



爾飛靈 500AG/500AG

33Km 點對點(PtP)WiFi-802.11a (5.8GHz)無線系統傳輸測試報告

2009.07.15



# 33Km 點對點(PtP)WiFi-802.11a (5.8GHz)無線系統傳輸測試報告

## 壹、 測試目的

測試 33Km 遠距離 WiFi 無線，802.11a-5.8GHz 傳輸的真實流量與天線調整技術的精進練習。

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一般而言，802.11g (2.4GHz)比 802.11a (5.8GHz)的無線射頻傳輸，有三大特性差異：

1. 802.11g (2.4GHz)比 802.11a (5.8GHz)的無線射頻輸出功率，約大 2~3dBm,因此同一個無線模塊，11g 會比 11a 傳輸的距離更遠。
2. 802.11g (2.4GHz)比 802.11a (5.8GHz)的波長更長，空氣中傳輸更能抗衰減，因此，11g 的訊號會比 11a 傳更穩；但因 11g-2.4GHz 干擾源較多，實際架設情況剛好相反。
3. 802.11g (2.4GHz)比 802.11a (5.8GHz)的抗雨衰能力更強，差異會達到 2~3dB 以上，特別是遠距離，有時會相差到 5~7dB。

此次測試，以 5.8GHz 的 27dBi Grid 定向拋物線柵欄天線為測試天線，利用比上次測試 33km-11g 24dBi Grid 天線多 3dBi 的增益值，來補強輸出功率差 3dBm 的輸出值，以求測試比對的相等功率輸出無線訊號值。

| 項目內容   | 2008/11/4 - 33km    |                     | 2009/07/15 - 33km    |                      | 比對天線 07/15       | 比對天線 07/14        |
|--------|---------------------|---------------------|----------------------|----------------------|------------------|-------------------|
| 架設點    | 台中縣 台中港 61m 高       | 苗栗縣 通宵鎮 72m 高       | 台中縣 台中港 61m 高        | 苗栗縣 通宵鎮 72m 高        |                  |                   |
| 測試設備   | M500AG--AC          | M600AG(RF1)--AP     | 500AG--AC            | 500AG--AP            |                  |                   |
| 測試頻率   | 2.4GHz-2.437GHz-6Ch | 2.4GHz-2.437GHz-6Ch | 5.8GHz—5.180GHz—36Ch | 5.8GHz—5.180GHz—36Ch |                  |                   |
| 設備輸出功率 | 17dBm=50mW          | 17dBm=50mW          | 15dBm=31.6mW         | 15dBm=31.6mW         |                  |                   |
| 搭配天線增益 | 24dBi-Grid (威海尼可)   | 24dBi-Grid (威海尼可)   | 27dBi-Grid (威海尼可)    | 27dBi-Grid (威海尼可)    | 27dBi-Grid (健博通) | 26.5dBi-Grid (勝百) |
| 測試環境天候 | 晴，夜間                | 晴，夜間                | 晴，傍晚~夜間              | 晴，傍晚~夜間              | 晴，傍晚~夜間          | 下雨，傍晚~夜間          |
| 架設環境問題 | 受前方建築物略為干擾          | 無干擾                 | 受前方建築物略為干擾           | 無干擾                  |                  |                   |

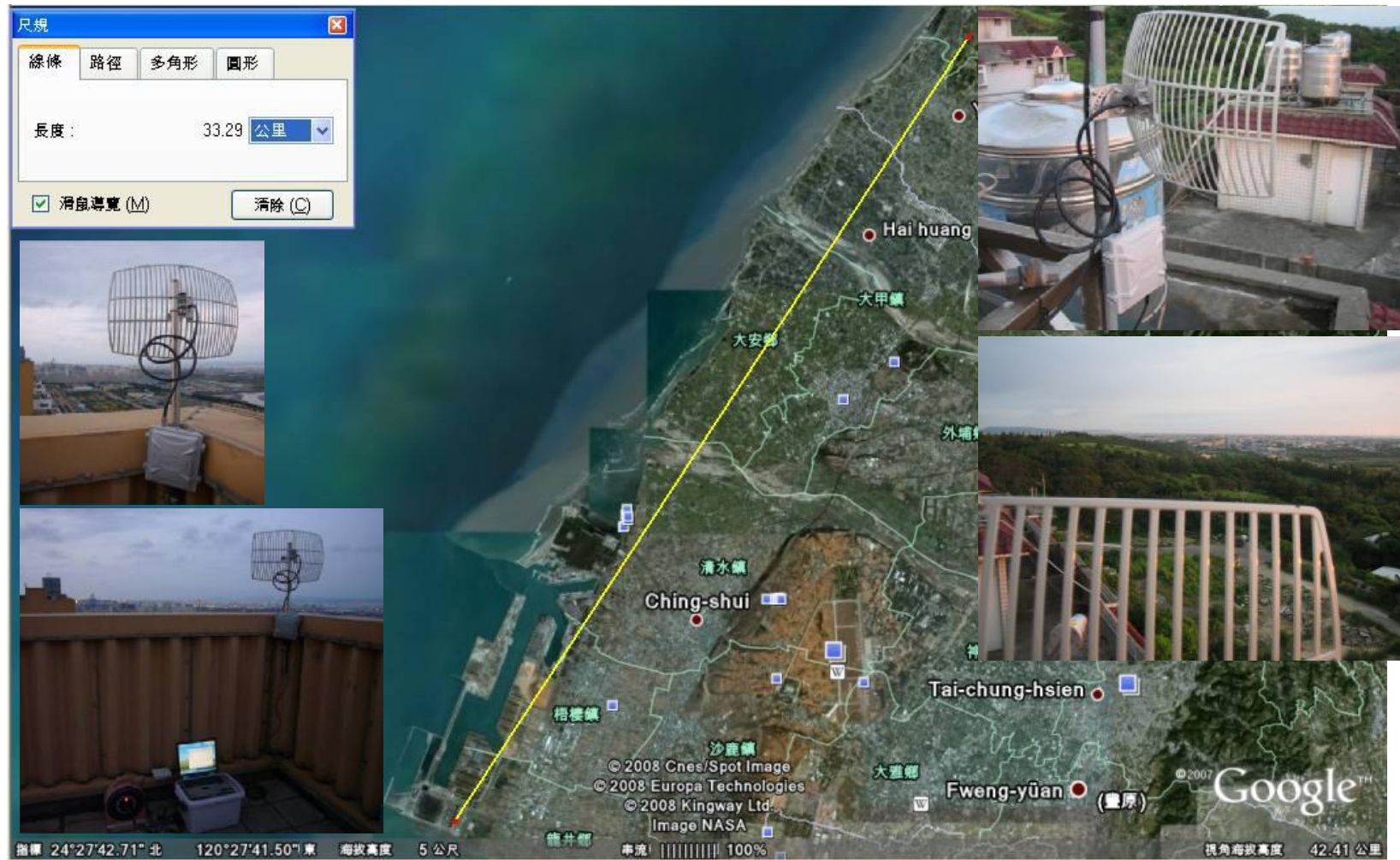
## 33Km 點對點(PtP)WiFi - 802.11g (2.4GHz)無線系統傳輸測試報告

