ms	v	v
2	Youtube	DualStack	否	3ms	v	v
3	Facebook	DualStack	否	3ms	v	v
4	Yahoo	DualStack	否	140ms	v	v
5	Netflix	DualStack	否	163ms	v	v
6	Twitter	IPv4 only	是	56ms	v	v

基本測試是檢測 WEB 目標網站連線狀態，使用 ICMP 及瀏覽器測試網站連線。目標網站包含 google.com、youtube.com、facebook.com、yahoo.com、netflix.com 及 twitter.com，測試結果顯示，所有網站皆通過測試。唯 twitter.com 無支援 IPv6 服務，須經由 NAT64 的轉換後方可存取網站。

連線測試是以測試端對端連現有無經過 NAT64/464XLAT 轉換機制的差異，測試基本測項中六個網站，並和 Native IPv6 環境比較，主要驗證其經過 NAT64 轉換後是否會對其 response time 造成影響。而包含 Google、Youtube、Facebook、Yahoo 及

Netflix 在內的 5 個測試網站皆為 DualStack，無論 IPv4 或 IPv6 連線方式皆可存取網站服務。而 twitter.com 因無支援 IPv6 方式連線，故無法經由 Native IPv6 環境存取服務。

應用測試是以終端設備操作介面或 APP 為基礎檢測應用服務使用狀態。測試目標為 SKYPE、FTP、SFTP、Outlook、Gmail。結果顯示所有應用測項皆通過測試。

NAT64 逐項測試截圖請參考圖 3～圖 56。其中圖 3～圖 18 為 Windows10 之測試截圖；圖 19～圖 34 為 Windows8 測試結果；Android 及 iOS 測試截圖則分別位於圖 35～圖 45 及圖 46～圖 56。

測試主機 (Win 10)

ipconfig (IPv6 only)

```
Windows IP Configuration

Ethernet adapter 乙太網路:

    Connection-specific DNS Suffix  . : 
    IPv6 Address. . . . . : 2001:288:3001:59:8875:adc1:987c:a198
    Temporary IPv6 Address. . . . . : 2001:288:3001:59:64bd:e592:684c:1d94
    Link-local IPv6 Address . . . . . : fe80::8875:adc1:987c:a198%15
    Default Gateway . . . . . : fe80::66a0:e7ff:fe43:3841%15

Wireless LAN adapter Wi-Fi:

    Media State . . . . . : Media disconnected
    Connection-specific DNS Suffix  . : 

Wireless LAN adapter 區域連線* 1:

    Media State . . . . . : Media disconnected
    Connection-specific DNS Suffix  . : 

Wireless LAN adapter 區域連線* 2:

    Media State . . . . . : Media disconnected
    Connection-specific DNS Suffix  . : 

C:\WINDOWS\system32>
```

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圖 3 NAT64 Windows10 測試主機資訊

Windows 10 - Case 1 – Google (Dual - Stack)

nslookup

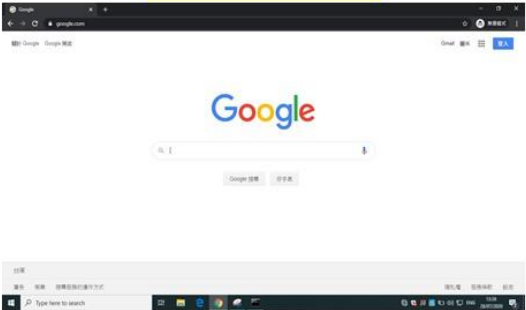
```
C:\WINDOWS\system32>nslookup
Default Server: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

> google.com
Server: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

Non-authoritative answer:
Name: google.com
Addresses: 2404:6800:4008:801::200e
          216.58.200.46

>
```

browser



ping

```
C:\WINDOWS\system32>ping google.com

Pinging google.com [2404:6800:4008:801::200e] with 32 bytes of data:
Reply from 2404:6800:4008:801::200e: time=3ms
Reply from 2404:6800:4008:801::200e: time=3ms
Reply from 2404:6800:4008:801::200e: time=3ms
Reply from 2404:6800:4008:801::200e: time=3ms

Ping statistics for 2404:6800:4008:801::200e:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 3ms, Maximum = 3ms, Average = 3ms

C:\WINDOWS\system32>
```

tracert

```
C:\WINDOWS\system32>tracert google.com

Tracing route to google.com [2404:6800:4008:801::200e]
over a maximum of 30 hops:

  0  1 ms  <1 ms  <1 ms  2001:288:3001:59::254
  1  1 ms  1 ms  1 ms  2001:288:3001:1::254
  2  *      *      *      Request timed out.
  3  2 ms  1 ms  2 ms  2001:288:0:1659:192:192:61:101
  4  3 ms  2 ms  2 ms  2001:288:0:1659:192:192:61:24
  5  3 ms  *      *      2001:288:0:1659:192:192:61:0
  6  3 ms  3 ms  3 ms  2001:288:0:1659:192:192:61:184
  7  4 ms  4 ms  4 ms  2001:288:3b0:5::9264:1
  8  3 ms  3 ms  3 ms  2001:c08:7f:1::35
  9  4 ms  4 ms  4 ms  2001:288:0:f:109::9
 10  4 ms  4 ms  4 ms  2001:c08:7f:1::20
 11  4 ms  4 ms  4 ms  2001:4860:0:1012::1
 12  4 ms  4 ms  4 ms  2001:4860:0:1::1e9d
 13  3 ms  3 ms  3 ms  tsa01s08-in-x0e.1e100.net [2404:6800:4008:801::200e]
 14  *      *      *      Trace complete.
```

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圖 4 Windows 10 - Case 1 – Google

Windows 10 - Case 2 – Youtube (Dual - Stack)

nslookup

```
C:\WINDOWS\system32>nslookup
Default Server: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

> youtube.com
Server: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

Non-authoritative answer:
Name: youtube.com
Addresses: 2404:6800:4012::200e
172.217.160.78

>
```

browser

ping

```
C:\WINDOWS\system32>ping youtube.com

Pinging youtube.com [2404:6800:4008:800::200e] with 32 bytes of data:
Reply from 2404:6800:4008:800::200e: time=4ms
Reply from 2404:6800:4008:800::200e: time=4ms
Reply from 2404:6800:4008:800::200e: time=4ms
Reply from 2404:6800:4008:800::200e: time=4ms

Ping statistics for 2404:6800:4008:800::200e:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 4ms, Maximum = 4ms, Average = 4ms
```

tracert

```
C:\WINDOWS\system32>tracert youtube.com

Tracing route to youtube.com [2404:6800:4012::200e]
over a maximum of 30 hops:
  0  1 ms  <1 ms  <1 ms  2001:288:3001:59:25e:ab37:b87a:d487
  1  1 ms  1 ms  1 ms  2001:288:3001:1:1:254
  2  1 ms  1 ms  1 ms  Request timed out.
  3  2 ms  2 ms  2 ms  2001:288:0:1659:192:192:61:101
  4  2 ms  2 ms  2 ms  2001:288:0:1659:192:192:61:24
  5  3 ms  3 ms  3 ms  Request timed out.
  6  *  *  *  Request timed out.
  7  3 ms  3 ms  3 ms  2001:288:0:1659:192:192:61:184
  8  4 ms  4 ms  4 ms  2001:288:300:5:9264:1
  9  3 ms  3 ms  3 ms  2001:c08:7f:1:35
 10  4 ms  4 ms  4 ms  2001:288:0:f:109:9
 11  6 ms  4 ms  4 ms  2001:c08:7f:1:20
 12  3 ms  3 ms  3 ms  2001:4860:0:1011:1
 13  *  *  *  Request timed out.
 14  4 ms  4 ms  4 ms  tsu01a09-in-x0e.le100.net [2404:6800:4012::200e]

Trace complete.
```

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圖 5 Windows 10 - Case 2 – Youtube

Windows 10 - Case 3 – Yahoo (Dual - Stack)

nslookup

```
C:\WINDOWS\system32>nslookup
Default Server: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

> yahoo.com
Server: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

Non-authoritative answer:
Name: yahoo.com
Addresses: 2001:4998:58:1836::10
2001:4998:58:1836::11
2001:4998:c:1023::5
2001:4998:c:1023::4
2001:4998:44:41d::3
2001:4998:44:41d::4
98.137.246.7
98.138.219.231
98.138.219.232
98.138.219.233
98.137.246.8

>
```

browser

ping

```
C:\WINDOWS\system32>ping yahoo.com

Pinging yahoo.com [2001:4998:c:1023::5] with 32 bytes of data:
Reply from 2001:4998:c:1023::5: time=156ms
Reply from 2001:4998:c:1023::5: time=156ms
Reply from 2001:4998:c:1023::5: time=156ms
Reply from 2001:4998:c:1023::5: time=156ms

Ping statistics for 2001:4998:c:1023::5:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 156ms, Maximum = 156ms, Average = 156ms

C:\WINDOWS\system32>
```

tracert

```
C:\WINDOWS\system32>tracert yahoo.com

Tracing route to yahoo.com [2001:4998:c:1023::5]
over a maximum of 30 hops:
  0  1 ms  13 ms  1 ms  2001:288:3001:59:25e:ab37:b87a:d487
  1  3 ms  1 ms  2 ms  2001:288:3001:1:1:254
  2  *  *  *  Request timed out.
  3  2 ms  1 ms  2 ms  2001:288:0:1659:192:192:61:101
  4  3 ms  2 ms  2 ms  2001:288:0:1659:192:192:61:24
  5  3 ms  *  *  2001:288:0:1659:192:192:61:0
  6  4 ms  3 ms  3 ms  2001:288:0:1659:192:192:61:232
  7  *  *  *  Request timed out.
  8  3 ms  3 ms  3 ms  2001:288:0:1659:192:192:68:62
  9  3 ms  3 ms  2 ms  2406:d400:1:133:203:163:222:36
 10  3 ms  3 ms  3 ms  et-3-3-0.pat1.twy.yahoo.com [2406:2000:f027::1]
 11  134 ms  134 ms  134 ms  ae-9.pat1.pao.yahoo.com [2406:2000:f028::1]
 12  154 ms  154 ms  153 ms  ae-0.pat1.swp.yahoo.com [2001:4998:f002::1]
 13  159 ms  159 ms  157 ms  ae-7.pat2.gqb.yahoo.com [2001:4998:f007::1]
 14  157 ms  157 ms  157 ms  et-18-1-0.ms2.gql.yahoo.com [2001:4998:f00f:209::1]
 15  156 ms  156 ms  156 ms  et-19-1-0.clr2-a-gdc.gql.yahoo.com [2001:4998:cf23::1]
 16  158 ms  158 ms  158 ms  2001:4998:c:f800::1
 17  156 ms  156 ms  156 ms  media-router-fp2.prod1.media.vip.gql.yahoo.com [2001:4998:c:1023::5]

Trace complete.
```

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圖 6 Windows 10 - Case 3 – Yahoo

Windows 10 - Case 4 – Facebook (Dual - Stack)

nslookup

```
C:\WINDOWS\system32>nslookup
Default Server: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

> facebook.com
Server: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

Non-authoritative answer:
Name: facebook.com
Addresses: 2a03:2880:f15a:83:face:b00c:0:25de
          31.13.87.36
>
```

browser

ping

```
C:\WINDOWS\system32>ping facebook.com

Pinging facebook.com [2a03:2880:f15a:83:face:b00c:0:25de] with 32 bytes of data:
Reply from 2a03:2880:f15a:83:face:b00c:0:25de: time=26ms
Reply from 2a03:2880:f15a:83:face:b00c:0:25de: time=26ms
Reply from 2a03:2880:f15a:83:face:b00c:0:25de: time=26ms
Reply from 2a03:2880:f15a:83:face:b00c:0:25de: time=26ms

Ping statistics for 2a03:2880:f15a:83:face:b00c:0:25de:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 26ms, Maximum = 26ms, Average = 26ms
C:\WINDOWS\system32>
```

tracert

```
C:\WINDOWS\system32>tracert facebook.com

Tracing route to facebook.com [2a03:2880:f15a:83:face:b00c:0:25de]
over a maximum of 30 hops:
  0  1 ms  <1 ms  <1 ms  2001:288:3001:59:254
  1  1 ms  <1 ms  <1 ms  2001:288:3001:11:254
  2  *      *      *      Request timed out.
  3  *      *      *      Request timed out.
  4  2 ms  2 ms  1 ms  2001:288:0:1659:192:192:61:101
  5  3 ms  2 ms  2 ms  2001:288:0:1659:192:192:61:24
  6  *      *      *      Request timed out.
  7  3 ms  3 ms  3 ms  2001:288:0:1659:192:192:61:232
  8  3 ms  3 ms  3 ms  2001:288:0:1659:192:192:61:562
  9  3 ms  3 ms  3 ms  2001:288:0:1659:192:192:68:62
 10  4 ms  3 ms  3 ms  2403:e800:705:100:121
 11  25 ms 26 ms 26 ms 2403:e800:f460:1002:1
 12  28 ms 28 ms 28 ms 2403:e800:f420:101d:1
 13  25 ms 25 ms 25 ms 2403:e800:f420:1027:1
 14  25 ms 25 ms 25 ms 2403:e800:e801:1008:2
 15  25 ms 25 ms 25 ms po124.arv02.hkg1.tfbw.net [2620:0:1cfff:dead:beef:b38]
 16  25 ms 25 ms 25 ms po222.paw02.hkg1.tfbw.net [2620:0:1cfff:dead:beef:275d]
 17  26 ms 26 ms 26 ms po2.newtai.01.kkt1.tfbw.net [2a03:2880:f05a:ffff:34d]
 18  26 ms 26 ms 26 ms edge-star-mini6-shv-01-bkt1.facebook.com [2a03:2880:f15a:83:face:b00c:0:25de]

Trace complete.
```

圖 7 Windows 10 - Case 4 – Facebook

Windows 10 - Case 5 – Twitter (IPv4 - only)

nslookup

```
C:\WINDOWS\system32>nslookup
Default Server: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

> twitter.com
Server: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

Non-authoritative answer:
Name: twitter.com
Addresses: 64:ff9b::68f4:2a01
          104.244.42.1
>
```

browser

ping

```
C:\WINDOWS\system32>ping twitter.com

Pinging twitter.com [64:ff9b::68f4:2a01] with 32 bytes of data:
Reply from 64:ff9b::68f4:2a01: time=56ms
Reply from 64:ff9b::68f4:2a01: time=56ms
Reply from 64:ff9b::68f4:2a01: time=56ms
Reply from 64:ff9b::68f4:2a01: time=56ms

Ping statistics for 64:ff9b::68f4:2a01:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 55ms, Maximum = 56ms, Average = 55ms
C:\WINDOWS\system32>
```

tracert

```
C:\WINDOWS\system32>tracert twitter.com

Tracing route to twitter.com [64:ff9b::68f4:2a01]
over a maximum of 30 hops:
  0  <1 ms  <1 ms  <1 ms  2001:288:3001:59:d0fc:b48d:4ad3:fa0a
  1  1 ms  1 ms  1 ms  64:ff9b::c8b8:6401
  2  1 ms  1 ms  1 ms  64:ff9b::8c73:3bfe
  3  1 ms  1 ms  1 ms  64:ff9b::c848:f4b9
  4  2 ms  2 ms  2 ms  tyrc-ncu.ncu.edu.tw [64:ff9b::c848:f4e1]
  5  3 ms  2 ms  2 ms  64:ff9b::c0c0:3d66
  6  3 ms  2 ms  3 ms  64:ff9b::c0c0:3d05
  7  4 ms  4 ms  4 ms  64:ff9b::c0c0:3ded
  8  5 ms  5 ms  5 ms  64:ff9b::c0c0:3d3a
  9  23 ms 23 ms 23 ms 64:ff9b::c0c0:443e
 10  23 ms 23 ms 24 ms unknown.telstraglobal.net [64:ff9b::d2b0:2cb1]
 11  28 ms 22 ms 23 ms i-92.tpe1-core01.telstraglobal.net [64:ff9b::ca54:89f9]
 12  61 ms 60 ms 60 ms i-14236.jtha-core02.telstraglobal.net [64:ff9b::ca54:8cc9]
 13  66 ms 66 ms 65 ms i-0-7-0-7.sik011.telstraglobal.net [64:ff9b::ca2f:68fa]
 14  59 ms 61 ms 58 ms 64:ff9b::d2ad:b086
 15  *      *      *      Request timed out.
 16  56 ms 55 ms 55 ms 64:ff9b::68f4:2a01

Trace complete.
```

圖 8 Windows 10 - Case 5 – Twitter

Windows 10 - Case 6 – Netflix (Dual - Stack)

nslookup

```
C:\WINDOWS\system32>nslookup
DNS request timed out.
    timeout was 2 seconds.
Default Server: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

> netflix.com
Server: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

Non-authoritative answer:
Name: netflix.com
Addresses: 2620:108:700f::3422:26c8
2620:108:700f::22d0:15cc
2620:108:700f::340b:d31a
2620:108:700f::36bb:9332
2620:108:700f::3695:a0a4
2620:108:700f::340b:6811
2620:108:700f::23a7:6da3
2620:108:700f::3429:f4bd
35.167.205.73
54.187.149.50
54.148.216.188
52.41.168.84
52.36.238.206
35.166.68.183
35.160.251.36
```

ping

```
Microsoft Windows [Version 10.0.18362.1082]
(c) 2019 Microsoft Corporation. All rights reserved.

C:\WINDOWS\system32>ping netflix.com

Pinging netflix.com [2620:108:700f::3429:f4bd] with 32 bytes of data:
Reply from 2620:108:700f::3429:f4bd: time=165ms
Reply from 2620:108:700f::3429:f4bd: time=159ms
Reply from 2620:108:700f::3429:f4bd: time=159ms
Reply from 2620:108:700f::3429:f4bd: time=159ms

Ping statistics for 2620:108:700f::3429:f4bd:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 159ms, Maximum = 165ms, Average = 160ms
```

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browser



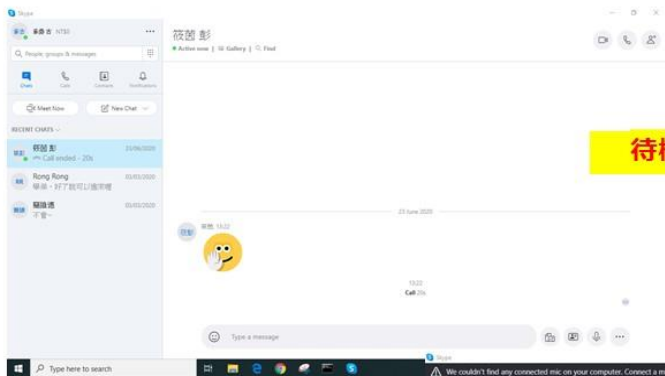
tracert

```
C:\WINDOWS\system32>tracert netflix.com
Tracing route to netflix.com [2620:108:700f::3429:a654]
over a maximum of 30 hops:
  0  1 ms  1 ms  1 ms  2001:288:3001:59::254
  1  1 ms  1 ms  1 ms  2001:288:3001:1::254
  2  1 ms  1 ms  1 ms  2001:288:30ff::2
  3  1 ms  1 ms  1 ms  2001:288:0:1659:192:192:61:101
  4  1 ms  1 ms  1 ms  2001:288:0:1659:192:192:61:24
  5  2 ms  2 ms  2 ms  Request timed out.
  6  *  *  *  Request timed out.
  7  3 ms  2 ms  2 ms  2001:288:0:1659:192:192:61:232
  8  3 ms  2 ms  2 ms  2001:288:0:1659:192:192:61:562
  9  3 ms  2 ms  3 ms  2001:288:0:1659:192:192:68:62
 10  3 ms  3 ms  3 ms  2403:e800:705:100::21
 11 139 ms 142 ms 142 ms 2403:e800:f700:110::8b
 12 146 ms 144 ms 144 ms 2403:e800:f661:1004::1
 13 146 ms 146 ms 145 ms 2403:e800:f725:1008::1
 14 140 ms 141 ms 140 ms 2403:e800:f402:1000::
 15 139 ms 139 ms 139 ms 2403:e800:e802:a::2
 16  *  *  *  Request timed out.
 17 144 ms 144 ms 146 ms 2620:107:3000::e
 18  *  *  *  Request timed out.
 19  *  *  *  Request timed out.
 20 161 ms 160 ms 160 ms 2620:107:4000:9008::49
 21 159 ms 159 ms 158 ms 2620:107:4000:9008::30
 22 160 ms 161 ms 161 ms 2620:107:4000:9008::20
 23 168 ms 163 ms 163 ms 2620:107:4000:9008::1c
 24 160 ms 160 ms 160 ms 2620:107:4000:9008::25
 25 160 ms 168 ms 160 ms 2620:107:4000:8005::25
 26  *  *  *  Request timed out.
 27  *  *  *  Request timed out.
 28  *  *  *  Request timed out.
 29  *  *  *  Request timed out.
 30  *  *  *  Request timed out.

Trace complete.
```

圖 9 Windows 10 - Case 6 – Netflix

Windows 10 - Case 7 – Skype



待機畫面

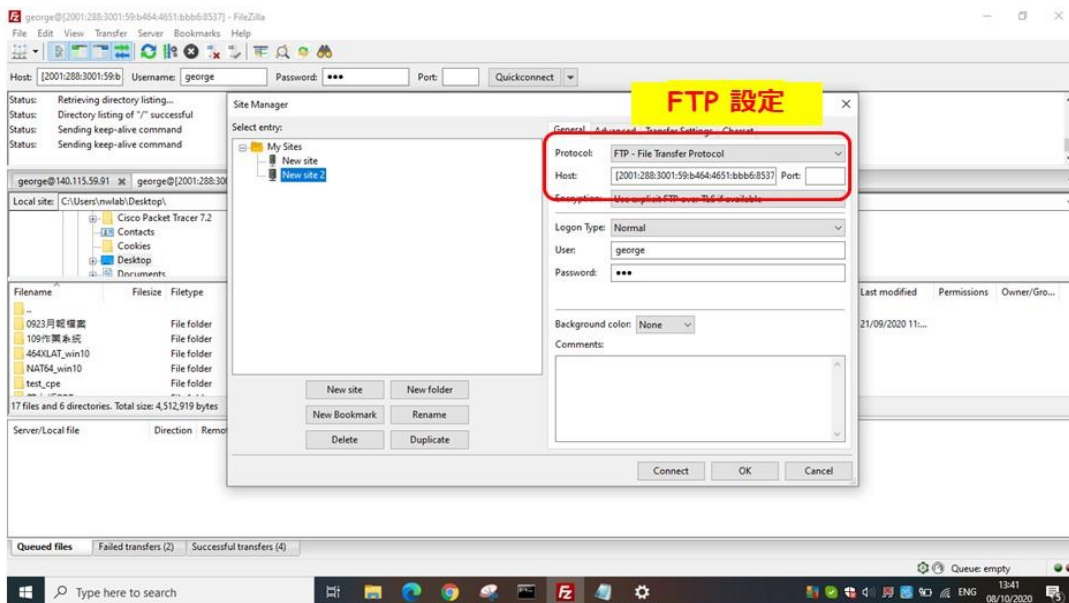


接通畫面

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圖 10 Windows 10 - Case 7 – Skype

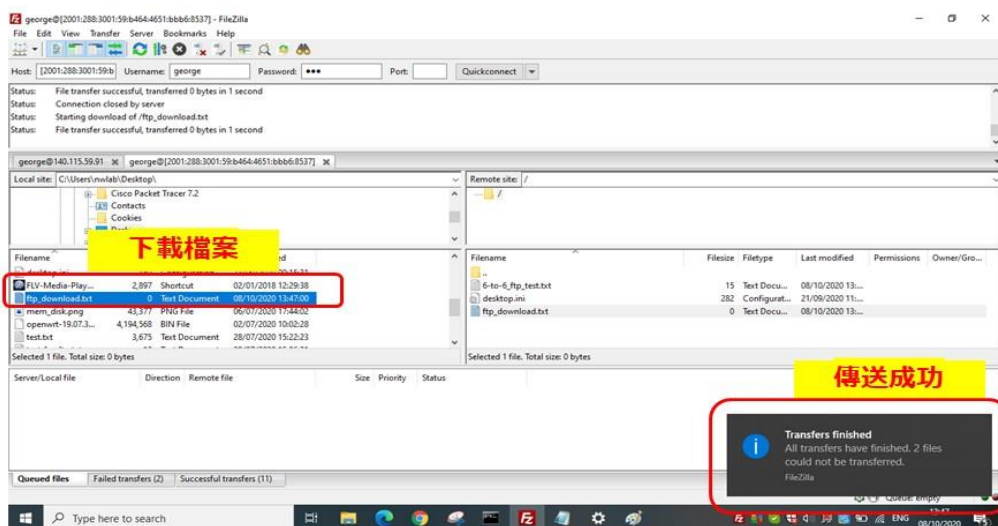
Windows 10 - Case 8 – FTP (FileZilla)



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圖 11 Windows 10 - Case 8 – FTP (FileZilla)

Windows 10 - Case 8 – FTP (FileZilla) - Download



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圖 12 Windows 10 - Case 8 – FTP (FileZilla) - Download

Windows 10 - Case 8 – FTP (FileZilla) - Upload

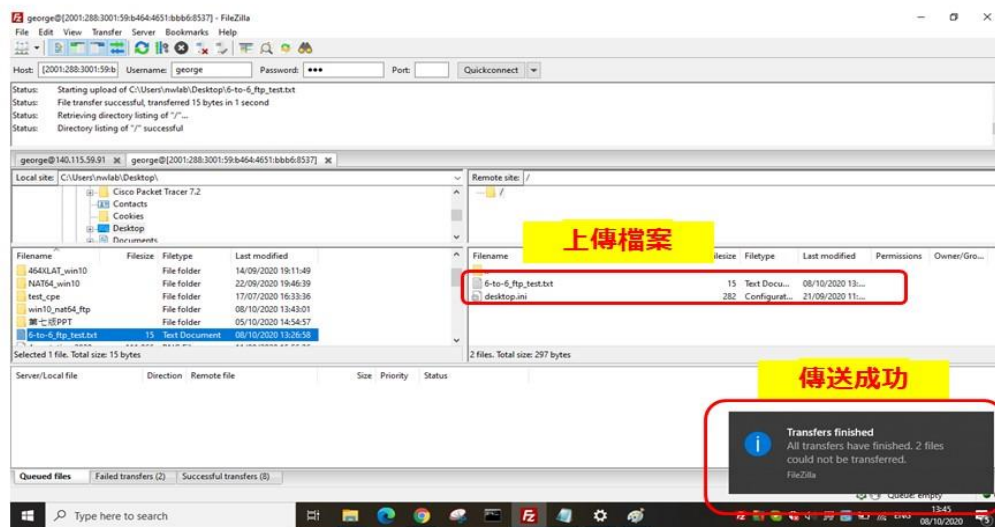


圖 13 Windows 10 - Case 8 – FTP (FileZilla) - Upload

Windows 10 - Case 9 – SFTP (FileZilla)

