# Wireless LAN 的功能、互通、及效能實驗 v0.9

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### I. 實驗目的

由於 Wireless LAN 技術的快速更迭,以及 Wi-Fi (Wireless-Fidelity)標準認證的大幅普及, 這些實驗的目的是安排學生對於 WLAN 的新技術與認證標準,進行合於科學觀點的實驗,並希 望能藉由對目前新 Access Point 與 Station 產品的功能、互通(包括了 Wi-Fi 測試)、與效能測試 等多種角度的觀察結果,能再提出自己的實驗方法(Methodology)。

WLAN 最近的技術進展之一例,就是已經由 802.11b 的 11Mbps 提升到 802.11g 的 54Mbps; 其他的例子還包括 Wi-Fi 聯盟要求系統廠商推出可相容於 WPA(Wi-Fi Protected Access)安全性 功能的產品。這些實驗的內容安排了一些與新技術及認證標準有關的測試,列表如下:

實驗代碼	實驗名稱	主題	所需時間
FT-1	Functionality Test 1	Basic Settings	60 min
FT-2	Functionality Test 2	Security Modes	
FT-2x	The Extension of Functionality Test 2		
IT-1	Interoperability Test 1 - Wi-Fi Style	(see later section)	60 min
IT-2	Interoperability Test 2	b/g Mixed Mode	
PT-1	Performance Test 1	Throughput vs. Chipset	30 min

終究,這些實驗的目的是期待所有學生能以研究角度探討如何安排好的實驗,以及對實驗的 觀察結果做合理的分析,因此請再多花 30 min 的時間,與助教討論這方面的問題。(註:本學期 WLAN 的實驗可找 NBL WLAN 領域的專案經理討論。)

另外,實驗報告的內容應是經過討論、整理後而得,內容至少要包含:實驗題目、時間地點、 參與人員、記錄(不只是實驗結果,也應包含實驗過程所遭遇到的問題與困難)、問題討論、心 得等;注意,若助教對報告內容的要求不同,請以助教的要求為準。 待測的 AP (Access Point under Test)

AF	· 部分	數量
1.	APUT:由 NBLWLAN 測試平台中選出的 Access Point 或 Wireless Router	1
2.	SMC 2804WBR Barricade g Cable/DSL Broadband Router	1
3.	Buffalo WBR-G54 802.11g Wireless Broadband Router	1
4.	D-Link DI-624+ AirPlus XtremeG+ Wireless Router	1

待測的 STA (Station under Test)

STA 部分		
1.	STAUT:由 NBLWLAN 測試平台中選出的 Wireless Cardbus Adapter	1
2.	SMC 2835W EZ Connect g Wireless Cardbus Adapter	1
3.	Buffalo WLI-CB-G54A 802.11g Wireless Cardbus Adapter	1
4.	D-Link DWL-G650+ AirPlus XtremeG+ Wireless Cardbus Adapter	1
5.	D-Link DWL-AG650 AirXpertABG Wireless Cardbus Adapter	1

測試平台與工具(Test Platform and Utilities)

平台部分	數量	備註
1. Notebook PC w. WinXP & Win2K	1	要具備 Cardbus/ PCMCIA 插槽
2. Desktop PC w. WinXP	1	執行 Chariot Console 與 EndPoint 之用
3. Desktop PC w. WinSrv 2003	1	作爲憑證授權與網路驗證伺服器
4. 5-Port (or more) Ethernet Switch	1	將第2、3個平台設備相連接成 LAN
工具部分	數量	備註
5. NetIQ Chariot Console	1	安裝於第2個平台設備上
6. NetIQ Chariot EndPoint	3	安裝於第1、2個平台設備上,其中第1
		個平台設備的兩個作業系統都要安裝

#### WLAN 補充簡介

這裡只對 WLAN 做約略的簡介與補充,你/妳的基礎應該包括了計算機網路課程,當中有 對 WLAN 的介紹;以及目前的計算機網路實驗課程的介紹,至少應該翻過 WLAN 的實驗內容。 首先給一點對 WLAN 技術觀念的複習:(1)單一的 MAC(Medium Access Control)支援多重的 PHY(Physical Layer);(2)兩大主要的配置:Independent(或稱為 Ad Hoc)和 Infrastructure。

IEEE 802.11 的 MAC 標準已經行之有年,做法叫 CSMA/CA (Carrier Sense Multiple Access/ Collision Avoidance),目前在許多的相關教材裡都能找到對它的解說,但要知道現階段並非很多 的 WLAN 產品皆完整地實現所有關於它的標準。例如,對於 Hidden Node 的 Collision Avoidance 問題,有一些產品是不理會 RTS/CTS 設計需要的,或是雖然有實現但在預設上是不啓用此功能 的。況且,在這幾年來 PHY 的大幅進步,以及安全性議題的高漲,一直以來所用的 MAC 已經 不見得必然適用。於是,有更多用來擴充的 802.11 子標準已經在發展中,例如支持 AP 之間無縫 隙漫遊 (Seamless Roaming)的 802.11f (Inter-AP Protocol)、加強安全性成爲更完整加密與認證 的 802.11i (WEP/ TKIP/ AES + 802.1X Protocol)等。下面還會談到一個 MAC 的重大問題。

PHY 的進步是近年來 WLAN 的重頭戲,因為後來的電磁訊號調變技術,使得在空間中相同 頻帶(Frequency Band)的傳輸容量(Capacity)加大。例如多年前從主流 802.11 的 DSSS(Direct Sequence Spreading Spectrum)搭配上相位調變的 1Mbps 與 2Mbps 位元率,提升到 802.11b CCK (Complementary Code Keying)整合互補 DS 碼與相位調變的 5.5Mbps 與 11Mbps,便是大幅度 的進步。而自去年起,甫通過的新標準 802.11g,在 802.11b 的相同頻帶裡使用與 802.11a 相同的 訊號調變技術 OFDM (Orthogonal Frequency Division Multiplexing),突破至 54Mbps 的境界,更 是突顯出了正交分頻技術可能從此取代展頻技術的趨勢。然而,802.11g 的出現,卻也造成當初 MAC 設計在目前的窘境,CSMA/CA 對每個 Frame 的一部分仍必須採用傳統的調變方式,才能 正常運作,也才能與 802.11b 相容,此時你/妳可以察覺到,效能的提升一定受到影響。

