南華大學資訊工程學系 九十七學年度 高速網路

組別：3
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一、實驗名稱

實驗　1　–　IEEE802.11 WLAN AP

二、實驗目的

1. 瞭解一些 Linux 的基本指令與網路介面的設定
2. 學會基本的 AP 架設與 Client 端的無線連線
3. 學會如何經由無線連往 AP 轉為有線連出 WAN，並測試其連線速度

三、實驗原理

透過網路介面的設定，了解Linux的基本指令，再經由架設無線AP與Client等無線機制，來了解如何安裝相關套件來驅動無線網卡，並修改interfaces文件來架設AP相關資訊，與Client通過無線搜尋並連上AP，再啟動DHCP經由無線連到AP再連上DHCP server自動取得IP，然後以ttcp或wireshark等工具測試連線速度品質，以培養基本無線網路的認知應用和學習Linux的基本指令。

四、實驗項目

1. 架設無線 Access Point (AP)
2. 架設無線 client 端
3. 從 client 端經由無線連上 AP 再以有線網路啟動 DHCP 向 DHCP server 取得 IP
4. 以 ttcp/wsttcp 或 wireshark 等工具測試無線的連線速度和品質

五、實驗設備

- 硬體
  1. PC x3
  2. 有線網路卡 x3
  3. 無線網路卡 x3
- 軟體
  1. Linux-Ubuntu operation system
  2. Windows XP operation system
  3. madwifi 套件
  4. bridge-utils 套件
  5. ttcp\wsttcp 工具
  6. wireshark 工具

六、實驗步驟

(I) AP架設 (Linux系統)

Part 0. 進入superuser

因涉及安裝套件與介面設定請先進入superuser，才有權限操作。

```
$ sudo su –
[sudo] password for csie :
#
```

Part 1. 安裝madwifi套件和bridge套件至Linux系統上

因為要使用無線所以要安裝無線網路卡的驅動程式，才能正確的驅動無線網路卡。

1. 先查尋作業系統的版本，再搜尋madwifi套件找出合適的版本安裝。

```
#uname -a
Linux csie-desktop 2.6.24-19-generic #1 SMP Wed Aug 20 22:56:21 UTC 2008 i686 GNU/Linux
#apt-cache search madwifi
-------------------------------------
…
linux-restricted-modules-2.6.24-19-generic
…
-------------------------------------
#apt-get install linux-restricted-modules-2.6.24-19-generic
```

2. 安裝bridge套件

```
#apt-get install bridge-utils
```

Part 2. 建立AP無線網路介面

要先刪除不用的網路介面，再啟動所需的網路介面。

1. 查看網路介面

```
#ifconfig
root@csie-desktop:/etc/network# ifconfig
ath2      Link encap:Ethernet  HWaddr 00:1e:58:f6:01:29
          inet6 addr: fe80::21e:58ff:fef6:129/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

eth6      Link encap:Ethernet  HWaddr 00:21:9b:3b:10:65
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
          Memory:fe9e0000-fea00000

eth7      Link encap:Ethernet  HWaddr 00:02:a5:4e:95:f8
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
          Base address:0xdcc0 Memory:fe560000-fe580000

eth8      Link encap:Ethernet  HWaddr 00:02:a5:4e:95:f9
          inet addr:192.168.3.154  Bcast:192.168.3.255  Mask:255.255.255.0
          inet6 addr: fe80::202:a5ff:fe4e:95f9/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:9603 errors:0 dropped:0 overruns:0 frame:0
          TX packets:3212 errors:0 dropped:0 overruns:0 carrier:0
```

2. 解除原先的無線介面

```
#wlanconfig ath2 destroy
```

```
root@csie-desktop:~# wlanconfig ath2 destroy
root@csie-desktop:~# ifconfig
eth6      Link encap:Ethernet  HWaddr 00:21:9b:3b:10:65
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
          Memory:fe9e0000-fea00000

eth7      Link encap:Ethernet  HWaddr 00:02:a5:4e:95:f8
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
          Base address:0xdcc0 Memory:fe560000-fe580000

eth8      Link encap:Ethernet  HWaddr 00:02:a5:4e:95:f9
          inet addr:192.168.3.154  Bcast:192.168.3.255  Mask:255.255.255.0
          inet6 addr: fe80::202:a5ff:fe4e:95f9/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:28 errors:0 dropped:0 overruns:0 frame:0
          TX packets:33 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:100
          RX bytes:4027 (3.9 KB)  TX bytes:4311 (4.2 KB)
          Base address:0xdc80 Memory:fe540000-fe560000

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
```