2008/11/04 33Km 點對點(PtP)WiFi 無線系統傳輸測試報告 V1

2008/11/16 33Km 點對點(PtP)WiFi 無線系統傳輸測試報告 13Mbps V2

## 貳、 測試地點與測試距離

台灣苗栗縣通霄鎮 B à 台灣台中縣台中港南端，總距離 33.29Km。 2009 年 07 月 15 日





## 參、 測試環境

台灣苗栗縣通霄鎮 高度: 約海拔 72 公尺



台灣台中縣台中港南端 高度: 約海拔 61 公尺



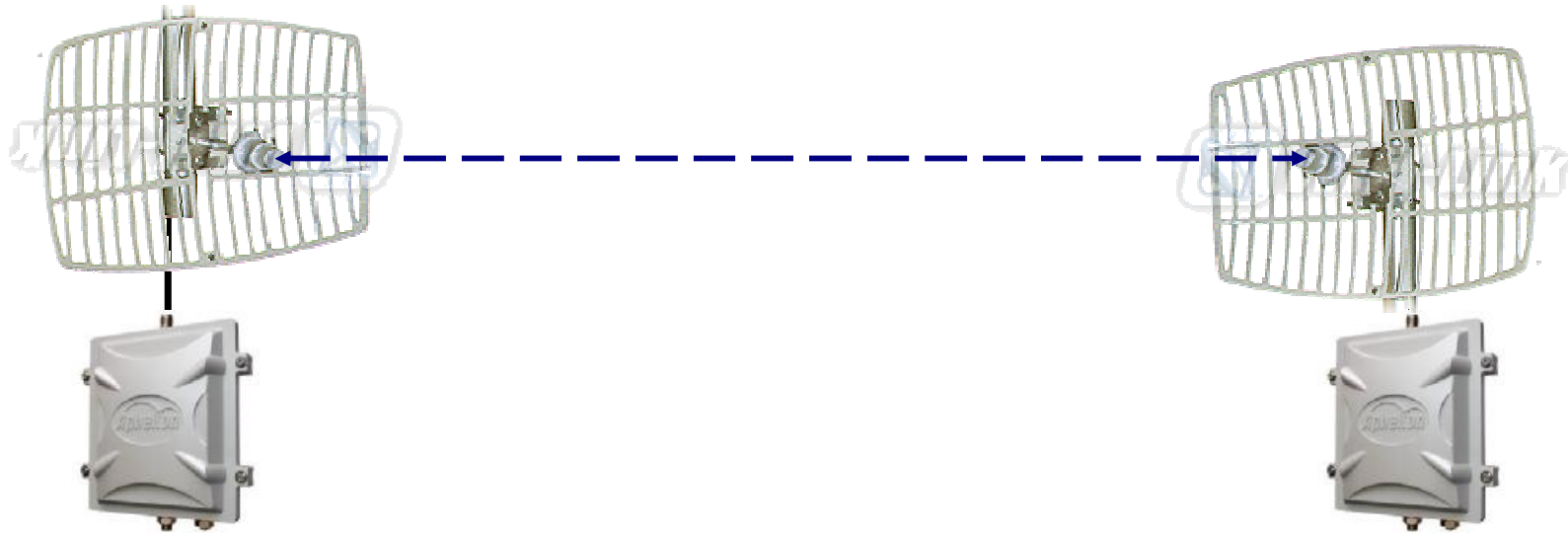
肆、 測試硬體設備

| 設備名稱                                 | 數量 | 規格                                                                                                                   | 說明                                                                                           |
|--------------------------------------|----|----------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| PC1                                  | 1  | 1.CPU:INTEL Q6600 四核心<br>2.RAM:4G<br>3.Operation S/W:Windows XP Pro                                                  | IP:192.168.1.20<br>VNC 遠端調測<br>阿樹                                                            |
| NB1                                  | 1  | 1.CPU:INTEL P4 1.8<br>2.RAM:1G<br>3.Operation S/W: Windows XP Pro                                                    | IP:192.168.1.33<br>VNC 遠端調測<br>阿南                                                            |
| NB2                                  | 1  | 1.CPU:INTEL P4 1.6GHz<br>2.RAM:512<br>3.Operation S/W: Windows XP Pro                                                | IP:192.168.1.21<br>VNC 遠端調測<br>阿樹                                                            |
| NB3                                  | 1  | 1.CPU:1.6GHz<br>2.RAM:1GB<br>3.Operation S/W: Win XP Home                                                            | VNC 遠端調測<br>Jmj10101                                                                         |
| AP1<br>Aphelion 500AG<br>(爾飛靈 500AG) | 1  | 1.CPU:533MHz 2.SDRAM:32MB<br>3.Flash:8MB<br>4.WiFi:802.11a/b/g RF Mini PCI Card *1<br>5.Output Power:31.6mW =15 dBm  | IP:192.168.1.2 (苗栗)                                                                          |
| AP2<br>Aphelion 500AG<br>(爾飛靈 500AG) | 1  | 1.CPU:533MHz 2.SDRAM:32MB<br>3.Flash:16MB<br>4.WiFi:802.11a/b/g RF Mini PCI Card *1<br>5.Output Power:31.6mW =15 dBm | IP:192.168.1.3 (台中)                                                                          |
| Antenna                              | 2  | 1.5.450 – 5.725 & 5.725~5.850 GHz Grid Antenna<br>2.Gain:27dBi<br>3.H-6° / V-9° or H-10° / V-14°<br>4.VSWR:<= 1.5    | 1.杭州勝百 5.725~5.850GHz 26.5dBi<br>2.崑海尼可 5.450~5.725GHz 27dBi<br>3.健博通 5.725~5.850GHz 26.5dBi |
| RF Cable                             | 2  | CFD-400 N-Type                                                                                                       |                                                                                              |
| WAN Modem                            | 1  | 10Mb Fiber Internet                                                                                                  |                                                                                              |

## 伍、 測試軟體

| 軟體名稱             | 數量 | 說明                                                                                |        |
|------------------|----|-----------------------------------------------------------------------------------|--------|
| IXChariot 5.4    | 2  | 1.High Performance Throughput<br>2.TCP<br>3.Point to Point                        |        |
| Network Stumbler | 2  | 1.Site Survey Wireless Environments                                               |        |
| VNC              | 3  | 1.Realtime Monitoring Each NBs<br>2.Realtime Control / Monitoring Wireless System |        |
| Skype            | 3  | 1.Realtime on Line Talking<br>2.Transport Images                                  |        |
| MSN              | 3  | 1.Realtime on Line Talking<br>2.Transport Images                                  |        |
| VPN              | 1  | 1.Realtime Monitoring Each NBs<br>2.Realtime Control / Monitoring Wireless System | VPN 網路 |

陸、 測試系統無線設備規畫



--台灣台中縣台中港南端 — NB1 192.168.1.21

Device: 500AG

System Mode: Bridge

IP: 192.168.1.3

Interface: RF1

Operation Mode: AC (Client)

ESSID: default0

Band: 802.11a

Channel: 36 (5.180GHz)

RF Output Power: 31.6mW = 15dBm

Fixed Rate: 36~48Mbps

Multicast Rate: 6Mbps

Max RF Distance: 350

Command Line: rateadaption 0 13 ; rateadaption 1 3  
; wlretry 1 2; wlosthreshold 1 2

--台灣苗栗縣通霄鎮 — PC1 192.168.1.20

Device: 500AG

System Mode: Bridge

IP: 192.168.1.2

Interface: RF1

Operation Mode: AP

ESSID: default0

Band: 802.11a

Channel: 36 (5.180GHz)

RF Output Power: 31.6mW = 15dBm

Fixed Rate: 36~48Mbps

Multicast Rate: 6Mbps

Max RF Distance: 350

Command Line: rateadaption 0 13 ; rateadaption 1 3  
; wlretry 1 2; wlosthreshold 1 2

## 柒、 33Km 無線系統透過 Ixchariot 測試 Throughput 狀況

### Test 1 : NB1-AC à PC1-AP 搭配 WiFi Link (崙海尼可) 27dBi Grid 天線

| Test 1 Item               | 500AG--AC                                     | 500AG-AP        | 測 試 說 明                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------|-----------------------------------------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.Limit Rate / Fixed Rate | 54Mbps / 36Mbps                               | 54Mbps / 36Mbps | 1.AP 無線訊號：從 AC 端所看到 AP 打過來訊號約-71~-74dBm，依鏈路計算約-70~-75dBm 範圍內，已屬對準度 95~98%。<br>2.AC 無線訊號：從 AP 端所看到 AC 打過來訊號約-76~-80dBm，依鏈路計算略高於-70~-75dBm，因架設環境有前方建築物干涉，經幾次調整無法改善，判斷應有對準，但干涉耗損 5dBm 訊號。<br>3.剛開始測試沒限制傳輸吞吐量，Throughput 只能達 2~4Mbps，後來進行 Fixed Rate = 36Mbps 後，搭配其他命令列參數設定，帶寬拉到 8~9Mbps。<br>4.改為垂直架設的水準極化，傳輸的 Throughput 仍約 8~9Mbps，影響不大，判斷是 11a-5.8GHz 的頻率干擾小，極化方向影響不大。 |
| 2.Max RF Distance         | 350                                           | 350             |                                                                                                                                                                                                                                                                                                                                                                       |
| 3.RX Link Rate            | 6~12~24~36Mbps                                | 36~48Mbps       |                                                                                                                                                                                                                                                                                                                                                                       |
| 4.TX Link Rate            | 6~12~24~36Mbps                                | 36~48Mbps       |                                                                                                                                                                                                                                                                                                                                                                       |
| 5.Noise Level             | -95~ -96dBm                                   | -95~ -96dBm     |                                                                                                                                                                                                                                                                                                                                                                       |
| 6.Link Quality            | 13-20                                         | 21-24           |                                                                                                                                                                                                                                                                                                                                                                       |
| 7.Signal Level (RSSI)     | -76 ~ -78~ -82dBm                             | -71 ~ -74dBm    |                                                                                                                                                                                                                                                                                                                                                                       |
| Throughput (Mbps)         | Average 8.327 / Minimum 6.763 / Maximum 9.234 |                 |                                                                                                                                                                                                                                                                                                                                                                       |

```
C:\ Telnet 192.168.1.2

Interface Configuration

Interface Selection : 1 - Wireless
Interface : ENABLE
Multicast Filter : Disable

Operation Mode(Wireless) : Access Point
ESSID(Wireless) : default0
Band(Wireless) : 80211a
Channel(Wireless) : 36 5180MHz
Tx Power(Wireless) : 17
RTS Threshold(Wireless) : 2312
Frag Threshold(Wireless) : 2346
Limited Rate(Wireless): 54 Mbps
Multicast Rate(wireless) : 6 Mbps
MAX RF Distance(wireless) : 350

Press SPACE select mode.
```

```
C:\ Telnet 192.168.1.3

Interface Configuration

Interface Selection : 1 - Wireless
Interface : ENABLE
Multicast Filter : Disable

Operation Mode(Wireless) : Wireless Station
AP To Association : 000000000000
ESSID(Wireless) : default0
Band(Wireless) : 80211a
Channel(Wireless) : 0 AUTO
Tx Power(Wireless) : 17
RTS Threshold(Wireless) : 2312
Frag Threshold(Wireless) : 2346
Limited Rate(Wireless): 54 Mbps
Multicast Rate(wireless) : 6 Mbps
MAX RF Distance(wireless) : 350

Press SPACE select mode.
```



```
C:\ Telnet 192.168.1.2

=====
IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl<100Kbps>
no      address  dBm dBm  rate Byte  Byte      bps      Me. U  D  U+D
=====
1 00:12:9e:60:11:25 17 -78 48/24 2.7M 19.0M 0K 0K off N/A N/A N/A
=====

IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl<100Kbps>
no      address  dBm dBm  rate Byte  Byte      bps      Me. U  D  U+D
=====
1 00:12:9e:60:11:25 17 -73 48/24 2.7M 19.0M 0K 0K off N/A N/A N/A
=====

IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl<100Kbps>
no      address  dBm dBm  rate Byte  Byte      bps      Me. U  D  U+D
=====
1 00:12:9e:60:11:25 17 -77 48/24 2.7M 19.0M 0K 8K off N/A N/A N/A
=====

IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl<100Kbps>
no      address  dBm dBm  rate Byte  Byte      bps      Me. U  D  U+D
=====
1 00:12:9e:60:11:25 17 -76 48/24 2.7M 19.0M 0K 6K off N/A N/A N/A
=====
```

```
C:\ Telnet 192.168.1.3

Interface Link Status

System UpTime : 000 Days 00:10:33 Temp : + 44.5 C CPU : 0% MEM Used :
Ethernet Status : ENABLE Connect Status : 100 Mbps/Full Duplex
RX kbps : 0 errors : 0 dropped : 0 frame : 0
TX kbps : 19 errors : 0 dropped : 0 carrier : 0

Wireless - 1 Status : ENABLE Type : Wireless Station
Tx-Power : 17 dBm Data Link Rate(Mbps) : 48Mbps
Noise Level : -96 dBm Link Quality : 24 Channel : 36 - 5180MHz
Signal Level : -71 dBm RX kbps : 12 TX kbps : 0

Press ESC exit menu.
```

```
C:\ Telnet 192.168.1.3

Interface Link Status

System UpTime : 000 Days 00:10:25 Temp : + 41.5 C CPU : 31% MEM Used : 80%
Ethernet Status : ENABLE Connect Status : 100 Mbps/Full Duplex
RX kbps : 172 errors : 0 dropped : 0 frame : 0
TX kbps : 8606 errors : 0 dropped : 0 carrier : 0

Wireless - 1 Status : ENABLE Type : Wireless Station
Tx-Power : 17 dBm Data Link Rate(Mbps) : 36Mbps
Noise Level : -95 dBm Link Quality : 21 Channel : 36 - 5180MHz
Signal Level : -74 dBm RX kbps : 8607 TX kbps : 224

Press ESC exit menu.
```

```
C:\ Telnet 192.168.1.2

=====
IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl<100Kbps>
no      address  dBm dBm  rate Byte  Byte      bps      Me. U  D  U+D
=====
1 00:12:9e:60:11:25 17 -79 36/36 159.7M 316.0M 4.2M 109K off N/A N/A N/A
=====

IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl<100Kbps>
no      address  dBm dBm  rate Byte  Byte      bps      Me. U  D  U+D
=====
1 00:12:9e:60:11:25 17 -79 36/36 160.8M 316.0M 8.4M 201K off N/A N/A N/A
=====

IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl<100Kbps>
no      address  dBm dBm  rate Byte  Byte      bps      Me. U  D  U+D
=====
1 00:12:9e:60:11:25 17 -79 36/36 161.9M 316.0M 8.7M 189K off N/A N/A N/A
=====

IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl<100Kbps>
no      address  dBm dBm  rate Byte  Byte      bps      Me. U  D  U+D
=====
1 00:12:9e:60:11:25 17 -78 36/36 163.0M 316.1M 9.1M 192K off N/A N/A N/A
=====
```