接下來再提到兩大主要配置,這個概念一直都沒有變,不僅如此,其中的 Independent,也 就是 Ad Hoc 的功能與用途仍然是一樣地貧乏,目前的產品雖然都能支援這兩種配置,但是使用 者幾乎只會用到 Infrastructure,而且許多廠商更是求新求變地擴充了 Infrastructure 的定義,賦予 Access Point 更多的角色,例如 Wireless Client、Wireless Bridge 等,分別能將 Ethernet 與 Wireless 架構的關係互換,與將 BSS (Basic Service Set)直接以無線媒介互連起來。下圖表示出最基本的 兩種 IEEE 802.11 配置圖,至於更新的 Infrastructure 配置,可以參考新產品的手冊。



From: © IEEE, "Tutorial of Draft Standard 802.11/D3.0"

如上圖,左邊的三個 Station 自成一個 Ad Hoc 系統,稱為 IBSS (Independent BSS);右邊的 一個 AP 與兩個 Station 則成為一個 BSS,若有多個 BSS 以其他的網路(通稱為 DS: Distribution System)互連起來,就形成了一個 ESS (Extended Service Set)。每種 Service Set 是以一個字串來 識別的,這樣的字串稱為 SSID (Service Set Identity),多數產品將它用於 BSS 時稱為 BSSID、 用於 ESS 時稱為 ESSID,其實是相同用途的字串,只要是設定為相同的字串,不同 WLAN 裝置 就屬於同一個 Service Set 了。礙於時間與可用設備規模的因素,這裡的實驗安排只牽涉到 BSS, 沒有採用到 IBSS 與 ESS 等配置,如果有興趣,當然可設計這些配置的實驗。

### WLAN 多種 PHY 技術的特色

IEEE 802.11 的 PHY 標準已經訂出了好幾個,從下表整理好的介紹可以看出來, Broadcom 這家晶片廠商對於 802.11g 是推廣有加的,其實它就是最致力於產生此標準的委員之一。

	802.11b	802.11a	802.11g	802.11a/g
Maximum Data Rate	11 Mbps	54 Mbps	54 Mbps	54 Mbps
Frequency Band	2.4 GHz	5 GHz	2.4 GHz	5/2.4 GHz
Channels	3	12	3	12/3
Typical Range	Up to 300 ft.	Up to 180 ft.	Up to 300 ft.	Up to 180/300 ft.
802.11b Compatible	Yes	No	Yes	Yes
Comments	Most widely deployed today	Incompatibility causes limited acceptance	Replaces 802.11b	Highest capacity at price premium

From: © Broadcom, "The New Mainstream Wireless LAN Standard"

不過,我們應該要注意 802.11b 和 802.11g 的可用頻帶資源其實很少,上表所列的 Channels 指的就是沒有相互重疊的頻道數量,而不是台灣使用者熟知的 11 個頻道(各國對 2.4GHz 頻帶 的頻道數量規範並不一樣)。因爲要相隔 5 個頻道才是真的沒有重疊的頻道,相隔不到 5 個頻道 的兩個頻道之間的訊號是會互相干擾的,因此最多只有編號為 1、5、11 的三個頻道是沒有互相 重疊的,加上因為 b/g 相容性設計而對效能所造成的影響,其實 802.11g 的發展空間相當有限。 相較之下,802.11a 儘管兼具效能與頻道數量的優勢,卻因為有效傳輸距離短,以及與最普及的 802.11b 沒有演進關係,短期內是很難普及的,但長期而言還很難說。

b/g 混合模式的相容性

前段提到了在相同頻帶使用不同調變方式,相容性的設計可能對效能的衝擊。下圖是晶片廠 Broadcom 對於 b/g 混合模式的簡介,可以看到 b/g 混合模式的兩個例子,圖左是 802.11g 的 AP 下有兩個分別是 802.11b 與 802.11g 的 Client,圖右是 802.11b 的 AP 有 802.11g 的 Client。左邊的 例子是說此時 AP 要支援混合模式,802.11b Client 如同它原來的行為與效能,而 802.11g Client 會比在純 802.11g 環境下的效能要低一些;右邊的例子是說 802.11g Client 在 802.11b AP 下的行 為可以如同 802.11b Client 一般。這兩個例子都是一個 BSS 的例子,其實還有第三個代表性的例 子,就是有兩個 BSS 的 b/g 混合模式,我們先不談那樣複雜的。就先看左邊的例子好了,我們 的實驗中會做相關的測試,可是請你/妳注意囉...仔細去做實驗,所得的結果未必如 Broadcom 所說的,包括就算是採用它推出的晶片的產品。在此先賣個關子,測試時便知。



From: © Broadcom, "The New Mainstream Wireless LAN Standard"

對於 WPA 的支援

對於 Wi-Fi 大力推廣(或該說是對廠商要求)的 WPA,我們要回頭看 IEEE 在 802.11 MAC 定義的 WEP(Wired Equivalence Privacy)造成的風風雨雨:許多報告指出 WEP 太容易被破解,

是個沒有安全性的規格,廠商迫於壓力需要更可靠的無線安全標準。姑且不論像 WLAN 這樣從 家庭到企業的各角落都可能部署的網路,是不是應該被要求全部都支援「更高檔」的加密技術, 部份廠商以此機會炒作的「新需求」多少也扮演刺激市場活絡的角色。而且,更有心的人會認為 這時是將認證的功能在 802.11 MAC 裡實現的好時機了,畢竟本來由使用者群體維護一個事先共 用金鑰(PSK: Pre-Shared Key)的做法,很快就會發生管理上的問題,當然,最直觀的方案便 是 802.1X EAPoL(Extended Authentication Protocol over LAN)。為此 IEEE 起草 802.11i 的增強型 安全標準,包含 802.1X 認證而且提供多種加密選項;但是完整標準的討論與定稿需要延宕多年, 等不及的幾家大廠就先提案,送交 Wi-Fi 聯盟的委員會通過了 WPA,而且 Wi-Fi 聯盟宣稱 WPA 是 IEEE 新標準的前身,投資 WPA 的開發並不會造成浪費。下圖就是 WPA 的組態



From: © Wi-Fi Alliance, "Overview of Wi-Fi Protected Access"

這是 WPA 最完整的組態範例(當然還可以有更大規模的組態,但這裡所用的元件種類已經 完整了),通稱為 EAP-TLS(EAP-Transport Layer Security),驗證功能部分就是撥接網路常用的 RADIUS 服務與 EAP 的整合,包括了用戶端 Station 上的 Supplicant、Access Point 上的 Agent、 以及一部 Server;加密功能部分就是在無線網段採用 TKIP(Temporal Key Integration Protocol) 取代 WEP,以及在有線網段使用主要由 Microsoft 發展的 EAP-TLS。如你/妳所看到的,這是 爲企業環境所設計,Wi-Fi 也有制定家用環境的 PSK 組態。

