

***Realtek 8186 Wi-Fi Protected Setup
User Guide V1.0***

1. Introduction

Purpose

This document describes the supported WPS features of Realtek 8186, the instructions of setting up a Wi-Fi network for different scenarios, and the recommended system configuration.

Scope

This document is aimed to the engineers who have basic knowledge about WPS and will utilize Realtek 8186 SDK to develop their products.

Definitions of Wi-Fi Protected Setup terminologies

(Wi-Fi Protected Setup Specification 1.0h.pdf, p. 11)

WPS: Stands for Wi-Fi Protected Setup; an optional certification program designed to ease set up of security-enabled Wi-Fi networks in the home and small office environment.

Device: An independent physical or logical entity capable of communicating with other Devices across a LAN or WLAN.

Domain: A set of one or more Devices governed by a common authority for the purpose of gaining access to one or more WLANs.

Enrollee: A Device seeking to join a WLAN Domain. Once an Enrollee obtains a valid credential, it becomes a Member.

In-band: Data transfer using the WLAN communication channel.

Out-of-band: Data transfer using a communication channel other than the WLAN

Member: A WLAN Device possessing Domain credentials.

Registration Protocol: A Registration Protocol is a (logically) three party in-band protocol to assign a Credential to the Enrollee. The protocol operates between the Enrollee and the Registrar and may receive support through a proxy. In this document, it is equivalent to “WPS handshake”.

Registrar: An entity with the authority to issue and revoke Domain Credentials. A registrar may be integrated into an AP, or it may be separate from the AP. A registrar may not have WLAN capability. A given Domain may have multiple registrars.

External Registrar: A registrar for an AP’s Domain that runs on a device separate from the AP.

PushButton Configuration (PBC): A configuration method triggered by pressing a physical or logical button on the Enrollee and on the Registrar.

PIN Configuration: Unique 4- or 8-digit PIN required for each device on the

network. PIN is entered into Registrar via a graphical user interface.

WLAN: A Wi-Fi network.

Credential: A data structure issued by a Registrar to an Enrollee, allowing the latter to gain access to the network. For examples, It contains SSID and security settings.

Proxy: The AP can work as a proxy to convey the messages between external registrar and enrollee.

Un-configured State: By default, Realtek 8186 will stay in this state when it is shipped from the factory. The SSID is assigned a default value and the security is set to open.

Configured State: In Realtek 8186 platform, if it is in un-configured state and the SSID or security is manually changed, or the registration protocol is successfully done, it will switch to this state.

Multiple PBC Sessions: Push Button Configuration is inherently unsecured due to the PIN is 00000000. As a result, only one pair of registrar and enrollee is allowed to initiate the WPS handshake at any time. Any WPS AP should detect whether there is more than one station that starts PBC before the handshake. Similarly, any WPS station should detect whether there is more than one AP that starts PBC. If any side of AP or station detects multiple PBC sessions, it should guide users to use other secure methods such as PIN Configuration.

1.4 Introduction of WPS

Although home Wi-Fi networks have become more and more popular, users still have trouble with the initial set up of network. This obstacle forces users to use the open security and increases the risk of eavesdropping. Therefore, WPS is designed to ease set up of security-enabled Wi-Fi networks and subsequently network management (Wi-Fi Protected Setup Specification 1.0h.pdf, p. 8).

The largest difference between WPS-enabled devices and legacy devices is that users do not need the knowledge about SSID, channel and security settings, but they could still surf in a security-enabled Wi-Fi network. For examples, in the initial network set up, if users want to use the PIN configuration, the only thing they need to do is entering the device PIN into registrar, starting the PIN method on that device and simply wait until the device joins the network. After the PIN method is started on both sides, a registration protocol will be initiated between the registrar and the enrollee. Typically, a registrar could be an access point or other device that is capable of managing the network. An enrollee could be an access point or a station that will join the network. After the registration protocol has been done, the enrollee will receive SSID and security settings from the registrar and then join the network. In

other words; if a station attempts to join a network managed by an access point with built-in internal registrar, users will need to enter station's PIN into the web page of that access point. If the device PIN is correct and valid and users start PIN on station, the access point and the station will automatically exchange the encrypted information of the network settings under the management of AP's internal registrar. The station then uses this information to perform authentication algorithm, join the secure network, and transmit data with the encryption algorithm. More details will be demonstrated in the following sections.

2. Supported WPS features

Currently, Realtek 8186 supports WPS features for AP mode, AP+WDS mode, Infrastructure-Client mode, and the wireless root interface of Universal Repeater mode. Other modes such as WDS mode, Infrastructure-Adhoc mode, and the wireless virtual interface of Universal Repeater mode are not implemented with WPS features. If those unsupported modes are enforced by users, WPS will be disabled. Under the configuration of every WPS-supported mode, Realtek 8186 has Push Button method and PIN method. For each method, Realtek 8186 offers different security levels included in network credential, such as open security, WEP 64 bits, WEP 128 bits, WPA-Personal TKIP, WPA-Personal AES, WPA2-Personal TKIP, and WPA2-Personal AES. Users could choose either one of the methods at their convenience.

AP mode

For AP mode, Realtek 8186 supports three roles, registrar, proxy, and enrollee in registration protocol. At different scenarios, 8186 will automatically switch to an appropriate role depending on the other device's role or a specific configuration.

2.1.1 AP as Enrollee

If users know AP's PIN and enter it into external registrar, the external registrar will configure AP with a new wireless profile such as new SSID and new security settings. The external registrar does this job either utilizing the in-band EAP (wireless) or out-of-band UPnP (Ethernet). During the WPS handshake, a wireless profile is encrypted and transmitted to AP. If the handshake is successfully done, AP will be re-initialized with the new wireless profile and wait for legacy stations or WPS stations to join its network.

2.1.2 AP as Registrar

Realtek 8186 also has a built-in internal registrar. Whenever users enter station's PIN into AP's webpage, click "Start PBC", or push the physical button, AP will switch to registrar automatically. If users apply the same method on station side and the WPS handshake is successfully done, SSID and security settings will be transmitted to that station without the risk of eavesdropping. And then the station will associate with AP in a security-enabled network.

2.1.3 AP as Proxy

At this state, AP is transparent to users. If users want to configure a station or any device that is capable of being an enrollee, they have to enter device's PIN into an

external registrar and choose an appropriate wireless profile. After the PIN is entered, the external registrar will inform AP this event. AP then conveys the encrypted wireless profile between the device and the external registrar. Finally, the device will use the wireless profile and associate with AP. However, the device may connect to other APs if the wireless profile does not belong to the proxy AP. Users must carefully choose the wireless profile or create a wireless profile on an external registrar.

Infrastructure-Client mode

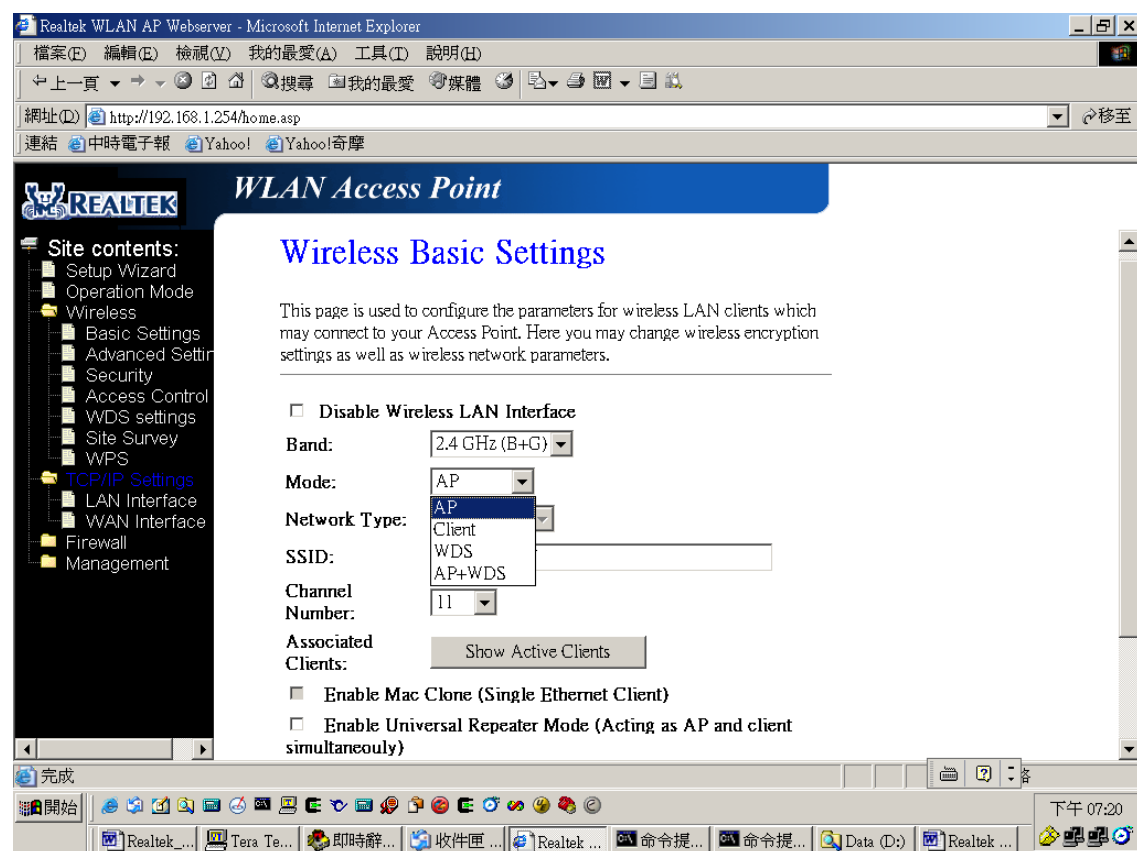
In Infrastructure-Client mode, Realtek 8186 only supports enrollee's role. If users click "Start PIN", click "Start PBC", or press the physical button on 8186, it will start to seek WPS AP. Once users apply the same method on registrar side, 8186 will receive the wireless profile upon successfully doing the registration protocol. Then 8186 will associate with an AP.

3. Instructions of AP's and Client's operations.

3.1 Introduction of AP's webpages

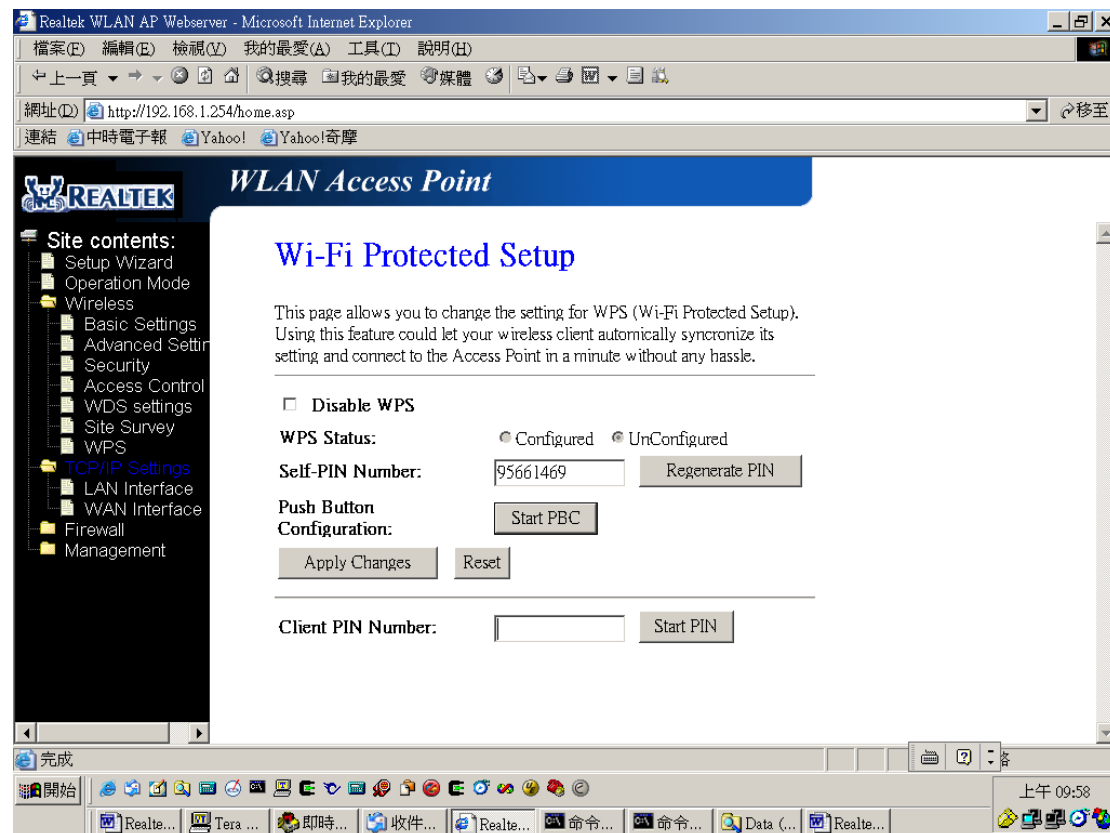
3.1.1 Wireless Basic Settings page

The instructions of operating WPS in AP mode, AP+WDS mode, and Universal Repeater mode are the same. Therefore, only AP mode will be demonstrated in this section and AP will represent those three modes hereafter. However, users could freely switch between those supported modes by selecting the pull-down menu next to "Mode" or check the box "Enable Universal Repeater Mode (Acting as AP and client simultaneously)" and click "Apply Changes" on Wireless Basic Settings page. Please see the figure below.



3.1.2 Wi-Fi Protected Setup page

The following sub-paragraphs will describe the function of each item. The webpage is as below.



3.1.2.1 Disable WPS

Checking this box and clicking “Apply Changes” will disable Wi-Fi Protected Setup. WPS is turned on by default.