測試結果：搭配 WiFi Link (崙海尼可) 27dBi Grid 天線 – 33Km Throughput = 8~9 Mbps

Summary - C:\untitled1.tst

|                      |                              |
|----------------------|------------------------------|
| Console version      | 5.40                         |
| Console build level  | 011                          |
| Console product type | IxChariot                    |
| Filename             | C:\untitled1.tst             |
| Run start time       | 2009 𐄂 7 𐄂 15 𐄂, 𐄂𐄂 06:13:30 |
| Run end time         | 2009 𐄂 7 𐄂 15 𐄂, 𐄂𐄂 06:18:28 |
| Elapsed time         | 00:04:58                     |
| How the test ended   | Ran to completion            |
| Number of pairs      | 1                            |

Run Options

|                                      |                          |
|--------------------------------------|--------------------------|
| End type                             | Run for a fixed duration |
| Duration                             | 00:05:00                 |
| Reporting type                       | Real-time                |
| Automatically poll endpoints         | Yes                      |
| Polling interval (minutes)           | 1                        |
| Stop run upon initialization failure | Yes                      |

|                                                  |     |
|--------------------------------------------------|-----|
| Connect timeout during test (minutes)            | 0   |
| Stop test after this many running pairs fail     | 1   |
| Collect endpoint CPU utilization                 | No  |
| Validate data upon receipt                       | No  |
| Use a new seed for random variables on every run | Yes |

### Test Setup (Console to Endpoint 1)

| Group/ Pair | Console Knows Endpoint 1 | Console Protocol | Console Service Quality | Pair Comment |
|-------------|--------------------------|------------------|-------------------------|--------------|
| All Pairs   |                          |                  |                         |              |
| Pair 1      | 192.168.1.21             | TCP              | n/a                     |              |

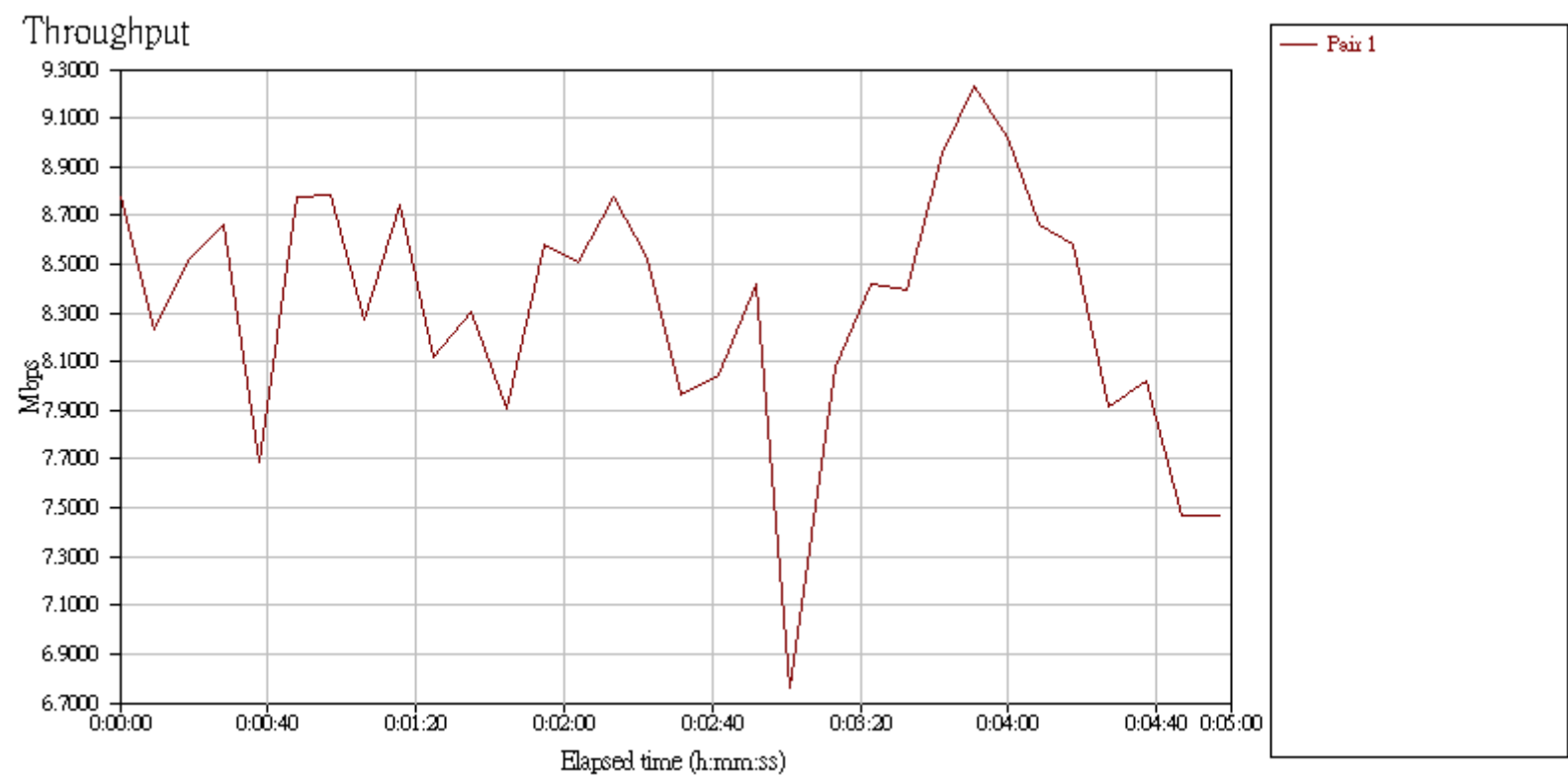
### Test Setup (Endpoint 1 to Endpoint 2)

| Group/ Pair | Endpoint 1 Knows Endpoint 2 (Setup) | Endpoint 2 Setup Protocol |
|-------------|-------------------------------------|---------------------------|
| All Pairs   |                                     |                           |
| Pair 1      | 192.168.1.20                        | TCP                       |

### Test Execution (Endpoint 1 to Endpoint 2)

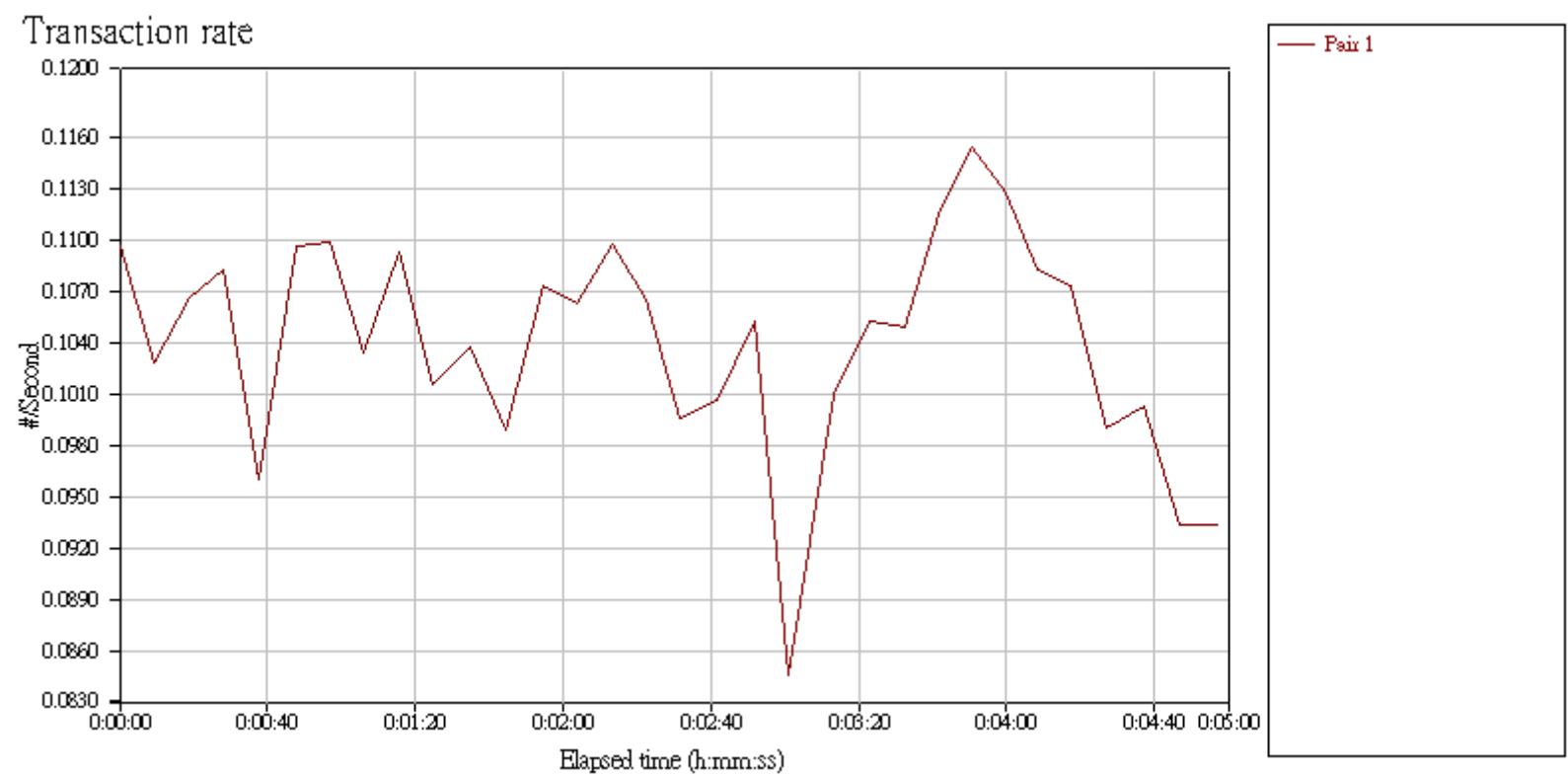
| Group/ Pair | Endpoint 1   | Endpoint 2   | Network Protocol | Service Quality | Script/Stream Name              |
|-------------|--------------|--------------|------------------|-----------------|---------------------------------|
| All Pairs   |              |              |                  |                 |                                 |
| Pair 1      | 192.168.1.21 | 192.168.1.20 | TCP              |                 | High_Performance_Throughput.scr |