Wi-Fi 聯盟要求產品必須能和兩家軟體廠商 Microsoft 與 Funk 實作的系統搭配運作,才可能 通過 WPA 的測試。我們將會使用以 Microsoft 的憑證授權(Certificate Authority)與網際網路驗 證服務(Internet Authentication Service)建構的 WPA 測試平台,可以驗明現今的產品是否如宣 稱的有支援 WPA,以及 Microsoft Windows XP 無線用戶端的 Update 是否非常可靠。 WLAN 的傳輸率有多大呢?這不能單純地從它的傳輸容量(Capacity)來認定,例如 11 Mbps 或是 54 Mbps。因為它的 CSMA/CA 機制包含了一些 IFS (Inter-Frame Space)的 Overhead,而且 是半雙工(Half-Duplex)的,所以不可能達到那樣的位元率。況且,從不同的網路層次來看, 因為不同的 Header 大小,與是否有使用反向訊務的流量控制(例如 TCP 使用 Ack 封包),不同 層次的測試可能得到不同的傳輸率數值。晶片廠商 Atheros 對於 WLAN 傳輸率有如下的整理

	Number of Non- Interfering Channels	Modulation	Maximum Link Rate	Theoretical Maximum TCP Rate	Theoretical Maximum UDP Rate
802.11b	3	CCK	11 Mbps	5.9 Mbps	7.1 Mbps
802.11g (with 802.11b)	3	OFDM/CCK	54 Mbps	14.4 Mbps	19.5 Mbps
802.11g (11g-only mode)	3	OFDM/CCK	54 Mbps	24.4 Mbps	30.5 Mbps
802.11a	19 <sup>1</sup>	OFDM	54 Mbps	24.4 Mbps	30.5 Mbps
802.11a Atheros Turbo Mode <sup>™</sup>	6	OFDM	108 Mbps	42.9 Mbps	54.8 Mbps

From: © Atheros Communications, "802.11 Wireless LAN Performance"

可以看到 TCP 與 UDP 在 WLAN 上的理論最大傳輸率就有很大的不同,請你/妳特別記下 這些數字,而不是只有知道大眾所見的數字。注意上表中的最後一列是 Atheros Turbo Mode,它 在業界非常有名,寫著兩倍於 802.11a 和 802.11g 的傳輸率。這是個很有意思的現象,幾家晶片 廠商試圖以自家規格超越 802.11 PHY 與 MAC 的標準,或是先實作了類似目前討論中的子標準 802.11e(QoS)草案。這些努力的成果各有千秋,從各家所宣稱的廣告術語來看,都不太一樣。 我們只能認為它們的做法是獨家的,而非是標準的實現。下表是從一份報導中整理所出來。

宣傳名稱	宣傳數字	實測最大傳輸率 (據稱)
Atheros Super A/G	108 Mbps	60Mbps
TI Turbo Mode (G+)	90 Mbps	35 Mbps
Broadcom 125 High Speed Mode	Boost of 35%	30~35 Mbps
Agere's new chipset	150 Mbps?	N/A

From: © Wi-Fi Planet News, "Wi-Fi Marketing's Favorite Numbers"







Atheros Super A/G

Broadcom 54g

D-Link Products enabling TI Turbo G+

消費者有機會在產品包裝盒上看到排在上面的商標之一,並享受產品搭配的效能提升,但是 在這些商業的包裝手法之後,是否有真正突破的結果?我們可以安排實驗來加以了解。

### IV. 實驗方法

每個實驗都基於一個假設,而設定出不變的條件、與操縱的變因,並有明確的觀察對象。如 第一節的實驗目的裡所列的,有三個功能測試、兩個互通測試、與一個效能測試。相關的設定都 列在下一節的實驗步驟裡。這裡我們先著重在採用的測試工具:NetIQ Chariot。

Chariot 是個 End-to-End 的純軟體測試方案,它可以測試各種區域網路,以至於大型的互連 網路,但前提是待測的網路設備必須能讓 TCP/IP 協定的封包通過、以及用來產生或接收訊務的 端點必須支援 TCP/IP 協定組。因此,它並不限於使用在特定實體技術的網路上,在這裡之所以 使用這個工具的因素一方面是基於方便性,另一方面是 Wi-Fi 聯盟指定它為 WLAN 互通測試的 標準工具。建構 Chariot 的測試平台並不困難,它只包含了兩種元件:(1) Console (2) Performance EndPoint。Console 安裝於 Windows 系統上;而 Performance EndPoint 則可安裝於各式 Windows、 Unix、Netware、OS/2、甚至是 Ixia 測試機台的 TXS 模組。測試人員可以安排許多雙向的連線, 指定 TCP、UDP 或 RTP 等傳輸協定,與連線所承載的各種應用協定,Chariot 可以測得每個連線 的 Throughput、Transaction Rate、與 Response Time 等,並繪出折線圖。以 WLAN 的測試而言, 下圖表示了最簡單卻最常用的組態。



From: © NetIQ,, "User Guide of Chariot"

將 APUT(Access Point under Test)置於兩個 EndPoint 之間,再將 SUT(Station under Test) 安裝於其中一個 EndPoint 之上,即可透過 Console 來控制訊務與收集結果,進行最基本的測試。 我們的實驗幾乎都是以這樣的架構來進行的,些微的差異是有兩個實驗會在左側的網路加一部 RADIUS 伺服器,另一個實驗則會在右側多加一個安裝 SUT的 EndPoint,其他請見下節。 V. 實驗步驟與紀錄 (共同作者: 俞丁發 Handson Yu, WLAN 助理工程師)

#### 1. 基本設定:

- 本實驗分為六個子項目,在操作每個子項目之前,必須先將 APUT 和 STAUT 的設定都改為 基本設定,然後再針對各個子項目的需求作個別調整。
- 1.2 基本設定表:

APUT Settings	IP Address	192.168.3.21 /24	
	Operation Mode	Infrastructure	
	Wireless Mode	802.11b/g Auto	
	SSID	'NBL'	
	Channel	11	
	Wireless Security	Disable	
	[Other Settings]	[Default]	
STAUT Settings	IP Address	192.168.3.31 /24	
	Power Save	Disable	
	[Other Settings]	[Same as APUT or Default]	