3. 新建立AP無線介面並啟動

```
#wlanconfig ath0 create wlandev wifi0 wlanmode ap
#ifconfig ath0 up
```

```
root@csie-desktop:~# wlanconfig ath0 create wlandev wifi0 wlanmode ap
ath0
root@csie-desktop:~# ifconfig
ath0      Link encap:Ethernet  HWaddr 06:1e:58:f6:01:29
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

eth6      Link encap:Ethernet  HWaddr 00:21:9b:3b:10:65
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
          Memory:fe9e0000-fea00000

eth7      Link encap:Ethernet  HWaddr 00:02:a5:4e:95:f8
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
          Base address:0xdcc0 Memory:fe560000-fe580000

eth8      Link encap:Ethernet  HWaddr 00:02:a5:4e:95:f9
          inet addr:192.168.3.154  Bcast:192.168.3.255  Mask:255.255.255.0
          inet6 addr: fe80::202:a5ff:fe4e:95f9/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:28 errors:0 dropped:0 overruns:0 frame:0
```

Part 3. 修改interfaces檔

此為修改所需的AP設定，如：Channel、ESSID和bridge設定。

1. 查看網路介面哪個是連接有線網路並分配到IP

```
#ifconfig
```

```
root@csie-desktop:~# ifconfig
ath0      Link encap:Ethernet  HWaddr 06:1e:58:f6:01:29
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

eth6      Link encap:Ethernet  HWaddr 00:21:9b:3b:10:65
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
          Memory:fe9e0000-fea00000

eth7      Link encap:Ethernet  HWaddr 00:02:a5:4e:95:f8
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
          Base address:0xdcc0 Memory:fe560000-fe580000

eth8      Link encap:Ethernet  HWaddr 00:02:a5:4e:95:f9
          inet addr:192.168.3.154  Bcast:192.168.3.255  Mask:255.255.255.0
          inet6 addr: fe80::202:a5ff:fe4e:95f9/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:28 errors:0 dropped:0 overruns:0 frame:0
```

2. 修改interfaces內的channel、ESSID、bridge_prot。(修改前先備份)

```
#cd /etc/network
#vi interfaces
```

```
auto lo
iface lo inet loopback

auto ath0
iface ath0 inet manual
    wireless-channel 2
    wireless-essid GG33
    # IF you use WEP, put the key here:
    #wireless-key 1234-1234-1234-1234

auto br0
iface br0 inet dhcp
#    address 192.168.0.[x]
#    network 192.168.0.0
#    netmask 255.255.255.0
#    broadcast 192.168.0.255
#    gateway 192.168.0.1
    # Bridge eth0 and ath0 with br0.
    bridge_ports eth8 ath0
```

3. 重新啟動網路設定

#/etc/init.d/networking restart

```
root@csie-desktop:/etc/network# /etc/init.d/networking restart
 * Reconfiguring network interfaces...
device br0 already exists; can't create bridge with the same name

Waiting for br0 to get ready (MAXWAIT is 32 seconds).
There is already a pid file /var/run/dhclient.br0.pid with pid 7622
killed old client process, removed PID file
Internet Systems Consortium DHCP Client V3.0.6
Copyright 2004-2007 Internet Systems Consortium.
All rights reserved.
For info, please visit http://www.isc.org/sw/dhcp/

wifi0: unknown hardware address type 801
wifi0: unknown hardware address type 801
Listening on LPF/br0/00:02:a5:4e:95:f9
Sending on   LPF/br0/00:02:a5:4e:95:f9
Sending on   Socket/fallback
DHCPREQUEST of 192.168.3.154 on br0 to 255.255.255.255 port 67
DHCPACK of 192.168.3.154 from 192.168.3.254
bound to 192.168.3.154 -- renewal in 874 seconds.
```

(II) Client架設 (Linux系統)

Part 0. 進入superuser (同AP架設 Part 0)

因涉及安裝套件與介面設定請先進入superuser，才有權限操作。

```
$ sudo su –
[sudo] password for csie :
#
```