Throughput



| Group/ Pair | Average (Mbps) | Minimum (Mbps) | Maximum (Mbps) | Throughput 95% Confidence Interval | Measured Time (secs) | Relative Precision |
|-------------|----------------|----------------|----------------|------------------------------------|----------------------|--------------------|
| All Pairs   | 8.327          | 6.763          | 9.234          |                                    |                      |                    |
| Pair 1      | 8.328          | 6.763          | 9.234          | 0.198                              | 297.806              | 2.373              |
| Totals:     | 8.327          | 6.763          | 9.234          |                                    |                      |                    |

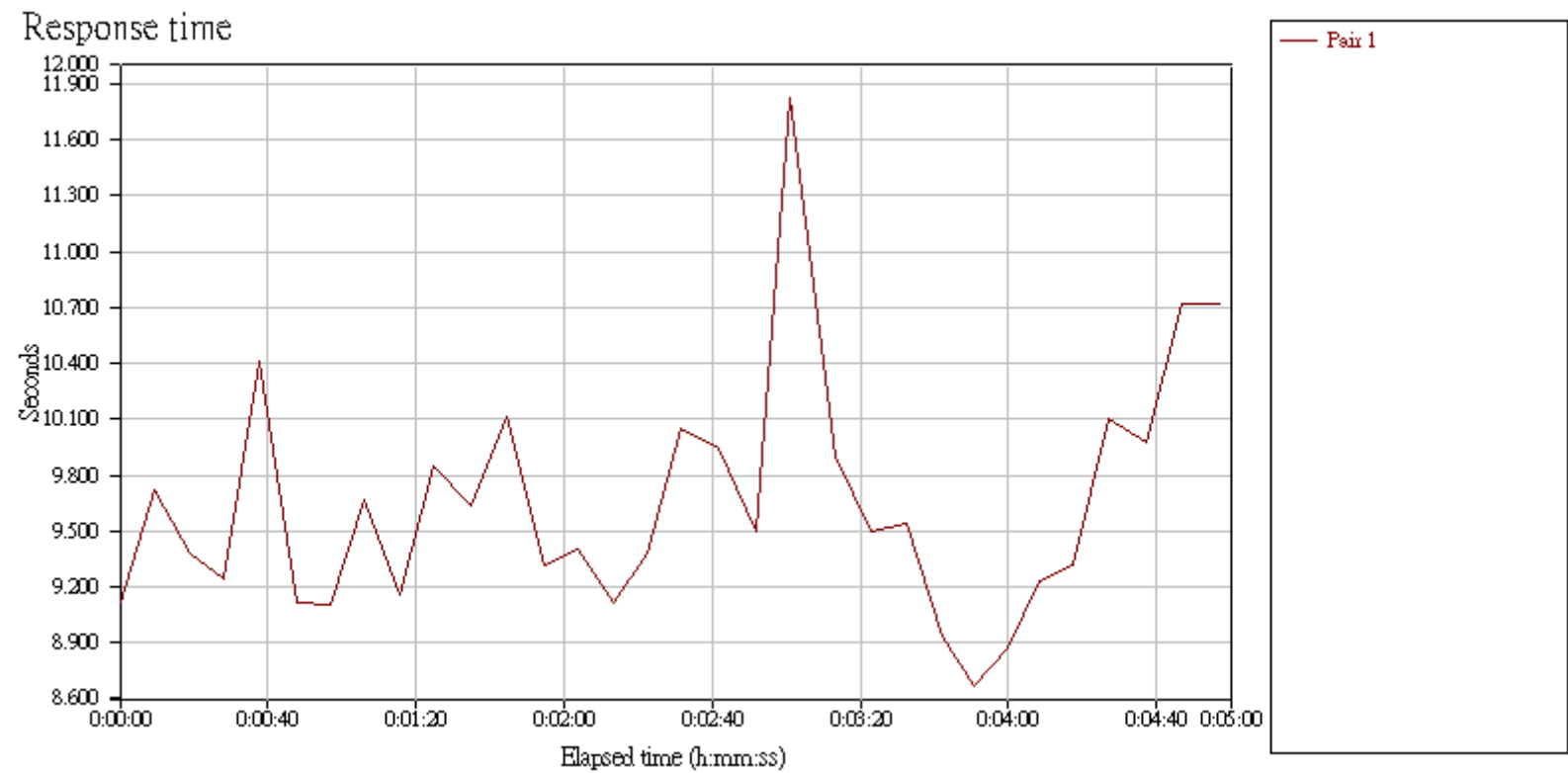
Transaction Rate



| Group/<br>Pair | Transaction Rate<br>Average | Transaction Rate<br>Minimum | Transaction Rate<br>Maximum | Transaction Rate 95% Confidence<br>Interval | Measured Time<br>(secs) | Relative<br>Precision |
|----------------|-----------------------------|-----------------------------|-----------------------------|---------------------------------------------|-------------------------|-----------------------|
| All Pairs      | 0.104                       | 0.085                       | 0.115                       |                                             |                         |                       |
| Pair 1         | 0.104                       | 0.085                       | 0.115                       | 0.002                                       | 297.806                 | 2.373                 |
| Totals:        | 0.104                       | 0.085                       | 0.115                       |                                             |                         |                       |



Response Time



| Group/<br>Pair | Response Time<br>Average | Response Time<br>Minimum | Response Time<br>Maximum | Response Time 95% Confidence<br>Interval | Measured Time<br>(secs) | Relative<br>Precision |
|----------------|--------------------------|--------------------------|--------------------------|------------------------------------------|-------------------------|-----------------------|
| All Pairs      | 9.607                    | 8.664                    | 11.829                   |                                          |                         |                       |
| Pair 1         | 9.607                    | 8.664                    | 11.829                   | 0.228                                    | 297.806                 | 2.373                 |
| Totals:        | 9.607                    | 8.664                    | 11.829                   |                                          |                         |                       |

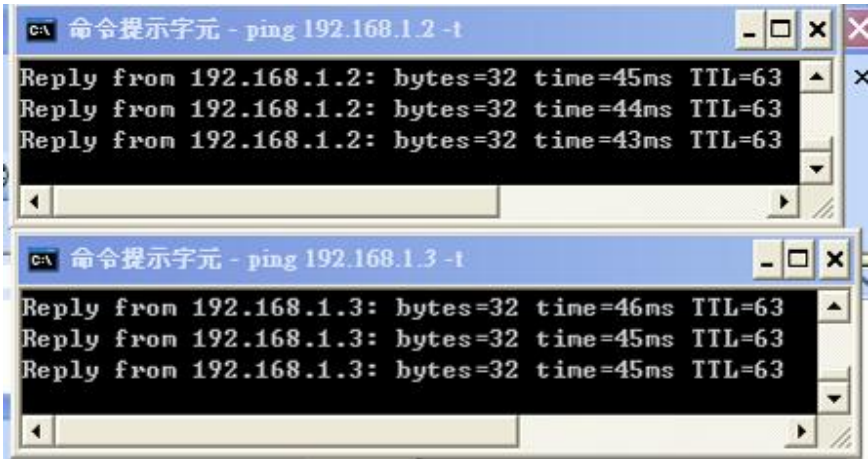
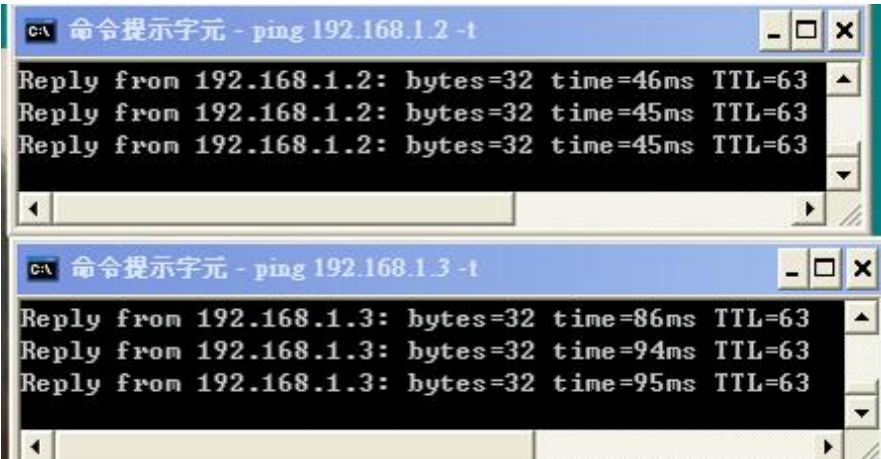
## Endpoint Configuration

| Group/ Pair | E1 Operating System | E1 Version | E1 Build Level | E1 Product Type | E2 Operating System | E2 Version | E2 Build Level | E2 Product Type |
|-------------|---------------------|------------|----------------|-----------------|---------------------|------------|----------------|-----------------|
| All Pairs   |                     |            |                |                 |                     |            |                |                 |
| Pair 1      | Windows XP (32-bit) | 5.1        | 8149           | Retail          | Windows XP (32-bit) | 5.1        | 8149           | Retail          |

## Raw Data Totals

| Group/ Pair | Number of Timing Records | Transaction Count | Bytes Sent by E1 | Bytes Received by E1 | Measured Time (secs) | Relative Precision |
|-------------|--------------------------|-------------------|------------------|----------------------|----------------------|--------------------|
| All Pairs   | 31                       | 31                | 310,000,000      | 31                   |                      |                    |
| Pair 1      | 31                       | 31                | 310,000,000      | 31                   | 297.806              | 2.373              |
| Totals:     | 31                       | 31                | 310,000,000      | 31                   |                      |                    |