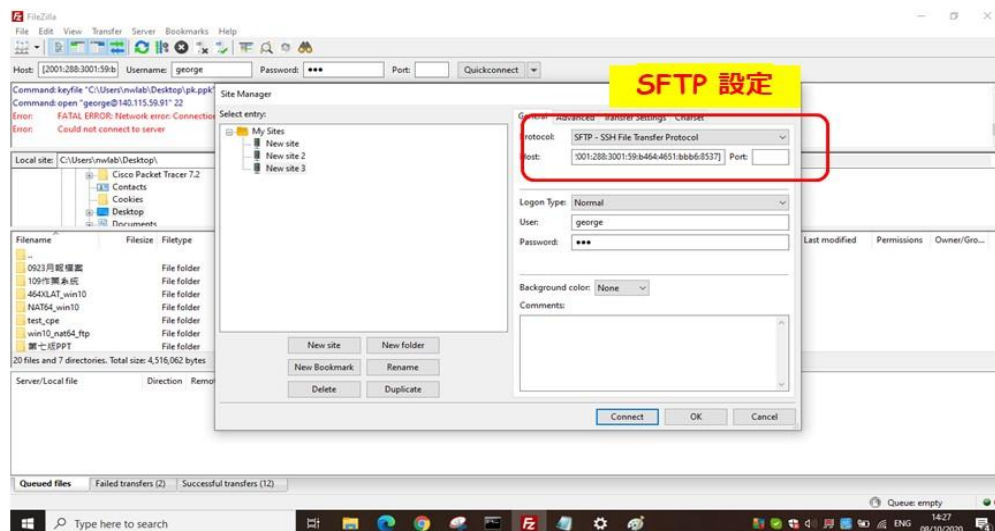
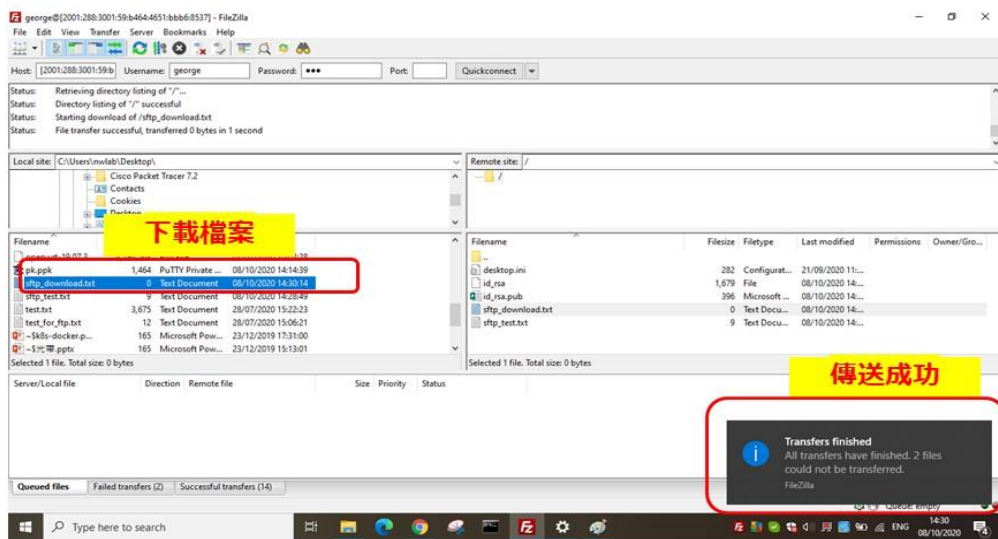


圖 14 Windows 10 - Case 9 – SFTP (FileZilla)

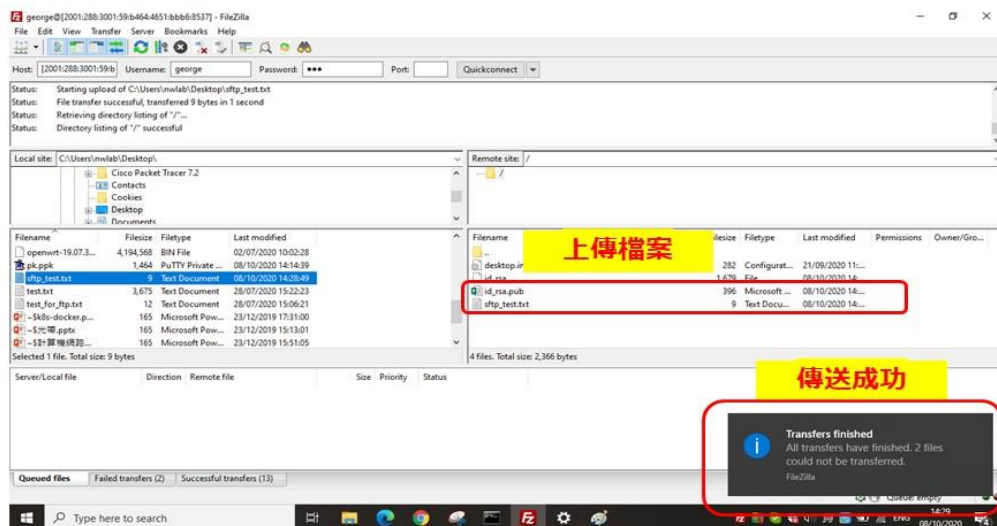
Windows 10 - Case 9 – SFTP (FileZilla) - Download



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圖 15 Windows 10 - Case 9 – SFTP (FileZilla) - Download

Windows 10 - Case 9 – SFTP (FileZilla) - Upload



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圖 16 Windows 10 - Case 9 – SFTP (FileZilla) - Upload

Windows 10 - Case 10 – Windows Outlook

網頁版



應用程式版

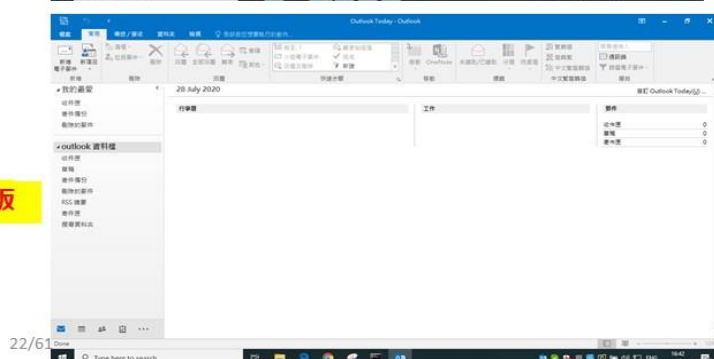
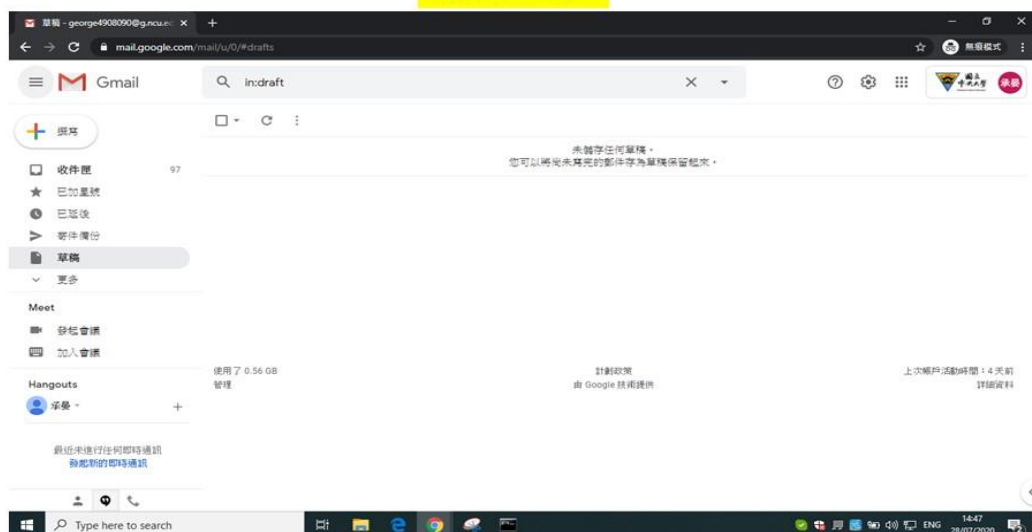


圖 17 Windows 10 - Case 10 – Windows Outlook

Windows 10 - Case 11 – Gmail

Gmail 網頁



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圖 18 Windows 10 - Case 11 – Gmail

測試主機 (Win 8)

ipconfig (IPv6 only)

```
C:\Windows\system32>ipconfig

Windows IP 設定

乙太網路卡 Ethernet0:

    連線特定 DNS 尾碼 . . . . . : lan
    IPv6 位址. . . . . : 2001:288:3001:59:8903:ecf8:a4ca:a51e
    臨時 IPv6 位址. . . . . : 2001:288:3001:59:7d14:b0bb:b425:dc3b
    連結-本機 IPv6 位址 . . . . . : fe80::8903:ecf8:a4ca:a51e%3
    預設閘道 . . . . . : fe80::66a0:e7ff:fe43:3841%3

C:\Windows\system32>
```

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圖 19 NAT64 Windows8 測試主機資訊

Windows 8 - Case 1 – Google (Dual - Stack)

nslookup

```
C:\Windows\system32>nslookup
DNS request timed out.
    timeout was 2 seconds.
預設伺服器: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

> google.com
伺服器: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

未經授權的回答:
名稱: google.com
Addresses: 2404:6800:4012::200e
          172.217.160.78

>
```

browser



ping

```
C:\Windows\system32>ping google.com

Ping google.com [2404:6800:4012::200e] (使用 32 位元組的資料):
回覆自 2404:6800:4012::200e: 時間=4ms
回覆自 2404:6800:4012::200e: 時間=4ms
回覆自 2404:6800:4012::200e: 時間=4ms
回覆自 2404:6800:4012::200e: 時間=4ms

2404:6800:4012::200e 的 Ping 統計資料:
    封包: 已傳送 = 4, 已收到 = 4, 已遺失 = 0 (0% 遺失),
    大約的來回時間 (毫秒):
        最小值 = 4ms, 最大值 = 4ms, 平均 = 4ms

C:\Windows\system32>
```

tracert

```
C:\Windows\system32>tracert google.com

在上限 30 個躍點上
追蹤 google.com [2404:6800:4012::200e] 的路由:

 1  39 ms    1 ms    <1 ms    2001:288:3001:59::254
 2  1 ms     1 ms    <1 ms    2001:288:3001:1::254
 3  1 ms     <1 ms  1 ms     2001:288:30ff::2
 4  1 ms     1 ms    1 ms     2001:288:0:1659:192:192:61:101
 5  2 ms     2 ms    2 ms     2001:288:0:1659:192:192:61:24
 6  2 ms     x       x        2001:288:0:1659:192:192:61:0
 7  4 ms     4 ms    4 ms     2001:288:0:1659:192:192:61:184
 8  2 ms     2 ms    2 ms     2001:288:3b0:5::9264:1
 9  3 ms     2 ms    2 ms     2001:c08:7f:1::35
10  2 ms     2 ms    2 ms     2001:288:0:f:109::9
11  3 ms     3 ms    3 ms     2001:4860:1:1::e0
12  5 ms     5 ms    5 ms     2001:4860:0:1012::1
13  5 ms     4 ms    5 ms     2001:4860:0:1::2b33
14  4 ms     4 ms    4 ms     tsa01s09-in-x0e.1e100.net [2404:6800:4012::200e]

追蹤完成。
```

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圖 20 Windows 8 - Case 1 – Google

Windows 8 - Case 2 – Youtube (Dual - Stack)

nslookup

```
C:\Windows\system32>nslookup
預設伺服器: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

> youtube.com
伺服器: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

未經授權的回應:
名稱: youtube.com
Addresses: 2404:6800:4008:803::200e
172.217.160.110

>
```

ping

```
C:\Windows\system32>ping youtube.com

Ping youtube.com [2404:6800:4008:803::200e] (使用 32 位元組的資料):
回覆自 2404:6800:4008:803::200e: 時間=3ms
回覆自 2404:6800:4008:803::200e: 時間=3ms
回覆自 2404:6800:4008:803::200e: 時間=3ms
回覆自 2404:6800:4008:803::200e: 時間=3ms

2404:6800:4008:803::200e 的 Ping 統計資料:
封包: 已傳送 = 4, 已收到 = 4, 已遺失 = 0 (0% 遺失),
大約的來回時間 (毫秒):
最小值 = 3ms, 最大值 = 3ms, 平均 = 3ms

C:\Windows\system32>
```

browser



tracert

```
C:\Windows\system32>tracert youtube.com

在 上 30 個躍點上
追蹤 youtube.com [2404:6800:4008:803::200e] 的路由:

 1  <1 ms  <1 ms  5 ms  2001:288:3001:59::254
 2  1 ms  1 ms  1 ms  2001:288:3001:1::254
 3  *  1 ms  <1 ms  2001:288:30ff::2
 4  1 ms  2 ms  1 ms  2001:288:0:1659:192:192:61:101
 5  2 ms  2 ms  2 ms  2001:288:0:1659:192:192:61:24
 6  *  *  *  要求等待逾時。
 7  4 ms  4 ms  4 ms  2001:288:0:1659:192:192:61:184
 8  9 ms  2 ms  2 ms  2001:288:3b0:5::9264:1
 9  3 ms  2 ms  2 ms  2001:288:7ff:1::35
10  3 ms  2 ms  2 ms  2001:288:0:f:109::9
11  3 ms  3 ms  3 ms  2001:4860:1:1::e0
12  4 ms  4 ms  4 ms  2001:4860:0:1013::1
13  3 ms  3 ms  3 ms  2001:4860:0:1::84d
14  3 ms  3 ms  3 ms  tea03602-in-x0e.1e100.net [2404:6800:4008:803::200e]

追蹤完成。
```

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圖 21 Windows 8 - Case 2 – Youtube

Windows 8 - Case 3 – Yahoo (Dual - Stack)

nslookup

```
C:\Windows\system32>nslookup
預設伺服器: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

> yahoo.com
伺服器: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

未經授權的回應:
名稱: yahoo.com
Addresses: 2001:4998:124:1507::f001
2001:4998:24:120d::1:0
2001:4998:44:3507::8001
2001:4998:44:3507::8000
2001:4998:124:1507::f000
2001:4998:24:120d::1:1
74.6.231.21
74.6.143.26
74.6.231.20
98.137.11.163
98.137.11.164
74.6.143.25

>
```

ping

```
C:\Windows\system32>ping yahoo.com

Ping yahoo.com [2001:4998:24:120d::1:1] (使用 32 位元組資料):
回覆自 2001:4998:24:120d::1:1: 時間=141ms
回覆自 2001:4998:24:120d::1:1: 時間=140ms
回覆自 2001:4998:24:120d::1:1: 時間=140ms
回覆自 2001:4998:24:120d::1:1: 時間=140ms

2001:4998:24:120d::1:1 的 Ping 統計資料:
封包: 已傳送 = 4, 已收到 = 4, 已遺失 = 0 (0% 遺失),
大約的來回時間 (毫秒):
最小值 = 140ms, 最大值 = 141ms, 平均 = 140ms

C:\Windows\system32>
```

browser



tracert

```
C:\Windows\system32>tracert yahoo.com

在 上 30 個躍點上
追蹤 yahoo.com [2001:4998:24:120d::1:1] 的路由:

 1  1 ms  1 ms  1 ms  2001:288:3001:59::254
 2  1 ms  1 ms  1 ms  2001:288:3001:1::254
 3  27 ms  2 ms  <1 ms  2001:288:30ff::2
 4  1 ms  1 ms  1 ms  2001:288:0:1659:192:192:61:101
 5  2 ms  2 ms  2 ms  2001:288:0:1659:192:192:61:24
 6  *  *  *  要求等待逾時。
 7  3 ms  3 ms  3 ms  2001:288:0:1659:192:192:61:232
 8  3 ms  *  3 ms  2001:288:0:1659:192:192:61:562
 9  3 ms  2 ms  2 ms  2001:288:0:1659:192:192:61:62
10  2 ms  2 ms  2 ms  2406:d400:1:133:203:163:222:36
11  2 ms  4 ms  3 ms  et-3-3-0.pat1.twy.yahoo.com [2406:2000:f027:1::1]
12  33 ms  33 ms  33 ms  et-10-3-0.pat1.jpz.yahoo.com [2406:2000:f028:1::1]
13  33 ms  33 ms  36 ms  et-2-1-0.pat1.jpz.yahoo.com [2406:2000:f02a:1::1]
14  136 ms  136 ms  140 ms  ae-3.pat1.swp.yahoo.com [2001:4998:f002:26::1]
15  140 ms  139 ms  139 ms  2001:4998:f007:d::1
16  141 ms  142 ms  141 ms  et-19-1-0.swp1.gq1.yahoo.com [2001:4998:f00f:9::1]
17  141 ms  141 ms  141 ms  et-0-0-0.cir2-a-gdc.gq1.yahoo.com [2001:4998:c:f022::1]
18  141 ms  140 ms  141 ms  et-8-1.fab1-2-gdc.gq1.yahoo.com [2001:4998:c:f078::1]
19  140 ms  139 ms  139 ms  unknown.yahoo.com [2001:4998:24:d800::1]
20  139 ms  139 ms  139 ms  unknown.yahoo.com [2001:4998:24:d811::1]
21  140 ms  141 ms  140 ms  media-router-fp74.prod.media.vip.gq1.yahoo.com [2001:4998:24:120d::1]

追蹤完成。
```

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圖 22 Windows 8 - Case 3 – Yahoo

Windows 8 - Case 4 – Facebook (Dual - Stack)

nslookup

```
C:\Windows\system32>nslookup
預設伺服器: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

> facebook.com
伺服器: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

未經授權的回答:
名稱: facebook.com
Addresses: 2a03:2880:f117:83:face:b00c:0:25de
31.13.77.35

>
```

browser



ping

```
C:\Windows\system32>ping facebook.com

Ping facebook.com [2a03:2880:f117:83:face:b00c:0:25de] (使用 32 位元組的資料):
回響自 2a03:2880:f117:83:face:b00c:0:25de: 時間=3ms
回響自 2a03:2880:f117:83:face:b00c:0:25de: 時間=3ms
回響自 2a03:2880:f117:83:face:b00c:0:25de: 時間=3ms
回響自 2a03:2880:f117:83:face:b00c:0:25de: 時間=3ms

2a03:2880:f117:83:face:b00c:0:25de 的 Ping 統計資料:
封包: 已傳送 = 4, 已收到 = 4, 已遺失 = 0 (0% 遺失),
大約的來回時間 (毫秒):
最小值 = 3ms, 最大值 = 3ms, 平均 = 3ms

C:\Windows\system32>
```

tracert

```
C:\Windows\system32>tracert facebook.com

在 30 個躍點上
追蹤 facebook.com [2a03:2880:f117:83:face:b00c:0:25de] 的路由:

 1  3 ms  1 ms  (1 ms  2001:288:3001:59::254
 2  1 ms  1 ms  1 ms  2001:288:3001:1::254
 3  *      *      1 ms  2001:288:30ff::2
 4  2 ms  2 ms  1 ms  2001:288:0:1659:192:192:61:101
 5  2 ms  2 ms  2 ms  2001:288:0:1659:192:192:61:24
 6  *      2 ms  *      2001:288:0:1659:192:192:61:0
 7  3 ms  3 ms  3 ms  2001:288:0:1659:192:192:61:232
 8  3 ms  3 ms  3 ms  2001:288:0:1659:192:192:61:562
 9  4 ms  4 ms  3 ms  ae5.pr01.tpe1.tfbnw.net [2620:0:1cff:dead:beee::c3e]
10  3 ms  3 ms  3 ms  po101.psw01.tpe1.tfbnw.net [2620:0:1cff:dead:bef0::237]
11  3 ms  3 ms  3 ms  po1.mslaj.01.tpe1.tfbnw.net [2a03:2880:f017:ffff::13]
12  3 ms  3 ms  3 ms  edge-star-mini6-shv-01-tpe1.facebook.com [2a03:2880:f117:83:face:b00c:0:25de]
```

圖 23 Windows 8 - Case 4 – Facebook

Windows 8 - Case 5 – Twitter (IPv4 - only)

nslookup

```
C:\Windows\system32>nslookup
預設伺服器: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

> twitter.com
伺服器: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

未經授權的回答:
名稱: twitter.com
Addresses: 64:ff9b::68f4:2ac1
64:ff9b::68f4:2a81
104.244.42.193
104.244.42.129

>
```

browser



ping

```
C:\Windows\system32>ping twitter.com

Ping twitter.com [64:ff9b::68f4:2ac1] (使用 32 位元組的資料):
回響自 64:ff9b::68f4:2ac1: 時間=56ms
回響自 64:ff9b::68f4:2ac1: 時間=56ms
回響自 64:ff9b::68f4:2ac1: 時間=56ms
回響自 64:ff9b::68f4:2ac1: 時間=56ms

64:ff9b::68f4:2ac1 的 Ping 統計資料:
封包: 已傳送 = 4, 已收到 = 4, 已遺失 = 0 (0% 遺失),
大約的來回時間 (毫秒):
最小值 = 56ms, 最大值 = 57ms, 平均 = 56ms

C:\Windows\system32>
```

tracert

```
C:\Windows\system32>tracert twitter.com

在 30 個躍點上
追蹤 twitter.com [64:ff9b::68f4:2ac1] 的路由:

 1  <1 ms  <1 ms  (1 ms  2001:288:3001:59:3c56:a07c:cf26:4ba3
 2  1 ms  1 ms  (1 ms  64:ff9b::c008:8404
 3  2 ms  1 ms  1 ms  64:ff9b::8c73:3bfe
 4  1 ms  1 ms  10 ms  64:ff9b::cb48:f4d9
 5  9 ms  2 ms  2 ms  tycr-ncu.ncu.edu.tw [64:ff9b::cb48:f4e1]
 6  4 ms  3 ms  3 ms  64:ff9b::c0c0:3d66
 7  3 ms  3 ms  3 ms  64:ff9b::c0c0:3d05
 8  5 ms  11 ms  4 ms  64:ff9b::c0c0:3d6d
 9  4 ms  9 ms  4 ms  64:ff9b::c0c0:3d3a
10  23 ms  23 ms  23 ms  64:ff9b::c0c0:443e
11  24 ms  23 ms  24 ms  unknown.telstraglobal.net [64:ff9b::d2b0:2cb1]
12  22 ms  26 ms  23 ms  i-92.tpe1-core01.telstraglobal.net [64:ff9b::ca54:89f9]
13  61 ms  61 ms  61 ms  i-1w236.lha-core02.telstraglobal.net [64:ff9b::ca54:8cc9]
14  67 ms  66 ms  71 ms  i-0-7-0-7.siko11.telstraglobal.net [64:ff9b::ca2f:d8fa]
15  55 ms  59 ms  60 ms  64:ff9b::d2ad:b098
16  55 ms  55 ms  57 ms  64:ff9b::68f4:2ac1

追蹤完成。
```

圖 24 Windows 8 - Case 5 – Twitter

Windows 8 - Case 6 – Netflix (Dual - Stack)

nslookup

```
C:\Windows\system32>nslookup
預設伺服器: Unknown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

> netflix.com
伺服器: Unknown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

未經授權的回應:
名稱: netflix.com
Addresses: 2620:108:700f::23a7:6da3
2620:108:700f::22d8:7e24
2620:108:700f::22d0:15cc
2620:108:700f::3422:9ea1
2620:108:700f::36bb:b0c4
2620:108:700f::22d2:6bc3
2620:108:700f::22d1:16ca
2620:108:700f::3429:9397
54.213.232.186
54.187.176.196
52.25.212.16
35.166.68.183
35.167.205.73
52.25.226.150
35.160.251.36
35.163.82.195
```

ping

```
C:\Windows\system32>ping netflix.com

Ping netflix.com [2620:108:700f::3419:d410] (使用 32 位元組的資料):
回覆自 2620:108:700f::3419:d410: 時間=164ms
回覆自 2620:108:700f::3419:d410: 時間=164ms
回覆自 2620:108:700f::3419:d410: 時間=164ms
回覆自 2620:108:700f::3419:d410: 時間=164ms

2620:108:700f::3419:d410 的 Ping 統計資料:
封包: 已傳送 = 4, 已收到 = 4, 已遺失 = 0 (0% 遺失),
大約的來回時間 (毫秒):
最小值 = 164ms, 最大值 = 164ms, 平均 = 164ms

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```

browser



tracert

```
C:\Windows\system32>tracert netflix.com

在 30 個躍點上追蹤 netflix.com [2620:108:700f::36d5:e8be] 的路由:

 1  < 1 ms  < 1 ms  < 1 ms  2001:288:3001:59::254
 2  < 1 ms  < 1 ms  < 1 ms  2001:288:3001:1::254
 3  < 1 ms  < 1 ms  < 1 ms  2001:288:30ff::2
 4  < 1 ms  < 1 ms  < 1 ms  2001:288:30ff::2
 5  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:101
 6  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:24
 7  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
 8  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
 9  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
10  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
11  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
12  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
13  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
14  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
15  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
16  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
17  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
18  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
19  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
20  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
21  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
22  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
23  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
24  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
25  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
26  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
27  < 1 ms  < 1 ms  < 1 ms  2001:288:0:1659:192:192:61:232
```

圖 25 Windows 8 - Case 6 – Netflix

Windows 8 - Case 7 – Skype

待機畫面



接通畫面



圖 26 Windows 8 - Case 7 – Skype

Windows 8 - Case 8 – FTP (FileZilla)

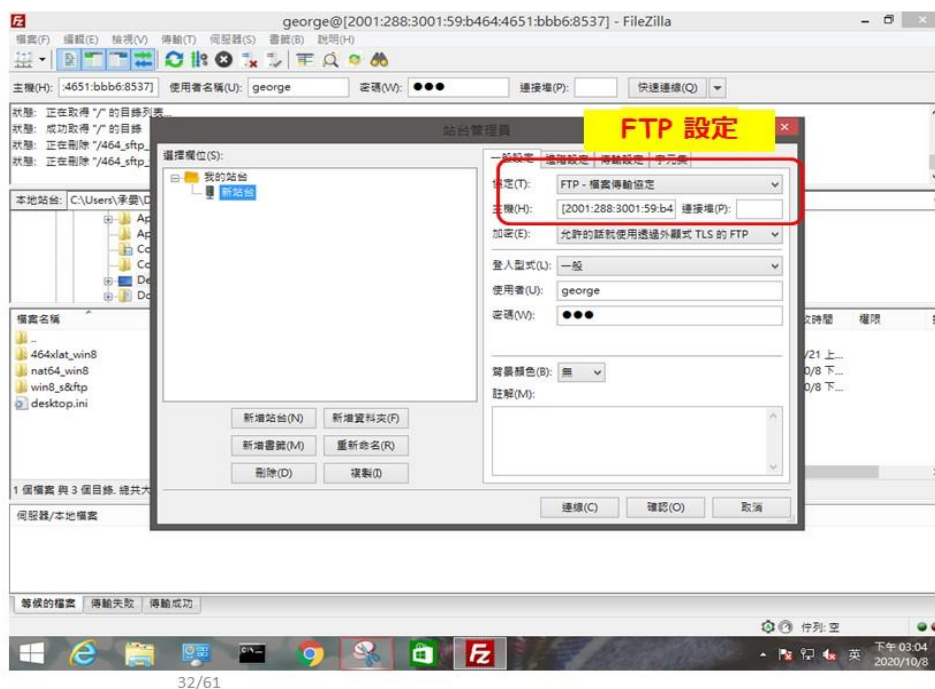


圖 27 Windows 8 - Case 8 – FTP (FileZilla)

Windows 8 - Case 8 – FTP (FileZilla) - Download

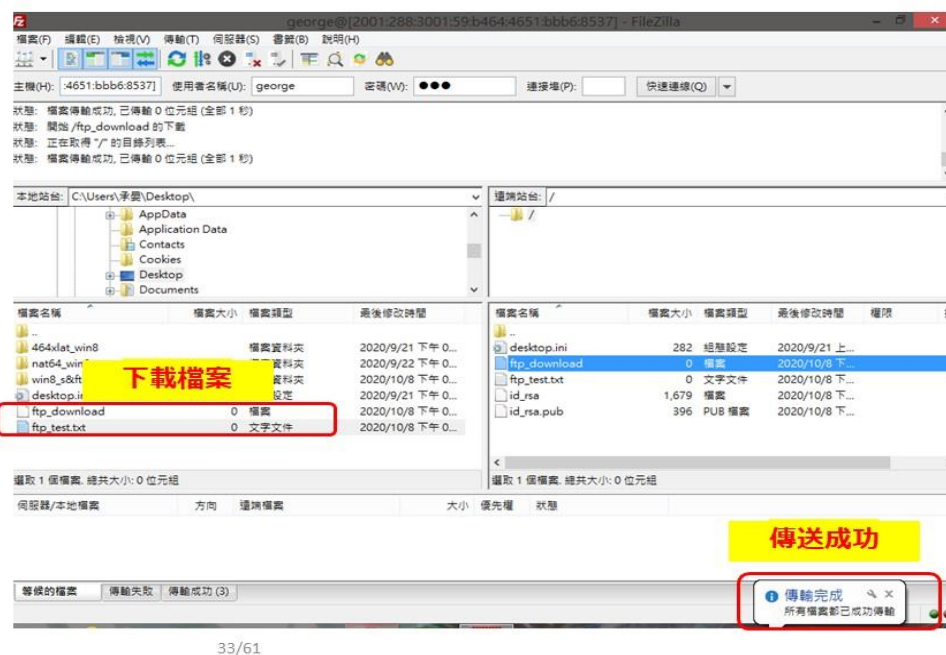


圖 28 Windows 8 - Case 8 – FTP (FileZilla) - Download

Windows 8 - Case 8 – FTP (FileZilla) - Upload

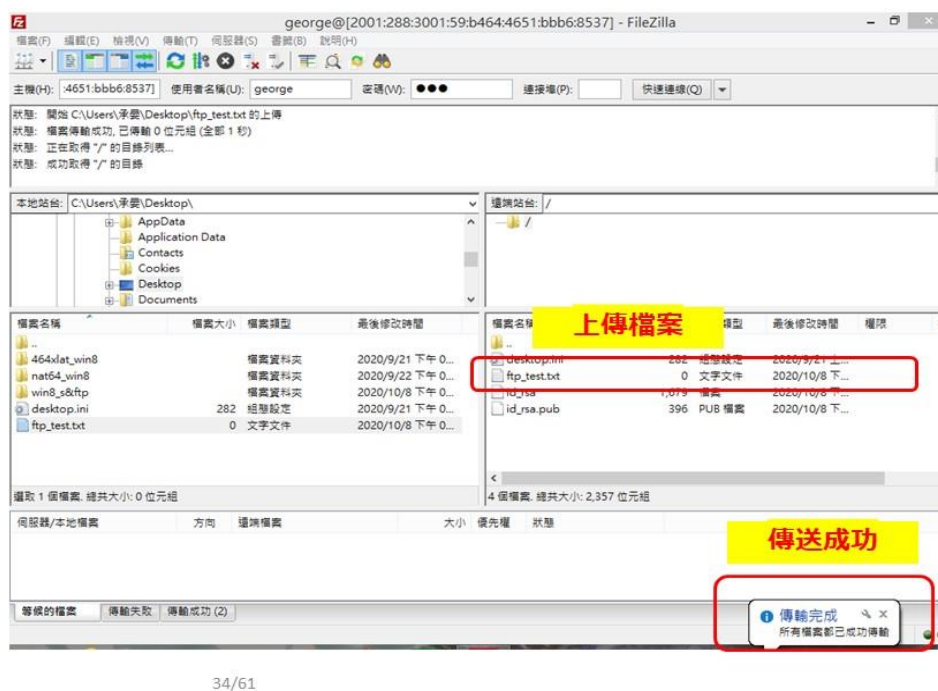


圖 29 Windows 8 - Case 8 – FTP (FileZilla) - Upload

Windows 8 - Case 9 – SFTP (FileZilla)

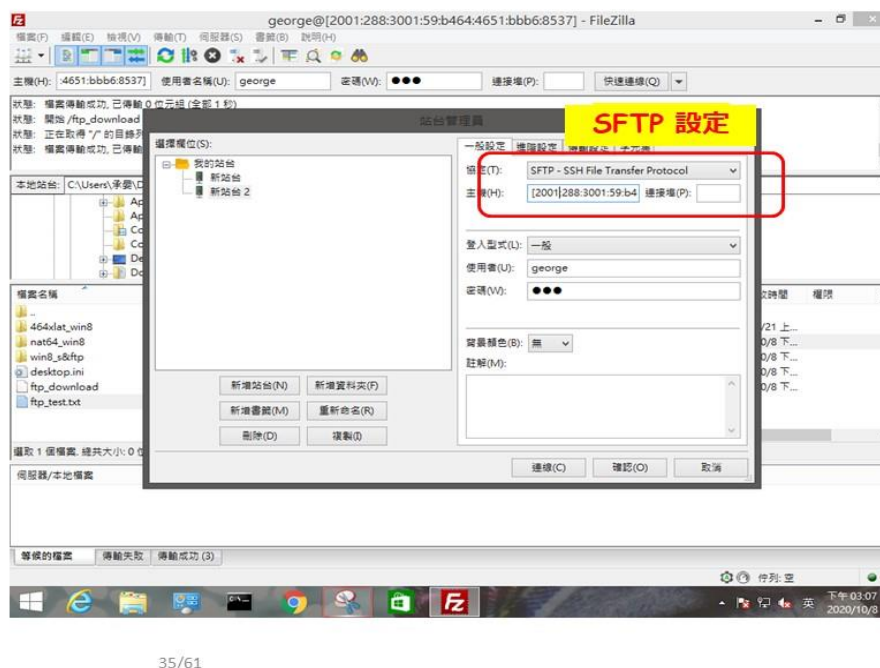
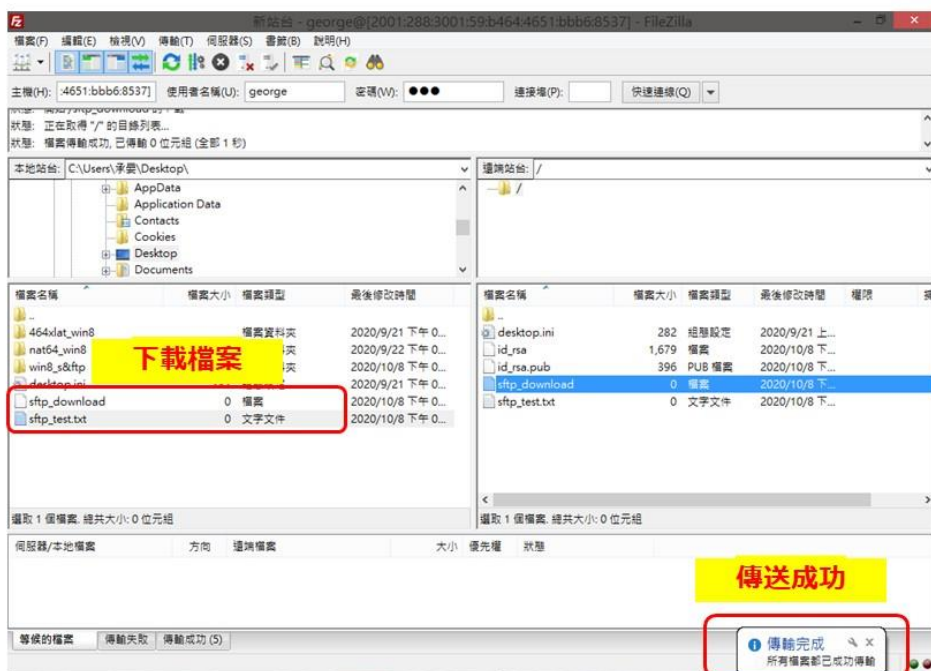


圖 30 Windows 8 - Case 9 – SFTP (FileZilla)

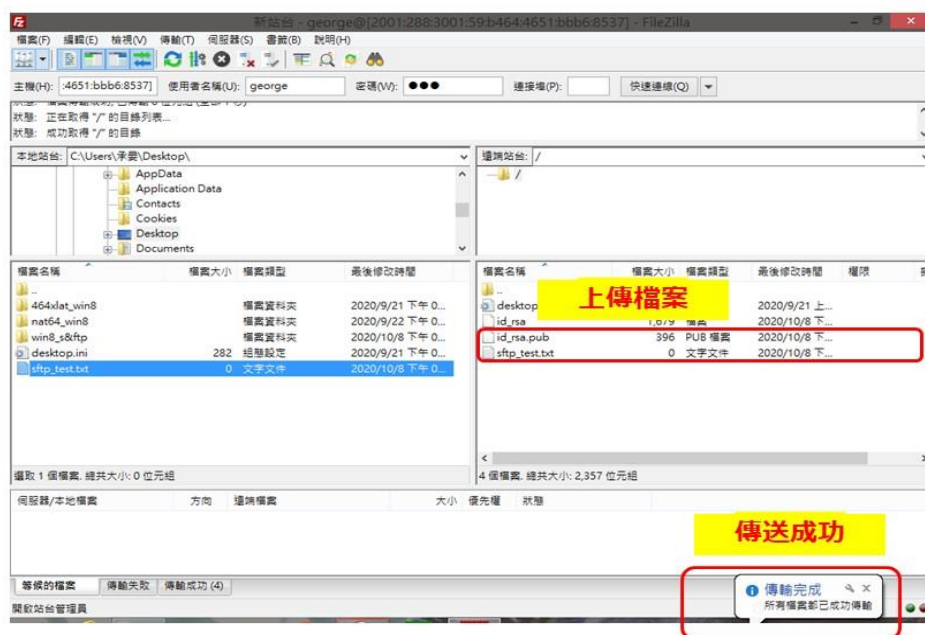
Windows 8 - Case 9 – SFTP (FileZilla) - Download



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圖 31 Windows 8 - Case 9 – SFTP (FileZilla) - Download

Windows 8 - Case 9 – SFTP (FileZilla) - Upload



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圖 32 Windows 8 - Case 9 – SFTP (FileZilla) - Upload

Windows 8 - Case 10 – Windows Outlook

outlook 網頁



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圖 33 Windows 8 - Case 10 – Windows Outlook

Windows 8 - Case 11 – Gmail

Gmail 網頁

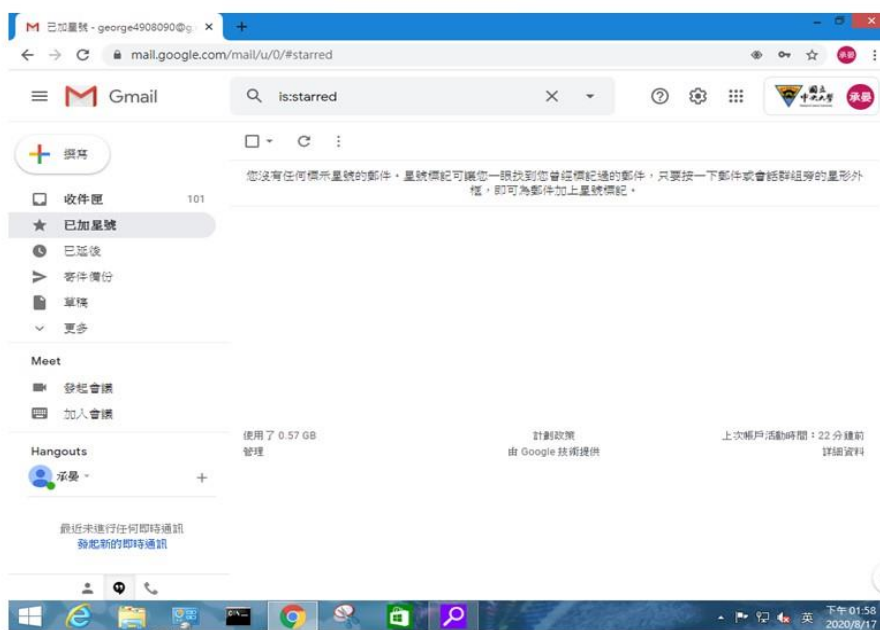
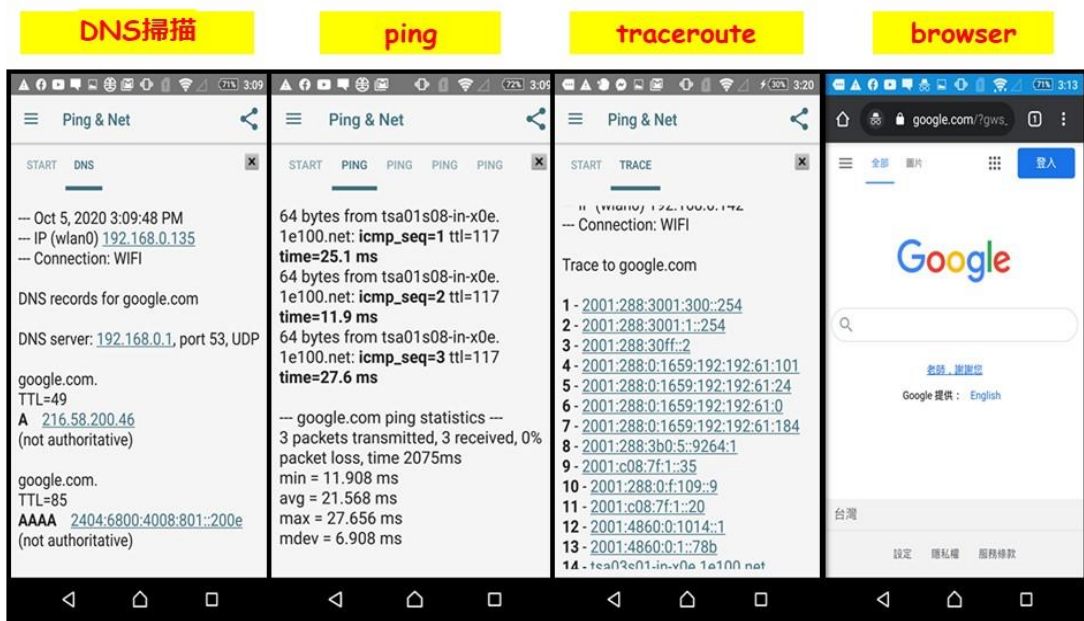


圖 34 Windows 8 - Case 11 – Gmail

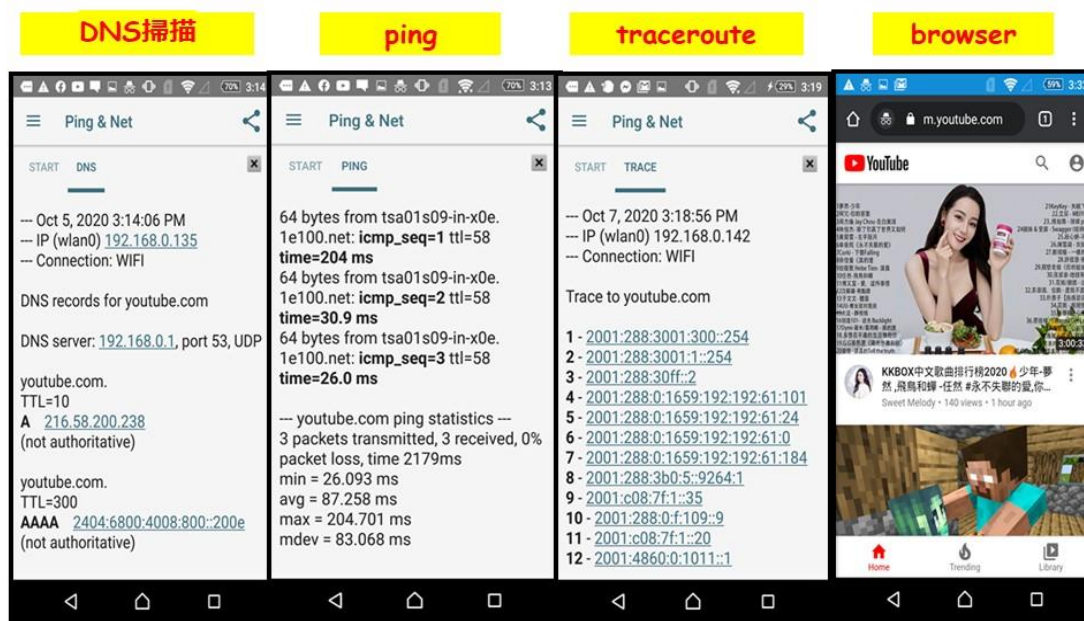
Android - Case 1 – Google (Dual - Stack)



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圖 35 Android - Case 1 – Google

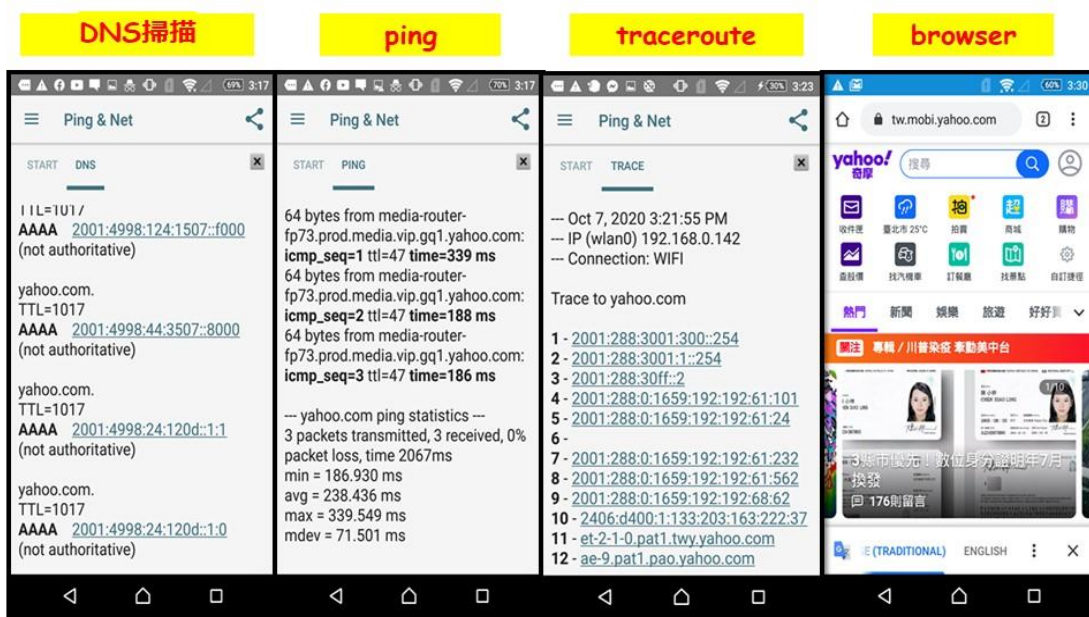
Android - Case 2 – Youtube (Dual - Stack)



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圖 36 Android - Case 2 – Youtube

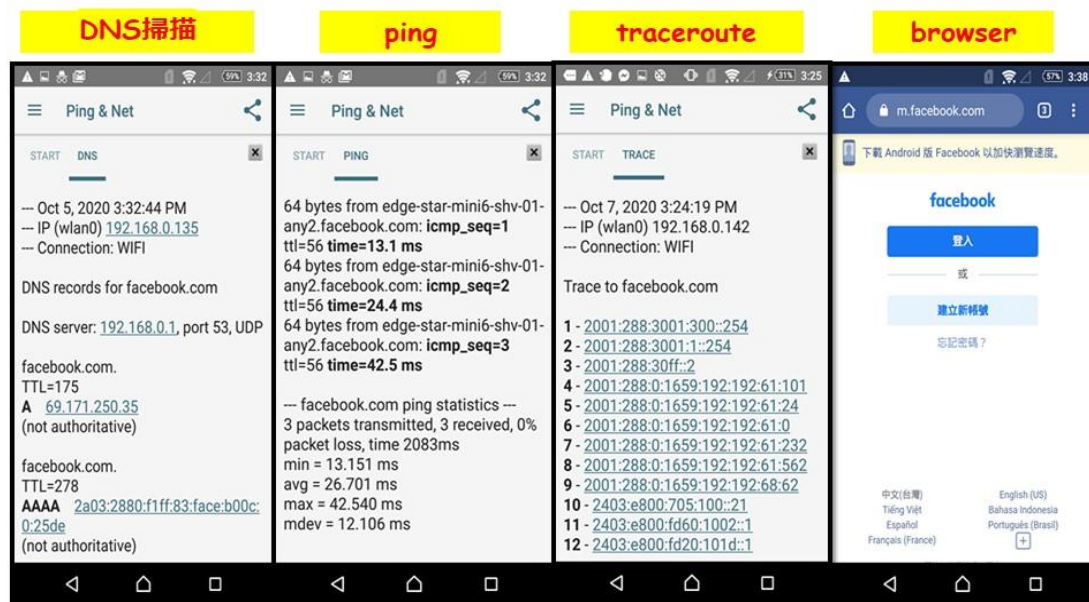
Android - Case 3 – Yahoo (Dual - Stack)



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圖 37 Android - Case 3 – Yahoo

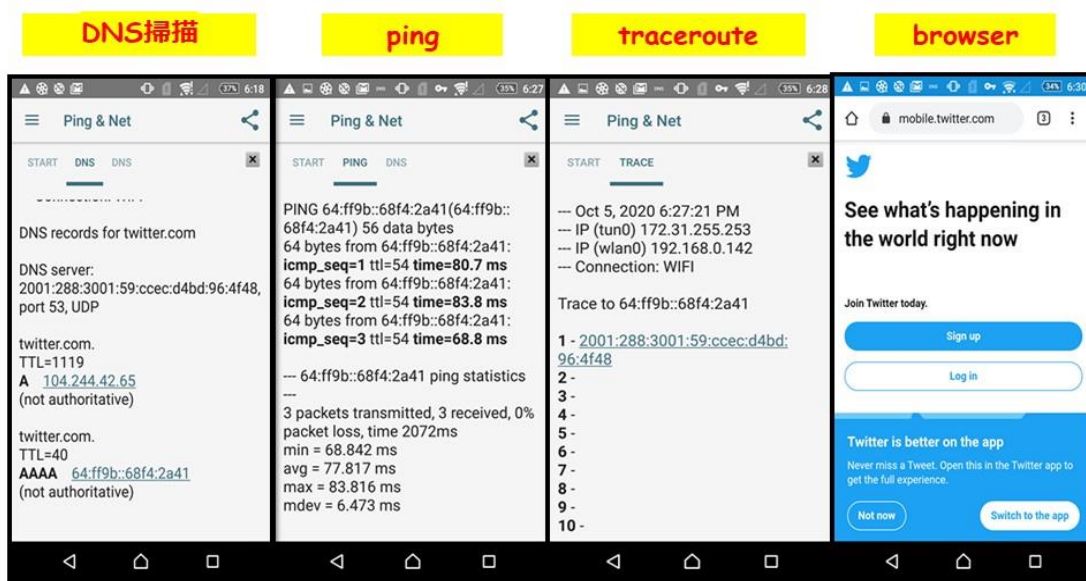
Android - Case 4 – Facebook (Dual - Stack)



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圖 38 Android - Case 4 – Facebook