Part 1. 安裝madwifi套件至Linux系統上

因為要使用無線所以要安裝無線網路卡的驅動程式，才能正確的驅動無線網路卡。

先查尋作業系統的版本，再搜尋madwifi套件找出合適的版本安裝。

```
#uname -a
Linux csie-desktop 2.6.24-19-generic #1 SMP Wed Aug 20 22:56:21 UTC 2008 i686 GNU/Linux
#apt-cache search madwifi
-------------------------------------
…
linux-restricted-modules-2.6.24-19-generic
…
-------------------------------------
#apt-get install linux-restricted-modules-2.6.24-19-generic
```

Part 2. 建立Client無線網路介面

要先刪除不用的網路介面，再啟動所需的無線網路介面，最好拔除網路線。

1. 查看網路介面

```
#ifconfig
root@csie-desktop:~# ifconfig
ath2      Link encap:Ethernet  HWaddr 00:1e:58:f6:01:3c
          inet6 addr: fe80::21e:58ff:fef6:13c/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

eth6      Link encap:Ethernet  HWaddr 00:02:a5:4e:98:9d
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
          Base address:0xdcc0 Memory:fe560000-fe580000

eth7      Link encap:Ethernet  HWaddr 00:21:9b:3e:70:ca
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
          Memory:fe9e0000-fea00000

eth8      Link encap:Ethernet  HWaddr 00:02:a5:4e:98:9c
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
```

2. 關閉有線介面，解除原先的無線介面並拔除網路線

```
#ifconfig eth6 down
#ifconfig eth7 down
#ifconfig eth8 down
#wlanconfig ath2 destroy
```

```
root@csie-desktop:~# ifconfig eth6 down
root@csie-desktop:~# ifconfig eth7 down
root@csie-desktop:~# ifconfig eth8 down
root@csie-desktop:~# wlanconfig ath2 destroy
root@csie-desktop:~# ifconfig
lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:16436  Metric:1
          RX packets:2598 errors:0 dropped:0 overruns:0 frame:0
          TX packets:2598 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:129900 (126.8 KB)  TX bytes:129900 (126.8 KB)
```

3. 新建立station無線介面並啟動

```
#wlanconfig ath0 create wlandev wifi0 wlanmode sta
#ifconfig ath0 up
```

```
root@csie-desktop:~# wlanconfig ath0 create wlandev wifi0 wlanmode sta
ath0
root@csie-desktop:~# ifconfig
ath0      Link encap:Ethernet  HWaddr 06:1e:58:f6:01:3c
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:16436  Metric:1
          RX packets:2598 errors:0 dropped:0 overruns:0 frame:0
          TX packets:2598 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:129900 (126.8 KB)  TX bytes:129900 (126.8 KB)

wifi0     Link encap:UNSPEC  HWaddr 00-1E-58-F6-01-3C-00-00-00-00-00-00-00-00-00-00
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:40 errors:0 dropped:0 overruns:0 frame:1
          TX packets:180 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:280
          RX bytes:2536 (2.4 KB)  TX bytes:8280 (8.0 KB)
          Interrupt:16
```

Part 3. attach AP

此為掃描目前有訊號的AP，查詢資訊並連上所選的ESSID AP。

1. 以ath0 介面搜尋範圍內的無線AP

```
#wlanconfig ath0 list scan
```

```
root@csie-desktop:~# wlanconfig ath0 list scan
SSID              BSSID              CHAN RATE  S:N   INT CAPS
G4-1              06:1e:58:f6:01:61    1   54M 11:0   100 ESs  WME ATH
                  06:1e:58:f6:01:29    1   54M  6:0   100 ESs  WME ATH
                  06:1e:58:f6:01:82   11   54M  6:0   100 ESs  WME ATH
Boss              06:1e:58:f0:77:4b    7   54M  5:0   100 ESs  WME ATH
GG33              06:1e:58:f6:01:29    2   54M  7:0   100 ESs  WME ATH
```