3.1.2.2 WPS Status

When AP’s settings are factory default (out of box), it is set to open security and un-configured state. It will be displayed by “WPS Status”. If it already shows “Configured”, some registrars such as Vista WCN will not configure AP. Users will need to go to the “Save/Reload Settings” page and click “Reset” to reload factory default settings.

3.1.2.3 Self-PIN Number

“Self-PIN Number” is AP’s PIN. Whenever users want to change AP’s PIN, they could click “Regenerate PIN” and then click “Apply Changes”. Moreover, if users want to make their own PIN, they could enter four digit PIN without checksum and then click “Apply Changes”. However, this would not be recommended since the

registrar side needs to be supported with four digit PIN.

3.1.2.4 Push Button Configuration

Clicking this button will invoke the PBC method of WPS. It is only used when AP acts as a registrar.

3.1.2.5 Apply Changes

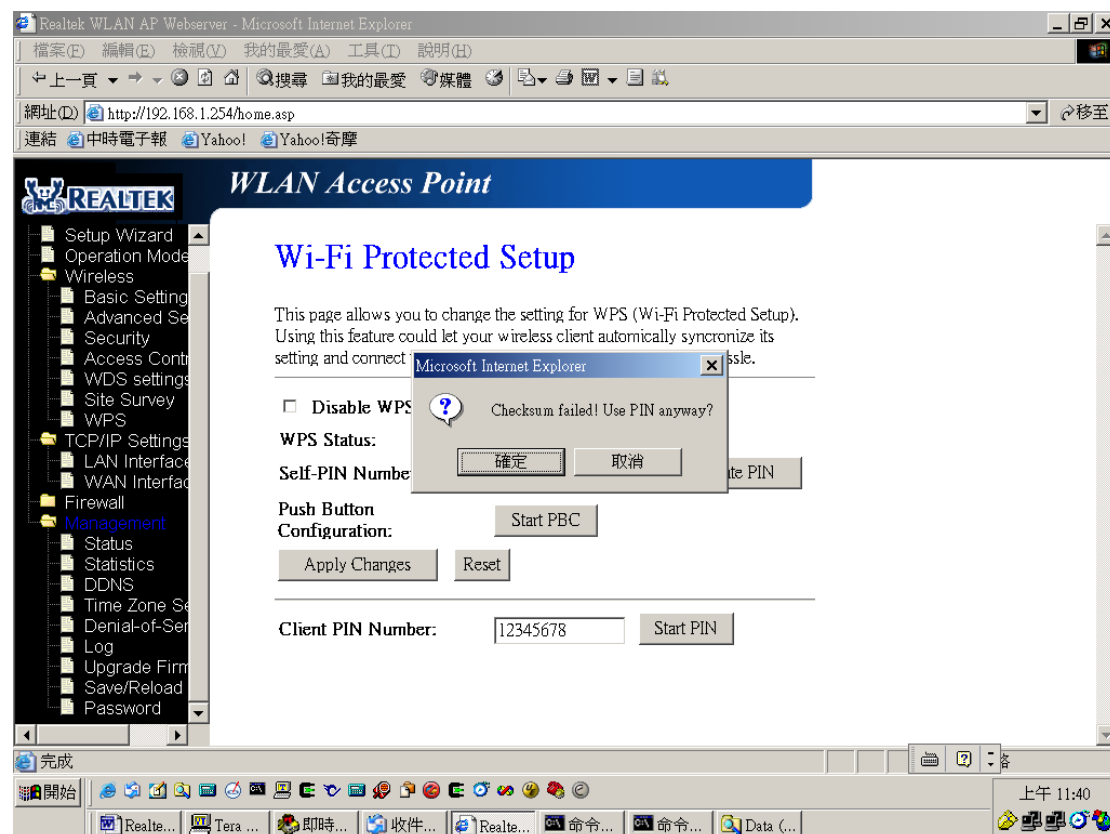
Whenever users want to enable/disable WPS or change AP's PIN, they need to apply this button to commit changes.

3.1.2.6 Reset

It restores the original values of “Self-PIN Number” and “Client PIN Number”.

3.1.2.7 Client PIN Number

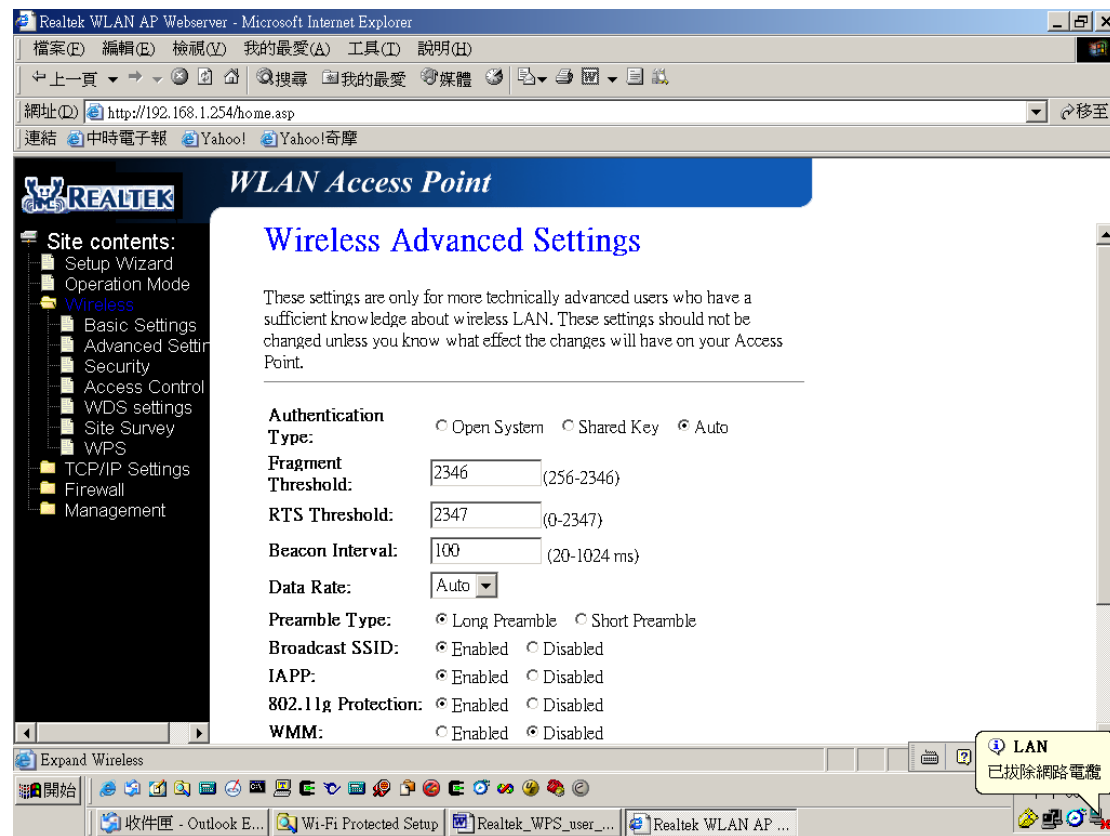
It is only used when users want their station to join AP's network. The length of PIN is limited to four or eight numeric digits. If users enter eight digit PIN with checksum error, there will be a warning message popping up.



If users insist on this PIN, AP will take it.

3.1.3 Wireless Advanced Settings page

Users need to make sure the “Broadcast SSID” file is set to “Enabled”. Otherwise, it might prevent WPS from working properly.



3.2 Operations of AP

3.2.1 AP being an enrollee

In this case, AP will be configured by any registrar either through in-band EAP or UPnP. Here, users do not need to do any action on AP side. They just need AP's device PIN and enter it into registrar. An example from Vista WCN will be given.

1. Make sure AP is in un-configured state. (Figure 3.1)

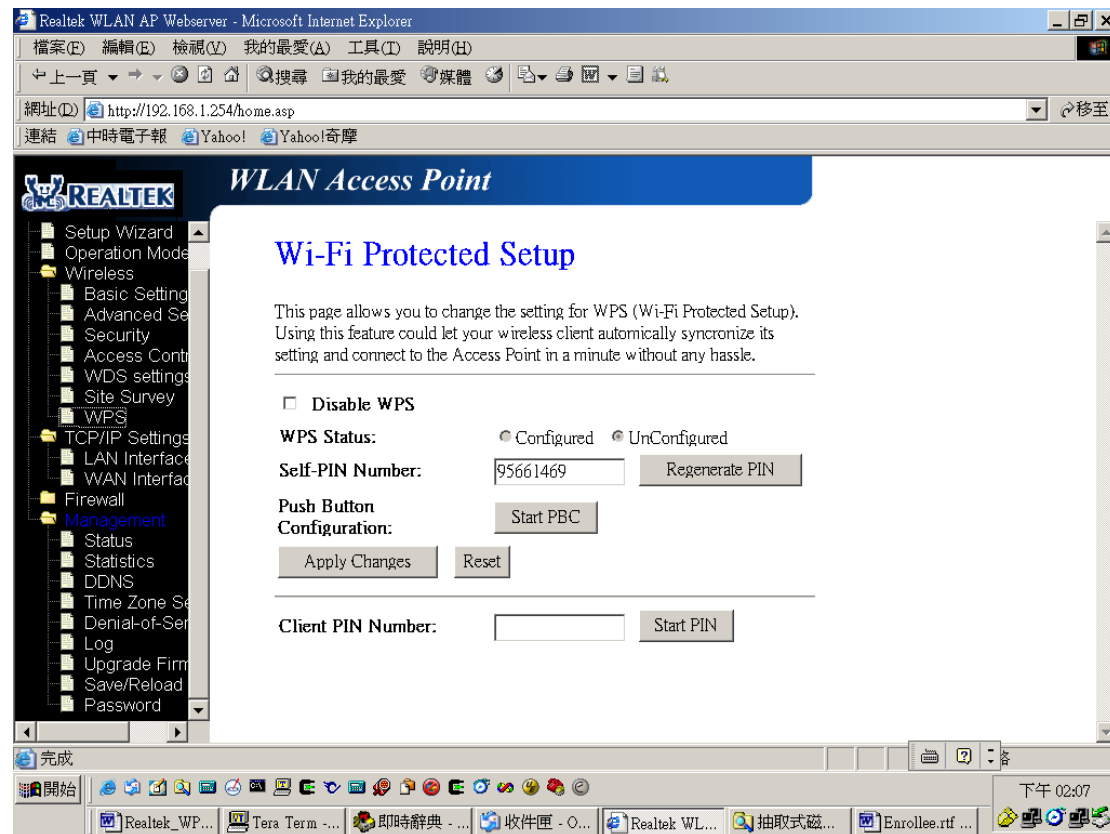


Figure 3.1

2. Plug the Ethernet cable into AP's LAN port and make sure the IP connection is valid with Vista.
3. Make sure WCN is enabled. Users may need to enable it at the first time. They could open the "Control Panel", open "Administrative Tools", double click "Services", edit properties of "Windows Connect Now", choose the "Startup type" with "Automatic" and click "Start". (Figure 3.2)

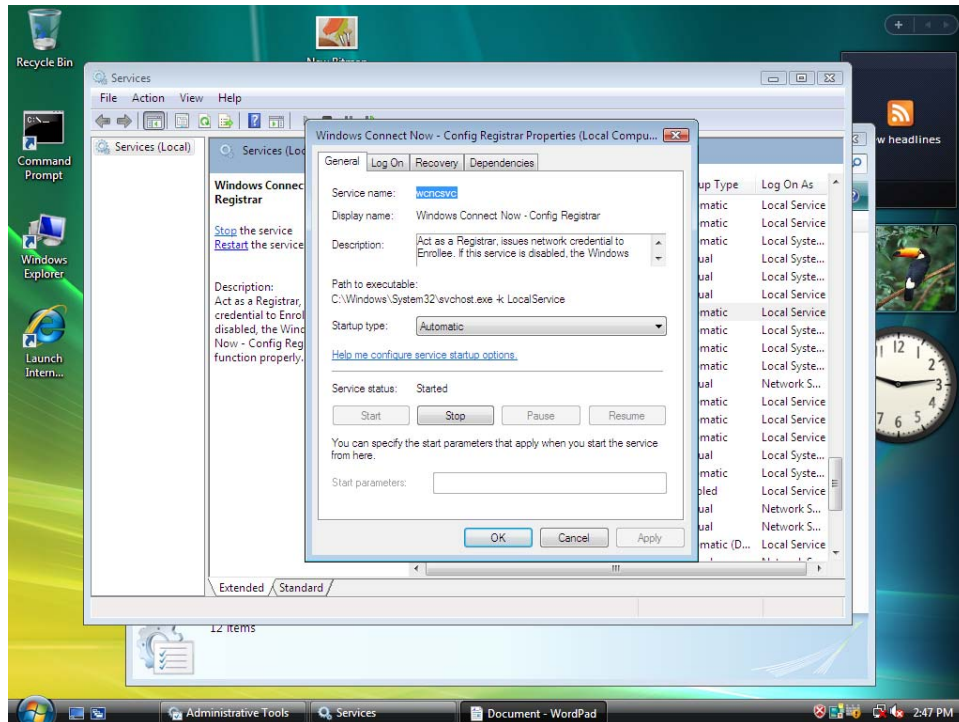


Figure 3.2

4. If the previous steps are done, open Windows Explorer. Go to the Network section. Right-click mouse and select Refresh, and AP's icon will show up. Double click on it. Users could also Click "Add a wireless device" if the icon is not there. Click "next". (Figure 3.3)