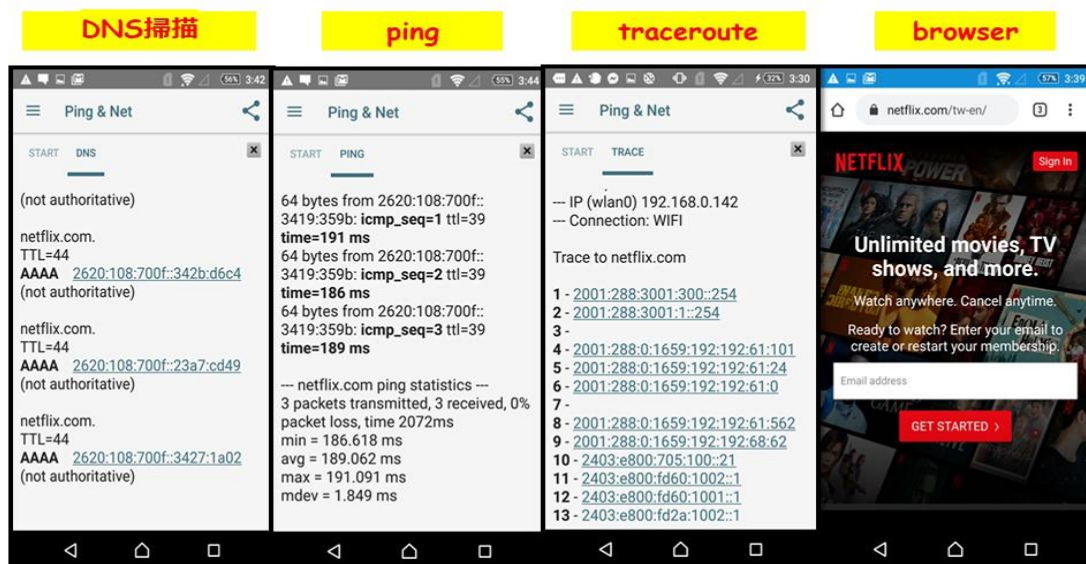
Android - Case 5 – Twitter (IPv4 - only)



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圖 39 Android - Case 5 – Twitter

Android - Case 6 – Netflix (Dual - Stack)



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圖 40 Android - Case 6 – Netflix

Android - Case 7 – Skype



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圖 41 Android - Case 7 – Skype

Android - Case 8 – FTP (FileManager+ - FileZilla)



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圖 42 Android - Case 8 – FTP (FileManager+ - FileZilla)

Android - Case 9 – SFTP (FileManager+ - FileZilla)



圖 43 Android - Case 9 – SFTP (FileManager+ - FileZilla)

Android - Case 10 – Windows Outlook

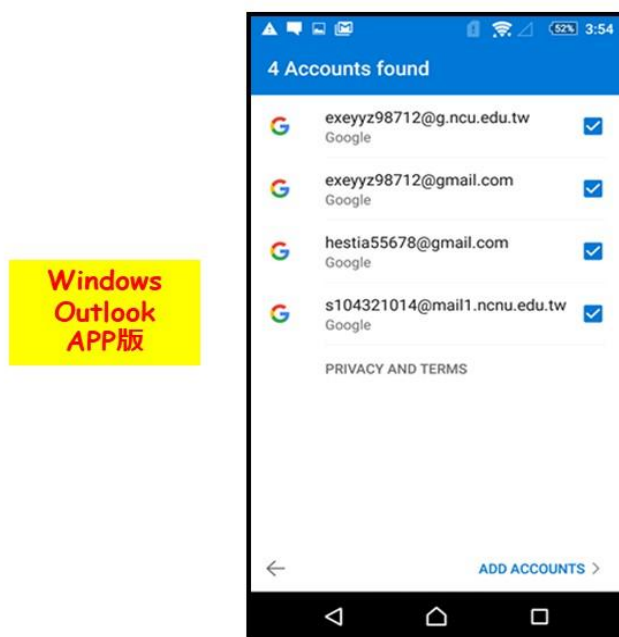
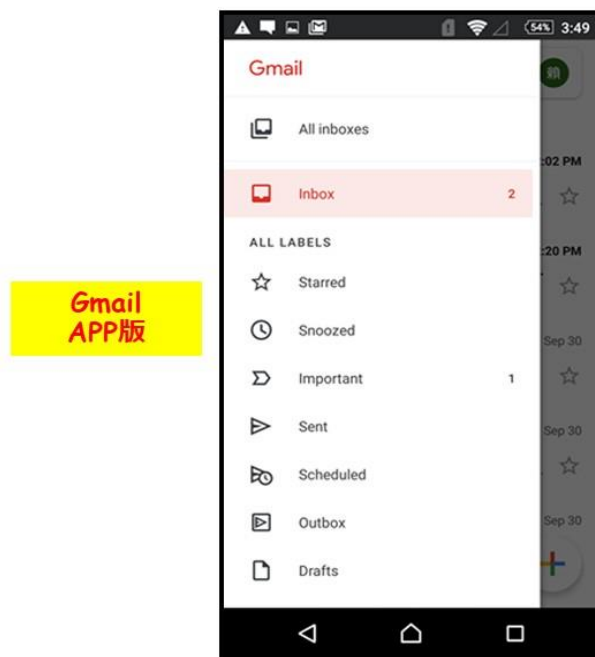


圖 44 Android - Case 10 – Windows Outlook

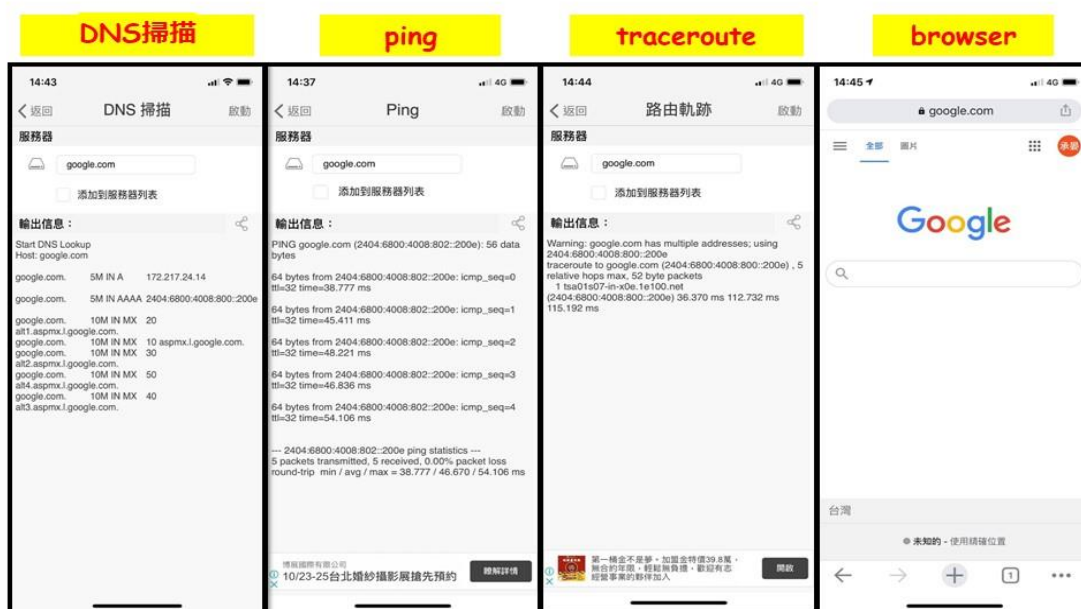
Android - Case 11 – Gmail



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圖 45 Android - Case 11 – Gmail

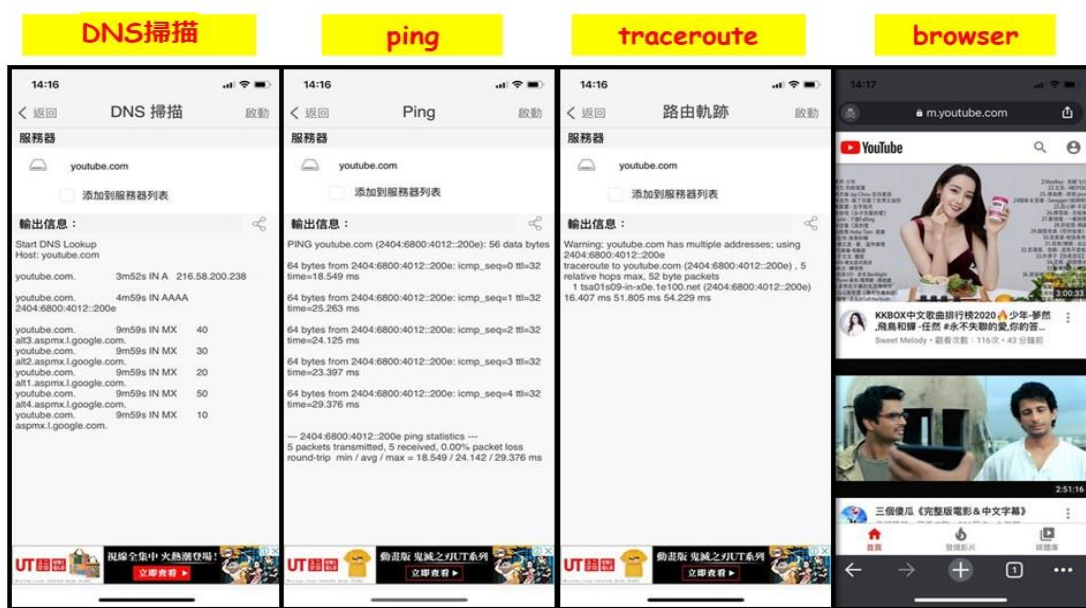
iOS - Case 1 – Google (Dual - Stack)



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圖 46 iOS - Case 1 – Google

iOS - Case 2 – Youtube (Dual - Stack)



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圖 47 iOS - Case 1 – Google

iOS - Case 3 – Yahoo (Dual - Stack)

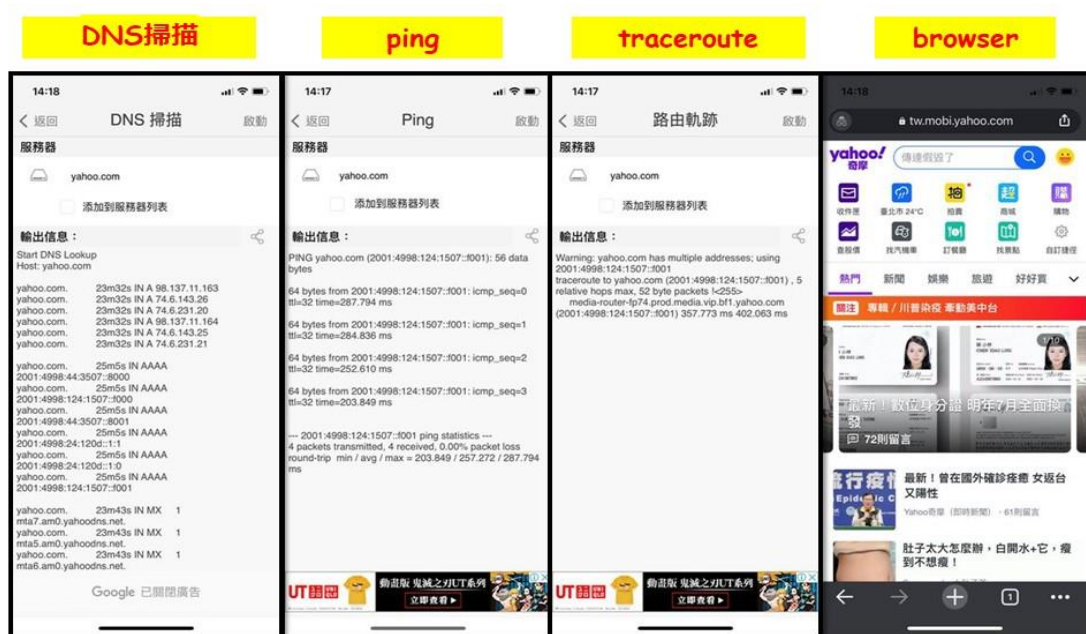


圖 48 iOS - Case 2 – Yahoo

iOS - Case 4 – Facebook (Dual - Stack)

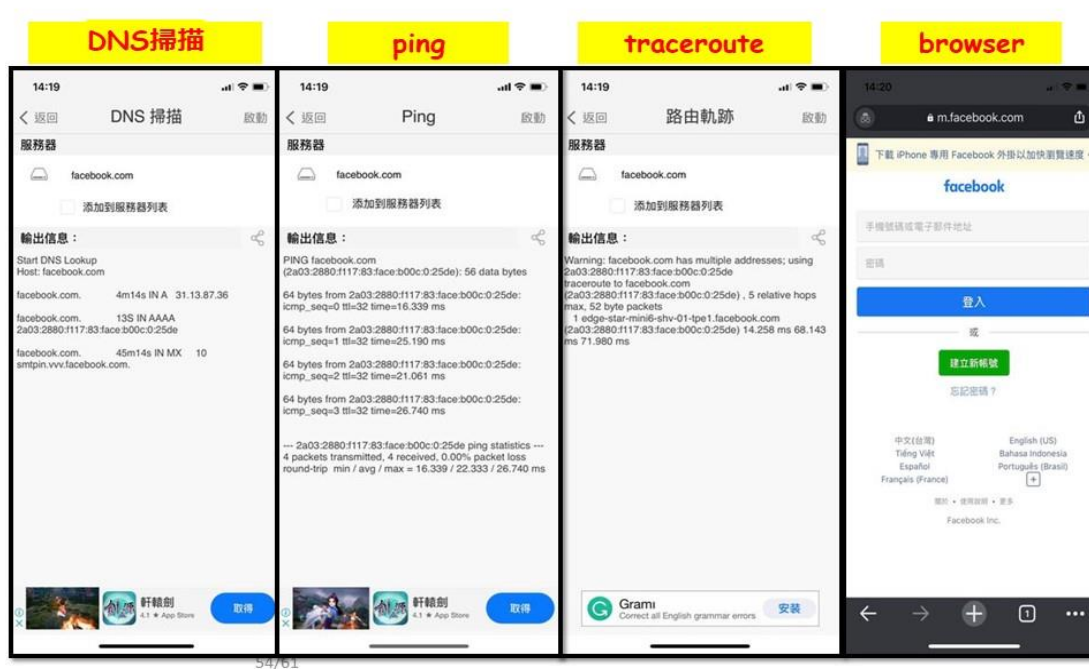


圖 49 iOS - Case 4 – Facebook

iOS - Case 5 – Twitter (IPv4 - only)

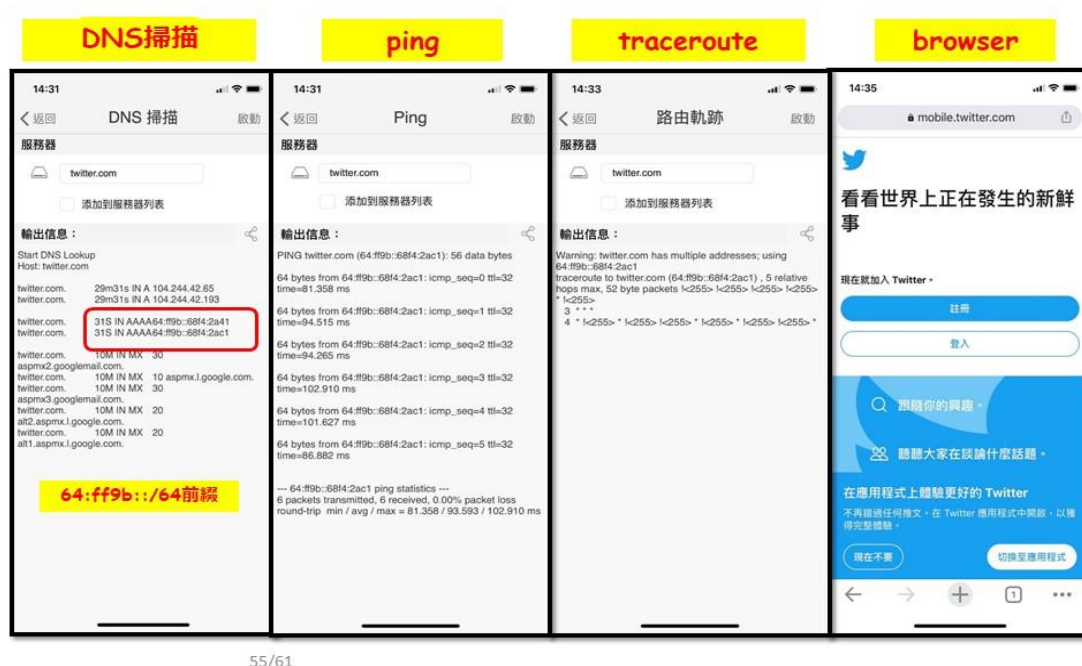


圖 50 iOS - Case 5 – Twitter

iOS - Case 6 – Netflix (Dual - Stack)

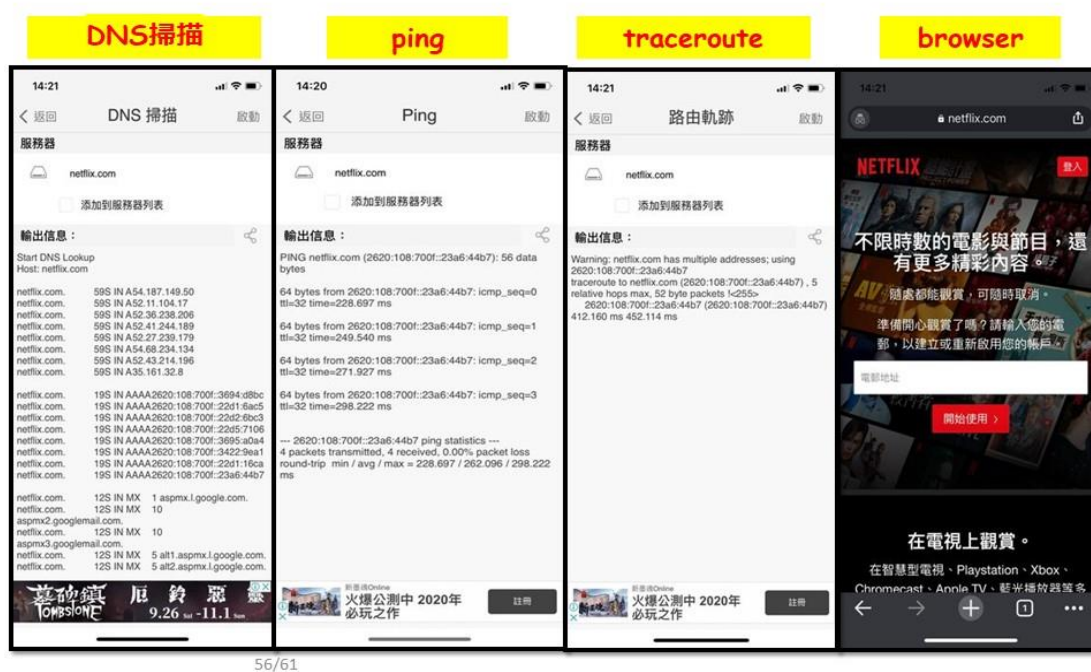


圖 51 iOS - Case 6 – Netflix

iOS - Case 7 – Skype

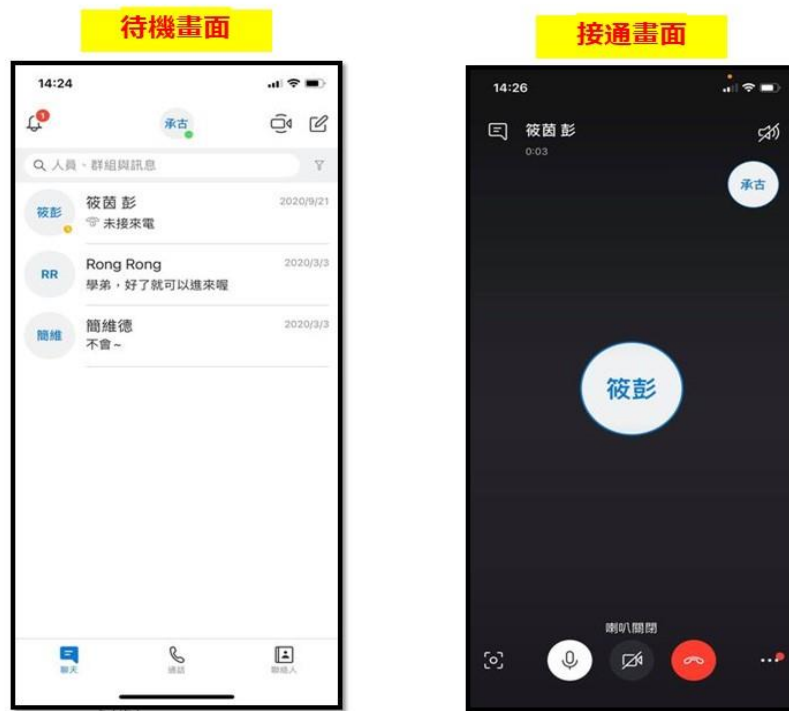


圖 52 iOS - Case 7 – Skype

iOS - Case 8 – FTP (FTPManager - FileZilla)

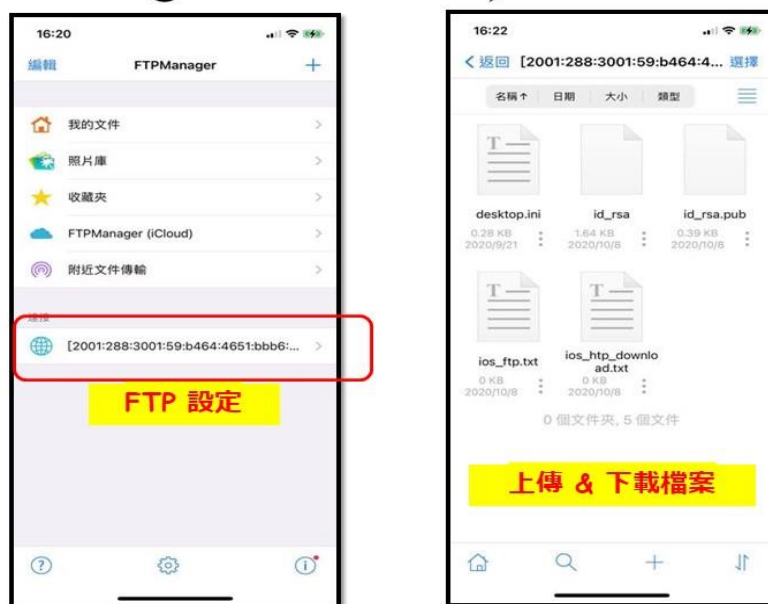


圖 53 iOS - Case 8 – FTP (FTPManager - FileZilla)

iOS - Case 9 – SFTP (FTPManager - FileZilla)



圖 54 iOS - Case 9 – SFTP (FTPManager - FileZilla)

iOS - Case 10 – Windows Outlook

Windows
Outlook
APP版



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圖 55 iOS - Case 10 – Windows Outlook

iOS - Case 11 – Gmail

Gmail
APP版



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圖 56 iOS - Case 11 – Gmail

二、 464XLAT 測試成果

464XLAT 測試結果摘要如表 4 所示。同樣分為基本測試、
連線測試及應用測試，測試結果如下說明：

表 4 464XLAT 測試摘要

項次	網站名稱	網站類型	有線裝置		無線裝置	
			Win8	Win10	Android	iOS
1	Google	入口網站	v	v	v	v
2	Youtube	影音網站	v	v	v	v
3	Facebook	社群網站	v	v	v	v
4	Yahoo	入口網站	v	v	v	v
5	Netflix	影音網站	v	v	v	v
6	Twitter	社群網站	v	v	v	v
項次	服務	名稱	有線裝置		無線裝置	
			Win8	Win10	Android	iOS
7	SKYPE	通訊服務	v	v	v	v
8	FTP	下載服務	v	v	v	v
9	SFTP	傳輸服務	v	v	v	v
10	Outlook	郵件服務	v	v	v	v
11	Gmail	郵件服務	v	v	v	v

網站支援	網站名稱	訊務是否經過CLAT	訊務是否經過PLAT	464XLAT			Native IPv4		
				Response time	Ping	Web	Response time	Ping	Web
DS	Google	是	否	3ms	v	v	4ms	v	v
DS	Youtube	是	否	4ms	v	v	4ms	v	v
DS	Facebook	是	否	3ms	v	v	28ms	v	v
DS	Yahoo	是	否	167ms	v	v	165ms	v	v
DS	Netflix	是	否	165ms	v	v	X	X	v
IPv4 only	Twitter	是	是	66.3ms	v	v	65ms	v	v

結果顯示，464XLAT 基本測試所有測項皆可透過 464XLAT 連網環境存取。其中 twitter.com 須經由 4-to-6-to-4 的轉換，而其他網站則是 6-to-6 的方式。

連線測試的部分，6 個目標網站皆可透過 464XLAT 環境存取。從表中 twitter.com 測項結果可看出經由 464XLAT 轉換和 Native IPv4 的連線方式之差異，response time 只差距 1.3ms，轉換影響甚小。

應用測試的部分，Windows10、Windows8、Android 及 iOS 四種作業系統皆皆可通過所有應用測試。

464XLAT 逐項測試截圖請參考圖 57 ~ 圖 110。其中 Windows10 測試結果為圖 57 ~ 圖 72；Windows8 測試結果為圖 73 ~ 圖 88；Android 測試結果為圖 89 ~ 圖 99；iOS 測試

結果為圖 100 ~ 圖 110。

測試主機 (Win 10)

ipconfig (IPv6 only)