2. 列出ath0 介面搜尋到的AP資訊

```
#iwlist ath0 scan
```

```
          Cell 04 - Address: 06:1E:58:F0:77:4B
                    ESSID:"Boss"
                    Mode:Master
                    Frequency:2.442 GHz (Channel 7)
                    Quality=5/70  Signal level=-90 dBm  Noise level=-95 dBm
                    Encryption key:off
                    Bit Rates:1 Mb/s; 2 Mb/s; 5.5 Mb/s; 6 Mb/s; 9 Mb/s
                              11 Mb/s; 12 Mb/s; 18 Mb/s; 24 Mb/s; 36 Mb/s
                              48 Mb/s; 54 Mb/s
                    Extra:bcn_int=100
                    Extra:wme_ie=dd180050f2020101870003a4000027a4000042435e0062322f00
                    Extra:ath_ie=dd0900037f01010024ff7f
          Cell 05 - Address: 06:1E:58:F6:01:29
                    ESSID:"GG33"
                    Mode:Master
                    Frequency:2.417 GHz (Channel 2)
                    Quality=7/70  Signal level=-88 dBm  Noise level=-95 dBm
                    Encryption key:off
                    Bit Rates:1 Mb/s; 2 Mb/s; 5.5 Mb/s; 6 Mb/s; 9 Mb/s
                              11 Mb/s; 12 Mb/s; 18 Mb/s; 24 Mb/s; 36 Mb/s
                              48 Mb/s; 54 Mb/s
                    Extra:bcn_int=100
                    Extra:wme_ie=dd180050f2020101870003a4000027a4000042435e0062322f00
                    Extra:ath_ie=dd0900037f01010024ff7f
```

3. attech the AP 並查看ath0 介面狀態

```
#iwconfig ath0 essid “GG33”
#iwconfig ath0
```

```
root@csie-desktop:~# iwconfig ath0 essid "GG33"
root@csie-desktop:~# iwconfig ath0
ath0      IEEE 802.11g  ESSID:"GG33"  Nickname:""
          Mode:Managed  Frequency:2.417 GHz  Access Point: 06:1E:58:F6:01:29
          Bit Rate:36 Mb/s   Tx-Power:19 dBm   Sensitivity=1/1
          Retry:off   RTS thr:off   Fragment thr:off
          Encryption key:off
          Power Management:off
          Link Quality=9/70  Signal level=-87 dBm  Noise level=-96 dBm
          Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
          Tx excessive retries:0  Invalid misc:0   Missed beacon:0
```

Part 4. 啟動DHCP取得IP

從client端經由無線連往AP再以有線往外向DHCP server取得IP。

以ath0 介面啟動DHCP

```
#dhclient ath0
```

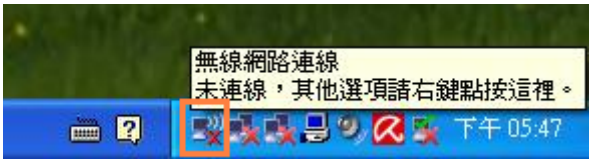
```
root@csie-desktop:~# dhclient ath0
There is already a pid file /var/run/dhclient.pid with pid 7128
killed old client process, removed PID file
Internet Systems Consortium DHCP Client V3.0.6
Copyright 2004-2007 Internet Systems Consortium.
All rights reserved.
For info, please visit http://www.isc.org/sw/dhcp/

wifi0: unknown hardware address type 801
wifi0: unknown hardware address type 801
Listening on LPF/ath0/06:1e:58:f6:01:3c
Sending on   LPF/ath0/06:1e:58:f6:01:3c
Sending on   Socket/fallback
DHCPDISCOVER on ath0 to 255.255.255.255 port 67 interval 5
DHCPDISCOVER on ath0 to 255.255.255.255 port 67 interval 9
DHCPDISCOVER on ath0 to 255.255.255.255 port 67 interval 17
No DHCPOFFERS received.
No working leases in persistent database - sleeping.
```