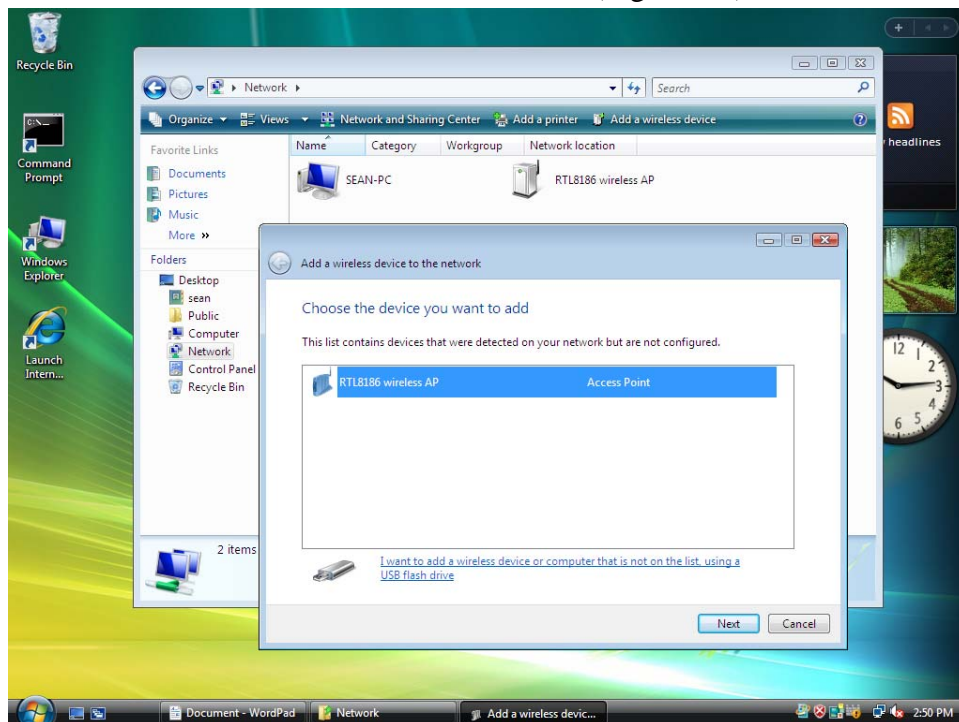


Figure 3.3

5. Enter AP's PIN (Self-PIN Number in Figure 3.1) and click “next”.
(Figure 3.4)

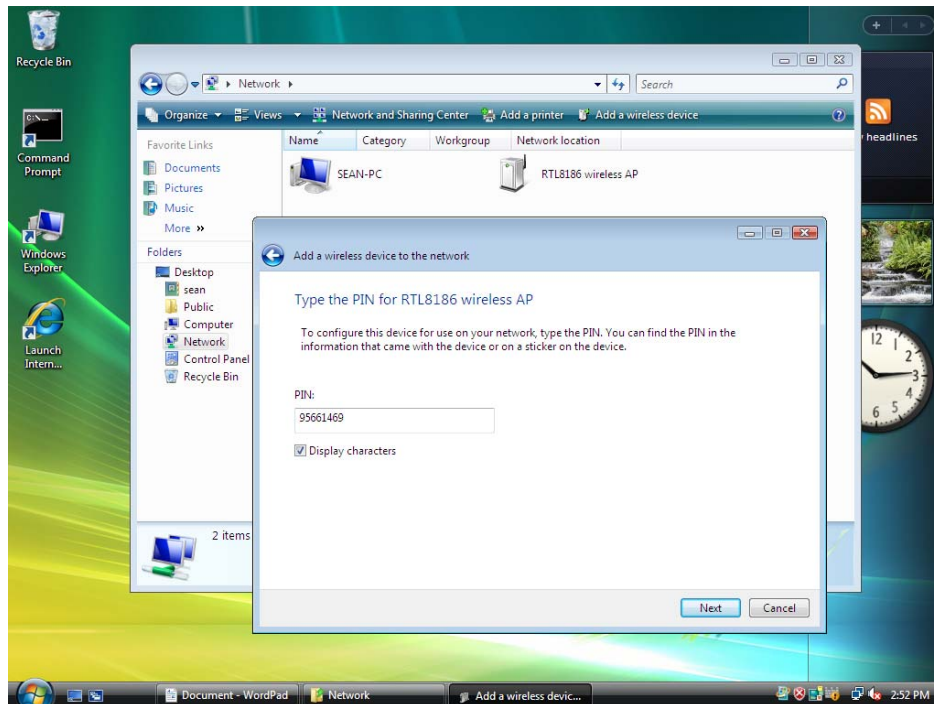


Figure 3.4

6. Select a wireless profile or Click “Create a new Wireless Network Profile”.
Click “next” (Figure 3.5)

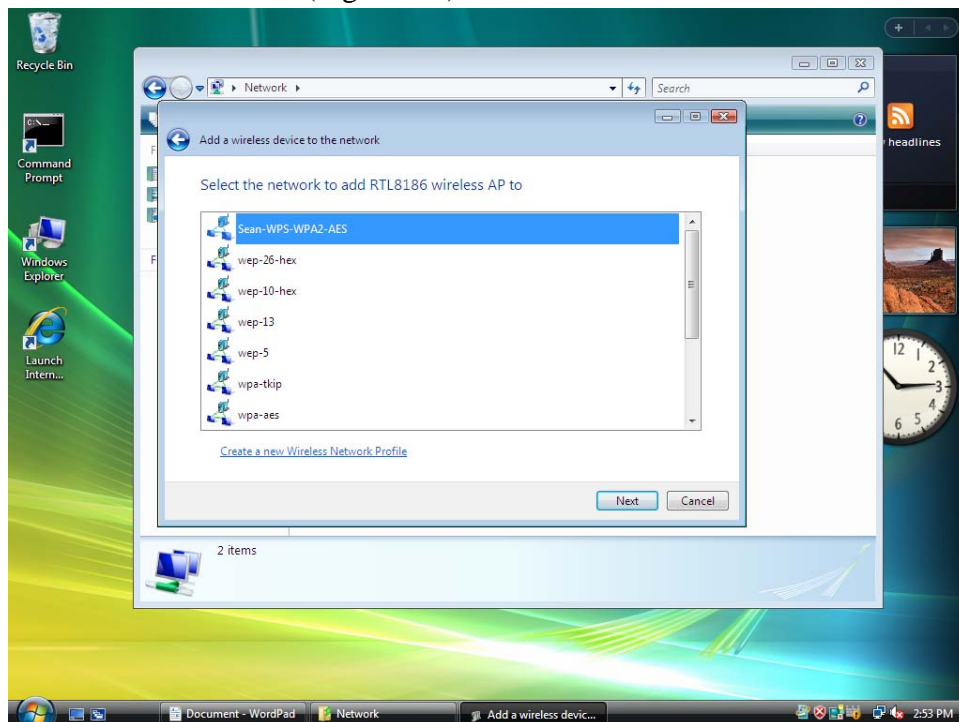


Figure 3.5

7. If the next window is shown as Figure 3.6, then AP is successfully configured by WCN.

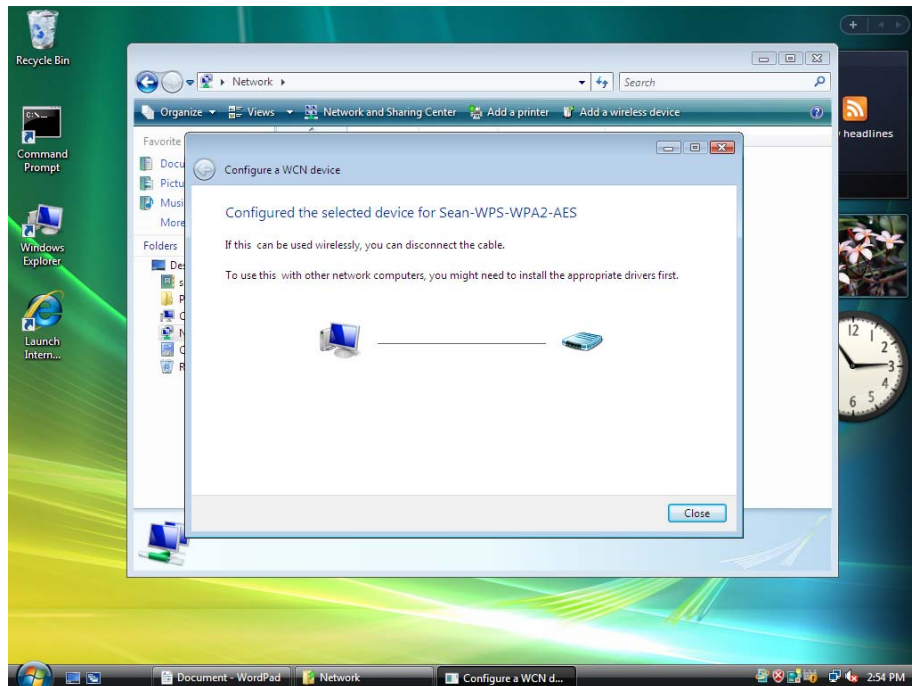


Figure 3.6

8. Finally, AP will become configured (see WPS Status). The authentication algorithm, encryption algorithm, and key assigned by WCN will be displayed below “Current Key Info”. (Figure 3.7)

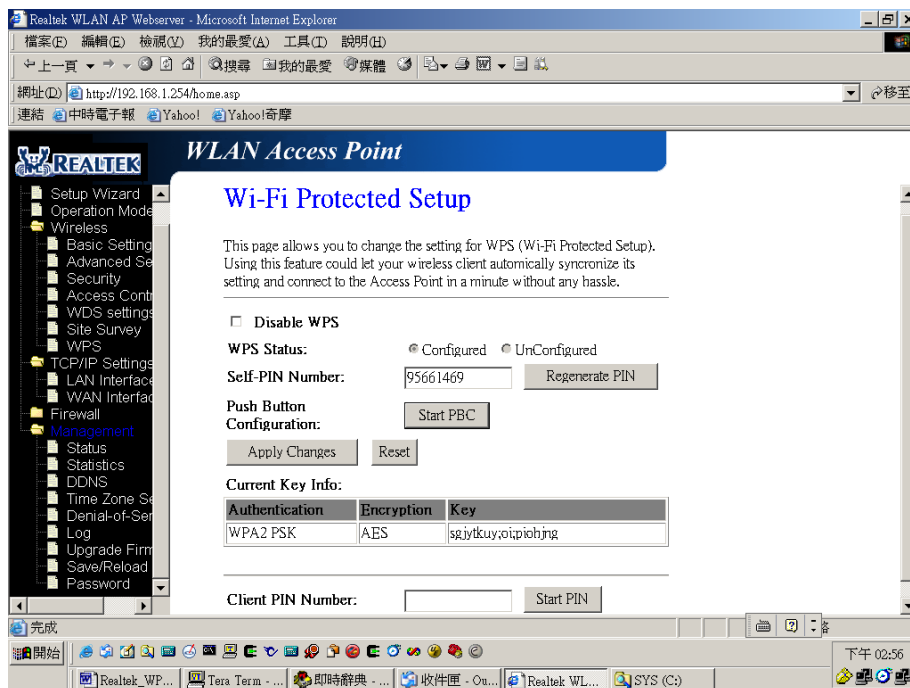


Figure 3.7

9. The SSID field of Wireless Basic Settings page will also be modified with the value assigned by WCN. (Figure 3.8)

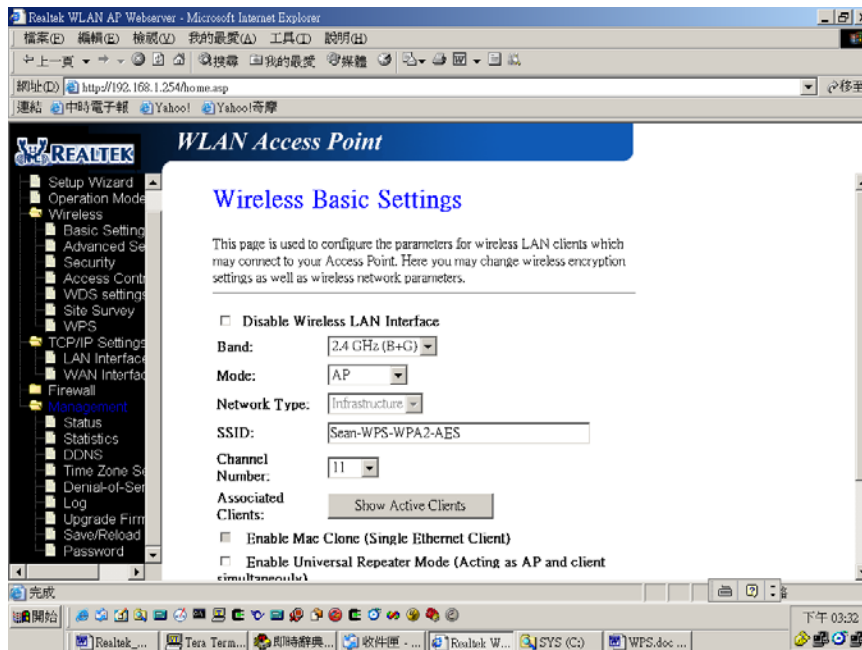


Figure 3.8

If users try to modify the SSID at this moment, there will be a warning message popping up that informs the risk of this action. The reason is that users may not know whether the SSID is already given to a station. Changing the SSID will result in the link between AP and stations to be broken. If users insist on this action, AP will take their decision. (Figure 3.9)

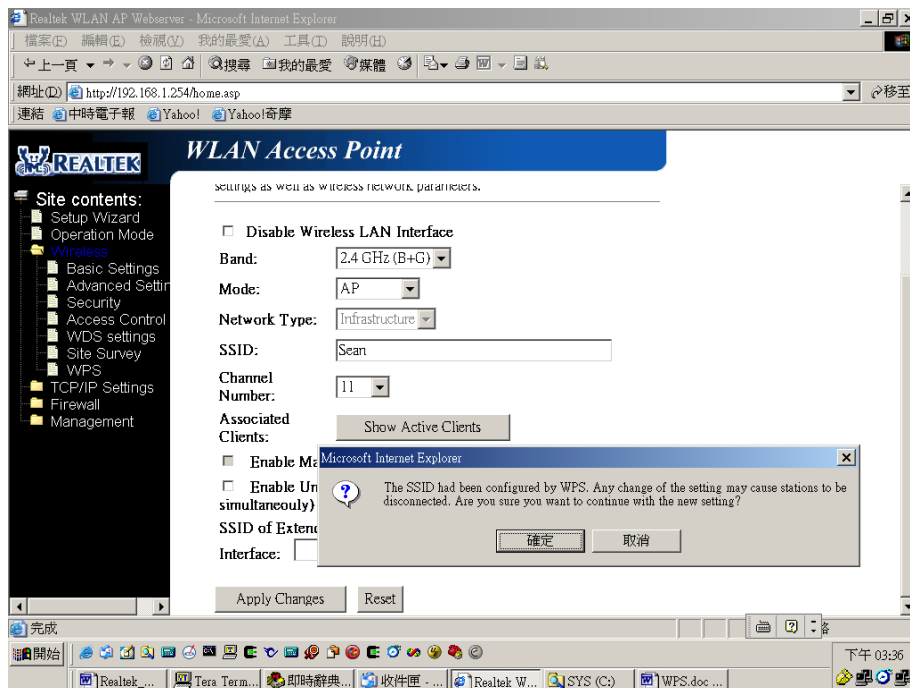


Figure 3.9

10. The security settings on the Wireless Security Page will be modified by WCN, too (Figure 3.10). The warning message will show up if users try to modify the security settings (Figure 3.11). The reason is the same as we explained in the previous section.