```
C:\WINDOWS\system32>ipconfig

Windows IP Configuration

Ethernet adapter 乙太網路:

    Connection-specific DNS Suffix  . : lan
    IPv6 Address. . . . . : 2001:288:3001:300:8875:adc1:987c:a198
    Temporary IPv6 Address. . . . . : 2001:288:3001:300:208f:b50:c9b:8f75
    Link-local IPv6 Address . . . . . : fe80::8875:adc1:987c:a198%15
    IPv4 Address. . . . . : 192.168.132.160
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : fe80::66a0:e7ff:fe43:3841%15
                                fe80::c081:d7bd:33ce:b73b%15
                                192.168.132.134
```

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圖 57 464XLAT Windows10 測試主機資訊

Windows 10 - Case 1 – Google (Dual - Stack)

nslookup

```
C:\WINDOWS\system32>nslookup
Default Server: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

> google.com
Server: UnKnown
Address: 2001:288:3001:59:25e:ab37:b87a:d487

Non-authoritative answer:
Name: google.com
Addresses: 2404:6800:4008:801::200e
          216.58.200.46
```

browser

ping

```
C:\WINDOWS\system32>ping google.com

Pinging google.com [2404:6800:4008:801::200e] with 32 bytes of data:
Reply from 2404:6800:4008:801::200e: time=3ms
Reply from 2404:6800:4008:801::200e: time=3ms
Reply from 2404:6800:4008:801::200e: time=3ms
Reply from 2404:6800:4008:801::200e: time=3ms

Ping statistics for 2404:6800:4008:801::200e:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 3ms, Maximum = 3ms, Average = 3ms
```

tracert

```
C:\WINDOWS\system32>tracert google.com

Tracing route to google.com [2404:6800:4008:801::200e]
over a maximum of 30 hops:
  0  <1 ms    <1 ms    <1 ms    2001:288:3001:300:4408:cbdf:6a82:82d4
  1  <1 ms    <1 ms    <1 ms    2001:288:3001:1::254
  2  <1 ms    <1 ms    <1 ms    2001:288:30ff::2
  3  <1 ms    <1 ms    <1 ms    2001:288:0:1659:192:192:61:101
  4  <1 ms    <1 ms    <1 ms    2001:288:0:1659:192:192:61:184
  5  <1 ms    <1 ms    <1 ms    2001:288:0:1659:192:192:61:101
  6  <1 ms    <1 ms    <1 ms    2001:288:0:1659:192:192:61:184
  7  <1 ms    <1 ms    <1 ms    2001:288:0:1659:192:192:61:184
  8  <1 ms    <1 ms    <1 ms    2001:288:3b0:5::9264:1
  9  <1 ms    <1 ms    <1 ms    2001:c08:7f:1::35
 10  <1 ms    <1 ms    <1 ms    2001:288:0:f:109:9
 11  <1 ms    <1 ms    <1 ms    2001:4860:1:1::e0
 12  <1 ms    <1 ms    <1 ms    2001:4860:0:1011:1
 13  <1 ms    <1 ms    <1 ms    2001:4860:0:1:1e9f
 14  <1 ms    <1 ms    <1 ms    tsa01s08-in-x0e.1e100.net [2404:6800:4008:801::200e]

Trace complete.
```

圖 58 Windows 10 - Case 1 – Google

Windows 10 - Case 2 – Youtube (Dual - Stack)

nslookup

```
C:\WINDOWS\system32>nslookup
Default Server: OpenWrt.lan
Address: 192.168.132.1

> youtube.com
Server: OpenWrt.lan
Address: 192.168.132.1

Non-authoritative answer:
Name: youtube.com
Addresses: 2404:6800:4008:802::200e
          172.217.27.142

>
```

browser

ping

```
C:\WINDOWS\system32>ping youtube.com

Pinging youtube.com [2404:6800:4008:802::200e] with 32 bytes of data:
Reply from 2404:6800:4008:802::200e: time=4ms
Reply from 2404:6800:4008:802::200e: time=4ms
Reply from 2404:6800:4008:802::200e: time=4ms
Reply from 2404:6800:4008:802::200e: time=4ms

Ping statistics for 2404:6800:4008:802::200e:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 4ms, Maximum = 4ms, Average = 4ms
```

tracert

```
C:\WINDOWS\system32>tracert youtube.com

Tracing route to youtube.com [2404:6800:4008:802::200e]
over a maximum of 30 hops:
  0  <1 ms    <1 ms    <1 ms    2001:288:3001:300:cb4:a857:d11b:1b53
  1  <1 ms    <1 ms    <1 ms    2001:288:3001:1::254
  2  <1 ms    <1 ms    <1 ms    2001:288:30ff::2
  3  <1 ms    <1 ms    <1 ms    2001:288:0:1659:192:192:61:101
  4  <1 ms    <1 ms    <1 ms    2001:288:0:1659:192:192:61:184
  5  <1 ms    <1 ms    <1 ms    2001:288:0:1659:192:192:61:101
  6  <1 ms    <1 ms    <1 ms    2001:288:0:1659:192:192:61:184
  7  <1 ms    <1 ms    <1 ms    2001:288:0:1659:192:192:61:184
  8  <1 ms    <1 ms    <1 ms    2001:288:3b0:5::9264:1
  9  <1 ms    <1 ms    <1 ms    2001:c08:7f:1::35
 10  <1 ms    <1 ms    <1 ms    2001:288:0:f:109:9
 11  <1 ms    <1 ms    <1 ms    2001:4860:1:1::e0
 12  <1 ms    <1 ms    <1 ms    2001:4860:0:1013:1
 13  <1 ms    <1 ms    <1 ms    2001:4860:0:1:1e9f
 14  <1 ms    <1 ms    <1 ms    tsa03s01-in-x0e.1e100.net [2404:6800:4008:802::200e]

Trace complete.
```

圖 59 Windows 10 - Case 2 – Youtube

Windows 10 - Case 3 – Yahoo (Dual - Stack)

nslookup

```
C:\WINDOWS\system32>nslookup
Default Server: OpenWrt.lan
Address: 192.168.132.1

> yahoo.com
Server: OpenWrt.lan
Address: 192.168.132.1

Non-authoritative answer:
Name: yahoo.com
Addresses: 2001:4998:24:120d::1:0
          2001:4998:124:1507::f000
          2001:4998:24:120d::1:1
          2001:4998:44:3507::8000
          2001:4998:124:1507::f001
          2001:4998:44:3507::8001
          74.6.143.25
          74.6.231.20
          74.6.231.21
          98.137.11.164
          98.137.11.163
          74.6.143.26

>
```

browser



ping

```
C:\WINDOWS\system32>ping yahoo.com

Pinging yahoo.com [2001:4998:44:3507::8001] with 32 bytes of data:
Reply from 2001:4998:44:3507::8001: time=167ms
Reply from 2001:4998:44:3507::8001: time=167ms
Reply from 2001:4998:44:3507::8001: time=167ms
Reply from 2001:4998:44:3507::8001: time=167ms

Ping statistics for 2001:4998:44:3507::8001:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 167ms, Maximum = 167ms, Average = 167ms

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```

tracert

圖 60 Windows 10 - Case 3 – Yahoo

Windows 10 - Case 4 – Facebook (Dual - Stack)

nslookup

```
C:\WINDOWS\system32>nslookup
Default Server: OpenWrt.lan
Address: 192.168.132.1

> facebook.com
Server: OpenWrt.lan
Address: 192.168.132.1

Non-authoritative answer:
Name: facebook.com
Addresses: 2a03:2880:ffff:83:face:b00c:0:25de
          69.171.250.35

>
```

browser



ping

```
C:\WINDOWS\system32>ping facebook.com

Pinging facebook.com [2a03:2880:ffff:83:face:b00c:0:25de] with 32 bytes of data:
Reply from 2a03:2880:ffff:83:face:b00c:0:25de: time=3ms
Reply from 2a03:2880:ffff:83:face:b00c:0:25de: time=3ms
Reply from 2a03:2880:ffff:83:face:b00c:0:25de: time=3ms
Reply from 2a03:2880:ffff:83:face:b00c:0:25de: time=3ms

Ping statistics for 2a03:2880:ffff:83:face:b00c:0:25de:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 3ms, Maximum = 3ms, Average = 3ms

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```

tracert

圖 61 Windows 10 - Case 4 – Facebook

Windows 10 - Case 5 – Twitter (IPv4 - only)

nslookup

```
C:\WINDOWS\system32>nslookup
Default Server: OpenWrt.lan
Address: 192.168.132.1

> twitter.com
Server: OpenWrt.lan
Address: 192.168.132.1

Non-authoritative answer:
Name: twitter.com
Addresses: 104.244.42.1
          104.244.42.193

>
```

ping

```
C:\WINDOWS\system32>ping twitter.com

Pinging twitter.com [104.244.42.193] with 32 bytes of data:
Reply from 104.244.42.193: bytes=32 time=66ms TTL=53
Reply from 104.244.42.193: bytes=32 time=66ms TTL=53
Reply from 104.244.42.193: bytes=32 time=67ms TTL=53
Reply from 104.244.42.193: bytes=32 time=66ms TTL=53

Ping statistics for 104.244.42.193:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 66ms, Maximum = 67ms, Average = 66ms
```

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browser



tracert

```
C:\WINDOWS\system32>tracert twitter.com

Tracing route to twitter.com [104.244.42.193]
over a maximum of 30 hops:

  0  <1 ms    <1 ms    <1 ms    clat-virtual-machine.lan [192.168.132.134]
  1  <1 ms    <1 ms    <1 ms    clat-virtual-machine.lan [192.168.132.134]
  2  1 ms     1 ms     1 ms     OpenWrt.lan [192.168.132.1]
  3  1 ms     1 ms     1 ms     OpenWrt.lan [192.168.132.1]
  4  2 ms     2 ms     2 ms     140.115.59.254
  5  2 ms     2 ms     2 ms     203.72.244.185
  6  3 ms     3 ms     2 ms     tyrc-ncu.ncu.edu.tw [203.72.244.225]
  7  3 ms     2 ms     3 ms     192.192.61.102
  8  3 ms     3 ms     3 ms     192.192.61.5
  9  4 ms     5 ms     5 ms     192.192.61.237
 10 12 ms    12 ms    5 ms     192.192.61.58
 11 24 ms    23 ms    24 ms    192.192.68.62
 12 25 ms    24 ms    24 ms    unknown.telstraglobal.net [210.176.44.177]
 13 25 ms    25 ms    22 ms    i-92.tpei-core01.telstraglobal.net [202.84.137.249]
 14 29 ms    29 ms    30 ms    202.84.138.73
 15 22 ms    21 ms    22 ms    202.84.153.26
 16 24 ms    25 ms    22 ms    twitter1-10g.hkix.net [123.255.90.149]
 17 *      *      *      Request timed out.
 18 66 ms    66 ms    66 ms    104.244.42.193

Trace complete.
```

圖 62 Windows 10 - Case 5 – Twitter

Windows 10 - Case 6 – Netflix (Dual - Stack)

nslookup

```
C:\WINDOWS\system32>nslookup
Default Server: OpenWrt.lan
Address: 192.168.132.1

> netflix.com
Server: OpenWrt.lan
Address: 192.168.132.1

Non-authoritative answer:
Name: netflix.com
Addresses: 2620:108:700f::22d2:b4b4
          2620:108:700f::342b:d6c4
          2620:108:700f::3422:26c8
          2620:108:700f::341a:4fae
          2620:108:700f::3419:d410
          2620:108:700f::36bb:b0c4
          2620:108:700f::3644:ea86
          54.148.216.188
          54.187.176.196
          52.11.211.26
          35.160.251.36
          52.34.38.200
          34.209.106.197
          34.216.180.180
          34.209.22.202
```

ping

```
C:\WINDOWS\system32>ping netflix.com

Pinging netflix.com [2620:108:700f::22d2:6bc3] with 32 bytes of data:
Reply from 2620:108:700f::22d2:6bc3: time=165ms
Reply from 2620:108:700f::22d2:6bc3: time=165ms
Reply from 2620:108:700f::22d2:6bc3: time=165ms
Reply from 2620:108:700f::22d2:6bc3: time=165ms

Ping statistics for 2620:108:700f::22d2:6bc3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 165ms, Maximum = 165ms, Average = 165ms
```

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browser



tracert

```
C:\WINDOWS\system32>tracert netflix.com

Tracing route to netflix.com [2620:108:700f::3644:ea86]
over a maximum of 30 hops:

  0  <1 ms    <1 ms    <1 ms    2001:288:3001:300:f593:1a61:3c22:c2e6
  1  2 ms     1 ms     1 ms     2001:288:3001:1::254
  2  1 ms     1 ms     1 ms     2001:288:30ff::2
  3  2 ms     2 ms     2 ms     2001:288:0:1659:192:192:61:101
  4  2 ms     2 ms     2 ms     2001:288:0:1659:192:192:61:24
  5  2 ms     2 ms     2 ms     2001:288:0:1659:192:192:61:0
  6  3 ms     3 ms     3 ms     2001:288:0:1659:192:192:61:232
  7  3 ms     3 ms     3 ms     2001:288:0:1659:192:192:61:562
  8  3 ms     3 ms     3 ms     2001:288:0:1659:192:192:68:62
  9  3 ms     3 ms     3 ms     2402:4480:2:6::4:1
 10 25 ms    24 ms    *      be2226.ccr21.hkg02.atlas.cogentco.com [2001:550:0:1000::9a36:2889]
 11 *      *      *      Request timed out.
 12 *      *      *      Request timed out.
 13 *      *      *      Request timed out.
 14 158 ms   161 ms   177 ms   2001:550:2:13::8b:2
 15 *      *      *      Request timed out.
 16 159 ms   160 ms   160 ms   2620:107:4000:4::2d
 17 *      *      *      Request timed out.
 18 *      *      *      Request timed out.
 19 167 ms   167 ms   167 ms   2620:107:4000:9008::42
 20 163 ms   163 ms   163 ms   2620:107:4000:9008::48
 21 162 ms   165 ms   164 ms   2620:107:4000:9008::1e
 22 167 ms   167 ms   167 ms   2620:107:4000:9008::30
 23 169 ms   167 ms   167 ms   2620:107:4000:9008::2a
 24 166 ms   166 ms   169 ms   2620:107:4000:8005::23
```

圖 63 Windows 10 - Case 6 – Netflix

Windows 10 - Case 7 – Skype

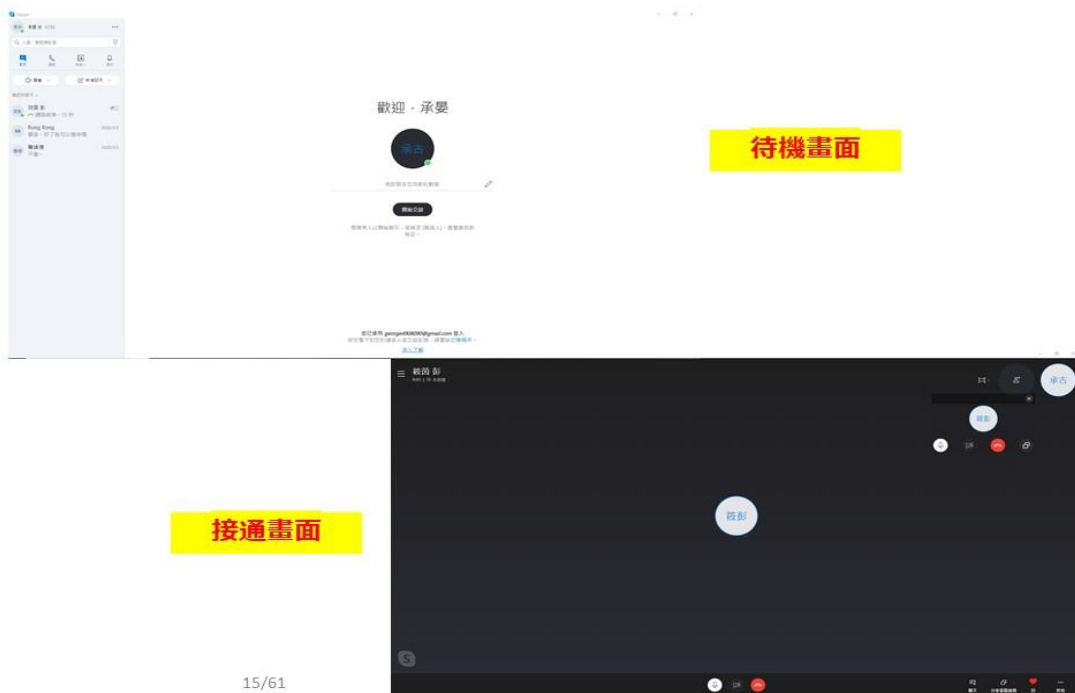


圖 64 Windows 10 - Case 7 – Skype

Windows 10 - Case 8 – FTP (FileZilla)

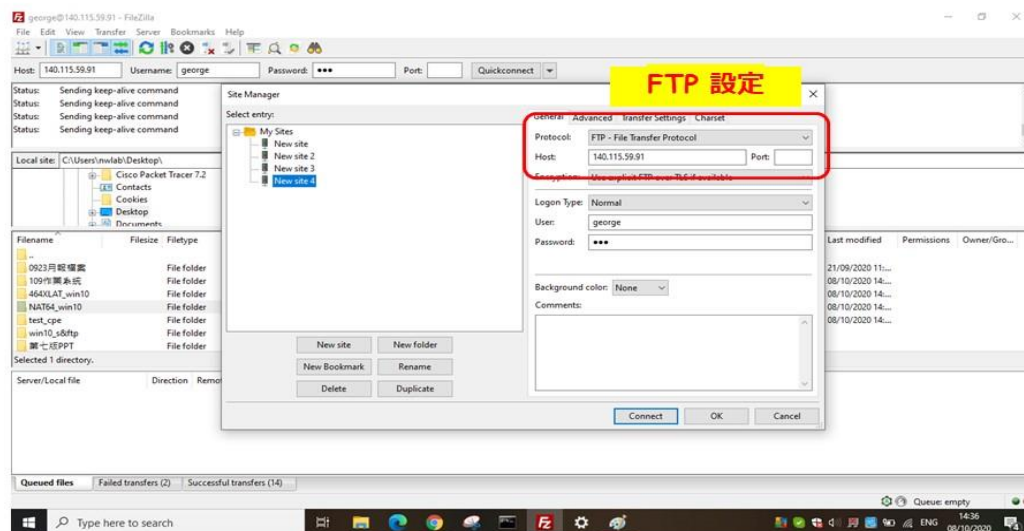
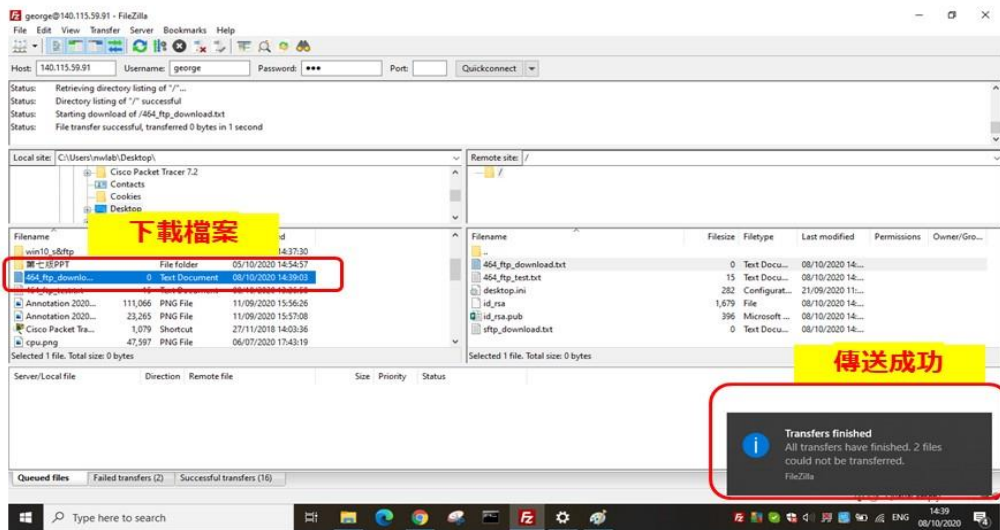


圖 65 Windows 10 - Case 8 – FTP (FileZilla)

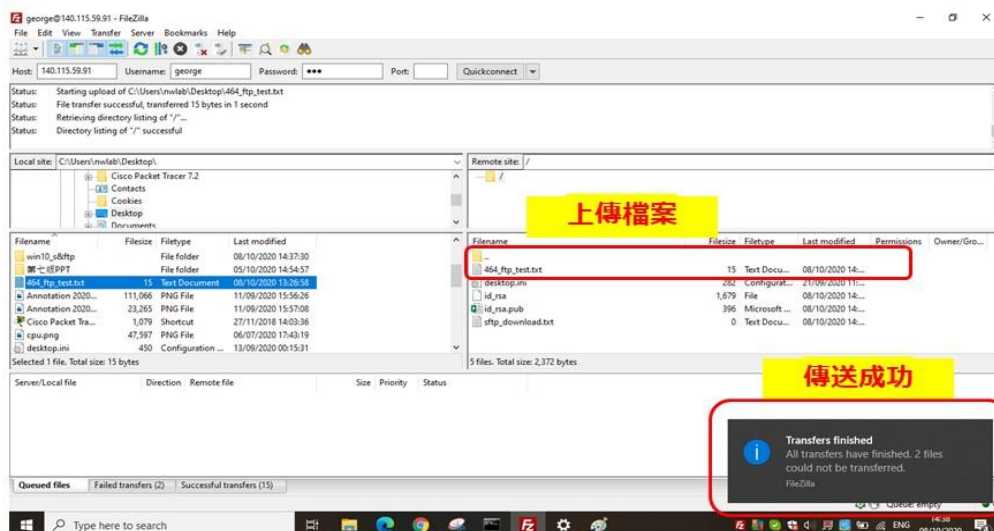
Windows 10 - Case 8 – FTP (FileZilla) - Download



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圖 66 Windows 10 - Case 8 – FTP (FileZilla) - Download

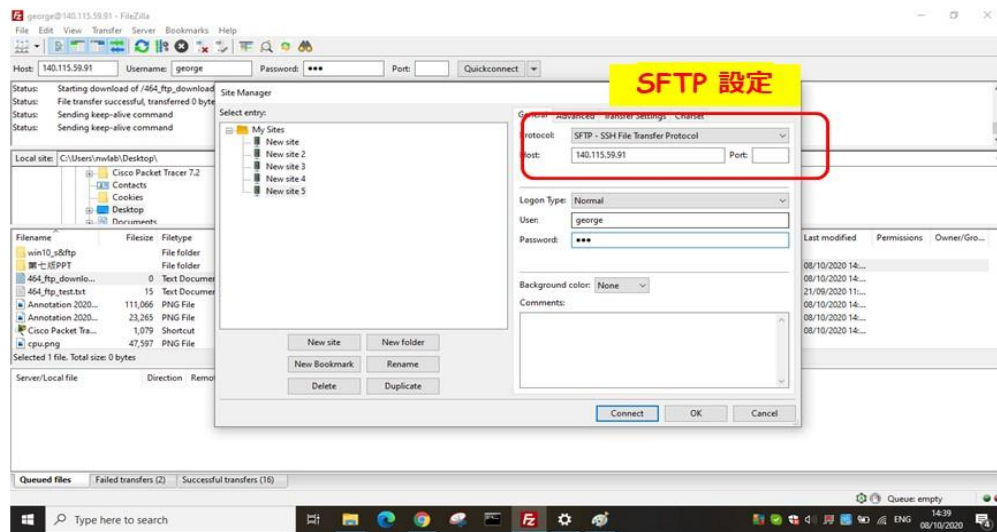
Windows 10 - Case 8 – FTP (FileZilla) - Upload



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圖 67 Windows 10 - Case 8 – FTP (FileZilla) - Upload

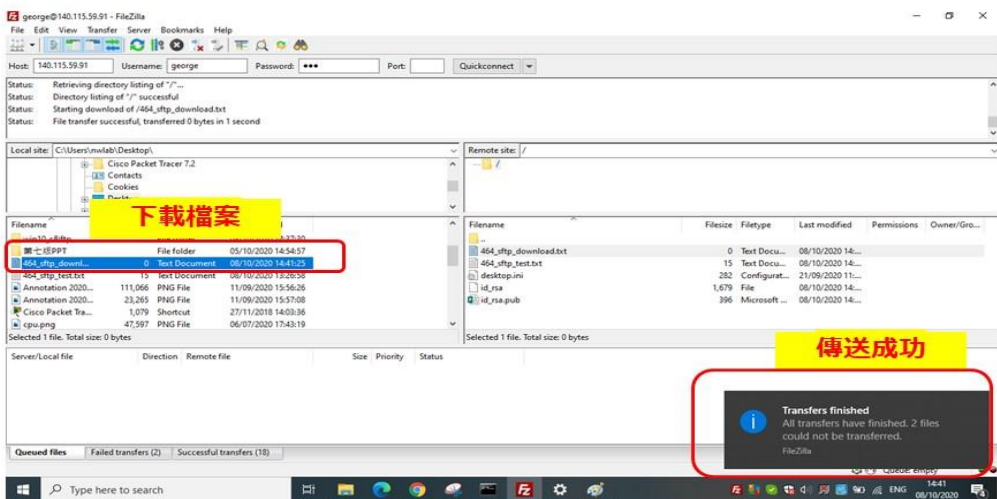
Windows 10 - Case 9 – SFTP (FileZilla)



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圖 68 Windows 10 - Case 9 – SFTP (FileZilla)

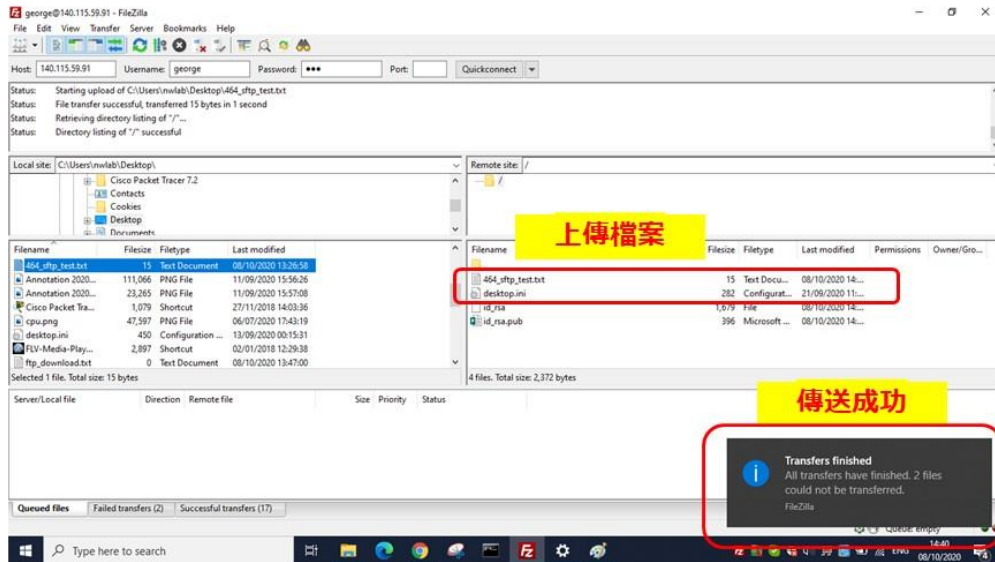
Windows 10 - Case 9 – SFTP (FileZilla) - Download



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圖 69 Windows 10 - Case 9 – SFTP (FileZilla) - Download

Windows 10 - Case 9 – SFTP (FileZilla) - Upload

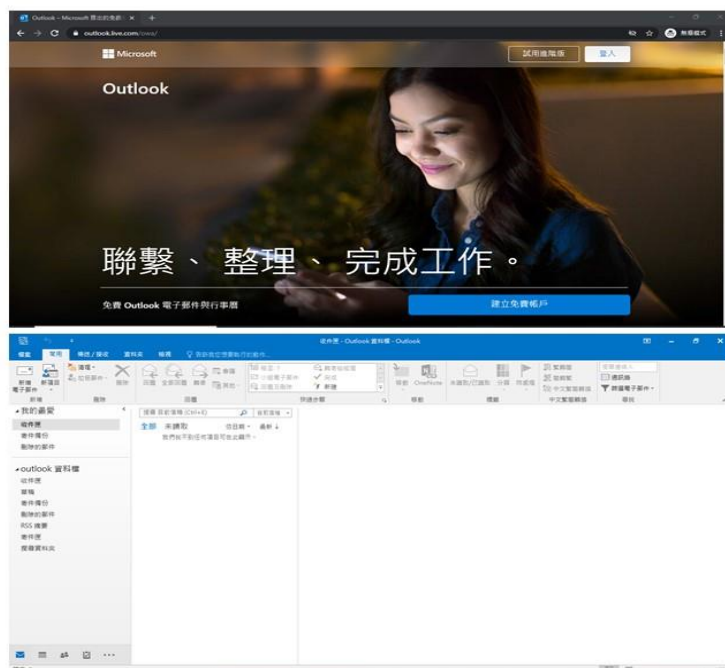


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圖 70 Windows 10 - Case 9 – SFTP (FileZilla) - Upload

Windows 10 - Case 10 – Windows Outlook

網頁版

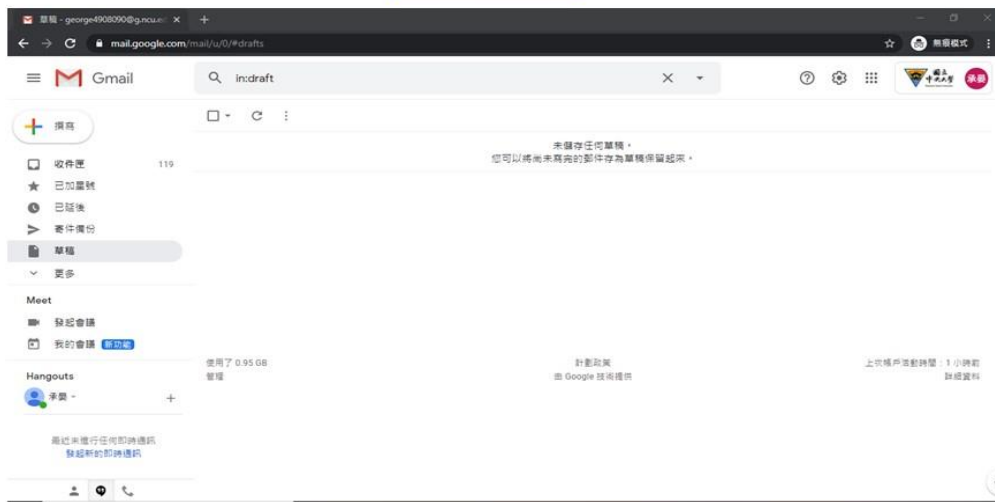


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圖 71 Windows 10 - Case 10 – Windows Outlook

Windows 10 - Case 11 – Gmail

Gmail 網頁



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圖 72 Windows 10 - Case 11 – Gmail

測試主機 (Win 8)

ipconfig (IPv6 only)