特別說明：在 33Km—11a 的兩端設備 Ping 的時間回應，在沒有下參數指令狀況， Ping Reply 時間長達 60~400ms 不等，並且大流量傳輸測試時會嚴重掉包，在下了 rateadaption 指令後，Ping Reply 時間縮為 40~60ms，大大改善 Reply 時間與傳輸穩定度。



## Test 2 : NB1-AC à PC1-AP 搭配 健博通 27dBi Grid 天線

| Test 1 Item           | 500AG--AC                                       | 500AG-AP        | 測 試 說 明                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----------------------|-------------------------------------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.Fixed Rate          | 36Mbps / 48Mbps                                 | 36Mbps / 48Mbps | 1.AP 無線訊號：從 AC 端所看到 AP 打過來訊號約-71~-74dBm，依鏈路計算約-70~-75dBm 範圍內，已屬對準度 95~98%。<br>2.AC 無線訊號：從 AP 端所看到 AC 打過來訊號約-76~-78dBm，依鏈路計算略高於-70~-75dBm，因架設環境有前方建築物干涉，經幾次調整無法改善，判斷應有對準，但干涉耗損 5dBm 訊號。<br>3.更換為健博通 27dBi Grid 5.725~5.850GHz 天線，仍設定為 36Ch-5.18GHz 頻率(36~64Ch 可連線與傳輸，反而 149Ch-5.745GHz 無法連上，這種情況與另一家勝百天線狀況一樣)。<br>4.健博通天線此次傳輸比其他廠家天線好，但就個人架設經驗，每次架設的天線與訊號狀況都會有差異，從無線訊號值差 2dBm 來看，屬安裝架設誤差值範圍內，因此尚不能說健博通天線是比較好。 |
| 2.Max RF Distance     | 350                                             | 350             |                                                                                                                                                                                                                                                                                                                                                                                                              |
| 3.RX Link Rate        | 24~36Mbps                                       | 36~48Mbps       |                                                                                                                                                                                                                                                                                                                                                                                                              |
| 4.TX Link Rate        | 24~36Mbps                                       | 36~48Mbps       |                                                                                                                                                                                                                                                                                                                                                                                                              |
| 5.Noise Level         | -95~ -96dBm                                     | -95~ -96dBm     |                                                                                                                                                                                                                                                                                                                                                                                                              |
| 6.Link Quality        | 17-19                                           | 18-24           |                                                                                                                                                                                                                                                                                                                                                                                                              |
| 7.Signal Level (RSSI) | -76 ~ -78dBm                                    | -71 ~ -77dBm    |                                                                                                                                                                                                                                                                                                                                                                                                              |
| Throughput (Mbps)     | Average 11.781 / Minimum 9.434 / Maximum 12.116 |                 |                                                                                                                                                                                                                                                                                                                                                                                                              |

```

c:\ Telnet 192.168.1.2

=====
IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl(100Kbps)
no      address   dBm dBm  rate Byte  Byte  hps   Me.  U  D  U+D
=====
1 00:12:9e:60:11:25 17 -78 48/48 33.9M 1.2G 233K 11.8M off N/A N/A N/A
=====

IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl(100Kbps)
no      address   dBm dBm  rate Byte  Byte  hps   Me.  U  D  U+D
=====
1 00:12:9e:60:11:25 17 -78 48/48 33.9M 1.2G 228K 12.1M off N/A N/A N/A
=====

IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl(100Kbps)
no      address   dBm dBm  rate Byte  Byte  hps   Me.  U  D  U+D
=====
1 00:12:9e:60:11:25 17 -78 48/48 33.9M 1.2G 218K 11.7M off N/A N/A N/A
=====

IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl(100Kbps)
no      address   dBm dBm  rate Byte  Byte  hps   Me.  U  D  U+D
=====
1 00:12:9e:60:11:25 17 -78 48/48 34.0M 1.2G 229K 12.1M off N/A N/A N/A
=====

```

```

c:\ Telnet 192.168.1.3

Mode: Station      ,ESSID: default0 , AP BSSID: 00129e600817
Link Quality is 20 ,RSSI -75 dBm, Noise -95 dBm
=====
Mode: Station      ,ESSID: default0 , AP BSSID: 00129e600817
Link Quality is 19 ,RSSI -76 dBm, Noise -95 dBm
=====
Mode: Station      ,ESSID: default0 , AP BSSID: 00129e600817
Link Quality is 19 ,RSSI -76 dBm, Noise -94 dBm
=====
Mode: Station      ,ESSID: default0 , AP BSSID: 00129e600817
Link Quality is 19 ,RSSI -76 dBm, Noise -94 dBm
=====
Mode: Station      ,ESSID: default0 , AP BSSID: 00129e600817
Link Quality is 18 ,RSSI -77 dBm, Noise -94 dBm
=====
Mode: Station      ,ESSID: default0 , AP BSSID: 00129e600817
Link Quality is 18 ,RSSI -77 dBm, Noise -94 dBm
=====
Mode: Station      ,ESSID: default0 , AP BSSID: 00129e600817
Link Quality is 20 ,RSSI -75 dBm, Noise -96 dBm
=====

```

```
GA Telnet 192.168.1.2

=====
IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl(100Kbps)
no      address   dBm dBm  rate  Byte  Byte      bps      Me. U  D  U+D
=====
1 00:12:9e:60:11:25 17 -78 48/48 26.2M 784.3M 204K 11.7M off N/A N/A N/A
=====

IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl(100Kbps)
no      address   dBm dBm  rate  Byte  Byte      bps      Me. U  D  U+D
=====
1 00:12:9e:60:11:25 17 -78 48/48 26.3M 785.7M 219K 11.6M off N/A N/A N/A
=====

IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl(100Kbps)
no      address   dBm dBm  rate  Byte  Byte      bps      Me. U  D  U+D
=====
1 00:12:9e:60:11:25 17 -78 48/48 26.3M 787.2M 206K 11.8M off N/A N/A N/A
=====

IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl(100Kbps)
no      address   dBm dBm  rate  Byte  Byte      bps      Me. U  D  U+D
=====
1 00:12:9e:60:11:25 17 -77 48/48 26.3M 788.6M 222K 11.6M off N/A N/A N/A
=====
```

```
GA Telnet 192.168.1.3

Interface Link Status

System UpTime : 000 Days 00:54:58 Temp : + 41.0 C CPU : 32% MEM Used : 80%
Ethernet Status : ENABLE Connect Status : 100 Mbps/Full Duplex
RX kbps : 207 errors : 0 dropped : 0 frame : 0
TX kbps : 11457 errors : 0 dropped : 0 carrier : 0

Wireless - 1 Status : ENABLE Type : Wireless Station
Tx-Power : 17 dBm Data Link Rate(Mbps) : 48Mbps
Noise Level : -95 dBm Link Quality : 21 Channel : 36 - 5180MHz
Signal Level : -74 dBm RX kbps : 11459 TX kbps : 273

Press ESC exit menu.
```

```
GA Telnet 192.168.1.2

=====
IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl(100Kbps)
no      address   dBm dBm  rate  Byte  Byte      bps      Me. U  D  U+D
=====
1 00:12:9e:60:11:25 17 -78 48/48 26.2M 784.3M 204K 11.7M off N/A N/A N/A
=====

IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl(100Kbps)
no      address   dBm dBm  rate  Byte  Byte      bps      Me. U  D  U+D
=====
1 00:12:9e:60:11:25 17 -78 48/48 26.3M 785.7M 219K 11.6M off N/A N/A N/A
=====

IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl(100Kbps)
no      address   dBm dBm  rate  Byte  Byte      bps      Me. U  D  U+D
=====
1 00:12:9e:60:11:25 17 -78 48/48 26.3M 787.2M 206K 11.8M off N/A N/A N/A
=====

IF      MAC      TXP RSSI RX/TX Recv  Xmit  Recv  Xmit  BWCtrl(100Kbps)
no      address   dBm dBm  rate  Byte  Byte      bps      Me. U  D  U+D
=====
1 00:12:9e:60:11:25 17 -77 48/48 26.3M 788.6M 222K 11.6M off N/A N/A N/A
=====
```

```
GA Telnet 192.168.1.3

Interface Link Status

System UpTime : 000 Days 00:43:17 Temp : + 41.5 C CPU : 35% MEM Used : 81%
Ethernet Status : ENABLE Connect Status : 100 Mbps/Full Duplex
RX kbps : 220 errors : 0 dropped : 0 frame : 0
TX kbps : 11043 errors : 0 dropped : 0 carrier : 0

Wireless - 1 Status : ENABLE Type : Wireless Station
Tx-Power : 17 dBm Data Link Rate(Mbps) : 48Mbps
Noise Level : -97 dBm Link Quality : 22 Channel : 36 - 5180MHz
Signal Level : -73 dBm RX kbps : 11049 TX kbps : 287

Press ESC exit menu.
```

測試結果：搭配 健博通 27dBi Grid 天線 – 33Km Throughput = 9 ~ 12 Mbps

Summary - untitled3.tst

|                      |                               |
|----------------------|-------------------------------|
| Console version      | 5.40                          |
| Console build level  | 011                           |
| Console product type | IxChariot                     |
| Filename             | untitled3.tst                 |
| Run start time       | 2009 𐄂 7 𐄂 15 𐄂, 𐄂 𐄂 07:55:37 |
| Run end time         | 2009 𐄂 7 𐄂 15 𐄂, 𐄂 𐄂 08:05:35 |
| Elapsed time         | 00:09:58                      |
| How the test ended   | Ran to completion             |
| Number of pairs      | 1                             |

Run Options

|                                      |                          |
|--------------------------------------|--------------------------|
| End type                             | Run for a fixed duration |
| Duration                             | 00:10:00                 |
| Reporting type                       | Real-time                |
| Automatically poll endpoints         | Yes                      |
| Polling interval (minutes)           | 1                        |
| Stop run upon initialization failure | Yes                      |

|                                                  |     |
|--------------------------------------------------|-----|
| Connect timeout during test (minutes)            | 0   |
| Stop test after this many running pairs fail     | 1   |
| Collect endpoint CPU utilization                 | No  |
| Validate data upon receipt                       | No  |
| Use a new seed for random variables on every run | Yes |

### Test Setup (Console to Endpoint 1)

| Group/ Pair | Console Knows Endpoint 1 | Console Protocol | Console Service Quality | Pair Comment |
|-------------|--------------------------|------------------|-------------------------|--------------|
| All Pairs   |                          |                  |                         |              |
| Pair 1      | 192.168.1.20             | TCP              | n/a                     |              |