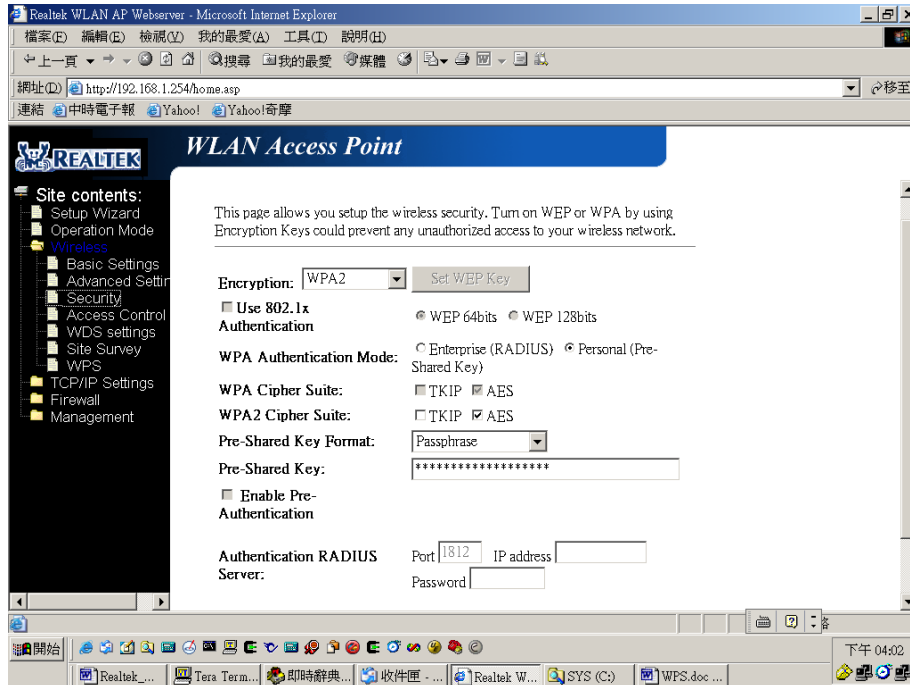


Figure 3.10

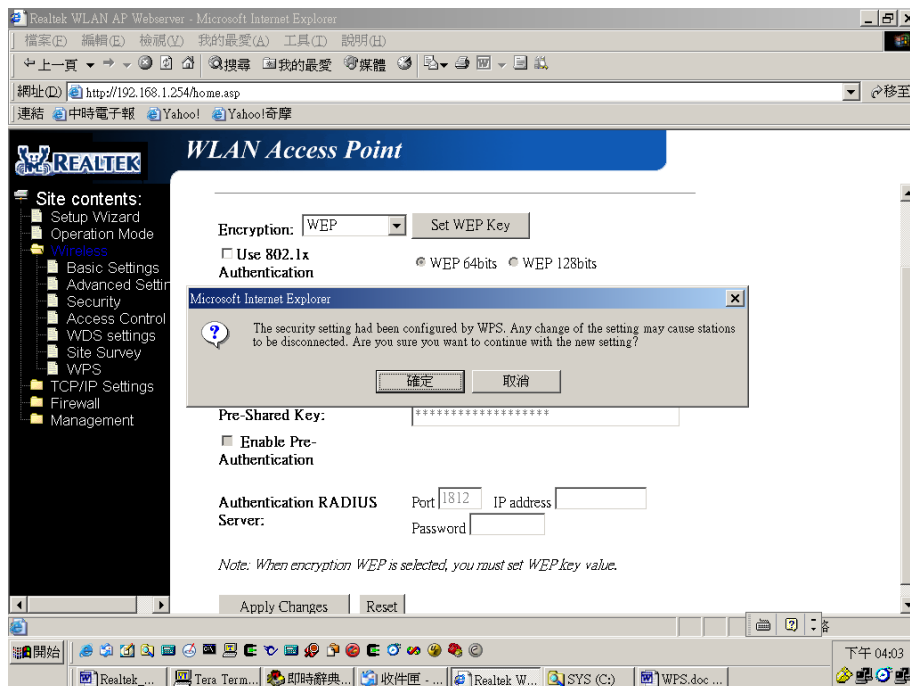


Figure 3.11

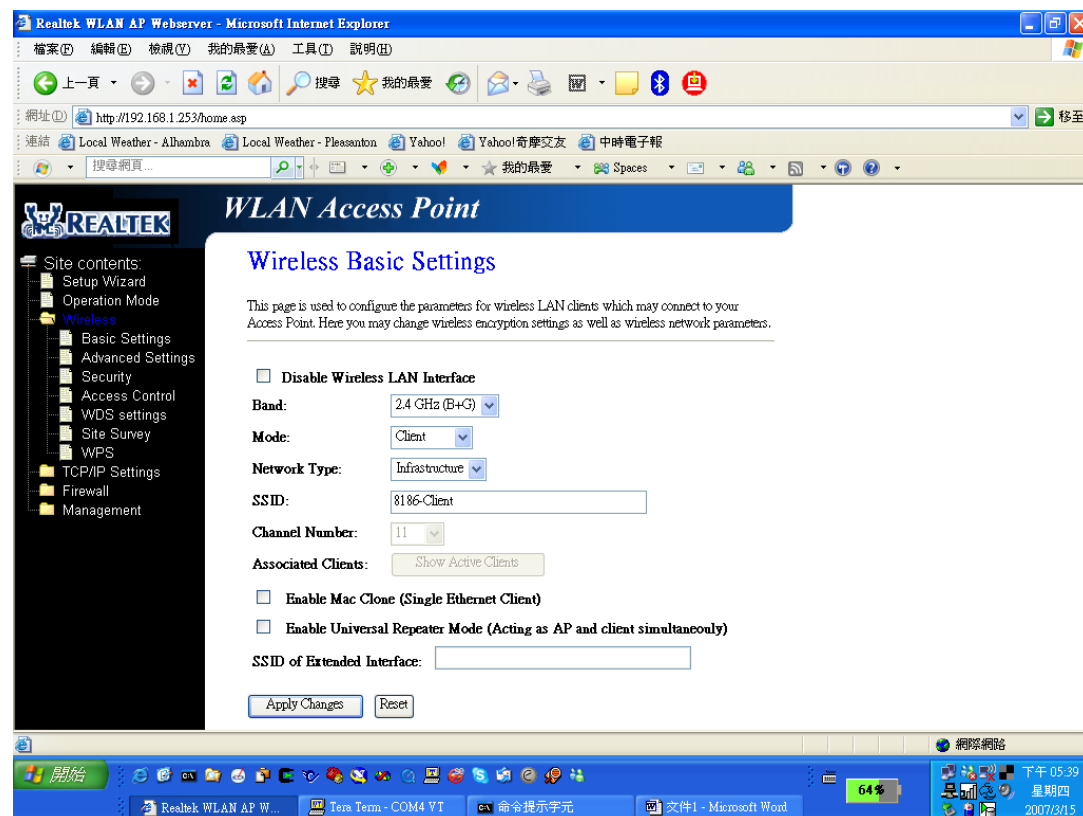
3.2.2 AP being a proxy

If AP satisfies all of the following conditions, AP will switch to proxy state automatically.

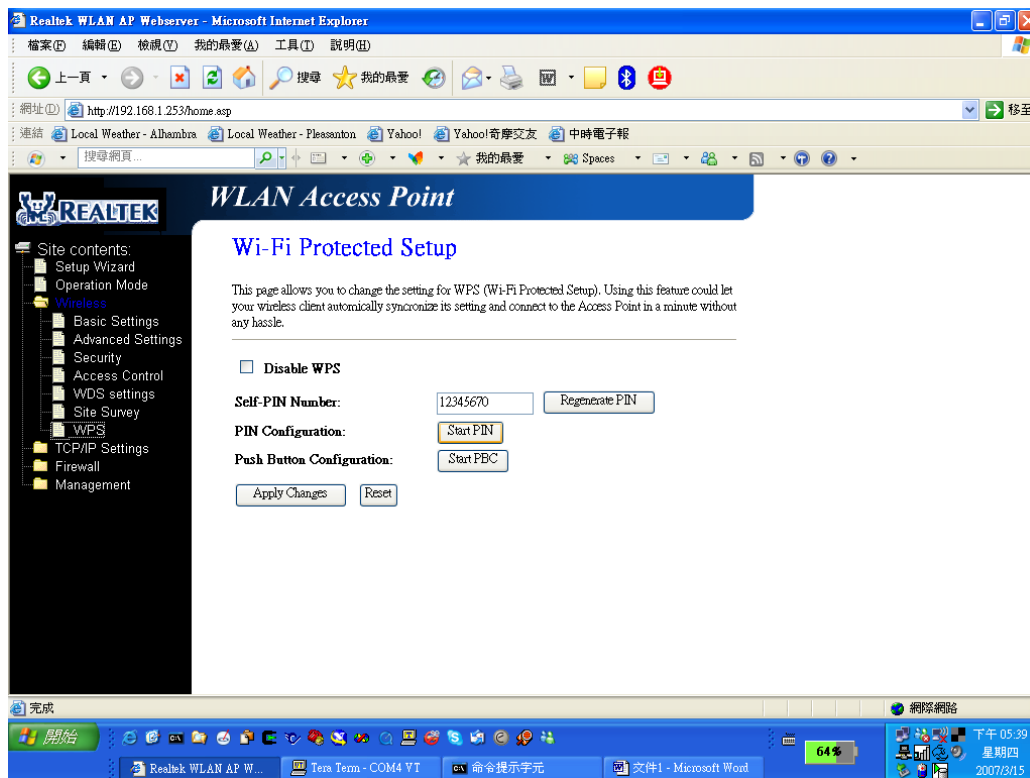
1. AP must be in configured state.
2. AP already established an IP connection with any external registrar.
3. AP is not configuring any devices at this moment. In other words, you are not entering device PIN into AP's WPS webpage, and not pushing PBC button on AP.
4. An external registrar is not configuring AP at this moment. In other words, you are not entering AP's PIN into any external registrar.

In this scenario, users need to make sure whether AP is in this state. If it is, then operate on station side and registrar side step by step. Here, we will illustrate an example from Vista WCN and Realtek 8186 Infrastructure-Client mode.

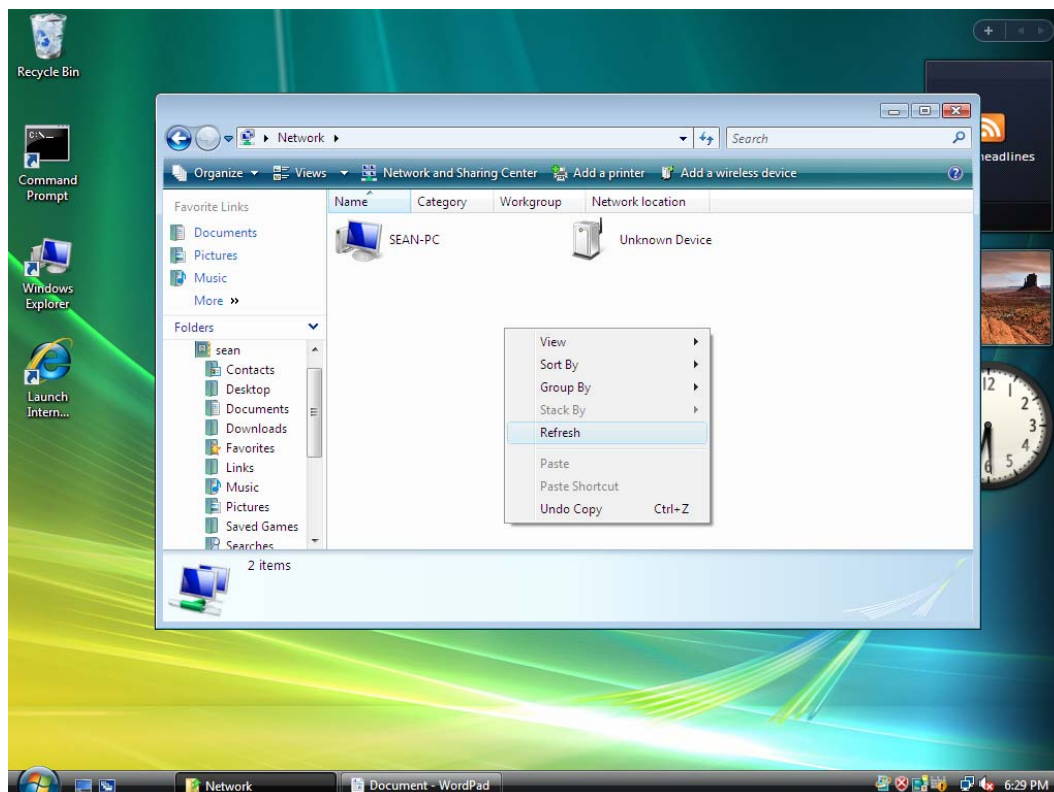
1. Go to the Wireless Basic Settings page of the other 8186 platform. Make sure it is in Infrastructure-Client mode.