```
C:\Users\承晏>ipconfig

Windows IP 設定

乙太網路卡 Ethernet0:

    連線特定 DNS 尾碼 . . . . . : lan
    IPv6 位址. . . . . : 2001:288:3001:300:8903:ecf8:a4ca:a51e
    臨時 IPv6 位址. . . . . : 2001:288:3001:300:e85c:8df4:573f:2ad2
    連結-本機 IPv6 位址 . . . . . : fe80::8903:ecf8:a4ca:a51e%3
    IPv4 位址 . . . . . : 192.168.132.213
    子網路遮罩 . . . . . : 255.255.255.0
    預設閘道 . . . . . : fe80::c081:d7bd:33ce:b73b%3
    . . . . . : fe80::66a0:e7ff:fe43:3841%3
    . . . . . : 192.168.132.1

通道介面卡 isatap.lan:

    媒體狀態 . . . . . : 媒體已中斷連線
    連線特定 DNS 尾碼 . . . . . : lan

C:\Users\承晏>
```

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圖 73 464XLAT Windows8 測試主機資訊

Windows 8 - Case 1 – Google (Dual - Stack)

nslookup

```
C:\Windows\system32>nslookup
預設伺服器: OpenWrt.lan
Address: 192.168.132.1

> google.com
伺服器: OpenWrt.lan
Address: 192.168.132.1

未經授權的回答:
名稱: google.com
Addresses: 2404:6800:4012:1::200e
216.58.200.238

>
```

browser



ping

```
C:\Windows\system32>ping google.com

Ping google.com [2404:6800:4012:1::200e] (使用 32 位元組的資料):
回覆自 2404:6800:4012:1::200e: 時間=4ms
回覆自 2404:6800:4012:1::200e: 時間=4ms
回覆自 2404:6800:4012:1::200e: 時間=4ms
回覆自 2404:6800:4012:1::200e: 時間=4ms

2404:6800:4012:1::200e 的 Ping 統計資料:
封包: 已傳送 = 4, 已收到 = 4, 已遺失 = 0 (0% 遺失),
大約的來回時間 (毫秒):
最小值 = 4ms, 最大值 = 4ms, 平均 = 4ms
```

tracert

```
C:\Windows\system32>tracert google.com

在上限 30 個躍點上
追蹤 google.com [2404:6800:4012:1::200e] 的路由:

 1 <1 ms <1 ms <1 ms 2001:288:3001:300:cb4:a857:d11b:1b53
 2 1 ms <1 ms <1 ms 2001:288:3001:300::254
 3 29 ms 30 ms 1 ms 2001:288:3001:1::254
 4 1 ms <1 ms 1 ms 2001:288:30ff::2
 5 2 ms 1 ms 1 ms 2001:288:0:1659:192:192:61:101
 6 2 ms 2 ms 2 ms 2001:288:0:1659:192:192:61:24
 7 * * * 要求等候逾時。
 8 3 ms * 3 ms 2001:288:0:1659:192:192:61:184
 9 2 ms 2 ms 2 ms 2001:288:3b0:5::9264:1
10 4 ms 3 ms 4 ms 2001:c08:7f:1::35
11 2 ms 2 ms 2 ms 2001:288:0:f:109::9
12 3 ms 3 ms 3 ms 2001:4860:1:1::e0
13 5 ms 5 ms 5 ms 2001:4860:0:1014::1
14 4 ms 4 ms * 2001:4860:0:1::2a0b
15 5 ms 4 ms 4 ms tea03s02-in-x0e.1e100.net [2404:6800:4012:1::200e]

追蹤完成。
```

圖 74 Windows 8 - Case 1 – Google

Windows 8 - Case 2 – Youtube (Dual - Stack)

nslookup

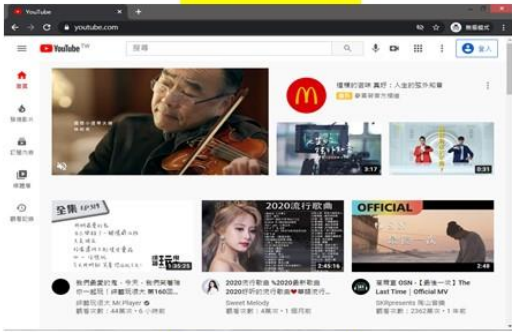
```
C:\Windows\system32>nslookup
預設伺服器: OpenWrt.lan
Address: 192.168.132.1

> youtube.com
伺服器: OpenWrt.lan
Address: 192.168.132.1

未經授權的回答:
名稱: youtube.com
Addresses: 2404:6800:4012::200e
216.58.200.46

>
```

browser



ping

```
C:\Windows\system32>ping youtube.com

Ping youtube.com [2404:6800:4012::200e] (使用 32 位元組的資料):
回覆自 2404:6800:4012::200e: 時間=4ms
回覆自 2404:6800:4012::200e: 時間=4ms
回覆自 2404:6800:4012::200e: 時間=4ms
回覆自 2404:6800:4012::200e: 時間=4ms

2404:6800:4012::200e 的 Ping 統計資料:
封包: 已傳送 = 4, 已收到 = 4, 已遺失 = 0 (0% 遺失),
大約的來回時間 (毫秒):
最小值 = 4ms, 最大值 = 4ms, 平均 = 4ms
```

tracert

```
C:\Windows\system32>tracert youtube.com

在上限 30 個躍點上
追蹤 youtube.com [2404:6800:4008:803::200e] 的路由:

 1 <1 ms <1 ms <1 ms 2001:288:3001:300:cb4:a857:d11b:1b53
 2 2 ms 9 ms 2 ms 2001:288:3001:1::254
 3 * 1 ms <1 ms 2001:288:30ff::2
 4 1 ms 1 ms 1 ms 2001:288:0:1659:192:192:61:101
 5 2 ms 2 ms 2 ms 2001:288:0:1659:192:192:61:24
 6 * * * 要求等候逾時。
 7 3 ms 3 ms 3 ms 2001:288:0:1659:192:192:61:184
 8 2 ms 2 ms 2 ms 2001:288:3b0:5::9264:1
 9 4 ms 3 ms 3 ms 2001:c08:7f:1::35
10 2 ms 2 ms 2 ms 2001:288:0:f:109::9
11 3 ms 3 ms 2 ms 2001:4860:1:1::e0
12 4 ms 4 ms 4 ms 2001:4860:0:1013::1
13 3 ms 3 ms 3 ms 2001:4860:0:1::84d
14 3 ms 3 ms 3 ms tea03s02-in-x0e.1e100.net [2404:6800:4008:803::200e]

追蹤完成。
```

圖 75 Windows 8 - Case 2 – Youtube

Windows 8 - Case 3 – Yahoo (Dual - Stack)

nslookup

```
C:\Windows\system32>nslookup
預設伺服器: OpenWrt.lan
Address: 192.168.132.1

> yahoo.com
伺服器: OpenWrt.lan
Address: 192.168.132.1

未經授權的回答:
名稱: yahoo.com
Addresses: 2001:4998:44:3507::8000
          2001:4998:24:120d::1:1
          2001:4998:44:3507::8001
          2001:4998:124:1507::f001
          2001:4998:124:1507::f000
          2001:4998:24:120d::1:0
          74.6.143.26
          98.137.11.163
          74.6.231.20
          74.6.231.21
          98.137.11.164
          74.6.143.25
```

ping

```
C:\Windows\system32>ping yahoo.com
```

```
Ping yahoo.com [2001:4998:24:120d::1:0] (使用 32 位元組的資料):
回覆自 2001:4998:24:120d::1:0: 時間=156ms
回覆自 2001:4998:24:120d::1:0: 時間=156ms
回覆自 2001:4998:24:120d::1:0: 時間=156ms
回覆自 2001:4998:24:120d::1:0: 時間=156ms
```

```
2001:4998:24:120d::1:0 的 Ping 統計資料:
封包: 已傳送 = 4, 已收到 = 4, 已遺失 = 0 (0% 遺失),
大約的來回時間 (毫秒):
最小值 = 156ms, 最大值 = 156ms, 平均 = 156ms
```

browser



tracert

```
C:\Windows\system32>tracert yahoo.com
在 30 個躍點上
追蹤 yahoo.com [2001:4998:24:120d::1:0] 的路由:
 1  <1 ms <1 ms <1 ms 2001:288:3001:300:cb4:a857:d1b:1b53
 2  1 ms <1 ms <1 ms 2001:288:3001:300::254
 3  2 ms 1 ms 1 ms 2001:288:3001:1::254
 4  1 ms 1 ms <1 ms 2001:288:30ff::2
 5  1 ms 1 ms 1 ms 2001:288:0:1659:192:192:61:101
 6  2 ms 2 ms 2 ms 2001:288:0:1659:192:192:61:24
 7  * * * 2001:288:0:1659:192:192:61:232
 8  * * * 要求等候逾時。
 9  * * * 要求等候逾時。
10  3 ms 2 ms 2 ms 2001:288:0:1659:192:192:68:62
11  2 ms 2 ms 2 ms 2406:d800:1:133:203:163:222:37
12  2 ms 2 ms 2 ms et-2-1-0.pat1.twg.yahoo.com [2406:2000:f027:201::1]
13 135 ms 134 ms 135 ms ae-9.pat1.pao.yahoo.com [2406:2000:f028:2::1]
14 152 ms 152 ms 152 ms ae-0.pat1.cwp.yahoo.com [2001:4998:f002:4::1]
15 160 ms 157 ms 157 ms ae-7.pat2.gqb.yahoo.com [2001:4998:f007:6::1]
16 157 ms 157 ms 161 ms et-18-1-0.asr2.gqi.yahoo.com [2001:4998:f00f:209::1]
17 157 ms 157 ms 157 ms et-18-1-0.c1r2-a-gdc.gqi.yahoo.com [2001:4998:c:f023::1]
18 157 ms 157 ms 157 ms et8-1.fab5-2-gdc.gqi.yahoo.com [2001:4998:c:f07c::1]
19 157 ms 157 ms 157 ms unknown.yahoo.com [2001:4998:24:d204::1]
20 156 ms 156 ms 156 ms unknown.yahoo.com [2001:4998:24:d211::1]
21 156 ms 156 ms 156 ms media-router-fp73.prod.media.vip.gqi.yahoo.com [2001:4998:24:120d::1]
追蹤完成。
```

圖 76 Windows 8 - Case 3 – Yahoo

Windows 8 - Case 4 – Facebook (Dual - Stack)

nslookup

```
C:\Windows\system32>nslookup
預設伺服器: OpenWrt.lan
Address: 192.168.132.1

> facebook.com
伺服器: OpenWrt.lan
Address: 192.168.132.1

未經授權的回答:
名稱: facebook.com
Addresses: 2a03:2880:f1ff:83:face:b00c:0:25de
          69.171.250.35
```

ping

```
C:\Windows\system32>ping facebook.com
```

```
Ping facebook.com [2a03:2880:f1ff:83:face:b00c:0:25de] (使用 32 位元組的資料):
回覆自 2a03:2880:f1ff:83:face:b00c:0:25de: 時間=3ms
回覆自 2a03:2880:f1ff:83:face:b00c:0:25de: 時間=3ms
回覆自 2a03:2880:f1ff:83:face:b00c:0:25de: 時間=3ms
回覆自 2a03:2880:f1ff:83:face:b00c:0:25de: 時間=3ms
```

```
2a03:2880:f1ff:83:face:b00c:0:25de 的 Ping 統計資料:
封包: 已傳送 = 4, 已收到 = 4, 已遺失 = 0 (0% 遺失),
大約的來回時間 (毫秒):
最小值 = 3ms, 最大值 = 3ms, 平均 = 3ms
```

browser



tracert

```
C:\Windows\system32>tracert facebook.com
在 30 個躍點上
追蹤 facebook.com [2a03:2880:f1ff:83:face:b00c:0:25de] 的路由:
 1  <1 ms <1 ms <1 ms 2001:288:3001:300:cb4:a857:d1b:1b53
 2  1 ms <1 ms <1 ms 2001:288:3001:300::254
 3  1 ms 1 ms 1 ms 2001:288:3001:1::254
 4  1 ms <1 ms <1 ms 2001:288:30ff::2
 5  2 ms 2 ms 1 ms 2001:288:0:1659:192:192:61:101
 6  2 ms 2 ms 2 ms 2001:288:0:1659:192:192:61:24
 7  * * * 2001:288:0:1659:192:192:61:0
 8  * * * 要求等候逾時。
 9  3 ms 3 ms 3 ms 2001:288:0:1659:192:192:61:562
10  3 ms 3 ms 3 ms ae5.pr01.tpel.tfbnw.net [2620:0:1cff:dead:beee::c3e]
11  3 ms 3 ms 3 ms po101.psw01.tpel.tfbnw.net [2620:0:1cff:dead:bef0::237]
12  3 ms 3 ms 3 ms po5.asw1ak.01.tpel.tfbnw.net [2a03:2880:f017:ffff::e5]
13  3 ms 3 ms 3 ms edge-star-mini6-shv-01-any2.facebook.com [2a03:2880:f1ff:83:face:b00c:0:25de]
```

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追蹤完成。

圖 77 Windows 8 - Case 4 – Facebook

Windows 8 - Case 5 – Twitter (IPv4 - only)

nslookup

```
C:\Windows\system32>nslookup
預設伺服器: OpenWrt.lan
Address: 192.168.132.1

> twitter.com
伺服器: OpenWrt.lan
Address: 192.168.132.1

未經授權的回答:
名稱: twitter.com
Addresses: 104.244.42.193
104.244.42.129
```

ping

```
C:\Windows\system32>ping twitter.com

Ping twitter.com [104.244.42.129] (使用 32 位元組的資料):
回覆自 104.244.42.129: 位元組=32 時間=66ms TTL=53
回覆自 104.244.42.129: 位元組=32 時間=66ms TTL=53
回覆自 104.244.42.129: 位元組=32 時間=68ms TTL=53
回覆自 104.244.42.129: 位元組=32 時間=67ms TTL=53

104.244.42.129 的 Ping 統計資料:
封包: 已傳送 = 4, 已收到 = 4, 已遺失 = 0 (0% 遺失),
大約的來回時間 (毫秒):
最小值 = 66ms, 最大值 = 68ms, 平均 = 66ms
```

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browser



tracert

```
C:\Windows\system32>tracert twitter.com

在上限 30 個躍點上
追蹤 twitter.com [104.244.42.129] 的路由:

 1  <1 ms <1 ms <1 ms clat-virtual-machine.lan [192.168.132.144]
 2  <1 ms <1 ms <1 ms clat-virtual-machine.lan [192.168.132.144]
 3  1 ms <1 ms <1 ms OpenWrt.lan [192.168.132.1]
 4  1 ms 1 ms 1 ms 140.115.59.254
 5  2 ms 1 ms 1 ms 203.72.244.185
 6  2 ms 1 ms 1 ms tyrc-ncu.ncu.edu.tw [203.72.244.225]
 7  3 ms 2 ms 2 ms 192.192.61.102
 8  2 ms 2 ms 2 ms 192.192.61.5
 9  4 ms 4 ms 4 ms 192.192.61.237
10  3 ms 4 ms 4 ms 192.192.61.58
11 22 ms 21 ms 26 ms 192.192.68.62
12 28 ms 42 ms 25 ms unknown.telstraglobal.net [210.176.44.177]
13 27 ms 30 ms 30 ms i-92.tpe1.core01.telstraglobal.net [202.84.137.249]
14 23 ms 22 ms 22 ms 202.84.138.73
15 25 ms 25 ms 24 ms 202.84.153.26
16 23 ms 23 ms 23 ms twitter1-10g.hkix.net [123.255.90.149]
17 * * * 要求等候逾時。
18 67 ms 69 ms 67 ms 104.244.42.129

追蹤完成。
```

圖 78 Windows 8 - Case 5 – Twitter

Windows 8 - Case 6 – Netflix (Dual - Stack)

nslookup

```
C:\Windows\system32>nslookup
預設伺服器: OpenWrt.lan
Address: 192.168.132.1

> netflix.com
伺服器: OpenWrt.lan
Address: 192.168.132.1

未經授權的回答:
名稱: netflix.com
Addresses: 2620:108:700f::22d8:b4b4
2620:108:700f::3421:9d13
2620:108:700f::22d1:16ca
2620:108:700f::22d8:7a24
2620:108:700f::23a7:cd49
2620:108:700f::3419:e296
2620:108:700f::23a1:5f46
2620:108:700f::36bb:b0c4
35.166.68.183
52.33.157.25
54.149.160.164
35.161.32.8
52.25.53.155
35.167.109.163
52.41.244.109
34.216.122.36
```

ping

```
C:\Windows\system32>ping netflix.com

Ping netflix.com [2620:108:700f::36bb:b0c4] (使用 32 位元組的資料):
回覆自 2620:108:700f::36bb:b0c4: 時間=175ms
回覆自 2620:108:700f::36bb:b0c4: 時間=175ms
回覆自 2620:108:700f::36bb:b0c4: 時間=175ms
回覆自 2620:108:700f::36bb:b0c4: 時間=175ms

2620:108:700f::36bb:b0c4 的 Ping 統計資料:
封包: 已傳送 = 4, 已收到 = 4, 已遺失 = 0 (0% 遺失),
大約的來回時間 (毫秒):
最小值 = 175ms, 最大值 = 175ms, 平均 = 175ms
```

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browser



tracert

```
C:\Windows\system32>tracert netflix.com

在上限 30 個躍點上
追蹤 netflix.com [2620:108:700f::22d0:15cc] 的路由:

 1  <1 ms <1 ms <1 ms 2001:288:3001:300:65c3:14e9:b568:b0cb
 2  1 ms <1 ms <1 ms 2001:288:3001:300::254
 3  1 ms 1 ms 1 ms 2001:288:3001:1::254
 4  1 ms 1 ms 1 ms 2001:288:300f::2
 5  2 ms 2 ms 1 ms 2001:288:0:1659:192:192:61:101
 6  3 ms 2 ms 2 ms 2001:288:0:1659:192:192:61:24
 7  * * * 要求等候逾時。
 8  * * * 要求等候逾時。
 9  3 ms 3 ms 3 ms 2001:288:0:1659:192:192:61:562
10  3 ms 3 ms 4 ms 2001:288:0:1659:192:192:68:62
11 4 ms 3 ms 3 ms 2402:1480:2:6::4:1
12 25 ms 24 ms 24 ms be2226.ccr21.hkg02.atlas.cogentco.com [2001:550:0:1000::9a36:2889]
13 156 ms * 156 ms be3701.ccr21.pdx01.atlas.cogentco.com [2001:550:0:1000::9a36:5779]
14 * * * 要求等候逾時。
15 161 ms 161 ms 162 ms 2001:550:2:13::c:2
16 * * * 要求等候逾時。
17 172 ms 172 ms 172 ms 2620:107:4000:4::19
18 * * * 要求等候逾時。
19 * * * 要求等候逾時。
20 163 ms 162 ms 162 ms 2620:107:4000:9008::41
21 174 ms 174 ms 174 ms 2620:107:4000:9008::45
22 175 ms 174 ms 174 ms 2620:107:4000:9008::19
23 161 ms 161 ms 164 ms 2620:107:4000:9008::2d
24 175 ms 175 ms 178 ms 2620:107:4000:9008::25
25 163 ms 161 ms 161 ms 2620:107:4000:9008::28