結果：經過數次全部重新測試都失敗！改換Windows系統。

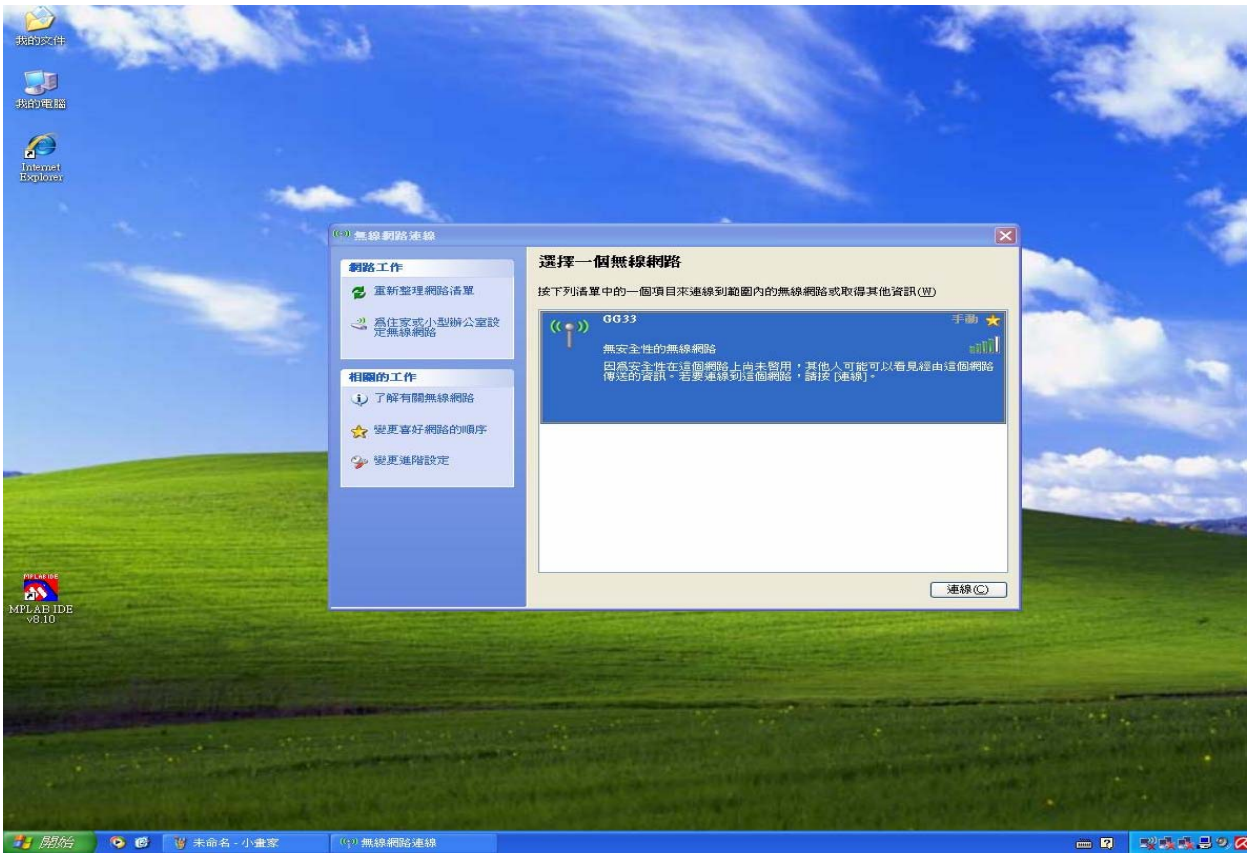
(III) Client架設 (Windows系統)