- 1.3 APUT 設定範例:(※在此以 Proxim AP 作為範例,其他廠牌請參考其所附的使用手冊)
  - 1.3.1 Default IP Address: 在開機過程 Proxim AP 會向網路中的 DHCP Server 要求 IP Address。 若所屬網路裡面無 DHCP Server,其內定的 IP Address 為 169.254.128.132。
  - 1.3.2 將電腦 IP 設定在與 AP 同一個子網域中(ex. 169.254.128.100),在 Web Browser 網址列 打入如上的 Default IP Address,此時會詢問登入資訊。(帳號:無 密碼: public)

, , o >< i m		
> WIRELESS HEI WURKS	Alarms Bridge	Security RADIUS VLAN
$\langle$	System Network	Interfaces Management Filtering
Status	IP Configuration DHCP Server	Link Integrity
Configure	This tab is used to configure the intern settings can be either entered manuall address) or obtained automatically (dyn configured, so that host names used fo their IP addresses.	et (TCP/IP) settings for the access point. These y (static IP address, subnet mask, and gateway IP namic). The DNS Client functionality can also be or configuring the access point can be resolved to
Commands	Note: Changes to these parameters requ	ire access point reboot in order to take effect.
Help	IP Address Assignment Type	Statio
Exit	IP Address	192.168.3.11
	Subnet Mask	255.255.255.0
	Gateway IP Address	

- 1.3.3 在左邊主目錄選擇 "Configure"。
- 1.3.4 設定 IP:在上方標籤選擇 "Network"。
- 1.3.5 設定 Wireless Mode & Channel & SSID:在上方標籤選擇"Interface"。
- 1.3.6 設定 Wireless Security:在上方標籤選擇 "Security"。

1.4 STAUT 設定範例:(※在此以 D-Link STA 作為範例)

- 1.4.1 進入 "Network Connection", 選擇 "Wireless Connection", 按右鍵選內容。
- 1.4.2 設定 IP:選擇標籤為 "General",進入 "Internet protocol (TCP\IP)"。
- 1.4.3 選擇連線的 AP 及設定:選擇標籤為 "Wireless Networks",點選要連線的 AP (以 SSID 為識別字串),按下 "Configure"。

L Wireless Network Connection Ath-STA	Properties 🛛 🛛 🔀
General Wireless Networks Advanced	
Use Windows to configure my wireless network	settings
Available networks:	
To connect to an available network, click Config	
I Proxim-BSS	Configure
LDLinkG+-BSS	Refresh
Preferred networks: Automatically connect to available networks in t	he order listed
below:	
	202

1.4.4 按下 "Configure" 後,就會出現下面的視窗,提供使用者對連線的設定。

Wireless network properties	? 🔀
Association Authentication	
Network <u>n</u> ame (SSID):	oxim-BSS
Wireless network key	
This network requires a key for t	he following:
Network <u>A</u> uthentication:	WPA
Data encryption:	ТКІР
Network <u>k</u> ey:	
Confirm network key:	
Key inde <u>x</u> (advanced):	*
The key is provided for me a	utomatically
This is a <u>c</u> omputer-to-computer points are not used	(ad hoc) network; wireless access

1.4.5 更改 Driver 進階設定(如 Power Save Mode): 選擇標籤為 "General", 按下 "Configure"。



1.4.6 按下 "Configure..."後,就會出現下面的視窗,提供使用者對 Driver 的進階設定。

	D-Link A	irXpert DV	VL-AG	50 Wireles	is Ca	rdbus Adap	ter #2 P	? 🔀
	General	Advanced	Driver	Resources				
	The fol proper right.	lowing prope ly you want to	rties are change	available for on the left, an	this ne d ther	etwork adapter 1 select its valu	r. Click the Je on the	
	Proper	ty:				⊻alue:		
	802.11 802.11 Map F	Authentication b Preamble tegisters	on Type			Off		•
$\mathbf{r}$	Power	rk Address Save Mode			$\supset$			
	Radio Transi	<del>On/Off</del> mit Power						
						OK		Cancel

1.5 APUT與SUT的安全性功能設定範例。

1.5.1 在 APUT 左邊主目錄選擇 "Configure"。

1.5.2 在上方標籤選擇 "Security"。

1.5.3 在下方標籤選擇 "Authentication", 並在 "Authentication Mode" 下拉式選單依據

WEP	選擇 "none"
WPA PSK	選擇 "WPA-PSK"
WPA EAP-TLS	選擇 "WPA"

1.5.4 若決定 WEP,會在 "Authentication" 標籤左邊出現 "Encryption" 標籤,點選進入"Encryption" 標籤裡面,可設定 WEP Key。