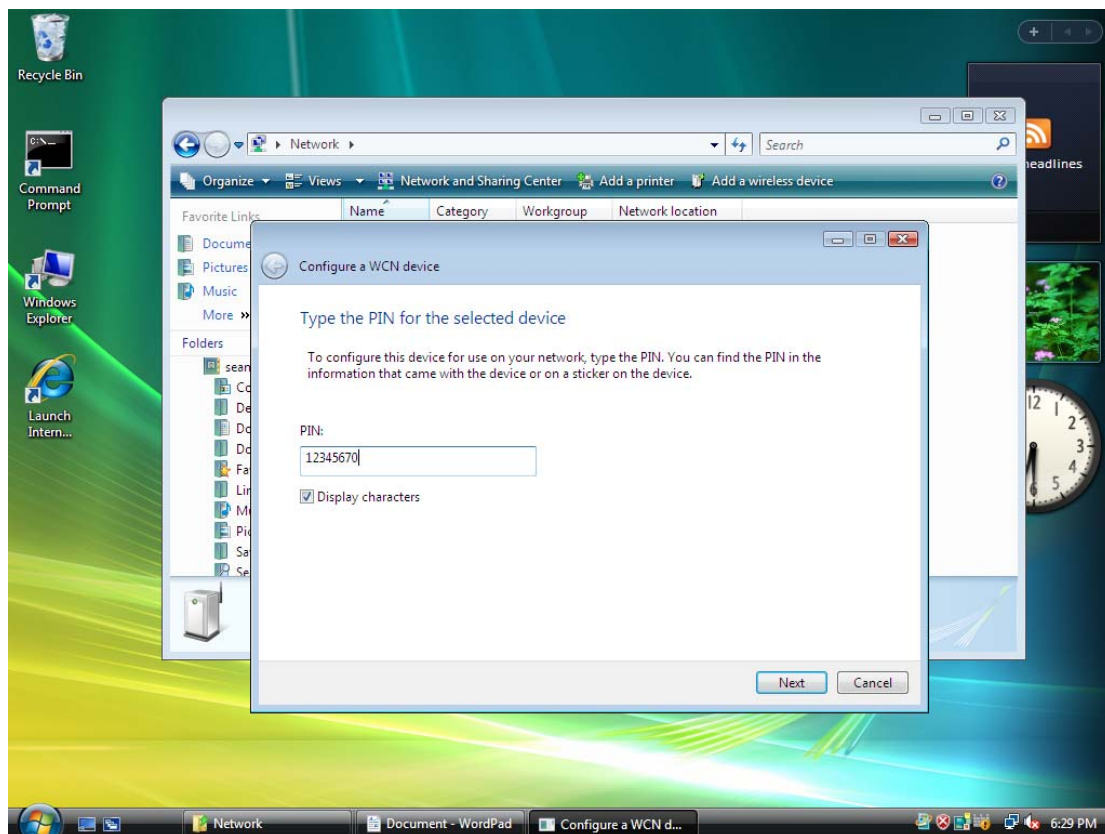
2. Go to the Wi-Fi Protected Setup page and click “Start PIN”.



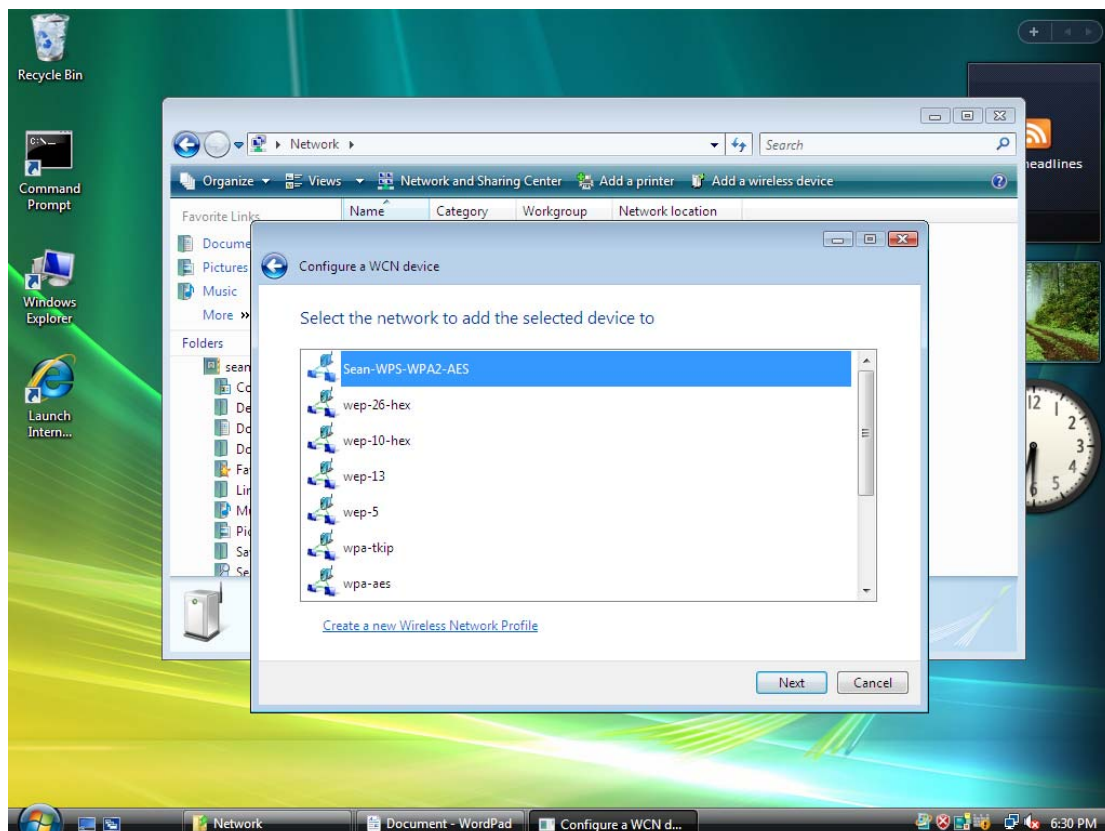
3. Open Windows Explorer on Vista and go to the Network section. Rick-click your mouse and select “Refresh”. After the “Unknown Device” icon shows up, double-click on it.



4. Enter the device PIN.

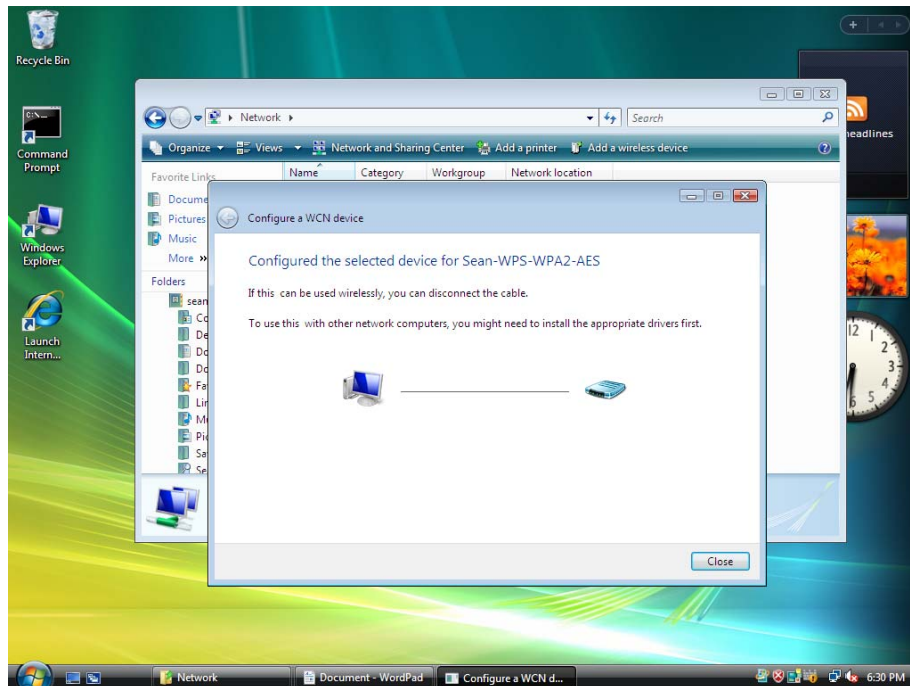


5. Choose the wireless profile previously assigned to the proxy AP.

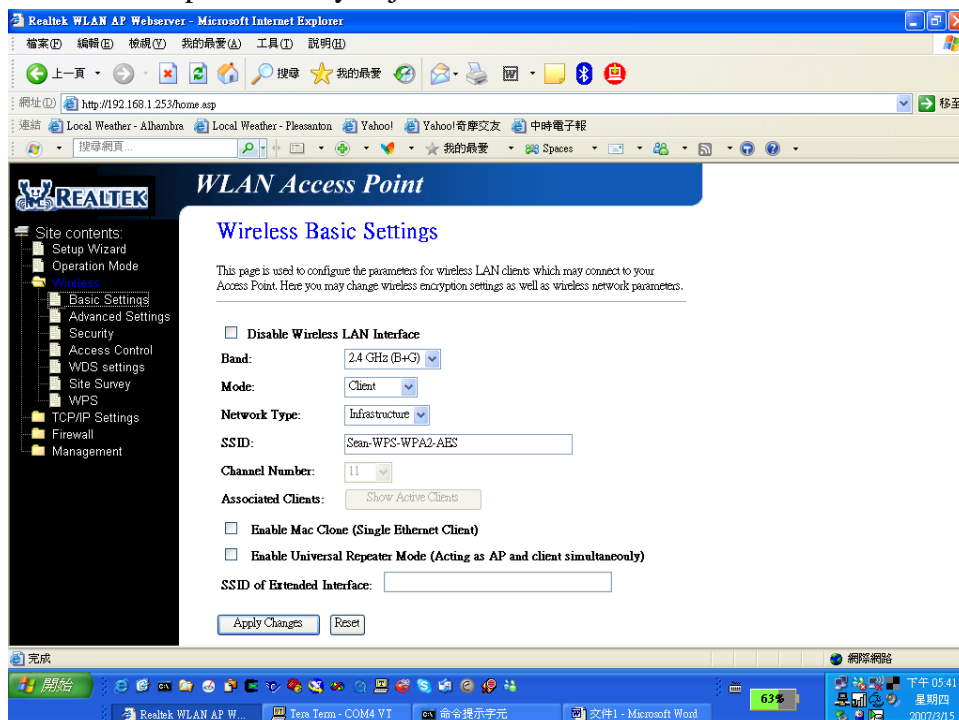


At this moment, WCN will inform AP this event and the LED of AP starts blinking.

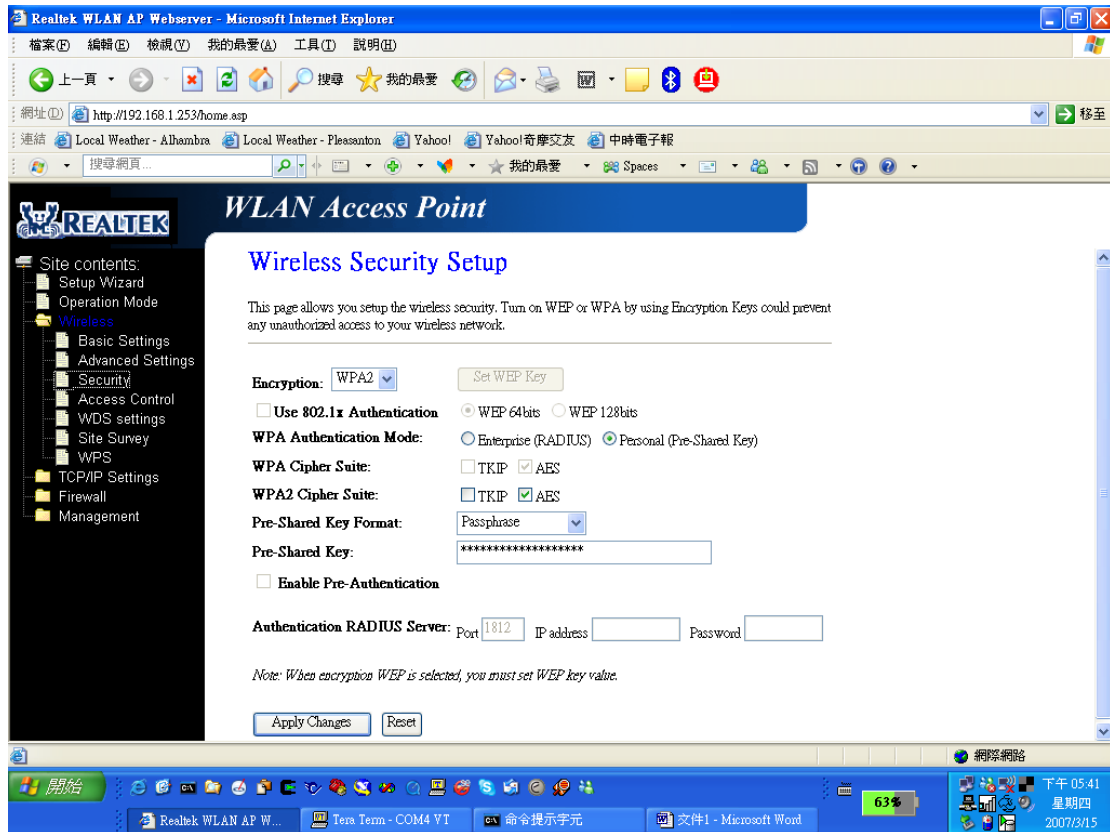
6. If WCN had successfully configured 8186 Infrastructure-Client, the LED of AP will be turned off. The window on Vista will be displayed as below.