Part 1. 啟動無線網路

1. 滑鼠左鍵雙擊視窗右下角無線網路圖示，打開無線網路連線對話視窗。

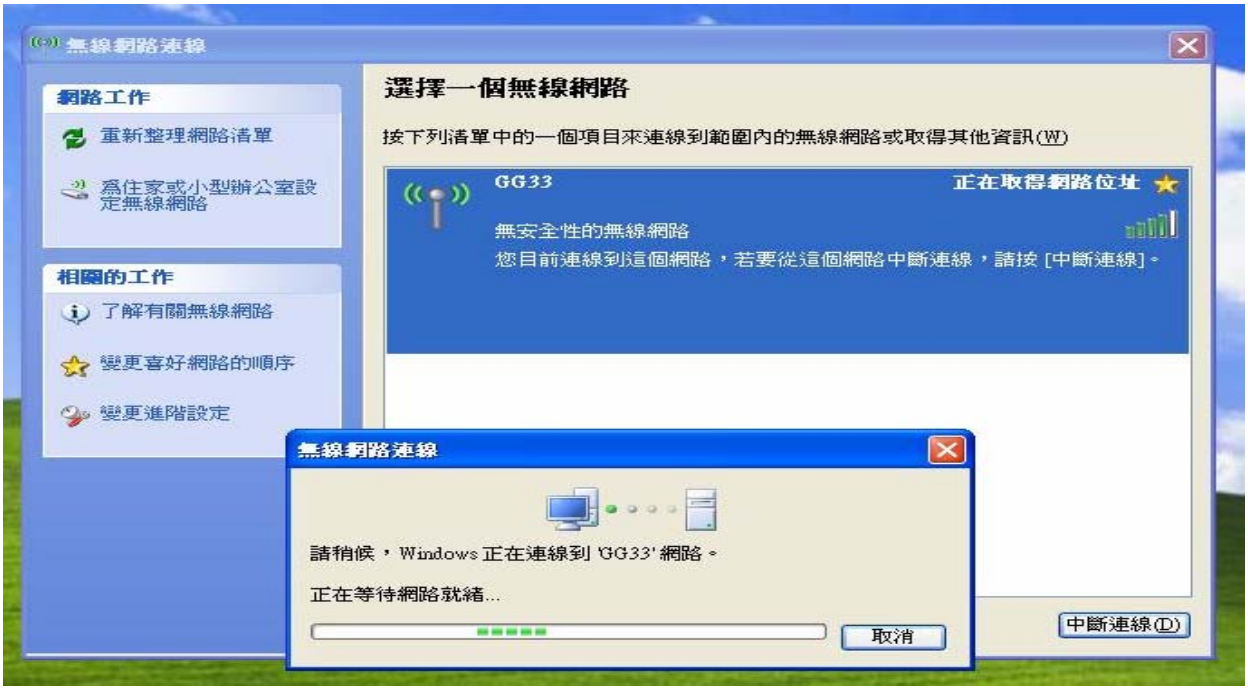


2. 打開後系統會自動掃描附近的無線網路



Part 2. 啟動無線網路

1. 點選GG33 並連線。



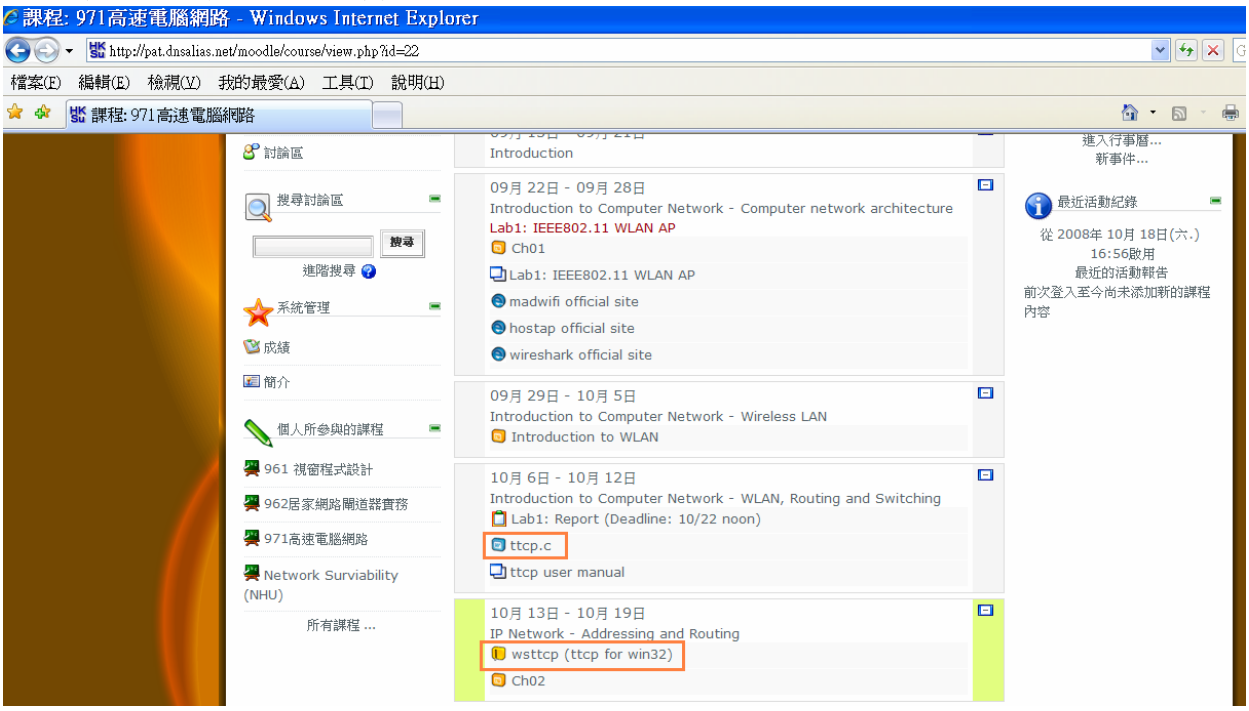
2. 點選GG33 並連線。

Part 3. 測試無線網路連線 (已拔有線網路)

(IV) 以ttcp/wsttcp工具測試無線網路品質

Part 0. ttcp/wsttcp工具準備

由老師的網路學習平台下載



Part 1. 在AP上使用ttcp (Linux系統)