### Test Setup (Endpoint 1 to Endpoint 2)

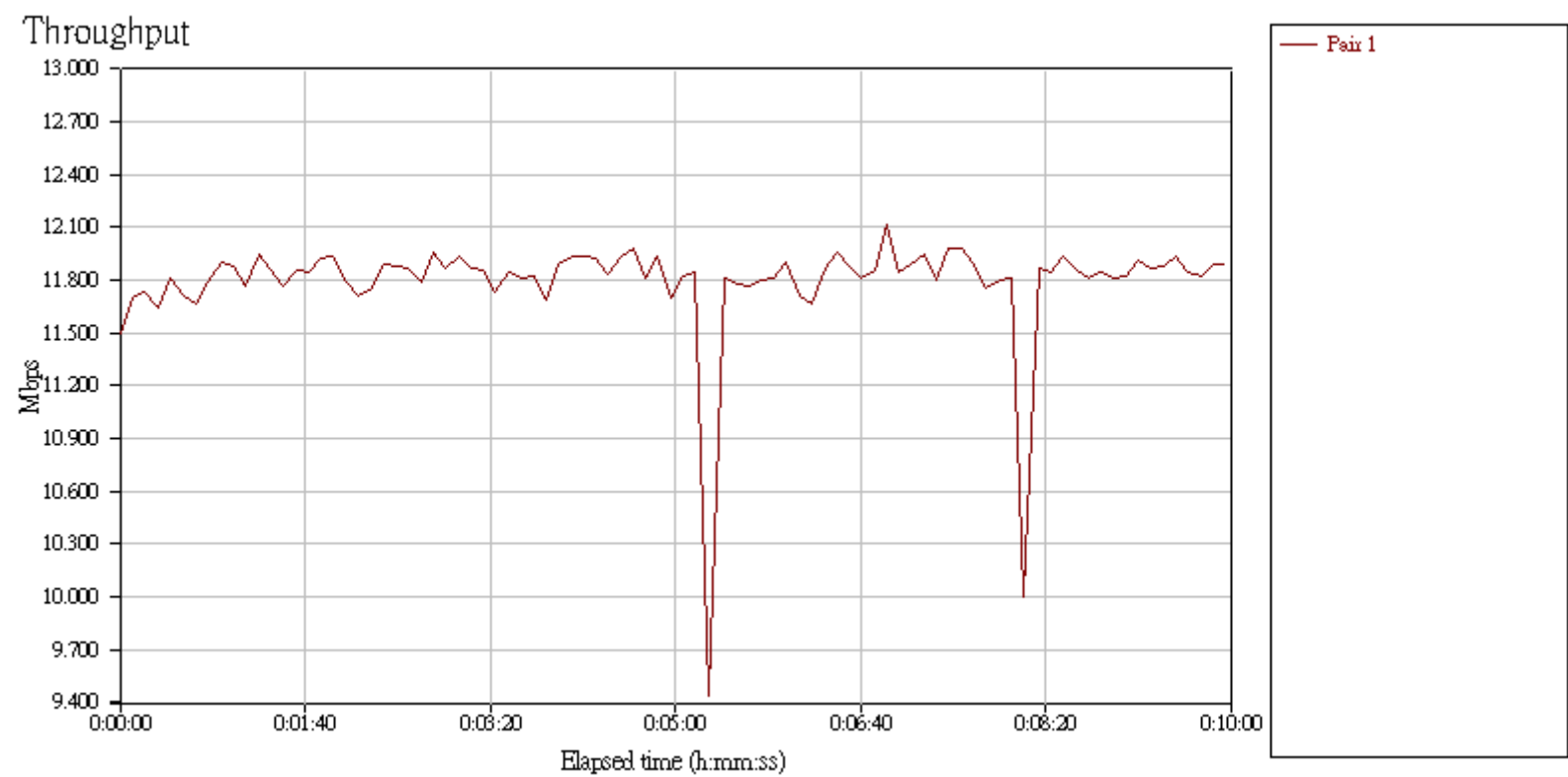
| Group/ Pair | Endpoint 1 Knows Endpoint 2 (Setup) | Endpoint 2 Setup Protocol |
|-------------|-------------------------------------|---------------------------|
| All Pairs   |                                     |                           |
| Pair 1      | 192.168.1.21                        | TCP                       |

### Test Execution (Endpoint 1 to Endpoint 2)

| Group/ Pair | Endpoint 1   | Endpoint 2   | Network Protocol | Service Quality | Script/Stream Name              |
|-------------|--------------|--------------|------------------|-----------------|---------------------------------|
| All Pairs   |              |              |                  |                 |                                 |
| Pair 1      | 192.168.1.20 | 192.168.1.21 | TCP              |                 | High_Performance_Throughput.scr |