7. The SSID of 8186 Infrastructure-Client will be assigned according to the wireless profile that you just selected.



8. The security settings of 8186 Infrastructure-Client will be assigned according to the wireless profile that you just selected.

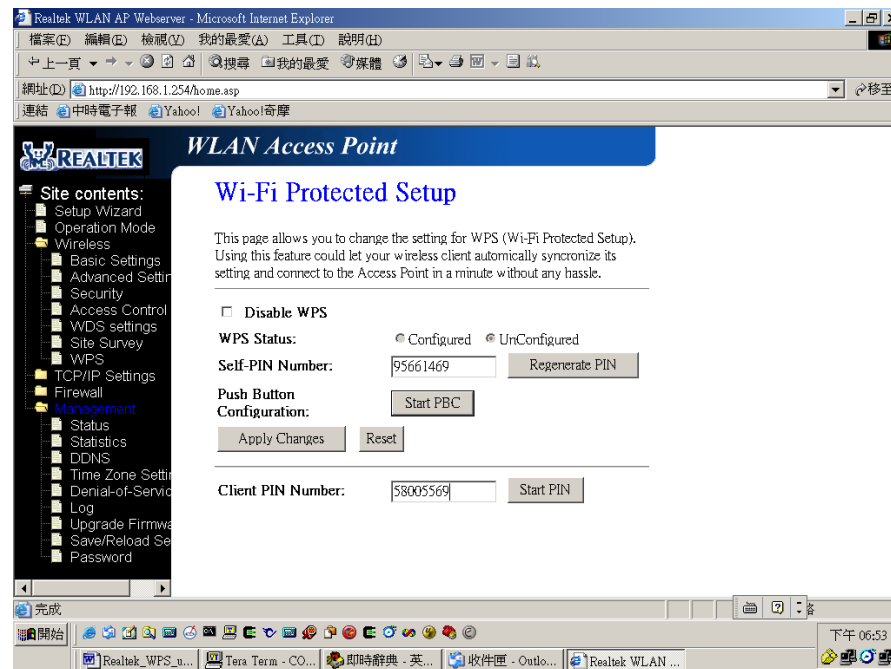


9. Finally, 8186 Infrastructure-Client will use the SSID and security to associate with the proxy AP.

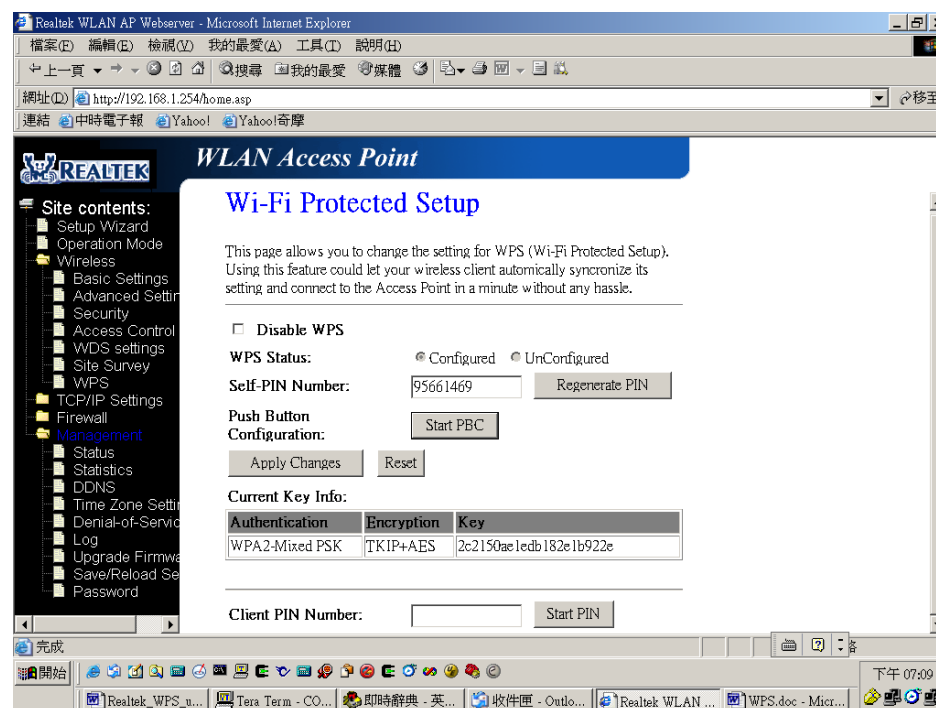
3.2.3 AP being a registrar

3.2.3.1 PIN method

Whenever users enter station's PIN into AP's Wi-Fi Protected Setup page and click "Start PIN", AP will become a registrar. The WPS LED will start blinking until the WPS handshake is successfully done or the session time out occurs. Users must start the PIN method on the station side within two minutes.



If the device PIN is correct and the WPS handshake is successfully done, AP's Wi-Fi Protected Setup page will be shown as below.



Other pages such as Wireless Basic Settings page and Wireless Security Setup page will also be updated appropriately as described in previous sections. In this case, AP is in un-configured state before the station initiates the WPS handshake. According to the WPS spec, AP will create a wireless profile with WPA2-mixed mode and a random-generated key upon successfully doing the WPS handshake. However, AP will use the original wireless profile and give it to the station if AP is already in configured state. That means all settings of AP will not change. Hence, all WPS related pages keep the same.

3.2.3.2 Push Button method

Realtek 8186 supports a virtual button “Start PBC” on the Wi-Fi Protected Setup page and a physical button on 8186 evaluation board for Push Button method. If users push any one of them, AP will initiate a WPS session and wait for any station to join. At this moment, AP will detect whether there is more than one station that starts the PBC method. If it happens, AP’s LED will be steady on for 30 seconds to indicate multiple PBC sessions; otherwise, the LED will be blinking until the WPS handshake is successfully done or session time out occurs. When multiple PBC sessions occurs, users should try PIN method.

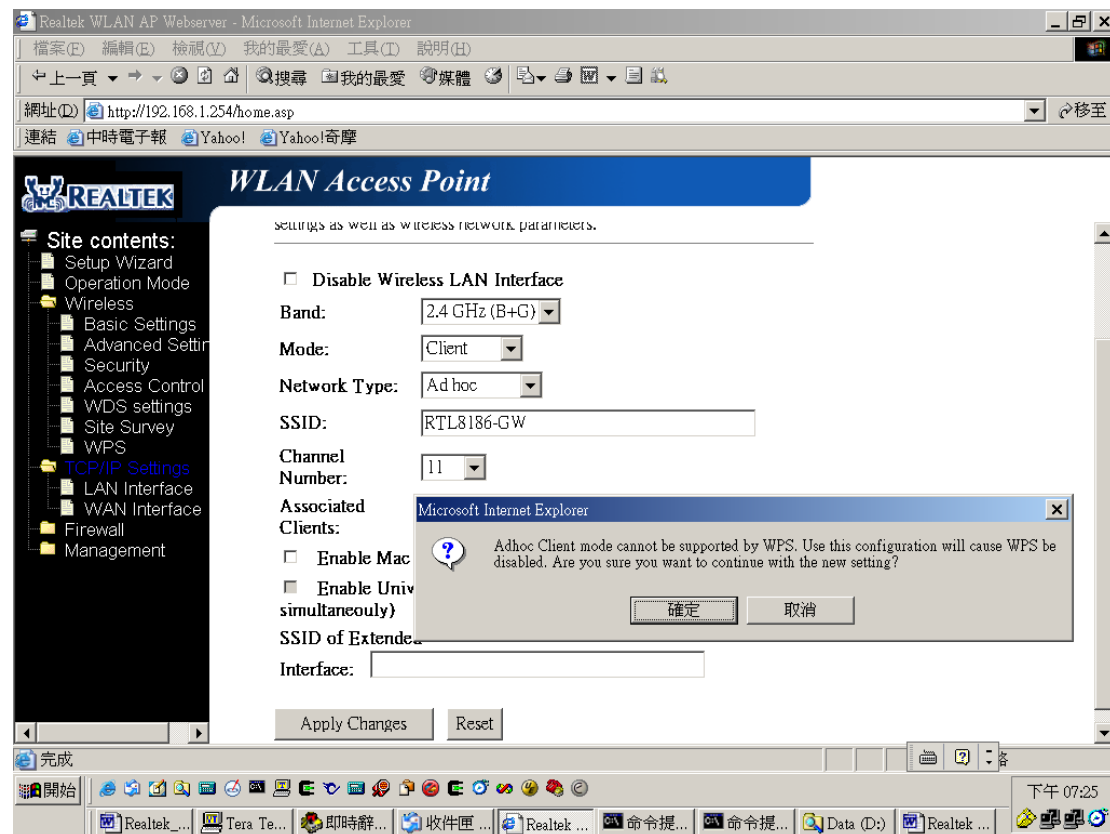
After users push AP’s PBC button, they must go to station side to push its button within two minutes. If the WPS is successfully done, AP will give its wireless profile to that station. The station could use this profile to associate with AP.

3.2.4 Warning pop-up windows of AP

When users try to operate on AP not appropriately, AP will give a warning message to them. All kinds of pop-up windows will be demonstrated in this section.

3.2.4.1 Un-supported mode in WPS

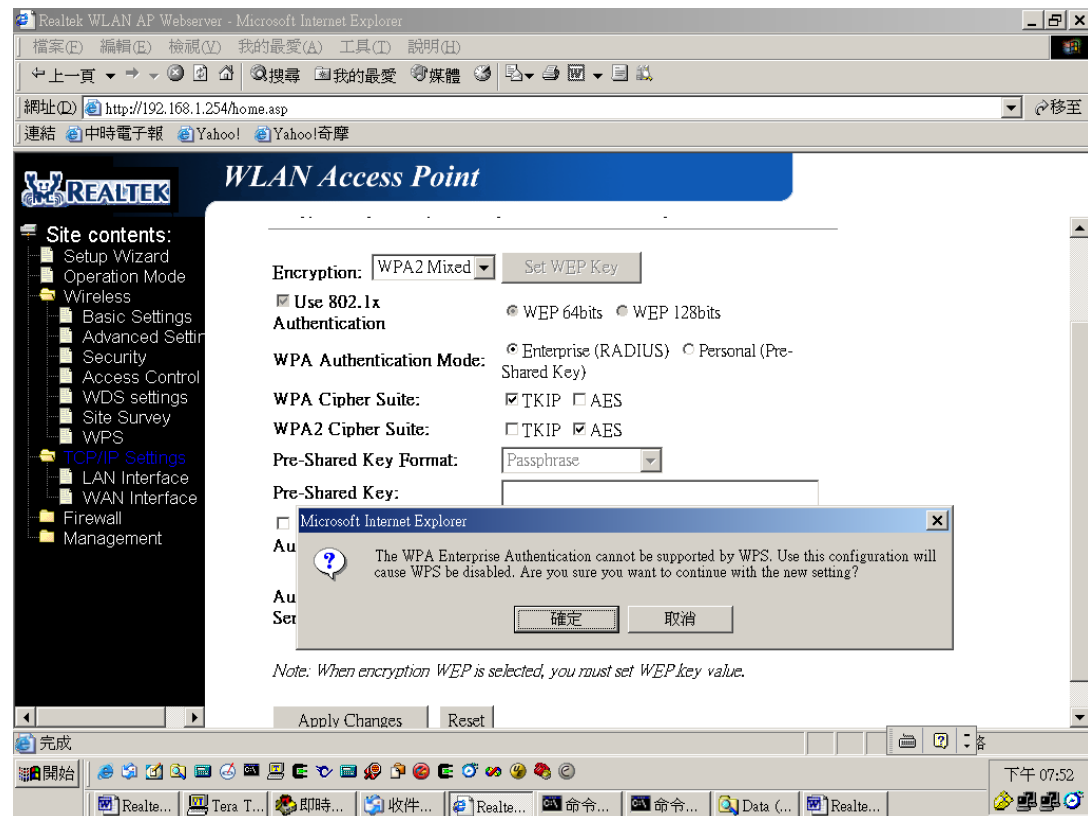
If users select any mode that is not supported with WPS, there will be a pop-up warning window as the following.



If users click “Yes”, WPS will be disabled.