LESS NETWORKS	System	1	letwork	Interfaces	Management	
	Alarms	Bridg	je 🤇	Security	RADIUS	
tus	MAC Access	Er Er	ncryption	Authentication		
igure	The access	point supports	s the standard	WPA and 802.1x prot	ocols for client authentica	ation
nitor	and dynamic and WPA-PS are support descriptions	c wireless enc K) and two 802 ed by the acce s of each secu	ryption key di .1x based sec ss point. See rity mode.	stribution. Two WPA urity modes (802.1x a user documentation	based security modes (M and mixed (WEP and 802.1) for more detailed	/PA k))
nands In	Some param RADIUS serv clients. Encr	neters on othe ver(s) must be yption keys m	r pages must configured to ust be configu	be configured for ea support authenticati ired for WEP clients i	ch security mode to funct on of WPA , 802.1x or WEP f mixed mode is selected	tion. I.
it	Note: Chang	jes to these par	ameters requi	re access point reboo	ot in order to take effect.	
	Wireless Int	erface	(	Slot A		
	Authenticatio	on Mode		None		
	Re-keying In	terval (Second	s)	900		
	Encryption K	ey Length		64 Bits	1 m	
	Pre-Shared	Key		********		
	PSK Pass P	hrase		*******		
MAC Acce	ss Encr	yption	OK Authenticat	on	2	
MAC Acce This tab is data secu Encryption	s used to configure rity for wireless cc n settings can be c	yption e encryption (M prommunication I onfigured for t	Authenticat Authenticat /EP) in the acc between the a poth wireless	on ess point. This is us ccess point and wird interfaces.	ed to provide eless clients.	
MAC Acce This tab is data secu Encryption Note: The in the dev 802.7x mo keys using	ss Encr s used to configure rity for wireless co n settings can be c access point suppor ice. 152 bit keys and de only. The follow g HEX or ASCII value	yption e encryption (M ommunication I onfigured for the orts 64, 128 and e supported for ing table providence.	Authenticat AEP) in the acc between the a both wireless 152 bit keys o 802.11a and b ides informati	on ess point. This is us ccess point and wirr interfaces. epending on the wire 002.11g cards running on on how to configu	ed to provide eless clients. Ness PC card in non- re encryption	
MAC Acce This tab is data secu Encryption Note: The in the dev 802.1x mo- keys using	s used to configure rity for wireless con access point suppo ice. 152 bit keys ard de only. The follow g HEX or ASCII valu	yption e encryption (A ommunication i onfigured for the outs 64, 128 and e supported for ing table providences.	Authenticat AEP) in the acc between the a booth wireless 152 bit keys a v 802.11a and to ides informati	on ess point. This is us ccess point and wird interfaces. epending on the wird b02.11g cards running on on how to configu	ed to provide eless clients. Ness PC card g in non- re encryption	
MAC Acce This tab is data secu Encryption Note: The in the dev 802.1x mo- keys using 64 b	ss Encr s used to configure rity for wireless cc n settings can be c access point suppo ice. 152 bit keys ard de only. The follow g HEX or ASCII valu	yption e encryption (M ommunication I onfigured for the supported for ing table provides. Configuration 10 character	Authenticat AEP) in the acc between the a booth wireless 152 bit keys a 902.11a and to ides informati	on ess point. This is us ccess point and wird interfaces. epending on the wire 02.11g cards running on on how to configu	ed to provide eless clients. Mess PC card g in non- re encryption	
MAC Acce This tab is data secu Encryption Note: The in the dev 802.1x mon keys using 64 b 128	ss Encr s used to configure rity for wireless co n settings can be c access point suppor tice. 152 bit keys ard de only. The follow g HEX or ASCII valu it encryption key bit encryption key	yption e encryption (A ommunication I onfigured for t e supported for ing table provi res. Configuratio 10 character 26 character	Authenticat AEP) in the acc between the a booth wireless 152 bit keys a 902.11a and a ides information in Hex Co s (0-F) 5 a s (0-F) 13	on ess point. This is use interfaces. epending on the wire to 211g cards running on on how to configu infiguration in ASCII alphanumeric charac alphanumeric charac	ed to provide eless clients. Hess PC card p in non- re encryption ters cters	
MAC Acce This tab is data secu Encryption Note: The in the dev 802.fx mo keys using 64 b 128 152	SS Encr s used to configure rity for wireless con a settings can be c access point support ice. 152 bit keys art do only. The follow g HEX or ASCII valu it encryption key bit encryption key bit encryption key	yption e encryption (M ommunication I onfigured for the supported for ing table providence Configuratio 10 character 26 character 32 character	Authenticat AEP) in the acc between the a booth wireless 7 152 bit keys a 802.11a and a ides informati n in Hex Co s (0-F) 13 s (0-F) 16	on ess point. This is use interfaces. epending on the wire to 2.11g cards running on on how to configu infiguration in ASCII alphanumeric charac alphanumeric charac	ed to provide eless clients. Mess PC card p in non- re encryption ters cters cters	
MAC Acce This tab is data secu Encryption Note: The in the dev 802.1x mo- keys using 64 b 128 152 Warning: clients be	ss Encr s used to configure rity for wireless co n settings can be c access point suppor tice. 152 bit keys ard de only. The follow g HEX or ASCII valu it encryption key bit encryption key bit encryption key bit encryption key Connectivity requir identical.	yption e encryption (M ommunication I onfigured for the e supported for ing table provides Configuration 10 character 26 character 32 character 32 character	Authenticat Authenticat AEP) in the acc between the a booth wireless acc acc acc acc acc acc acc a	on ess point. This is use interfaces.	ed to provide eless clients. Aless PC card o in non- re encryption ters cters cters cters	
MAC Acce This tab is Encryption Note: The in the dev 802 fx mo keys using 64 b 128 152 Warning: clients be Note: Cha	ss Encr s used to configure in y for wireless con n settings can be c access point suppor ice. 152 bit keys and de only. The follow g HEX or ASCII value it encryption key bit encryption key bit encryption key Connectivity requi identical. uges to these parate	yption e encryption (M formmunication for figured for the supported for img table provident Configuration 10 character 26 character 32 character fres that encryption meters require	Authenticat Authenticat AEP) in the acc between the a booth wireless 152 bit keys of 802.11a and t ides informati n in Hex Cc s (0-F) 5 i s (0-F) 13 s (0-F) 16 botton keys on t access point i	on ess point. This is use ccess point and wire interfaces. Expending on the wire 02.11g cards running on on how to configu infiguration in ASCII alphanumeric charac alphanumeric charac alphanumeric charac he access point and the eboot in order to tak	ed to provide eless clients. Mess PC card in non- re encryption ters cters cters cters cters e effect.	
MAC Acce This tab is data secu Encryption Note: The in the dev 802.5x mo- keys using 64 b 128 152 Warning: clients be Note: Cha Enable En	ss Encr s used to configure rity for wireless co n settings can be c access point suppor tice. 152 bit keys ard de only. The follow g HEX or ASCII valu it encryption key bit encryption key bit encryption key <b>Connectivity requi</b> identical.	yption e encryption (M ommunication I onfigured for the e supported for ing table provident Configuration 10 character 26 character 32 character ires that encryption meters require Wireless Interf	Authenticat Authenticat AEP) in the acc between the a booth wireless 152 bit keys of 802.11a and 1 ides informati n in Hex CC s (0-F) 13 s (0-F) 13 s (0-F) 16 otion keys on the access point r face	on ess point. This is use interfaces. epending on the wire both on the wire to an the wire to a spending on the wire to a	ed to provide eless clients. Mess PC card p in non- re encryption ters cters cters cters e effect.	
MAC Acce This tab is data secu Encryption Note: The in the dev 802.1x mo- keys using 64 b 128 152 Warning: clients be Note: Cha Enable En	ss Encr s used to configure rity for wireless con n settings can be c access point suppor ice. 152 bit keys an de only. The follow g HEX or ASCII valu it encryption key bit encryption key bit encryption key bit encryption key connectivity requi identical.	yption e encryption (W mmunication I onfigured for t e supported for ing table provi- res. Configuratio 10 character 26 character 32 character weters require Wireless Interf	Authenticat AEP) in the acc between the a poth wireless 152 bit keys or 802.11a and to ides informati n in Hex Co s (0-F) 5 a s (0-F) 13 s (0-F) 16 botion keys on to access point r face	on ess point. This is usi- interfaces. epending on the wire 00.11g cards running on on how to configu infiguration in ASCII alphanumeric charac alphanumeric chara alphanumeric chara he access point and the eboot in order to tak	ed to provide eless clients. Wess PC card in non- re encryption ters cters cters the wireless e effect.	
MAC Acce This tab is data secu Encryption Note: The in the dev 802.1x mo- keys using 64 b 128 152 Warning: clients be Note: Cha Enable En Wireless Encryption	ss Encr s used to configure rity for wireless con n settings can be c access point suppor ice. 152 bit keys ard de only. The follow g HEX or ASCH value it encryption key bit encryption key bit encryption key bit encryption key connectivity requi identical. unges to these parate neryption (WEP) for Interface n Key 1	yption e encryption (W mmmunication I onfigured for the proses 64, 128 and e supported for ing table provi- res. Configuration 10 character 26 character 32 character ing that encryption ing table provi- tes.	Authenticat AEP) in the acc between the a sooth wireless 152 bit keys or 902.11a and di ides informati n in Hex Co s (0-F) 5 a s (0-F) 18 s (0-F) 18 otion keys on the access point r face	on ess point. This is usi- interfaces. epending on the wire boot on the wi	ed to provide eless clients. Ness PC card in non- re encryption ters cters cters the wireless e effect.	
MAC Acce This tab is data secu Encryption Note: The in the dev 802.1x mo- keys using 64 b 128 152 Warning: clients be Note: Cha Enable En Wireless Encryption	ss Encr s used to configure rity for wireless con n settings can be c access point suppor ice. 152 bit keys ard de only. The follow g HEX or ASCH value it encryption key bit encryption key bit encryption key bit encryption key <b>Connectivity requi</b> <b>identical</b> . <b>unges to these parate</b> neryption (WEP) for <b>Interface</b> n Key 1 n Key 2	yption e encryption (W mmmunication onfigured for th ports 64, 128 and e supported for ing table provi- res. Configuratio 10 character 26 character 32 character ing that encryption ing table provi- tes.	Authenticat AEP) in the acc between the a sooth wireless 152 bit keys or 902.11a and di ides informati n in Hex Co s (0-F) 5 a s (0-F) 16 otion keys on t access point r face	on ess point. This is usi- inccess point and wire interfaces. epending on the wire boot on	ed to provide eless clients. Wess PC card in non- re encryption ters cters cters the wireless e effect.	