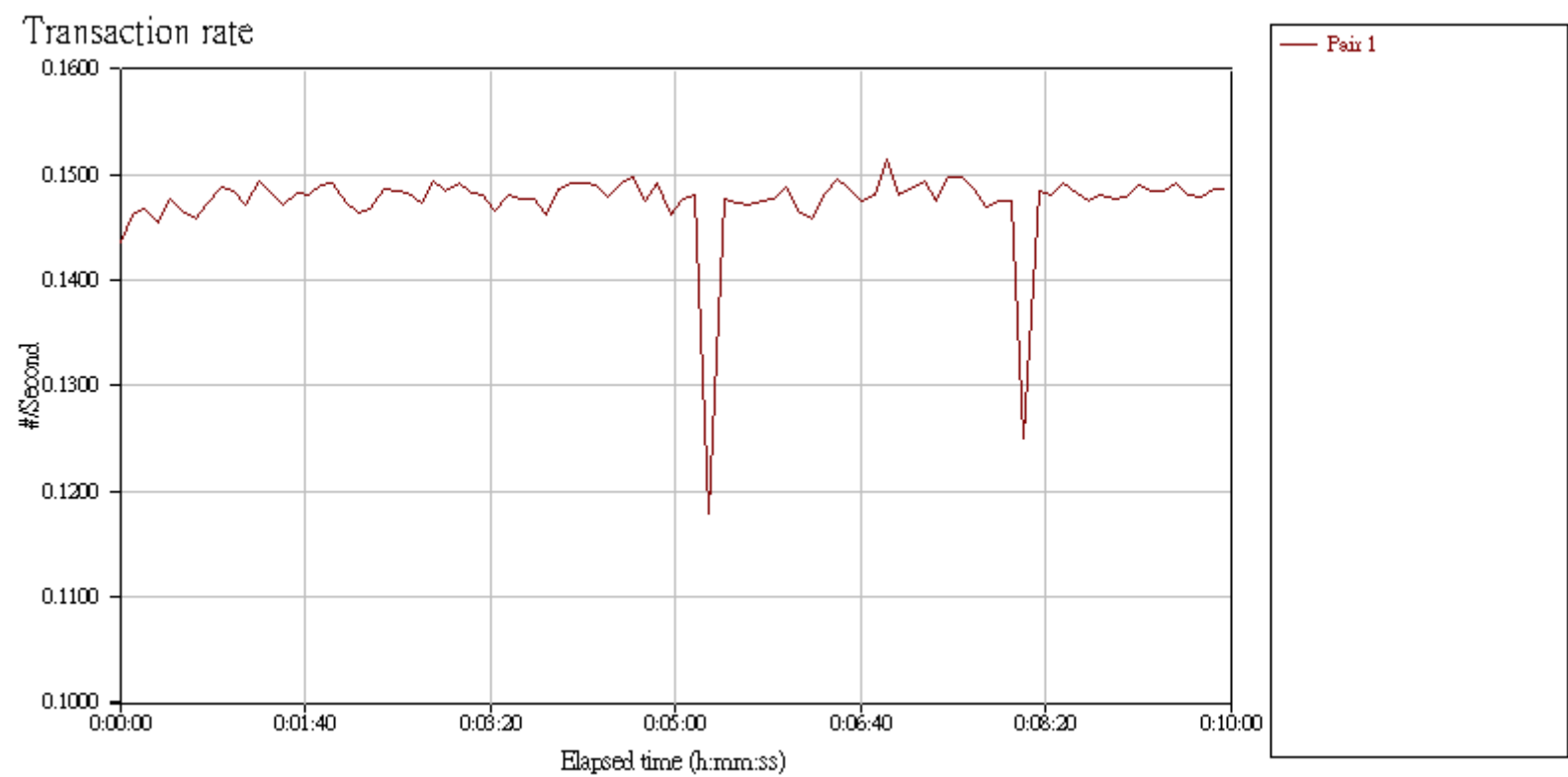


Throughput



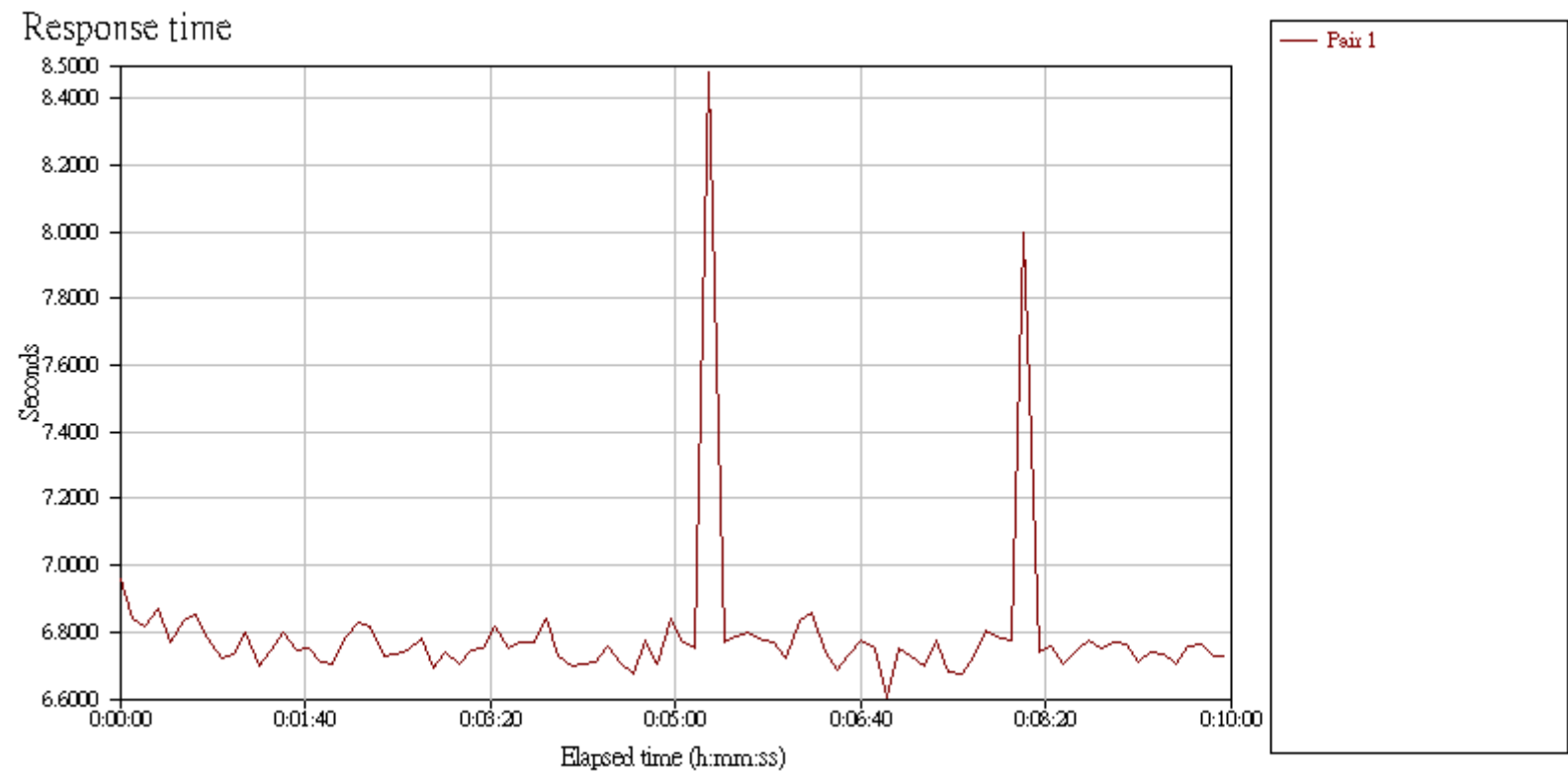
| Group/ Pair | Average (Mbps) | Minimum (Mbps) | Maximum (Mbps) | Throughput 95% Confidence Interval | Measured Time (secs) | Relative Precision |
|-------------|----------------|----------------|----------------|------------------------------------|----------------------|--------------------|
| All Pairs   | 11.781         | 9.434          | 12.116         |                                    |                      |                    |
| Pair 1      | 11.781         | 9.434          | 12.116         | 0.085                              | 597.552              | 0.723              |
| Totals:     | 11.781         | 9.434          | 12.116         |                                    |                      |                    |

Transaction Rate



| Group/<br>Pair | Transaction Rate<br>Average | Transaction Rate<br>Minimum | Transaction Rate<br>Maximum | Transaction Rate 95% Confidence<br>Interval | Measured Time<br>(secs) | Relative<br>Precision |
|----------------|-----------------------------|-----------------------------|-----------------------------|---------------------------------------------|-------------------------|-----------------------|
| All Pairs      | 0.147                       | 0.118                       | 0.151                       |                                             |                         |                       |
| Pair 1         | 0.147                       | 0.118                       | 0.151                       | 0.001                                       | 597.552                 | 0.723                 |
| Totals:        | 0.147                       | 0.118                       | 0.151                       |                                             |                         |                       |

Response Time



| Group/<br>Pair | Response Time<br>Average | Response Time<br>Minimum | Response Time<br>Maximum | Response Time 95% Confidence<br>Interval | Measured Time<br>(secs) | Relative<br>Precision |
|----------------|--------------------------|--------------------------|--------------------------|------------------------------------------|-------------------------|-----------------------|
| All Pairs      | 6.790                    | 6.603                    | 8.480                    |                                          |                         |                       |
| Pair 1         | 6.790                    | 6.603                    | 8.480                    | 0.049                                    | 597.552                 | 0.723                 |
| Totals:        | 6.790                    | 6.603                    | 8.480                    |                                          |                         |                       |

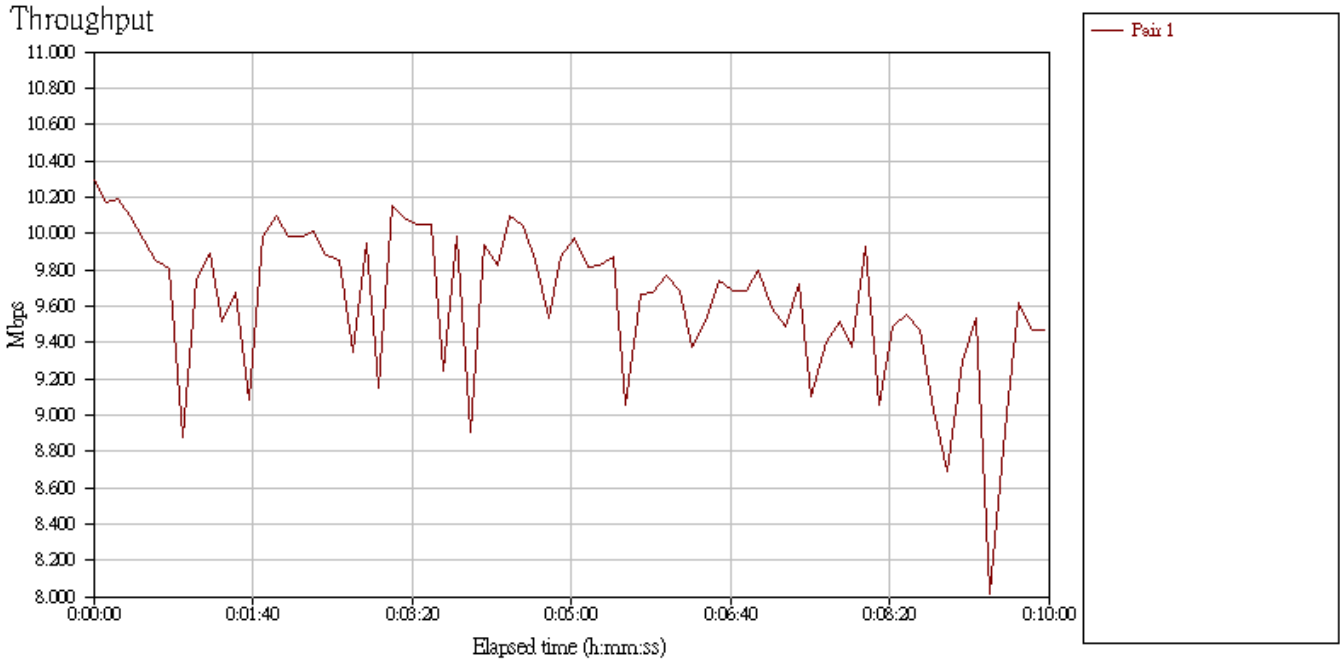
Endpoint Configuration

| Group/ Pair | E1 Operating System | E1 Version | E1 Build Level | E1 Product Type | E2 Operating System | E2 Version | E2 Build Level | E2 Product Type |
|-------------|---------------------|------------|----------------|-----------------|---------------------|------------|----------------|-----------------|
| All Pairs   |                     |            |                |                 |                     |            |                |                 |
| Pair 1      | Windows XP (32-bit) | 5.1        | 8149           | Retail          | Windows XP (32-bit) | 5.1        | 8149           | Retail          |

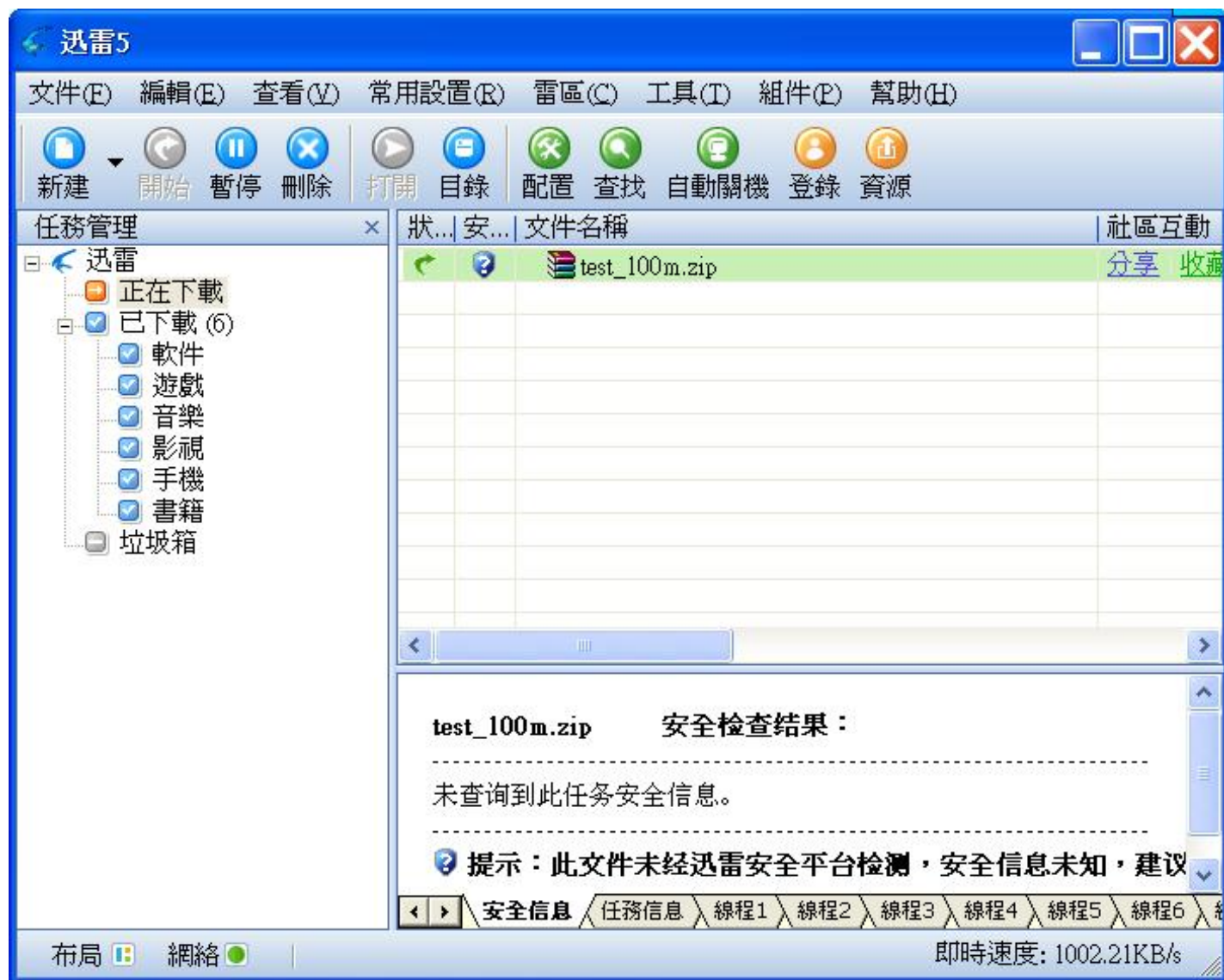
Raw Data Totals

| Group/ Pair | Number of Timing Records | Transaction Count | Bytes Sent by E1 | Bytes Received by E1 | Measured Time (secs) | Relative Precision |
|-------------|--------------------------|-------------------|------------------|----------------------|----------------------|--------------------|
| All Pairs   | 88                       | 88                | 880,000,000      | 88                   |                      |                    |
| Pair 1      | 88                       | 88                | 880,000,000      | 88                   | 597.552              | 0.723              |
| Totals:     | 88                       | 88                | 880,000,000      | 88                   |                      |                    |