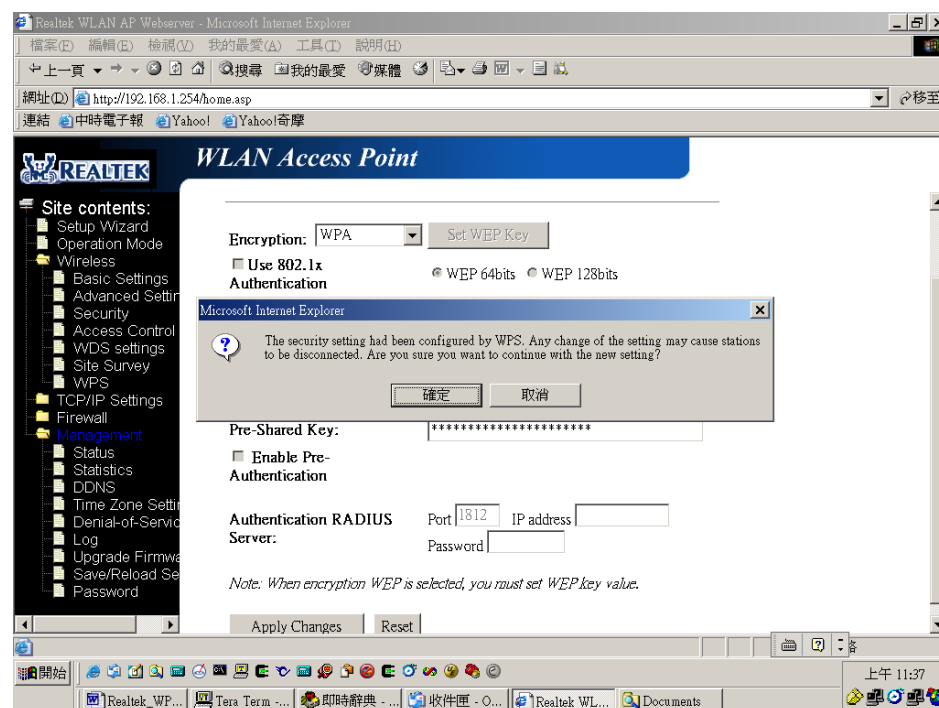
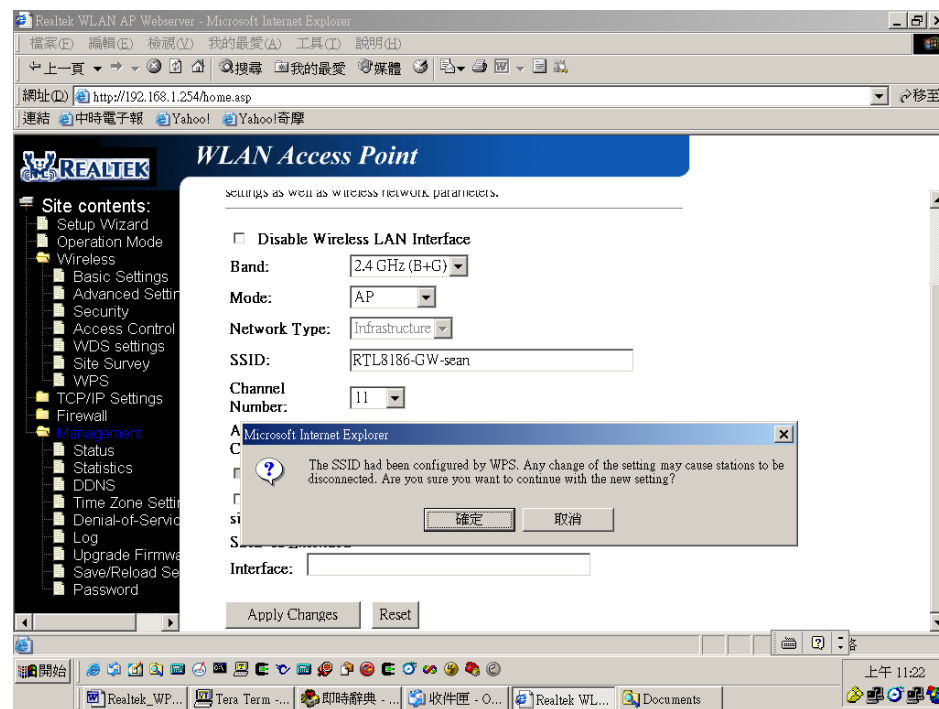
3.2.4.2 Un-supported security in WPS

If users try to select an unsupported type of security such as RADIUS support, a warning message will be given. If users enforce this security, WPS will be disabled. Please see below.



3.2.4.3 Change the SSID or security generated by internal registrar

If AP's original WPS status is un-configured, and any WPS station successfully does WPS handshake with AP either through PBC or PIN configuration, then this will force the internal registrar of AP to generate a new wireless profile with WPA2-mixed mode and a randomly-generated key. If users change SSID or security settings, the previously associated WPS stations will be disconnected due to the change of wireless profile. Please see below.



3.2.4.4 Change the SSID or security assigned by external registrar

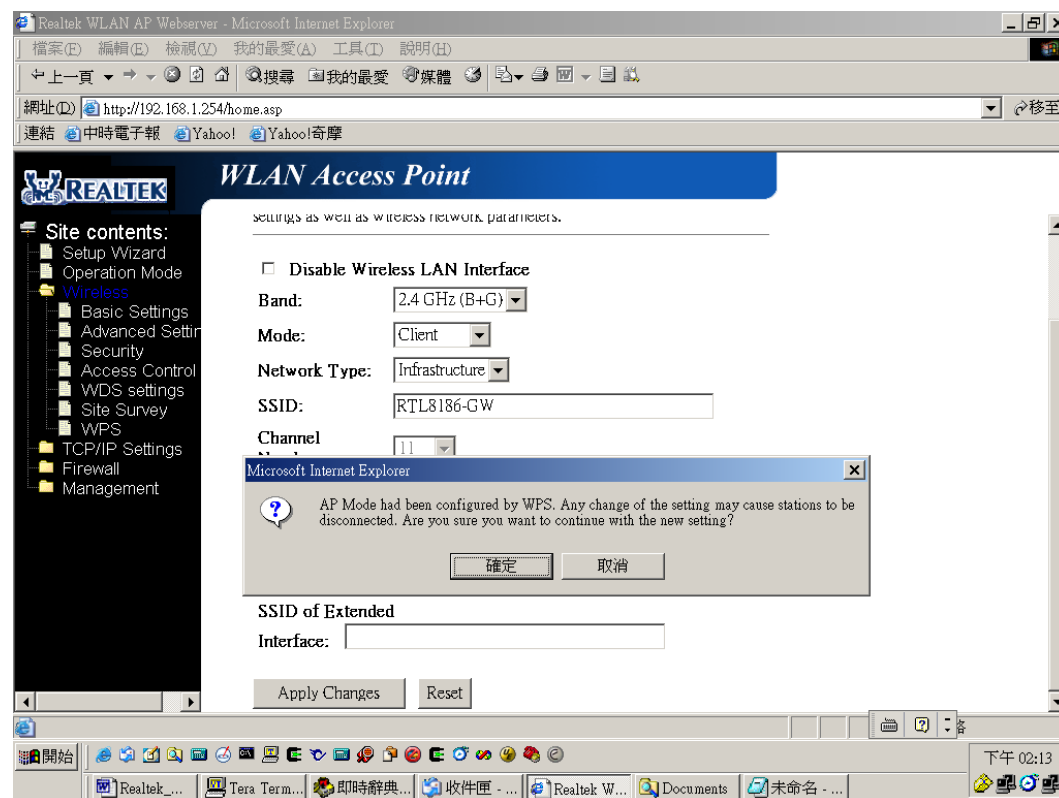
After AP is configured by an external registrar, there might be a possibility that some stations managed by that external registrar have already associated with AP. If users change SSID or any security settings on AP, this action will break the link between AP and those stations. Hence, the pop-up window will show up to warn users who are trying to perform these actions. However, users could still do it if they insist. The content of warning messages is the same as in section 3.2.4.3.

3.2.4.5 Manually configure SSID and security

When AP is in un-configured state, users are free to modify SSID or security. After the modification, AP will switch to configured state. Even though AP is in this state, users are still free to modify SSID or security until at least one WPS station had successfully done the WPS handshake with AP. If users enforce the SSID or security changes, that will break the link between AP and previously associated WPS stations. Therefore, a pop-up warning message will also be given in this case. The content of warning messages is the same as in section 3.2.4.3.

3.2.4.6 Change mode

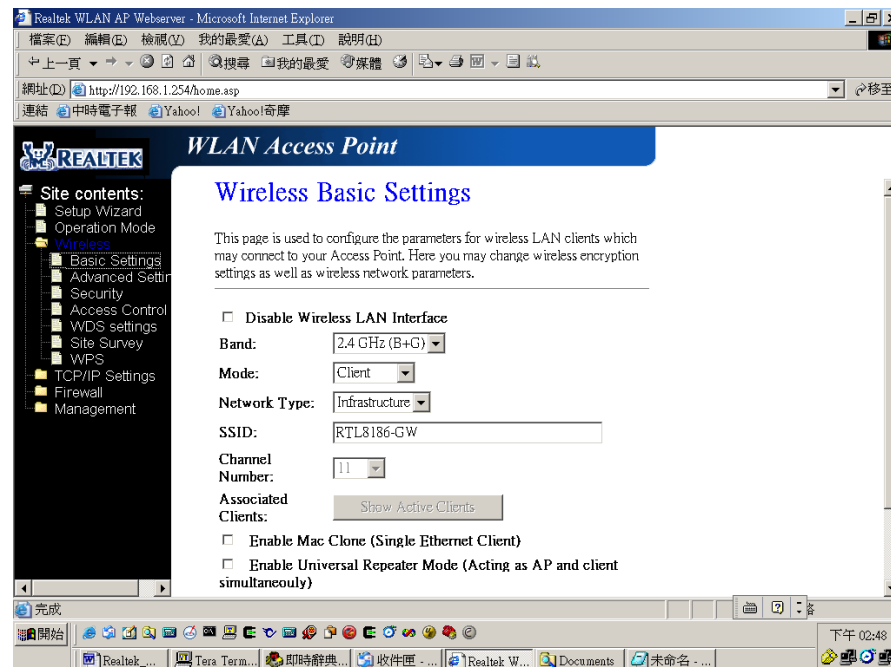
If AP is successfully configured by WPS and users try to change “Mode”, there will be a warning message to inform users the risk of breaking other WPS stations. Please see below.



3.3 Operations of Infrastructure-Client's mode

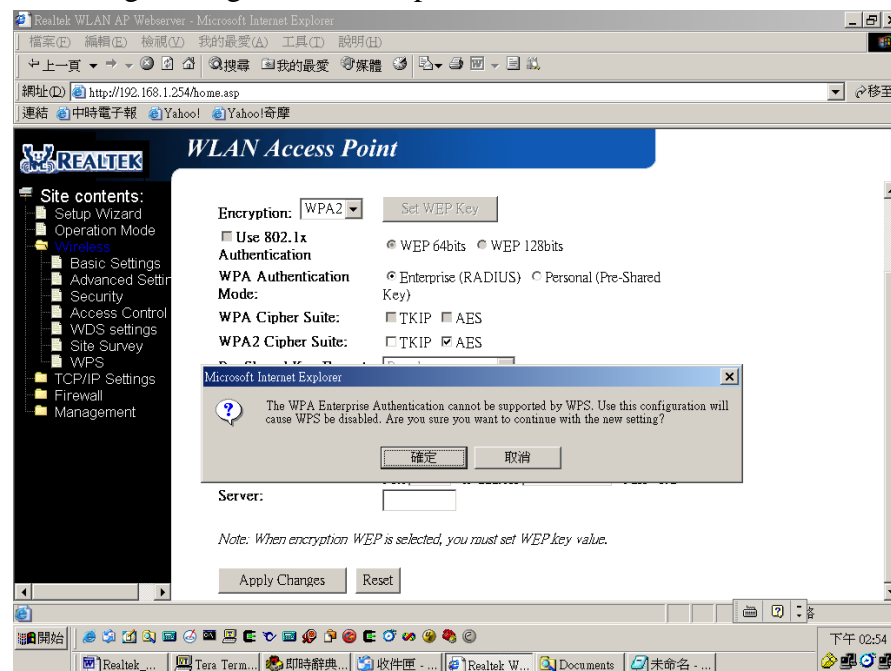
3.3.1 Wireless Basic Settings

Users need to select “Client” and “Infrastructure” on the Wireless Basic Settings page. They are free to change other settings on this page.



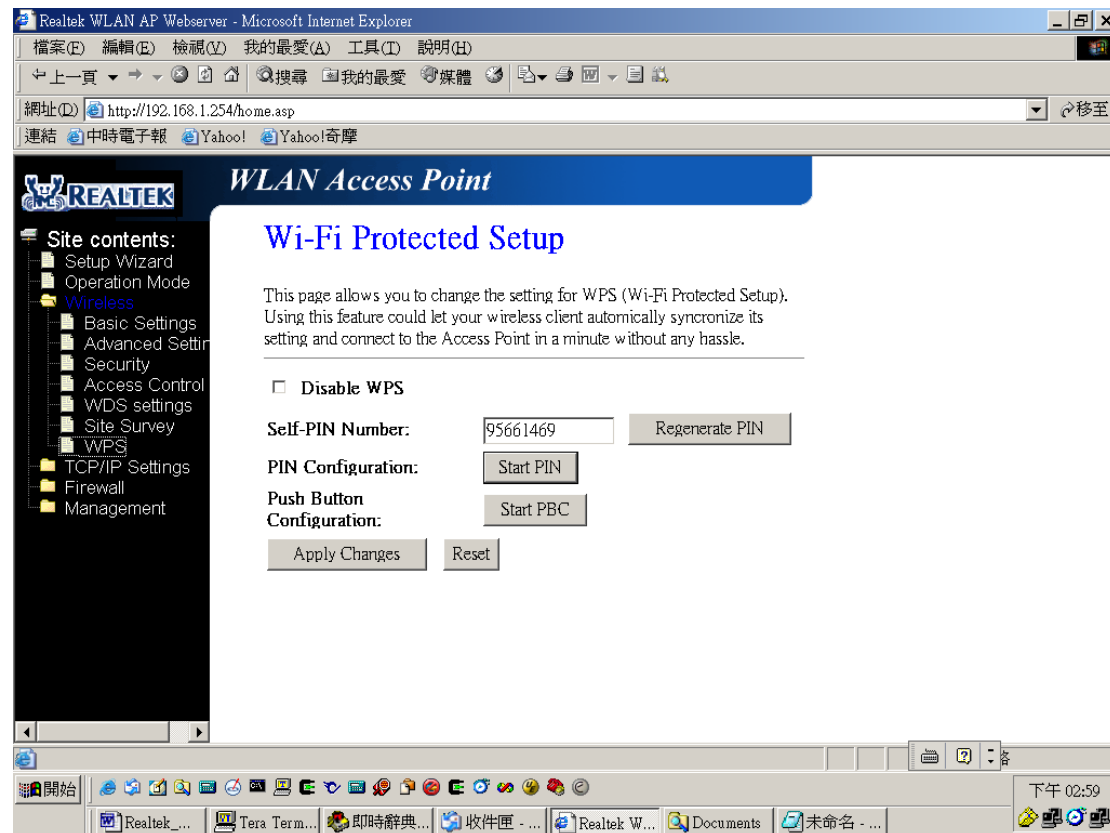
3.3.2 Wireless Security Setup page

Users are free to modify security settings if those are supported by WPS. Otherwise, a warning message will show up. If users enforce it, WPS will be disabled.



3.3.3 Wi-Fi Protected Setup page

Below is the WPS page of infrastructure-client mode.