- 1.5.5 若決定 WPA PSK,可直接在下方填入 Pre-Shared Key
- 1.5.6 若決定 WPA EAP-TLS,必須在上方標籤列切換到"RADIUS"標籤裡面,設定 RADIUS Server 的 IP、Port、與 Share Secret。

#### WPA PSK

MAC Access	Authentication				
The access point sup and dynamic wireless and WPA-PSK) and tw are supported by the descriptions of each	ports the standard s encryption key dis o 802.1x based sec access point. See u security mode.	WPA and 802.1x stribution. Two V irity modes (802 iser documenta	protocol VPA base 2.1x and r tion for r	s for client a ed security n nixed (WEP a nore detailed	uthenticatio nodes (WP/ nd 802.1x)) d
Some parameters on RADIUS server(s) mu clients. Encryption ke	other pages must st be configured to sys must be configu	be configured fo support authen red for WEP clie	or each s tication o nts if mi:	ecurity mod f WPA , 802.1 ked mode is	e to functio x or WEP selected.
Note: Changes to thes	e parameters requi	re access point i	eboot in	order to tak	e effect.
Note: Changes to thes Wireless Interface	se parameters requi	re access point r Slot A	eboot in	order to tak	e effect.
Note: Changes to thes Wireless Interface Authentication Mode	e parameters requi	re access point r Slot A WPA-PSK	eboot in	order to tak	e effect.
Note: Changes to thes Wireless Interface Authentication Mode Re-keying Interval (Se	e parameters requi	Slot A WPA-PSK 900	eboot in	order to take	e effect.
Note: Changes to these Wireless Interface Authentication Mode Re-keying Interval (Se Encryption Key Length	e parameters requi	Slot A WPA-PSK 900 64 Bits	eboot in	order to take	e effect.
Note: Changes to these Wireless Interface Authentication Mode Re-keying Interval (Se Encryption Key Length Pre-Shared Key	e parameters requir conds)	Slot A WPA-PSK 900 64 Bits	eboot in	order to take	e effect.
Note: Changes to these Wireless Interface Authentication Mode Re-keying Interval (Se Encryption Key Length Pre-Shared Key PSK Pass Phrase	e parameters requir	Slot A WPA-PSK 900 64 Bits	eboot in	order to take	e effect.

### WPA EAP-TLS

MAC Access A	uthentication				
The access point support and dynamic wireless e and WPA-PSK) and two if are supported by the ac descriptions of each se	orts the standard encryption key dia 802.1x based sec eccess point. See o ecurity mode.	WPA and 802.1x p stribution. Two Wi urity modes (802.1 user documentation	rotocols PA base Ix and m on for m	for client a d security m ixed (WEP a tore detailed	uthenticatio nodes (WPA nd 802.1x)) 1
Some parameters on of RADIUS server(s) must	ther pages must be configured to	be configured for support authentic	each se ation of	curity mode WPA , 802.1 ed mode is	e to functior x or WEP selected.
clients. Encryption keys	s must be coningt	I CO TOT VALE CIICIN		o and a star francis for	oolootoal
clients. Encryption keys	parameters requi	re access point rel	boot in c	order to take	effect.
clients. Encryption keys Note: Changes to these j Wireless Interface	parameters requi	re access point rel	boot in c	order to take	effect.
Note: Changes to these p Wireless Interface Authentication Mode	parameters requi	re access point rel Slot A WPA	boot in c	order to take	effect.
Note: Changes to these p Wireless Interface Authentication Mode Re-keying Interval (Seco	parameters requi	Slot A 900	boot in c	order to take	effect.
Wireless Interface Authentication Mode Re-keying Interval (Seco Encryption Key Length	parameters requi	Slot A WPA 900 04 BIts	boot in c	order to take	e effect.
Note: Changes to these f Wireless Interface Authentication Mode Re-keying Interval (Seco Encryption Key Length Pre-Shared Key	parameters requi	Slot A WPA 900 04 BHS	boot in c	order to take	effect.