微軟注冊商標。 * 要求等候逾時。
```

圖 79 Windows 8 - Case 6 – Netflix

Windows 8 - Case 7 – Skype

待機畫面

接通畫面

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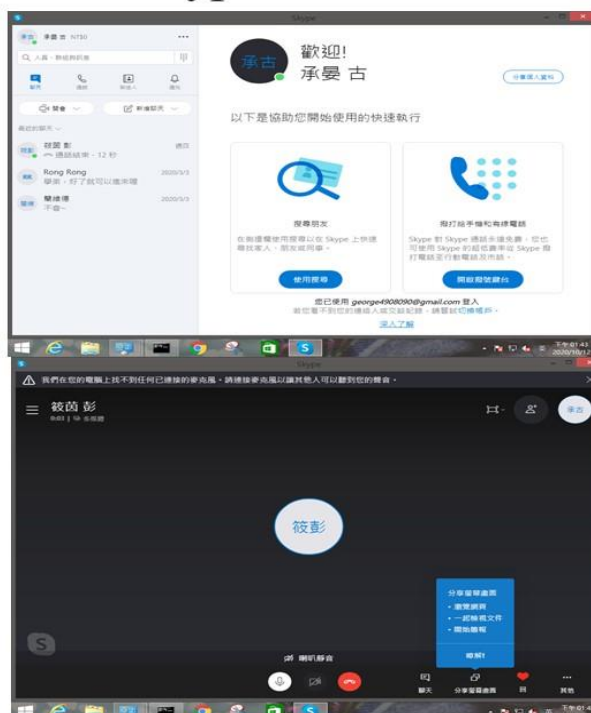
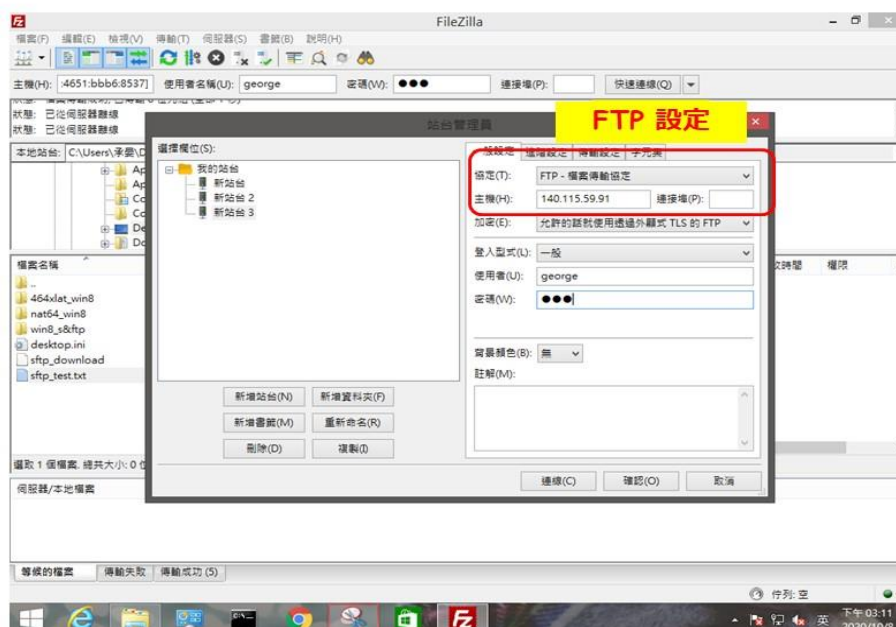


圖 80 Windows 8 - Case 7 – Skype

Windows 8 - Case 8 – FTP (FileZilla)



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圖 81 Windows 8 - Case 8 – FTP (FileZilla)

Windows 8 - Case 8 – FTP (FileZilla) - Download

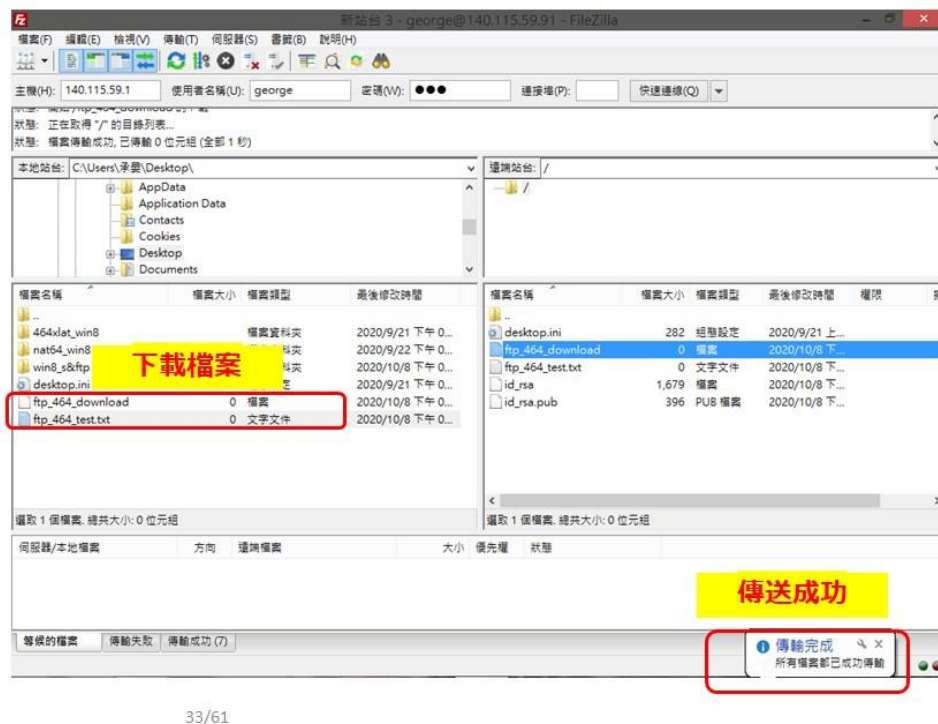


圖 82 Windows 8 - Case 8 – FTP (FileZilla) - Download

Windows 8 - Case 8 – FTP (FileZilla) - Upload

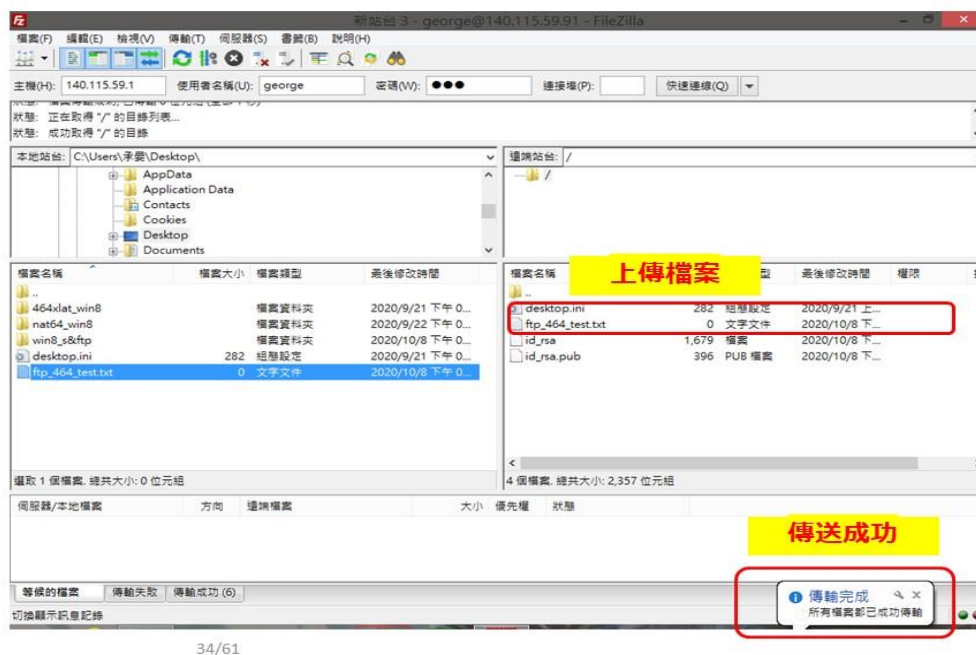
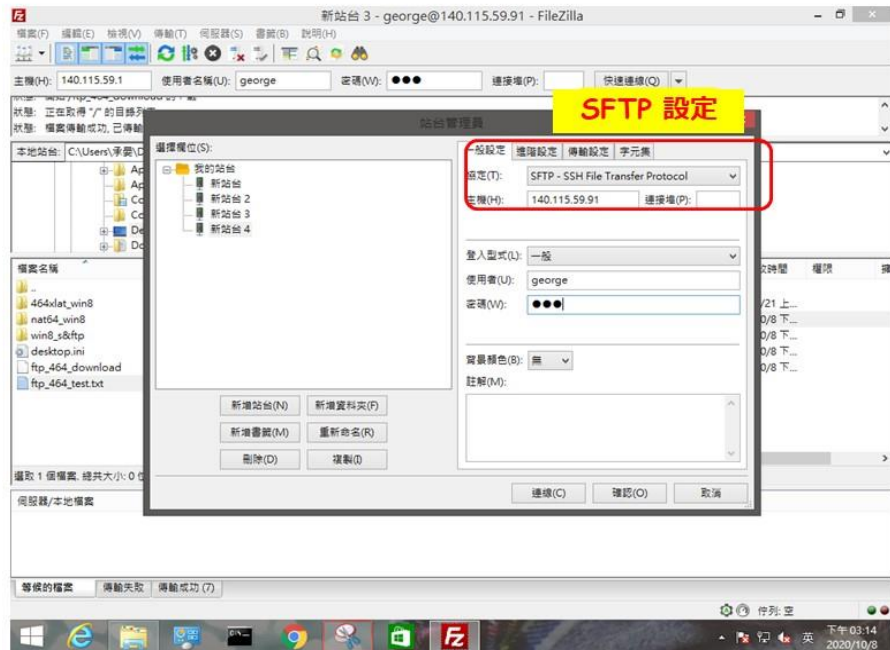


圖 83 Windows 8 - Case 8 – FTP (FileZilla) - Upload

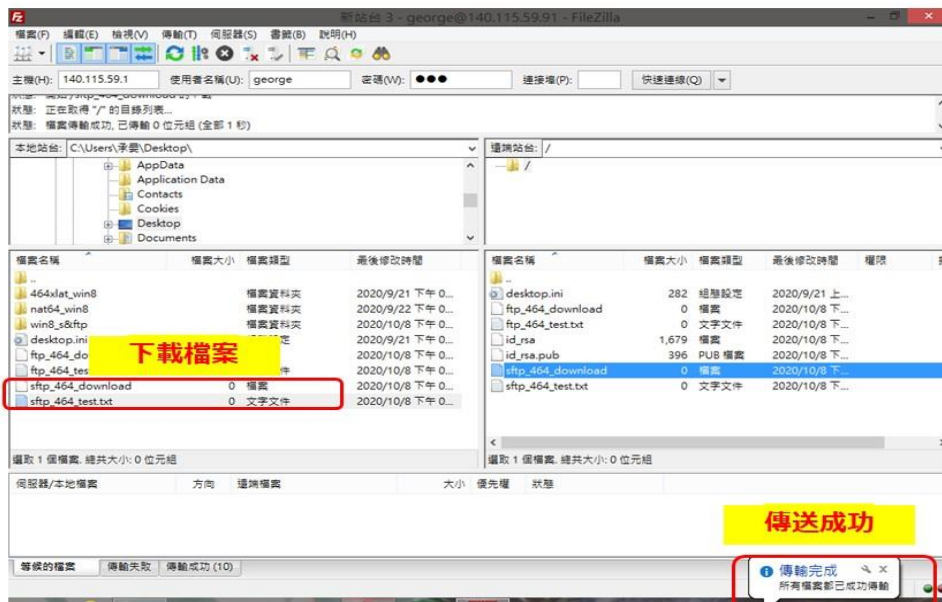
Windows 8 - Case 9 – SFTP (FileZilla)



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圖 84 Windows 8 - Case 9 – SFTP (FileZilla)

Windows 8 - Case 9 – SFTP (FileZilla) - Download



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圖 85 Windows 8 - Case 9 – SFTP (FileZilla) - Download

Windows 8 - Case 9 – SFTP (FileZilla) - Upload

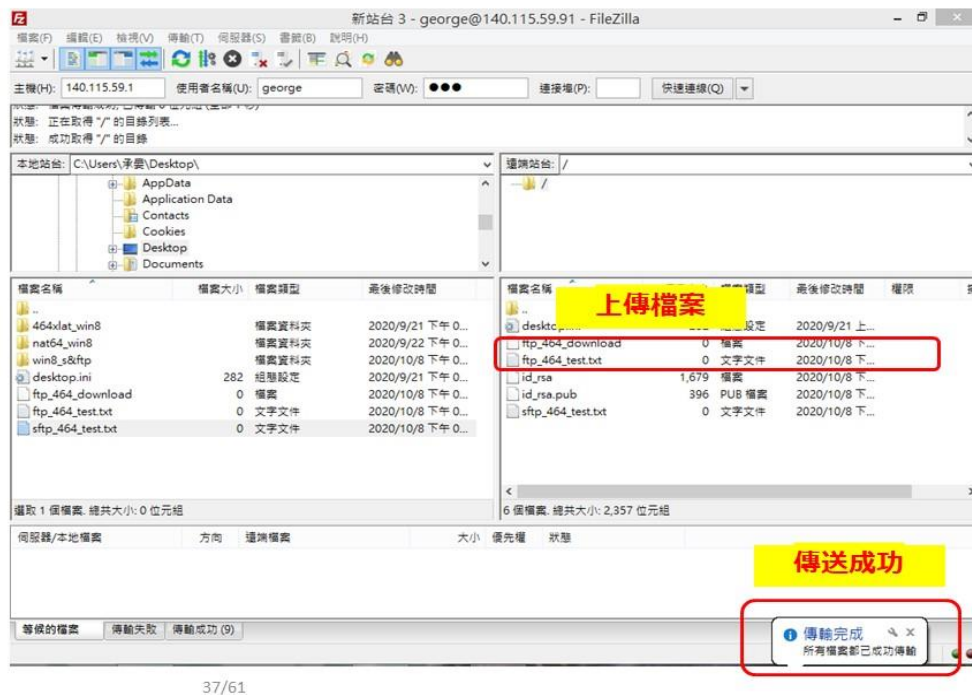


圖 86 Windows 8 - Case 9 – SFTP (FileZilla) - Upload

Windows 8 - Case 10 – Windows Outlook



圖 87 Windows 8 - Case 10 – Windows Outlook

Windows 8 - Case 11 – Gmail

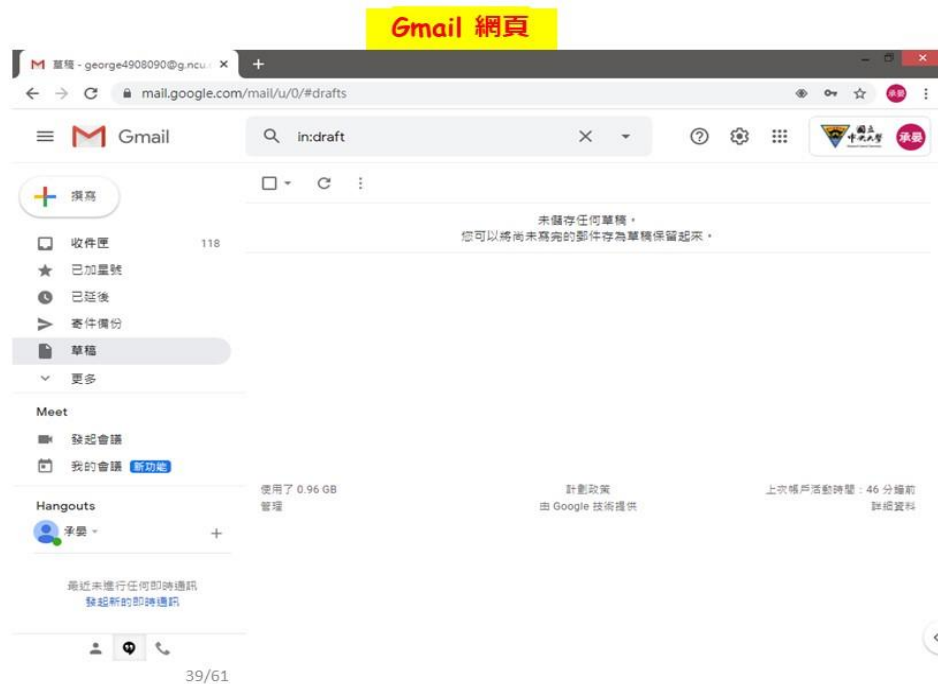


圖 88 Windows 8 - Case 11 – Gmail

Android - Case 1 – Google (Dual - Stack)

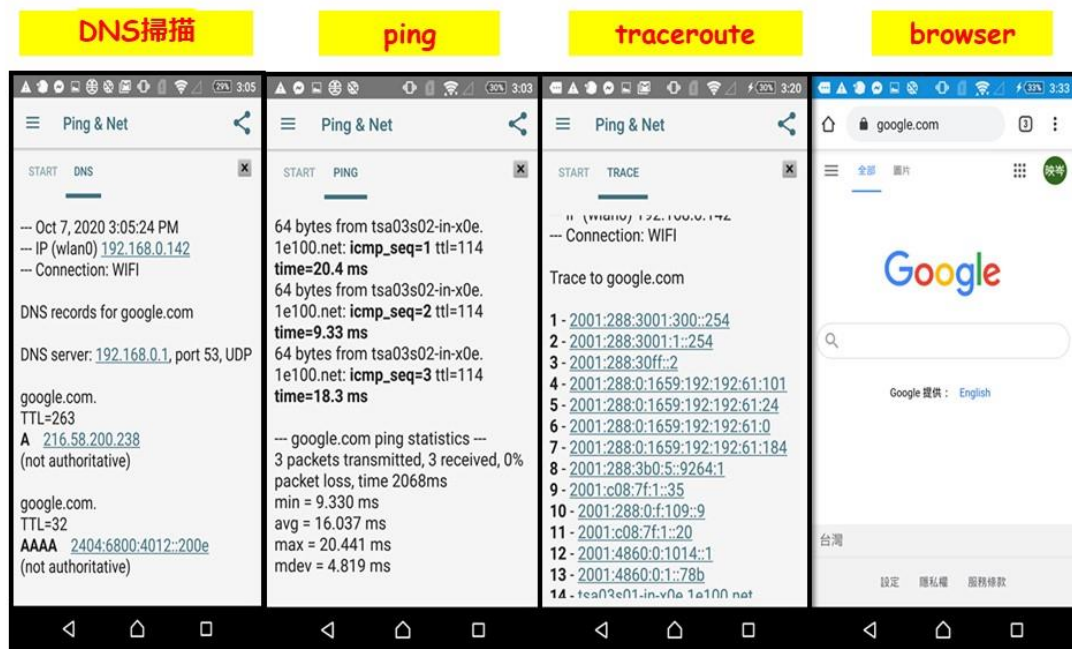
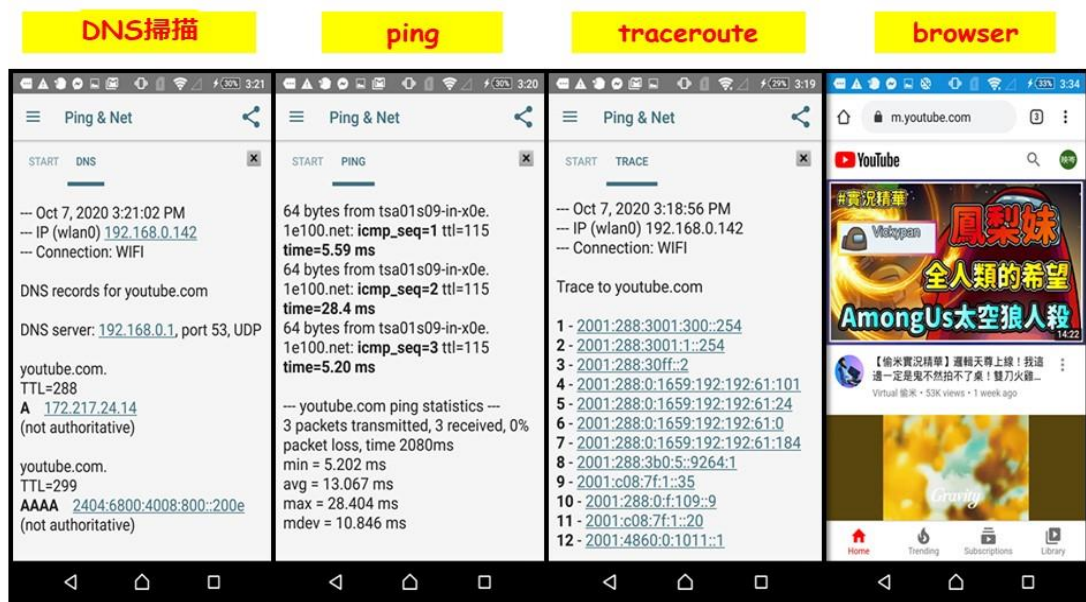


圖 89 Android - Case 1 – Google

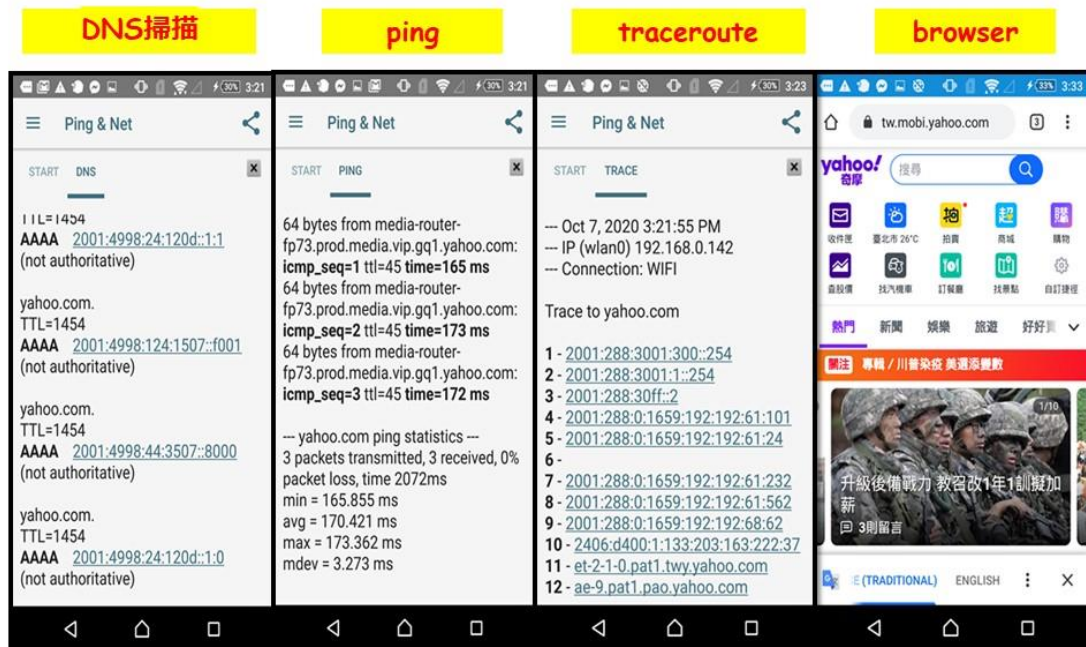
Android - Case 2 – Youtube (Dual - Stack)



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圖 90 Android - Case 2 – Youtube

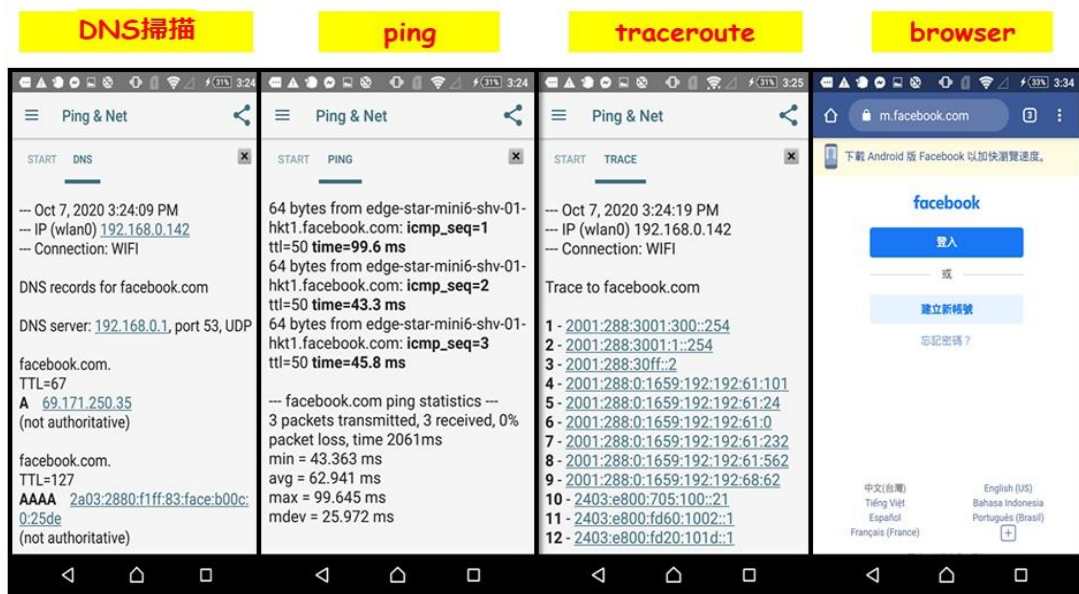
Android - Case 3 – Yahoo (Dual - Stack)



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圖 91 Android - Case 3 – Yahoo

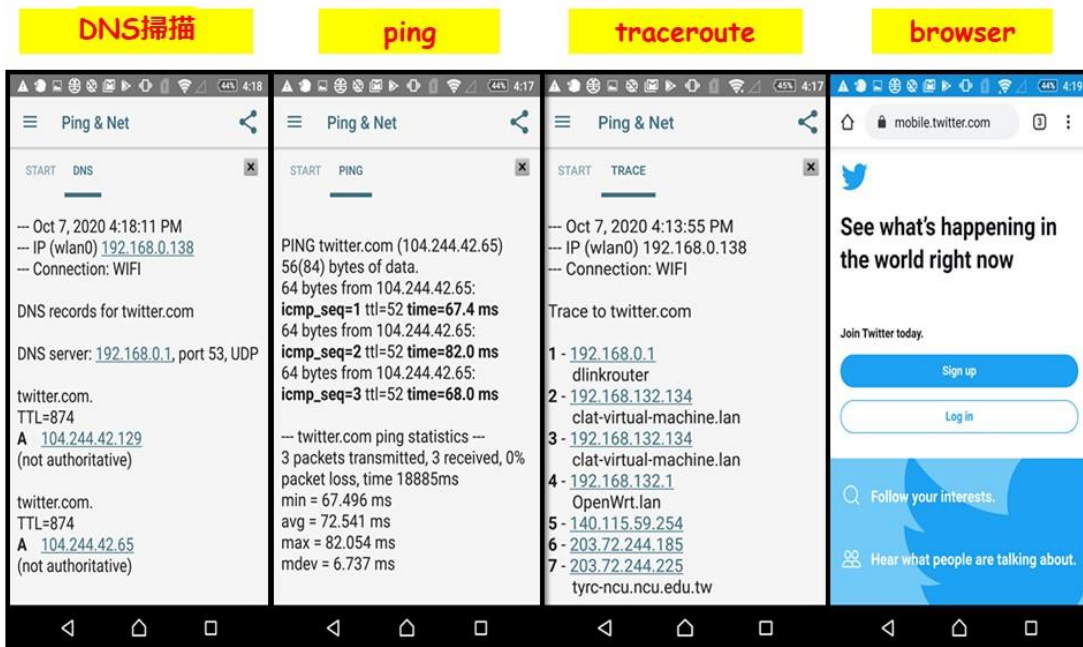
Android - Case 4 – Facebook (Dual - Stack)



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圖 92 Android - Case 4 – Facebook

Android - Case 5 – Twitter (IPv4 - only)



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圖 93 Android - Case 5 – Twitter

Android - Case 6 – Netflix (Dual - Stack)

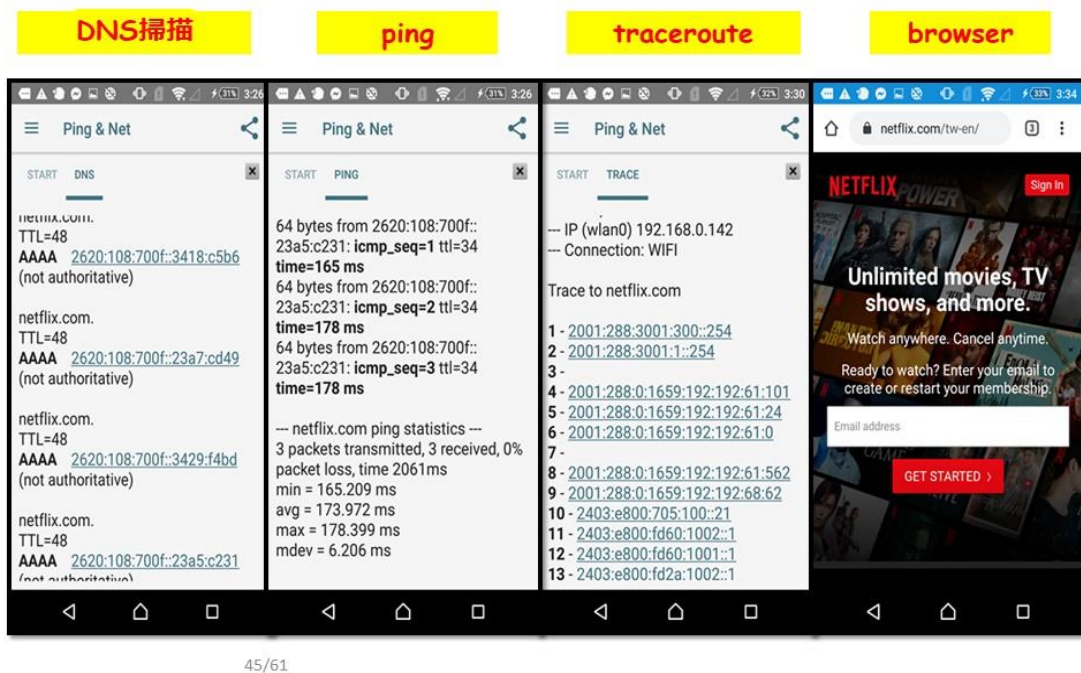


圖 94 Android - Case 6 – Netflix

Android - Case 7 – Skype



圖 95 Android - Case 7 – Skype

Android - Case 8 – FTP (FileManager+ - FileZilla)



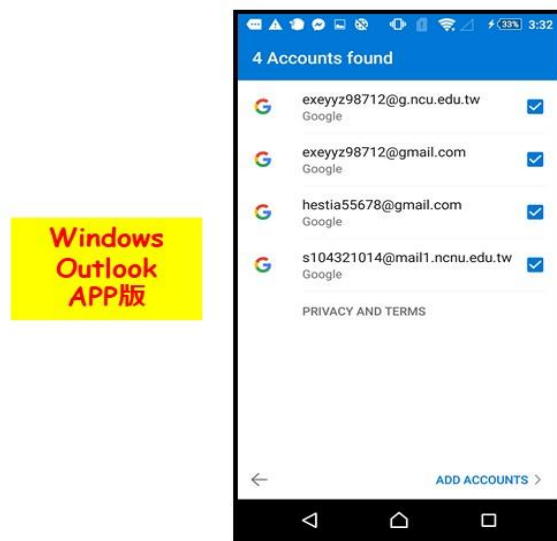
圖 96 Android - Case 8 – FTP (FileManager+ - FileZilla)

Android - Case 9 – SFTP (FileManager+ - FileZilla)



圖 97 Android - Case 9 – SFTP (FileManager+ - FileZilla)

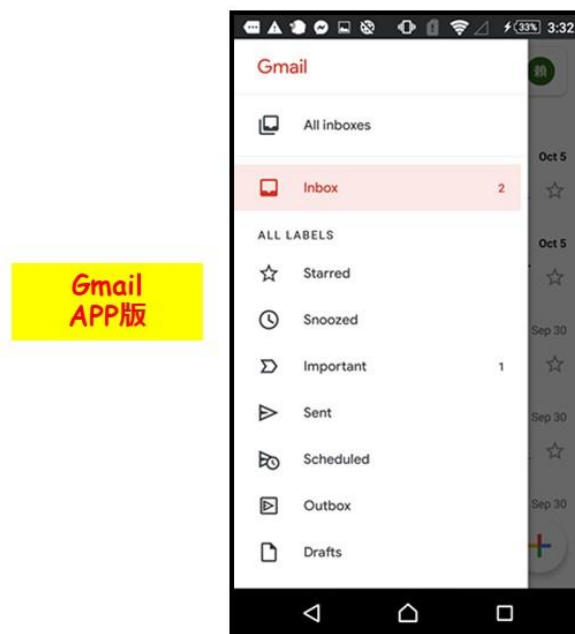
Android - Case 10 – Windows Outlook



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圖 98 Android - Case 10 – Windows Outlook

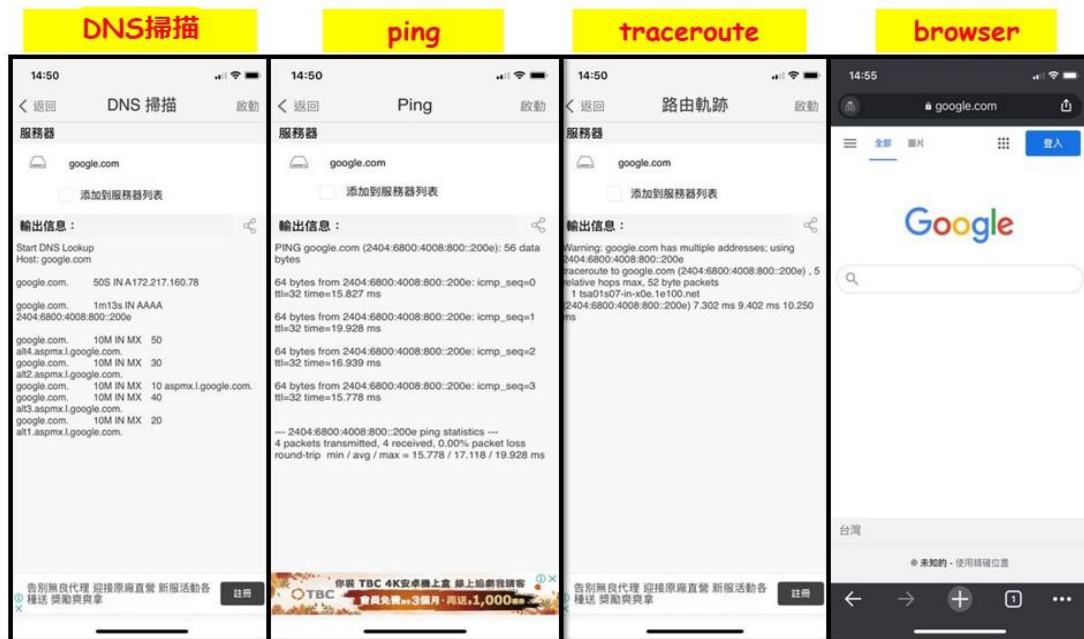
Android - Case 11 – Gmail



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圖 99 Android - Case 11 – Gmail

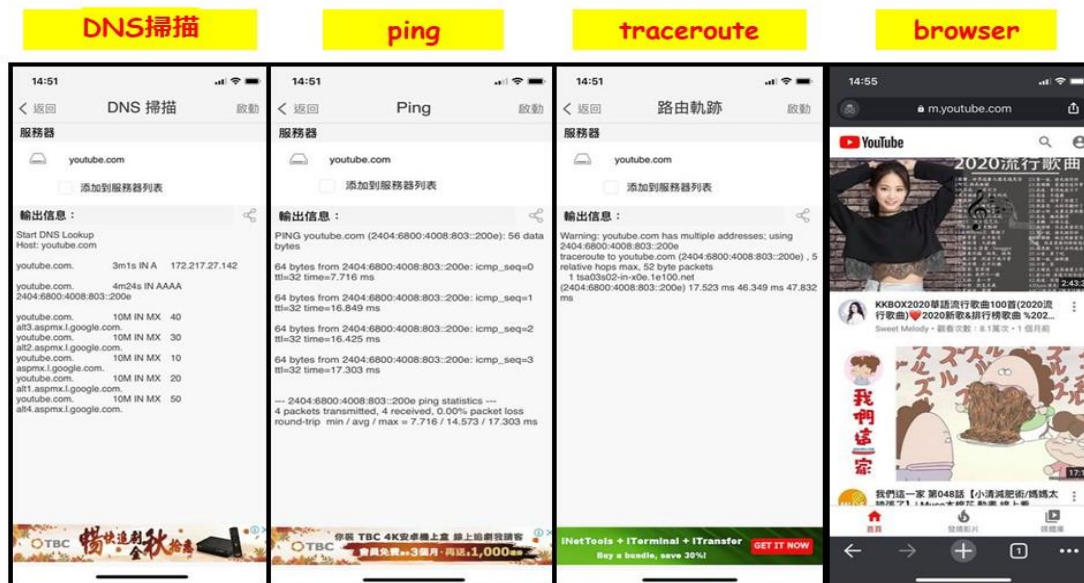
iOS - Case 1 – Google (Dual - Stack)



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圖 100 iOS - Case 1 – Google

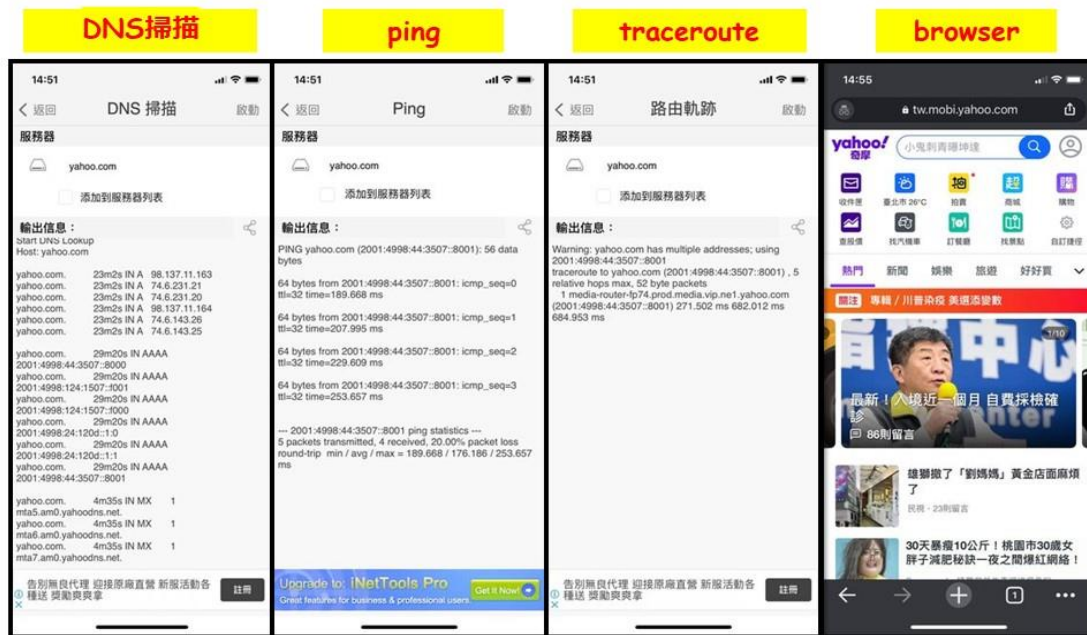