1. 安裝編譯ttcp的套件

```
#apt-get install libstdc++6-4.2-dev
```

2. 編譯ttcp.c

```
#gcc ttcp.c –o ttcp
```

3. 在ttcp所在位置啟動AP端的ttcp (可加port號多開-p 5001 等，client參數為-st最後面加AP的IP)

```
#./ttcp –sr
```

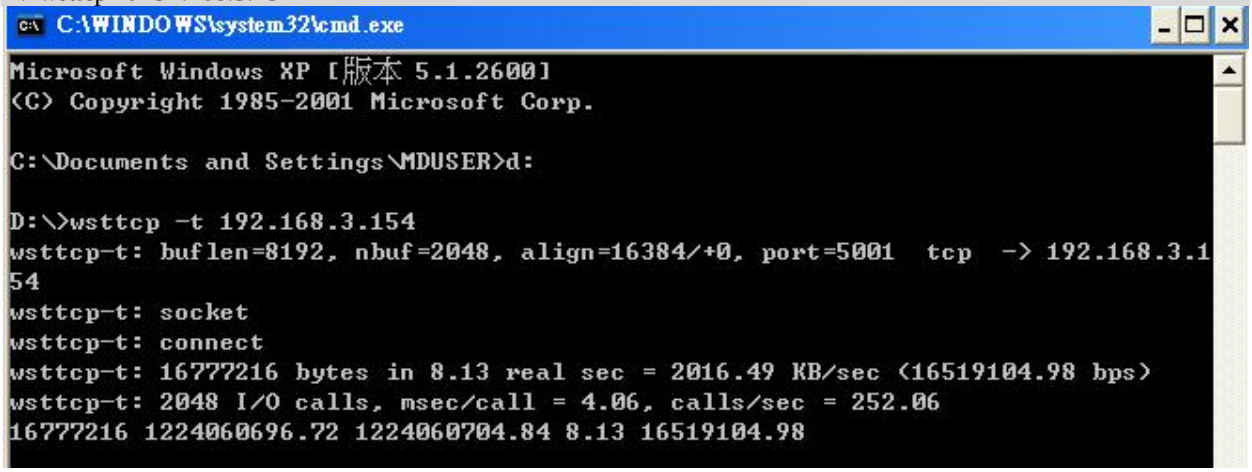
```
root@csie-desktop:/home/csie# ./ttcp -sr
ttcp-r: buflen=8192, nbuf=2048, align=16384/0, port=5001  tcp
ttcp-r: socket
ttcp-r: accept from 192.168.3.13
ttcp-r: 16777216 bytes in 8.12 real seconds = 2017.71 KB/sec +++
ttcp-r: 12273 I/O calls, msec/call = 0.68, calls/sec = 1511.44
ttcp-r: 0.0user 0.0sys 0:08real 0% 0i+0d 0maxrss 0+2pf 12291+0csw
```

此為已有Client連上本AP之完成測試訊息，速度為 2017.71KB/sec。

Part 2. 在Client上使用wsttcp (Windows系統)

1. 開啟命令提示字元
2. 在wsttcp所在位置啟動Client端的wsttcp

```
\>wsttcp –t 192.168.3.154
```



此為已連上AP完成測試訊息，速度為 2MBps不到。

七、問題與討論

- 架設AP所遇到的問題：
  1. 無線網路每個channel內的頻寬是共享的，所以各小組最好能把channel分散開來。
  2. 建立AP無線介面後，要注意此介面是否為master。
  3. 在設定interfaces時，要注意橋接器port與對外網路port是否有對應。

- 架設client所遇到的問題：
  1. 關掉有線網路介面可能是無效的，最好能把網路線拔除。
  2. 在聆聽AP訊息時，常常會有幽靈ESSID出現，可能是干擾造成的殘訊。
  3. 有時聆聽AP訊息時，會出現與所架設AP的不同channel，可能是干擾造成，最好到AP端確認該介面的訊息資訊。

- Client無法穩定attach AP的問題：
  1. 可能是無線網路不穩，且干擾很大。
  2. 可能是無線網卡太新, 以至於韌體支援不全面造成不穩現象。

- 結論：
  1. 經過測試後發現，該教室的有線網路速度遠遠低於 1Gbps的水準。
  2. 測試後發現，無線網路速度遠遠低於有線網路的速度，也遠低於 54Mbpsd的水準。