note: Unanges to these parameters r	equire access point reboo	ot in order to take effect.
Enable RADIUS MAC Access Contro		
Enable Primary RADIUS Authenticati	on Server 🔽	
Enable Backup RADIUS Authenticati	on Server 📃	
Authorization Lifetime (seconds)	1800	
MAC Address Format Type	DashDeli	mited 🗸
RADIUS Authentication Server	Primary	Backup
RADIUS Authentication Server Server Addressing Format	Primary IP Address	Backup
RADIUS Authentication Server Server Addressing Format Server Name/IP Address	Primary IP Address 192.168.2.17	Backup
RADIUS Authentication Server Server Addressing Format Server Name/IP Address Destination Port	Primary IP Address 192.168.2.17 1812	Backup
RADIUS Authentication Server Server Addressing Format Server Name/IP Address Destination Port Shared Secret	Primary IP Address 192.168.2.17 1812	Backup
RADIUS Authentication Server Server Addressing Format Server Name/IP Address Destination Port Shared Secret Confirm Shared Secret	Primary IP Address 192.168.2.17 1812	Backup
RADIUS Authentication Server Server Addressing Format Server Name/IP Address Destination Port Shared Secret Confirm Shared Secret Response Time (seconds)	Primary IP Address 192.168.2.17 1812 10 10	Backup

1.5.7 SUT 的安全性功能設定範例。(類似 1.4.3 和 1.4.4 的設定方式)

ssociation Authentication	
Network name (SSID):	Proxim-BSS
Wireless network key	
This network requires a key	for the following:
Network Authentication:	WPA 🔽
Data encryption:	Open Shared
Network key:	WPA-PSK
Confirm network key:	
Key index (advanced):	1
The key is provided for r	ne automatically
This is a computer-to-comp points are not used	outer (ad hoc) network; wireless access

- 1.6 Chariot 設定與基本操作:
  - 1.6.1 進入程式集,開啓 NetIQ Chariot → Chariot Console,按下 "New"。



1.6.2 在 Chariot 視窗中,點選 "Edit" → "Add Pair"。



1.6.3 在 Endpoint 1 和 Endpoint 2 打入 Chariot Console 和 STAUT 的 IP, 按下 "Select Script"。

Add an Endpoint Pair	X
Pair comment FT-1 802.11b/g/	Auto
Endpoint 1 to Endpoint 2	<b>`</b>
Endpoint 1 network address	
192.168.3.11	•
Endpoint 2 network address	
192.168.3.31	•
Network protocol	Service quality
TCP	•
Edit This Script	
Select Script	
OK Cancel Hel	p

1.6.4 到"Benchmarks"的資料夾裡面選擇想要使用的 Script (應用協定)。

Open a Scrip	t File			? 🔀
Look in: 🖾	Benchmarks	•	🗢 🖻 💣 🛙	<b>.</b> .
Crediti Credits Dbasel Dbases Filercvi Filercvs Filesndi		High_Performance	_Throughput	
File <u>n</u> ame:	Inquiryl			Open
Files of type:	Chariot Script		•	Cancel
Application sc Inquiry, Long C	ript name: Connection			

1.6.5 在 Chariot 視窗中,點選 "Run" → "Set Run Option"。

_ с	hario	t Tesi	t - untitled2.tst								
File	Edit	View	Run Window Help	)							
Test	Setun	x] (= 1	Run Stop	Ctrl+R Ctrl+T		AL	L TCP SCR	EP1 EP2 SC	PG PC	i 🚺	🛛 🞯 ne
Grou	ip Ri	un Statu	Run Traceroute Set Run Options		ndpoint 2	Network Protocol	Service Quality	Script Filename	Pair Comment	Pair Group Name	Console I Endpoint
			Poll Endpoints Now	r FS							
<						ш					

1.6.6 可針對每次的 Test 作詳細的規劃,包含 Run time、Report Timings…

Run Options 🔀	
Run Options Datagram Result Ranges Choose how test runs are handled Set the test run options for performance testing. How to end a test run Run until any pair ends Run until any pairs end	
● Run for a fixed durationi       0      Hrs       1      Min       0      Sec         How to report timings       ●       Batch (gives most accurate results)       ●	
 OKancel	

1.6.7 設定完上面步驟後,便可執行 "Run" (快速鍵 Ctrl+R), 觀察實驗結果。

## 2. Functionality Test 1 (FT-1)

2.1 將設定更新爲步驟 1.1~1.4 的基本設定,針對本子項目作調整如下表(請參照 1.3.5 調整)。

1 Win	reless Mode	{802.11b/g Auto, 802.11g Turbo, 802.11b Only}
-------	-------------	---

#### 2.2 觀察項目與結果紀錄

	觀察項目
1	Associations occur
2	Good or Excellent status by Link and Signal Monitor indicated
3	Replies of ping from STAUT to Server received
4	'InquiryL' completes without any error for 30sec

結果紀錄				
	802.11b/g Auto	802.11g Turbo	802.11b Only	
1	(y/n)	(y/n)	(y/n)	
2	(y/n)	(y/n)	(y/n)	
3	(y/n)	(y/n)	(y/n)	
4	(y/n)	(y/n)	(y/n)	

2.3 將設定更新爲步驟 1.1~1.4 的基本設定,針對本子項目作調整如下表(請參照 1.3.5 調整)。

2 Channel {1, 6, 11}
----------------------

#### 2.4 觀察項目與結果紀錄

結果紀錄				
	Channel 1	Channel 6	Channel 11	
1	(y/n)	(y/n)	(y/n)	
2	(y/n)	(y/n)	(y/n)	
3	(y/n)	(y/n)	(y/n)	
4	(y/n)	(y/n)	(y/n)	

# 3. Functionality Test 2 (FT-2)

## 3.1 APUT 與 STAUT 都使用 SMC 的產品,請見實驗設備該節。

## 3.2 將設定更新為步驟 1.1~1.4 的基本設定,針對本子項目作調整如下表(請參照 1.5 調整)

1	WEP Key	0x9876543210
2	WPA PSK PassPhrase	Random ASCII of Length = {15, 31}
3	WPA EAP-TLS	-

#### 3.3 觀察項目與結果紀錄

觀察項目			
1	Associations occur		
2	Good or Excellent status by Link and Signal Monitor indicated		
3	Replies of ping from STAUT to Server received		
4	'InquiryL' completes without any error for 30sec		

	結果紀錄					
	WEP	WPA PSK 1	WPA PSK 2	WPA EAP-TLS		
1	(y/n)	(y/n)	(y/n)	(y/n)		
2	(y/n)	(y/n)	(y/n)	(y/n)		
3	(y/n)	(y/n)	(y/n)	(y/n)		
4	(y/n)	(y/n)	(y/n)	(y/n)		