iOS - Case 2 – Youtube (Dual - Stack)



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圖 101 iOS - Case 2 – Youtube

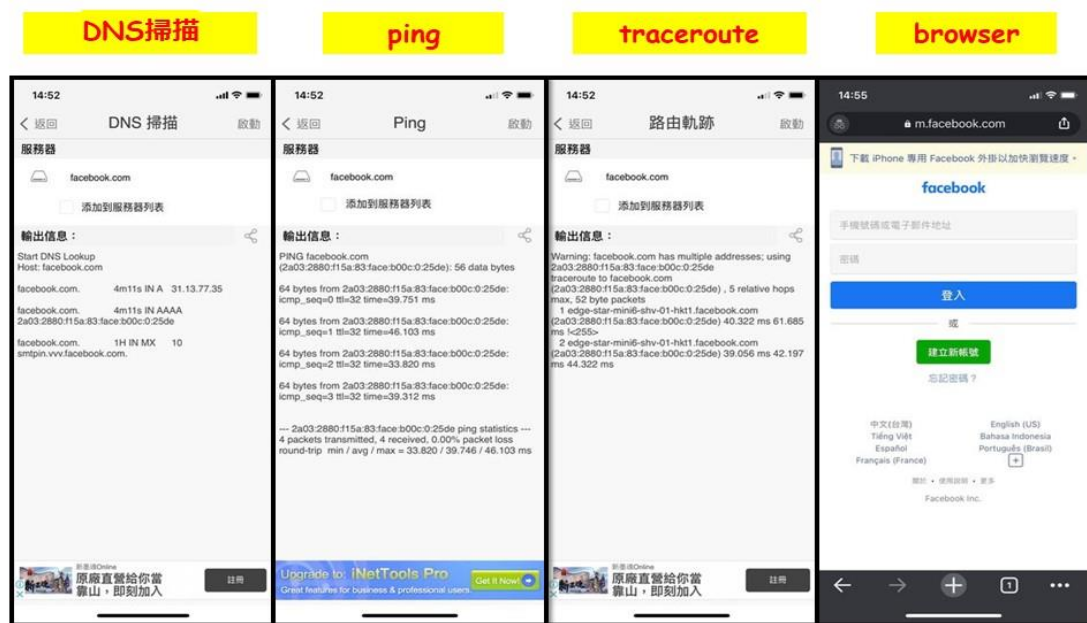
iOS - Case 3 – Yahoo (Dual - Stack)



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圖 102 iOS - Case 3 – Yahoo

iOS - Case 4 – Facebook (Dual - Stack)



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圖 103 iOS - Case 4 – Facebook

iOS - Case 5 – Twitter (IPv4 - only)

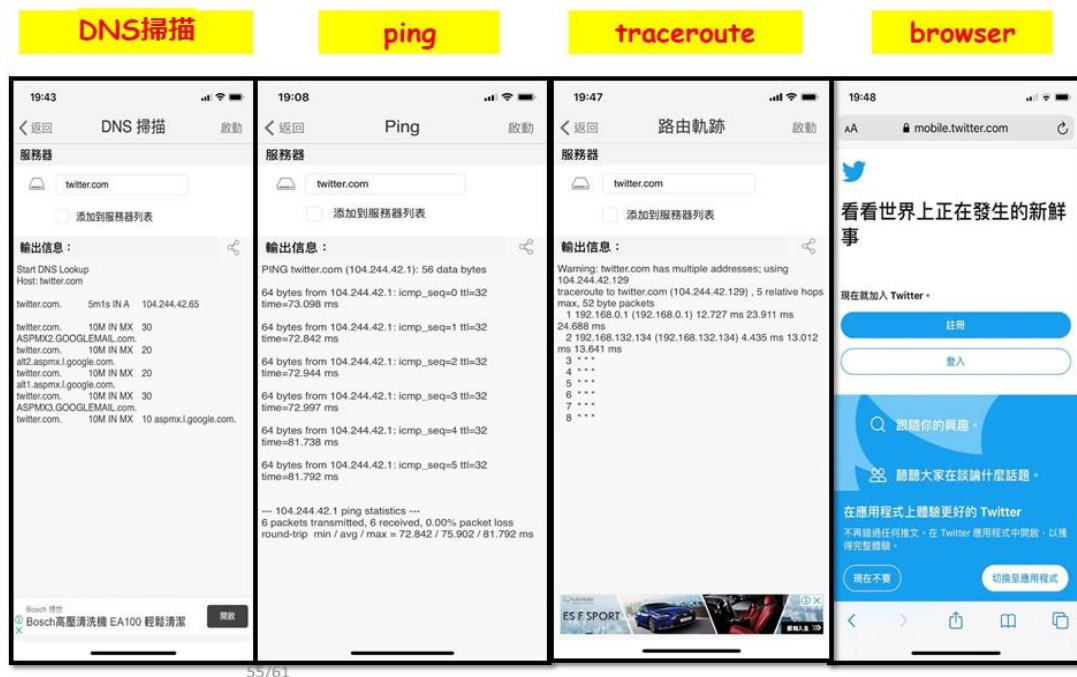


圖 104 iOS - Case 5 – Twitter

iOS - Case 6 – Netflix (Dual - Stack)

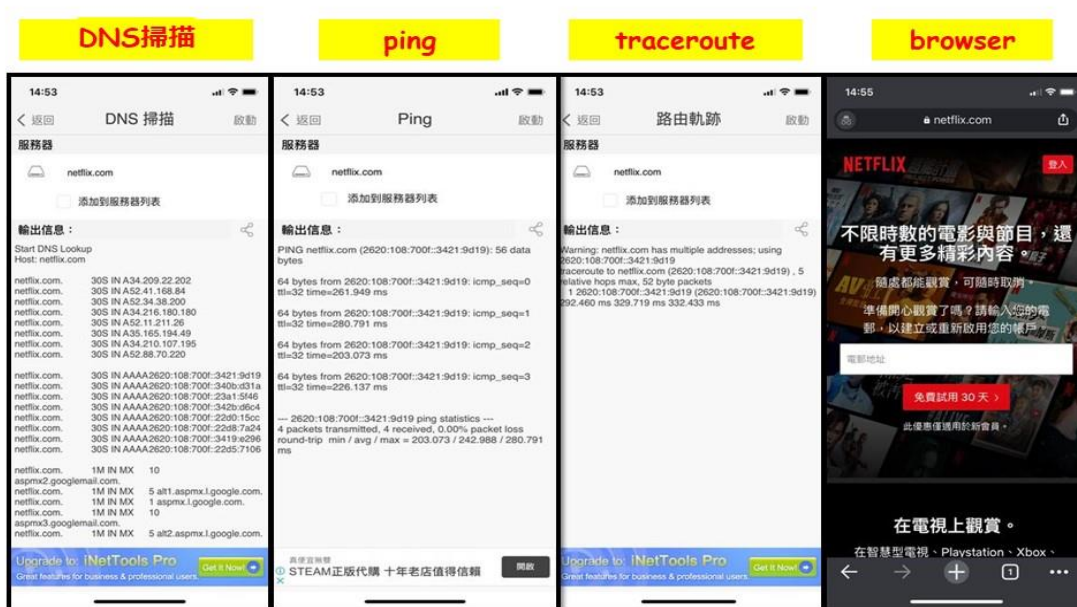


圖 105 iOS - Case 6 – Netflix

iOS - Case 7 – Skype



圖 106 iOS - Case 7 – Skype

iOS - Case 8 – FTP (FTPManager - FileZilla)



圖 107 iOS - Case 8 – FTP (FTPManager - FileZilla)

iOS - Case 9 – SFTP (FTPManager - FileZilla)



圖 108 iOS - Case 9 – SFTP (FTPManager - FileZilla)

iOS - Case 10 – Windows Outlook

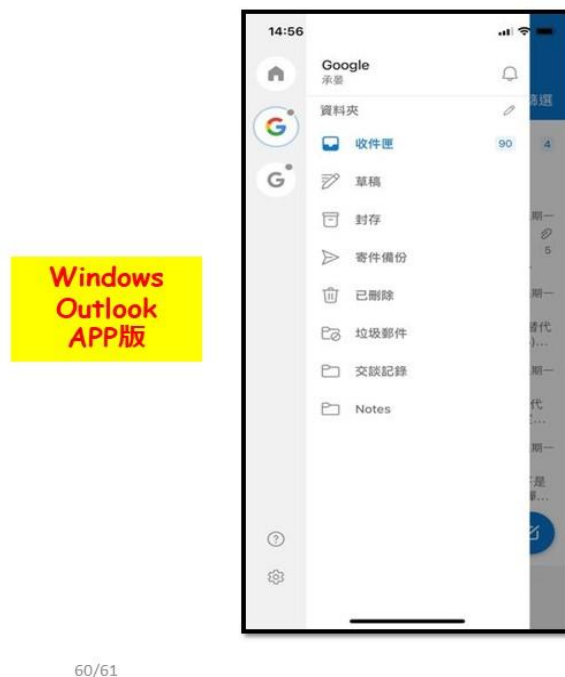


圖 109 iOS - Case 10 – Windows Outlook

iOS - Case 11 – Gmail

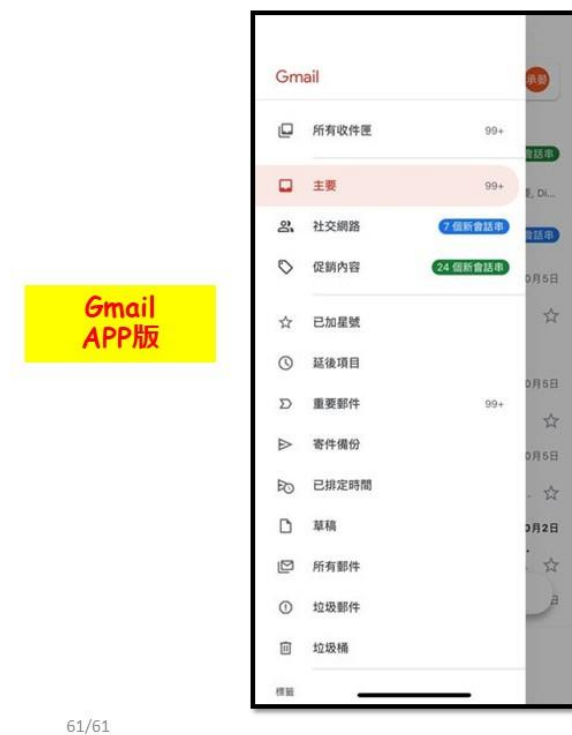


圖 110 iOS - Case 11 – Gmail

三、 交叉測試成果

此部分測試之比較對象為兩組，一組為 Windows10 主機，需經過 Native IPv6 環境才存取目的網站，另一組同樣為 Windows10 主機，但須透過 Native IPv4 的連接方式連接外網。測試過程由 10 位實驗室成員分別操作兩台主機各 10 分鐘，期間可隨意瀏覽網站、上傳及下載檔案，事前不告知哪台主機為 Native IPv4 環境，哪台為 Native IPv6 環境。此測試主要以使用者觀點進行操作測試，比較 IPv4 和 IPv6 連線品質的差異。

實驗結果顯示，有 5 位同學準確猜出哪台電腦為 Native IPv4 環境，哪台為 Native IPv6 環境；有 4 位同學回答錯誤，將 Native IPv4 電腦誤認為 Native IPv6 環境；將 Native IPv6 電腦誤認為是 Native IPv4 環境；還有 1 位同學無法分辨。事後對受測同學進行調查，無論猜對或猜錯的同學，均表示兩者差異甚小，幾乎感受不到差別。此實驗結果證明 464XLAT 轉換機制在主觀的使用者體驗上影響很小，幾乎可以省略。而客觀的數據，如 response time 也顯示有無經過轉換機制的差異並不大，可見以 JOOL 等 open source 搭建 464XLAT 轉換環境之方案可行。

肆、觀察與發現

IPv6 是屬於長期演進的技術，其 IPv6/IPv4 雙協定網路過渡共存期間，將無可避免產生 IPv6 網路與 IPv4 網路的轉換問題。本計畫針對 IETF 提出的解決方案：NAT64/DNS64 及 464XLAT，以 JOOL 及 BIND 開源軟體實現於校園網路環境中，並透過一系列的連網測試，有以下幾點觀察與發現：

- 一、 大部分熱門網站及應用程式皆以支援 Dual-stack 服務，唯少數網站（如 twitter）仍為 IPv4 only 環境
- 二、 NAT64/DNS64 可提供 IPv6 -> NAT64 -> IPv4 的應用情境，解決 Native IPv6 用戶連線 IPv4 服務的問題
- 三、 464XLAT 可提供 IPv4 -> CLAT -> IPv6 -> PLAT -> IPv4 的應用情境，可使裝置及應用程式的運作維持透通性。接取網路不需要使用 IPv4 位址，但亦可提供私有 IPv4 位址給使用者（以 CLAT 的方式），較符合未來 Native IPv6 網路演進之需求
- 四、 部署 IPv6 是否採用 NAT 技術，端視網路管理者設計網路架構的需求來取決

伍、結論

未來 IPv6 網路的發展方向將朝向 Native IPv6 方面演進，因此如何在 IPv4 與 IPv6 共存下連線成為一門重要課題。本測試報告主要針對 Native IPv6 網路環境測試，分為 NAT64 及 464XLAT 兩種轉換機制。測試報告結論摘要重點如下：

一、完成 Native IPv6 連網試驗基本運用與應用操作測試

- Windows10 (NAT64/DNS64 & 464XLAT): 總計完成 12 項基本測試 12 項連線測試與 10 項應用測試
- Windows8 (NAT64/DNS64 & 464XLAT): 完成 12 項基本測試 12 項連線測試與 10 項應用測試
- iOS (NAT64/DNS64 & 464XLAT): 完成 12 項基本測試 12 項連線測試與 10 項應用測試
- Android: 完成 12 項基本測試 12 項連線測試與 10 項應用測試

二、完成 NAT64/DNS64 與 464XLAT 連網環境建置與功能測試，可作為實際驗證 IPv6 用戶連線網站與應用服務的測試場域。

重要有關文獻

- [1] IETF RFC 6416, Stateful NAT64: Network Address and Protocol Translation from IPv6 Clients to IPv4 Servers, Available:
<https://tools.ietf.org/html/rfc6416>
- [2] IETF RFC 6174, DNS64: DNS Extensions for Network Address Translation from IPv6 Clients to IPv4 Servers, Available:
<https://tools.ietf.org/html/rfc6174>
- [3] IETF RFC 6877, 464XLAT: Combination of Stateful and Stateless Translation, <https://tools.ietf.org/html/rfc6877>
- [4] JOOL, <https://www.jool.mx/en/index.html>