特別說明：因為 AC 端架設環境略受干涉，訊號較 AP 端差，因此若從 AC 端往 AP 端傳送，Throughput 會相對較低，約 9~10Mbps。



捌、 測試迅雷 Download 速度，透過 33Km Internet PtP 無線系統傳輸狀況 可達 1002.21 KB/s



## 玖、 總結測試統計

| 測試記錄                           | Average<br>(Mbps)                            | Minimum<br>(Mbps) | Maximum<br>(Mbps) | Max RF<br>Distance | AC-RX<br>Link Rate | AC-TX<br>Link Rate | AP-RX Link<br>Rate | AP-TX Link<br>Rate | Noise Level<br>AC/AP dBm | Link Quality<br>AC/AP | Signal<br>Level dBm  |
|--------------------------------|----------------------------------------------|-------------------|-------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------------|-----------------------|----------------------|
| Test 1 AP ↔ AC<br>WiFi Link 天線 | 8.327                                        | 6.763             | 9.234             | 350                | 6~12~24~36<br>Mbps | 6~12~24~36<br>Mbps | 36~48Mbps          | 36~48Mbps          | -95 ~ -96                | 13-20/21-24           | -76~-82 /<br>-71~-74 |
| Test 2 AP ↔ AC<br>健博通 天線       | 11.781                                       | 9.434             | 12.116            | 350                | 24~36 Mbps         | 24~36 Mbps         | 36~48Mbps          | 36~48Mbps          | -95 ~ -96                | 17-19/18-24           | -75~-79 /<br>-73~-78 |
| Test 3 AC ↔ AP<br>健博通 天線       | 9.624                                        | 8.016             | 10.291            | 350                | 24~36 Mbps         | 24~36 Mbps         | 36~48Mbps          | 36~48Mbps          | -95 ~ -96                | 17-19/18-24           | -75~-79 /<br>-73~-78 |
| Test 0 AP ↔ AC<br>杭州勝百 天線      | 2009/07/14 雨天 無線訊號雖與 7/15<br>相當，但掉包嚴重，無法正常傳輸 |                   |                   | 350                | 6~24 Mbps          | 6~24 Mbps          | 6~36 Mbps          | 6~36 Mbps          | -95 ~ -96                | 20-25/22-25           | -77~-82 /<br>-72~-75 |

### 測 試 總 結

- 1.遠距離架設天線，需事前場地勘察清楚，架設相關的—1.架設高度 2.傳輸鏈路的天線場型干涉 3.架設點的水準 4.參考地標 5.遠距離對天線技術...等缺一不可。2008/11/4 & 11/16 架設 33Km-11g，花費 10 分鐘對準天線，此次架設 33Km-11a，只花費 5 分鐘就對準天線，主要的重點在焚化爐的煙囪地標，讓我們遠距離對天線很容易。
- 2.上次 2008/11/4 & 11/16 架設 33Km-11g，調整 Link Rate 與 Fixed Rate=36Mbps，並無明顯效果；但此次 33Km-11a 調整 Link Rate 與 Fixed Rate=36Mbps，產生明顯效果，整體 Throughput 可由 2 ~ 4Mbps，拉升到 8~12Mbps。
- 3.07/14 下雨天所測的杭州勝百的 27dBi 天線，無線訊號雖可達到相同值，但卻無法正常傳輸；是天候下雨造成掉包過多，或是無線射頻與天線頻率匹配出問題，造成波的變形，尚待下次測試驗證。
- 4.此次 33Km-11a 的 Ping Reply 時間較 33Km-11g 來的久，也驗證了 11a 過遠距離傳輸是有風險的(建議 10Km 以內為宜)。
- 5.此次 33Km-11a 的 Noise Level = -95~ -96dBm (抗干擾)沒有明顯 AP/AC 的值差異，相較於 2008/11/4 架設 33Km-11g 的 Noise Level 會出現 10~20dBm 的差異，顯示 802.11a 受干擾情況較少。
- 6.此次針對無線設備進行幾項設置調整與命令列參數設定，明顯改善無線鏈路傳輸，於後記詳述。
- 7.此次測試結果證實，無線射頻功率大小的重要性，遠低於無線訊號優化的重要性，即使 RF Output Power: 31.6mW，仍能達到遠距離高頻寬傳輸。
- 8.從 Signal Level 與 Link Rate 及 Max RF Distance 等數據來看，33Km 的 Throughput 應該還有成長空間，要超過 12Mbps 只加大到 30dBi 天線增益即可達成。
- 9.上次 2008/11/4 & 11/16 架設 33Km-11g，調整天線架設為垂直方向的水準極化，Throughput 明顯由 8Mbps 提昇為 12Mbps，但此次 33Km-11a 的水準與垂直極化產生的 Throughput 值差異不大。



## 後記

此次『33Km 點對點(PtP)WiFi-802.11a (5.8GHz)無線系統傳輸測試』進行了兩天，第一天因受下雨影響，加上測試結果不佳，只進行了兩小時；第二天因天候變佳，加上一開始測試狀況良好，進行了調整天線水準與垂直架法及更換天線動作，整體測試時間進行了五個小時左右，其中針對無線設備進行幾項設置調整與命令列參數設定，明顯改善無線鏈路傳輸，實值得詳述。

1. 無線設備的頻率設定 – 低頻會有較大輸出功率(普遍狀況)，因此測試初期以低頻 Channel = 36 = 5180MHz 為優先測試。
2. 無線設備的傳輸設定 – Limited Rate (最大傳輸吞吐量) 由 54Mbps 改為 **à Fixed Rate 36Mbps(或 48Mbps)**，以提升無線訊號強度與純度。
3. 無線設備的 AP/AC 設定 – 主控測試端建議設為 AP，另一端設為 AC (wireless station)；AC 端的 Channel 設為 Auto 自動，當變動頻率時，只需 AP 變動就可以(AC 會自動跟著變動)。
4. 無線設備的距離參數設定(ACK) – 以 100m 為一單位，33Km=3300m/100m=330 單位，可加 10%左右的變數參數，因此設為 350 距離參數。

```
Telnet 192.168.1.2

Interface Configuration

Interface Selection : 1 - Wireless
Interface : ENABLE
Multicast Filter : Disable

Operation Mode(Wireless) : Access Point
ESSID(Wireless) : default0
Band(Wireless) : 80211a
Channel(Wireless) : 36 5180MHz
Tx Power(Wireless) : 17
RTS Threshold(Wireless) : 2312
Frag Threshold(Wireless) : 2346
Limited Rate(Wireless): 54 Mbps
Multicast Rate(wireless) : 6 Mbps
MAX RF Distance(wireless) : 350

Press SPACE select mode.
```

```
Telnet 192.168.1.2

Interface Configuration

Interface Selection : 1 - Wireless
Interface : ENABLE
Multicast Filter : Disable

Operation Mode(Wireless) : Access Point
ESSID(Wireless) : default0
Band(Wireless) : 80211a
Channel(Wireless) : 64 5320MHz
Tx Power(Wireless) : 17
RTS Threshold(Wireless) : 2312
Frag Threshold(Wireless) : 2346
Fixed Rate(Wireless) : 48 Mbps
Multicast Rate(wireless) : 6 Mbps
MAX RF Distance(wireless) : 350

Press SPACE select mode.
```

```
Telnet 192.168.1.3

Interface Configuration

Interface Selection : 1 - Wireless
Interface : ENABLE
Multicast Filter : Disable

Operation Mode(Wireless) : Wireless Station
AP To Association : 000000000000
ESSID(Wireless) : default0
Band(Wireless) : 80211a
Channel(Wireless) : 0 AUTO
Tx Power(Wireless) : 17
RTS Threshold(Wireless) : 2312
Frag Threshold(Wireless) : 2346
Limited Rate(Wireless): 54 Mbps
Multicast Rate(wireless) : 6 Mbps
MAX RF Distance(wireless) : 350

Press SPACE select mode.
```

## 5. 針對命令列指令：

Command: rateadaption ( 實際產生效果：『傳輸率穩定』、『Throughput 增加』、『Ping Reply 時間縮短』、『掉包率減少』 )

適用：AP&AC 端介面設定

說明：透過指令調整無線參數，達到聯機的高傳輸率與穩定性，對無線骨幹系統與高速移動及無線監控等大頻寬需求應用，效果顯著。

操作說明: > rateadaption [下降/上升] [參數值] (建議下降/上升都設定)

>rateadaption 0 13      >rateadaption 1 3

Command: wlosthreshold ( 實際產生效果：『傳輸率穩定』、『Ping Reply 時間縮短』、『掉包率減少』、『斷線率減少』 )

適用：AC 用戶端介面設定 (當無線模組介面是 AC 用戶端時，此指令才可作用)

說明：此指令可減少 AP 與 AC 的斷線率，對聯機穩定有幫助。(若 AC 設參數值越大'AC 斷線反應會越慢，因此骨幹可設 2~4,上網覆蓋應預設 0)

操作說明: > wlosthreshold [無線模組號碼] [參數值]

> wlosthreshold 1 2

Command: wlretry ( 實際產生效果：『Throughput 增加』、『掉包率減少』 )

適用：AP&AC 端介面設定

說明：解決掉包率偏高環境的指令，此參數值的調整，會影響聯機頻寬率降低

操作說明: > wlretry [無線模組號碼] [參數值]

> wlretry 2 3