- 4. The Extension of Functionality Test 2 (FT-2x)
- 4.1 APUT與STAUT和上個子項目相同,設定調整也如上個子項目的表格,但使用不同版本的 Driver,要觀察安全性的功能是否仍然正常。注意!若出現任何預期之外的狀況,請立刻通 知助教(NBLWLAN領域的專案經理),千萬別急著設定Windows XP的用戶端。
- 4.2 觀察項目與結果紀錄

觀察項目				
1	Associations occur			
2	Good or Excellent status by Link and Signal Monitor indicated			
3	Replies of ping from STAUT to Server received			
4	'InquiryL' completes without any error for 30sec			

結果紀錄					
	WEP	WPA PSK 1	WPA PSK 2	WPA EAP-TLS	
1	(y/n)	(y/n)	(y/n)	(y/n)	
2	(y/n)	(y/n)	(y/n)	(y/n)	
3	(y/n)	(y/n)	(y/n)	(y/n)	
4	(y/n)	(y/n)	(y/n)	(y/n)	

## 5. Interoperability Test 1 - Wi-Fi Style (IT-1)

5.1 這個子項目是根據 Wi-Fi Test Plan 的某個測試項目 (AP Testing 4.2.2.8) 作設定的,其中要在 Globespan-G 的網路卡進階設定(參考1.4.3),讓其運作於 B Wi-Fi 模式。

4.2.2.8 Configuration #A4-Mixed-BG					
PARAMETER	G-STA Values	<b>B-STA Values</b>	AP Values		
Vendor	Atheros-G	Globespan-G	APUT		
Security	WPA, TLS	WPA, TLS	WPA, TLS		
OS	WinXP	WinXP	-		
Supplicant	MS	MS	-		
AP Channel	-	-	8		
AP Basic Rate	-	-	Basic Rate Set # 1		
RTS Threshold	Off	256	default for AP		
Fragmentation	Off	512 (see note)	default for AP		
Power Save	No	No	-		

Note: the Globespan-B STA can only select the value 512 instead of 500.

4.2.2.8.1 Test of Configuration #A4-Mixed-BG
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Association Test	if g and b association occurs, pass
Data Transfer #1	if g throughput > A4MGDT1 and b throughput > A4MBDT1, pass
Data Transfer #2	if g throughput > A4MGDT2 and b throughput > A4MBDT2, pass
Data Transfer #3	if g throughput > A4MGDT3 and b throughput > A4MBDT3, pass

代碼解說					
	Data Transfer # Meaning Threshold of Throughput				
#1	'FileSndL' Downstream	A4MGDT1: 3.4	A4MBDT1: 1.5		
#2	'FileSndL' Upstream	A4MGDT1: 2.8	A4MBDT1: 0.98		
#3	'InquiryL' Downstream	A4MGDT1: 0.48	A4MBDT1: 0.27		

#### 5.2 觀察項目與結果紀錄

	結果紀錄	
Association Test	if g and b association occurs	(pass/fail)
Data Transfer #1	if g throughput $> 3.4$ and b throughput $> 1.5$	(pass/fail)
Data Transfer #2	if g throughput $> 2.8$ and b throughput $> 0.98$	(pass/fail)
Data Transfer #2	if g throughput $> 0.48$ and b throughput $> 0.27$	(pass/fail)

## 6. Interoperability Test 2 (IT-2)

6.1 將設定更新為步驟 1.1~1.4 的基本設定,針對本子項目作調整如下表,這時就可能需要另外 增加一個 Station。注意:本項目並不包含 Security 設定。

Another Involved STA {802.11b device, 802.11g device, not exists}

#### 6.2 觀察項目與結果紀錄

觀察項目		
1	Associations occur	
2	Good or Excellent status by Link and Signal Monitor indicated	
3	Replies of ping from STAUT to Server received	
4	'InquiryL' completes without any error for 30sec	
5	Average Throughput of 'FileSndL' for 30sec	

結果紀錄			
	802.11b STA	802.11g STA	None
1	(y/n)	(y/n)	(y/n)
2	(y/n)	(y/n)	(y/n)
3	(y/n)	(y/n)	(y/n)
4	(y/n)	(y/n)	(y/n)
5	Mbps	Mbps	Mbps

### 7. Performance Test 1 (PT-1)

- 7.1 將 STAUT 的作業系統改為 Windows 2000 Professional。
- 7.2 將設定更新為步驟 1.1~1.4 的基本設定,針對本子項目作調整如下表,這時 APUT 與 STA 要 採用搭配成對的多個產品。由於操縱變因是不同產品,這個項目其實是在作效能評比。

AP-STA Pair of Chipset	{Broadcom BCM94306,TI TNETW1130}
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產品對照			
Chipset\ Pair	APUT	SUT	
Broadcom BCM94306	Buffalo WBR-G54	Buffalo WLI-CB-G54A	
TI TNETW1130	D-Link DI-624+	D-Link DWL-G650+	

7.3 使用廠商所提供的 Client Utility 來做最佳化傳輸率設定。例如

D D-Link AirPlus Xtren	neG+	×
Link Info.	SSID	NBL
Configuration >>>	Wireless Mode	Infrastructure
Encryption Site Survey	Channel	6 ® 8x Enable
<u>About</u>	TxRate	54 Mbps
	Preamble	Short Preamble
	Power Mode	Continuous Access Mode
		Apply Cancel

7.4 觀察項目與結果紀錄

觀察項目			
1	1 Replies of ping from STAUT to Server received		
2	Average Throughput of 'high_performance_throughput' for 60 sec		

結果紀錄			
	Broadcom BCM94306	TI TNETW1130	[Optional Another Pair]
1	(y/n)	(y/n)	(y/n)
2	Mbps	Mbps	Mbps

- 請借閱 "Wi-Fi 802.11g with WPA System Interoperability Test Plan"(或 802.11b with WPA 的也可以),看過第4節 AP Testing 其中的一張設定分配矩陣表,並將該節各測試項目瀏覽過後,請你/妳思考一下Wi-Fi測試算不算是合於科學精神的實驗呢?如果你/妳有機會為WLAN廠商進行 Wi-Fi Pretest,除了照著那份計劃書做以外,有沒有別的測試可以協助廠商?
- 一個設計得好的實驗大致可以從三個角度來看:科學面、技術面、與營運面,分別可以這麼說(1)遵從實驗原理(2)作的假設能反映技術與產業的議題(3)盡可能合理降低成本。故請你/妳設計一個新的實驗方法(Methodology),花30分鐘時間,和助教討論並進行這個新的實驗方法(如果現場能夠進行的話,但是不能超過時間)。