3.3.3.1 Disable WPS

Checking this box and clicking “Apply Changes” will disable all WPS functions.

3.3.3.2 Self-PIN Number

It is station's PIN. The valid format is either four digit numeric PIN or eight digit numeric PIN with checksum. Users are not encouraged to manually enter it because the eight digit PIN will need checksum calculation. They could just click “Regenerate PIN” or enter four digit numeric PIN. Then click “Apply Changes” to save the PIN number to flash memory. However, if users change the device PIN and click “Start PIN”, the PIN number will take effect immediately and be saved to flash memory too.

3.3.3.3 Start PIN

If users decide to use PIN method, click “Start PIN” and enter the Self-PIN Number into registrar side within two minutes. If the WPS handshake is successfully done, the Wireless Basic Settings page and Wireless Security Setup page will be updated appropriately with the given wireless profile. Please refer to section 3.2.2.

3.3.3.4 Start PBC

If users decide to use Push Button method, they could either click “Start PBC” or push the physical button on 8186 evaluation board. In addition, they must push the button on registrar side within two minutes. Upon successfully doing WPS handshake, the Wireless Basic Settings page and Wireless Security Setup page will be updated appropriately with the given wireless profile.

4. System Configuration

In this section, engineers need to know the important parameters for WPS to function correctly. Some parameters are located in the file “wscd.conf”, and some need to be burned in flash. “wscd.conf” is a configuration file that provides static information for WPS daemon. WPS daemon only needs to load this file once and will use those information for the registration protocol throughout its life time. Differently, the parameters located in flash are usually changeable and may be modified by WPS daemon to remember important states. In addition, some parameters are controlled by the webpage. Only setting those parameters appropriately could ensure the WPS functions. More detail will be demonstrated.

4.1 Parameters in wscd.conf

The format of “wscd.conf” is shown as the following:

```
# All words after “#” will not be parsed by WPS daemon and treated as
# comment.
# use ie=1, not use=0
use_ie = 1
```

```
# AUTH_OPEN=1, AUTH_WPA=2, AUTH_SHARED=4,
# AUTH_WPA=8, AUTH_WPA2=0x10, AUTH_WPA2PSK=0x20
auth_type_flags = 35
```

```
# ENCRYPT_NONE=1, ENCRYPT_WEP=2, ENCRYPT_TKIP=4,
# ENCRYPT_AES=8
encrypt_type_flags = 15
```

```
uuid = 63041253101920061228aabbccddeeff
manufacturer = "Realtek Semiconductor Corp."
model_name = "RTL8186"
model_num = "EV-2006-07-27"
serial_num = "123456789012347"
device_oui = 0050f204
device_category_id = 6
device_sub_category_id = 1
device_name = "RTL8186 wireless AP"
```

```
# PASS_ID_DEFAULT=0, PASS_ID_USER=1, PASS_ID_MACHINE=2,
```

```
# PASS_ID_REKEY=3,
# PASS_ID_PB=4, PASS_ID_REG=5, PASS_ID_RESERVED=6
device_password_id = 0
tx_timeout = 5
resent_limit = 2
reg_timeout = 120
block_timeout = 60
# end of wscd.conf
```

4.1.1 use_ie

Function : enable(1)/disable(0) the WPS IE. If it is set to 0, the registration protocol may not proceed successfully.

Value : either 0 or 1.

Recommended Value : 1

4.1.2 auth_type_flags

Function : indicates the authentication capability of enrollee in registration protocol.

Value : It is a bitwise OR of the fields in the following table. (Wi-Fi Protected Setup Specification 1.0h.pdf, p. 89)

Value	Description
0x0001	Open
0x0002	WPAPSK
0x0020	WPA2PSK

Recommended Value : 35 (bitwise OR of Open, WPAPSK, and WPA2PSK).

4.1.3 encrypt_type_flags

Function : indicates the encryption capability of enrollee in registration protocol.

Value : It is a bitwise OR of the fields in the following table. (Wi-Fi Protected Setup Specification 1.0h.pdf, p. 94)

Value	Description
0x0001	None
0x0002	WEP
0x0004	TKIP
0x0008	AES

Recommended Value : 15 (bitwise OR of NONE, WEP, TKIP, AND AES).

4.1.4 uuid

Function : It is the universally unique identifier assigned for the device. It also corresponds to UPnP uuid. Each device should have different uuid.

Value : must be 32 hex characters; the last 12 characters will be replaced by the device MAC address in the registration protocol.

Recommended Value : 63041253101920061228aabbccddeeff.

4.1.5 manufacturer

Function : It indicates the manufacturer name of the device.

Value : Any character enclosed by “”.

Recommended Value : “Customers’ company name”

4.1.6 model_name

Function : It indicates the model name of the device.

Value : Any character enclosed by “”.

Recommended Value : N/A.

4.1.7 model_num

Function : It indicates the model number of the device.

Value : Any character enclosed by “”.

Recommended Value : N/A.

4.1.8 serial_num

Function : It indicates the serial number of the device.

Value : Any numeric number enclosed by “”.

Recommended Value : N/A.

4.1.9 device_oui

Function : It indicates the OUI of the device which will be used in 802.11 IE element.

Value : must be 0050f204

Recommended Value : 0050f204.

4.1.10 device_category_id

Function : It is the primary device type.

Value : Any one of the ID Value of the category in table 3.1.10.

(Wi-Fi Protected Setup Specification 1.0h.pdf, p. 110)

Category	ID Value	Sub Category	ID Value
Computer	1	PC	1
		Server	2

		Media Center	3
Input Device	2		
Printers, Scanners, Faxes and Copiers	3	Printer	1
		Scanner	2
Camera	4	Digital Still Camera	1
Storage	5	NAS	1
Network Infrastructure	6	AP	1
		Router	2
		Switch	3
Displays	7	Television	1
		Electronic Picture Frame	2
		Projector	3
Multimedia Devices	8	DAR	1
		PVR	2
		MCX	3
Gaming Devices	9	Xbox	1
		Xbox360	2
		Playstation	3
Telephone	10	Windows Mobile	1

Table 3.1.10

Recommended Value : 6.

4.1.11 device_sub_category_id

Function : It is the sub-device type.

Value : Any one of the ID Value of the sub category in table 3.1.10.

Recommended Value : 1.

4.1.12 device_name

Function : It indicates the product name.

Value : Any character enclosed by “”.

Recommended Value : N/A

4.1.13 device_password_id

Function : It is used to specify which type of password id will be used in the registration protocol.

Value : Currently RTL 8186 only supports PIN, User-specified, and PushBUTTON. (Wi-Fi Protected Setup Specification 1.0h.pdf, p. 92)

Value	Description
0x0000	Default (PIN)
0x0001	User-specified
0x0002	Machine-specified
0x0003	Rekey
0x0004	PushButton
0x0005	Registrar-specified
0x0006 – 0x000F	Reserved

Recommended Value : 0.

4.1.14 tx_timeout

Function : It specifies the time out for transmitting a message in registration protocol.

Value : Any number between 1 and 10; measured by seconds.

Recommended Value : 5.

4.1.15 resent_limit

Function : It specifies the maximal number for re-transmitting a message in registration protocol.

Value : Any number between 0 and 10.

Recommended Value : 2.

4.1.16 reg_timeout

Function : It specifies the time out of registration protocol. When the time out occurs, the WPS handshake ends up.

Value : Any number greater than 60 and smaller than 300; measured in seconds.

Recommended Value : 120.

4.1.17 block_timeout

Function : It specifies the time that an unauthorized station to be blocked.

Value : Any number greater than 10 and smaller than or equal to registration time out; measured by seconds.

Recommended Value : 60.

4.2 Parameters in flash

There are two groups of parameters related to WPS in the flash. One group is located in the default-setting section. This includes the WPS default settings burned in factories. The other group is located in the current-setting section. Initially, the parameters in these two sections will be burned the same values which are called the out-of-box settings. After the registration protocol is done, some WPS parameters in the current-setting section might be changed, but those WPS parameters in the default-setting section will be never modified. Whenever users start the reload default function of the webpage, the WPS parameters in the current-setting section will be assigned the corresponding values from the default-setting section. This process is called “reset WPS to out-of-box setting”. All parameters are shown as below. The parameters prefixed with “DEF” are located in the default-setting section. Otherwise, parameters are in the current-setting section. Currently, Realtek 8186 only supports one wireless interface for WPS. If the WPS wireless interface of your product is “wlan0”, then WLANn will represent WLAN0 in the following sections.

4.2.1 DEF_WLANn_WSC_DISABLE and WLANn_WSC_DISABLE

Function : enable(0)/disable(1) the WPS function. WLANn_WSC_DISABLE could be controlled by the webpage

Value : either 0 or 1.

Recommended Value : 0.

4.2.2 DEF_WLANn_WSC_METHOD and DEF_WLANn_WSC_METHOD

Function : It specifies the configuration methods that could be used in registration protocol. Realtek 8186 currently supports PIN and PushButton.

Value : a bitwise OR of PIN (0x1) and PushButton (0x2).

Recommended Value : 3.

4.2.3 DEF_WLANn_WSC_CONFIGURED and WLANn_WSC_CONFIGURED

Function : It records the configuration state. WLANn_WSC_CONFIGURED will be controlled by the webpage or WPS daemon.

Value : either 0 (not configured) or 1 (configured).

Default Value : 0.

4.2.4 DEF_WLANn_WSC_PIN and WLANn_WSC_PIN

Function : It specifies the PIN used in registration protocol. Factories must assign unique four (without checksum) or eight (with checksum) numeric digits to DEF_WLANn_WSC_PIN and WLANn_WSC_PIN of each device before it

is shipped out. WLANn_WSC_PIN might be changed by the webpage. The formula of calculating and validating checksum is as below. (Wi-Fi Protected Setup Specification 1.0h.pdf, p. 39)

The formula of calculating checksum:

```
int ComputeChecksum(unsigned long int PIN)
{
    unsigned long int accum = 0;
    PIN *= 10;
    accum += 3 * ((PIN / 10000000) % 10);
    accum += 1 * ((PIN / 1000000) % 10);
    accum += 3 * ((PIN / 100000) % 10);
    accum += 1 * ((PIN / 10000) % 10);
    accum += 3 * ((PIN / 1000) % 10);
    accum += 1 * ((PIN / 100) % 10);
    accum += 3 * ((PIN / 10) % 10);
    int digit = (accum % 10);
    return (10 - digit) % 10;
}
```

The formula of validating the checksum:

```
bool ValidateChecksum(unsigned long int PIN)
{
    unsigned long int accum = 0;
    accum += 3 * ((PIN / 10000000) % 10);
    accum += 1 * ((PIN / 1000000) % 10);
    accum += 3 * ((PIN / 100000) % 10);
    accum += 1 * ((PIN / 10000) % 10);
    accum += 3 * ((PIN / 1000) % 10);
    accum += 1 * ((PIN / 100) % 10);
    accum += 3 * ((PIN / 10) % 10);
    accum += 1 * ((PIN / 1) % 10);
    return (0 == (accum % 10));
}
```

Note : When the device is upgraded firmware, there is a possibility that the default-setting section and the current-setting section might be reloaded to hard-coded default values due to the mismatched MIB version. In this case, DEF_WLANn_WSC_PIN and WLANn_WSC_PIN will be assigned 12345670. Engineers might want to modify the reference codes to randomly generate device PIN in the case of software-reload-default.

Value : must be four or eight (with checksum) numeric digits.

Recommended Value : eight numeric digits with checksum.

4.2.5 DEF_WLANn_WSC_AUTH and WLANn_WSC_AUTH

Function : It specifies the authentication algorithm of security.

WLANn_WSC_AUTH will be controlled by the webpage or WPS daemon.

Value : In infrastructure-client mode, DEF_WLANn_WSC_AUTH and WLANn_WSC_AUTH must be set to one of the following values.
(Wi-Fi Protected Setup Specification 1.0h.pdf, p. 89)

Value	Description
-------	-------------

0x0001	Open
--------	------

0x0002	WPAPSK
--------	--------

0x0020	WPA2PSK
--------	---------

In AP mode, DEF_WLANn_WSC_AUTH and WLANn_WSC_AUTH could be one of the values or a bitwise OR of WPAPSK and WPA2PSK.

Recommended Value : 1.

NOTE: If engineers decide to modify the recommended value other than Open. They also need to modify other security parameters in the flash. The following demonstrates which parts to modify.

In infrastructure-client mode:

1. If DEF_WLANn_WSC_AUTH and WLANn_WSC_AUTH are set to 0x 2 (WPAPSK), DEF_WLANn_ENCRYPT and WLANn_ENCRYPT need to be set to 0x2.
2. If DEF_WLANn_WSC_AUTH and WLANn_WSC_AUTH are set to 0x 20 (WPA2PSK), DEF_WLANn_ENCRYPT and WLANn_ENCRYPT need to be set to 0x4.

In AP mode: The modified parts are the same as infrastructure-client mode except in the case that DEF_WLANn_WSC_AUTH and WLANn_WSC_AUTH are set to a bitwise OR of WPAPSK and WPA2PSK. In this case DEF_WLANn_ENCRYPT and WLANn_ENCRYPT need to be set to 0x6.

4.2.6 DEF_WLANn_WSC_ENC and WLANn_WSC_ENC

Function : It specifies the encryption algorithm of security. WLANn_WSC_ENC Will be controlled by the webpage or WPS daemon.

Value : In infrastructure-client mode, DEF_WLANn_WSC_ENC and WLANn_WSC_ENC must be one of the following values. (Wi-Fi Protected Setup Specification 1.0h.pdf, p. 110)

Value	Description
-------	-------------

0x0001	None
--------	------

0x0002	WEP
--------	-----

0x0004	TKIP
--------	------

0x0008	AES
--------	-----

In AP mode, DEF_WLANn_WSC_ENC and WLANn_WSC_ENC could be one of the values or a bitwise OR of TKIP and AES.

Recommended Value : 1.

NOTE : If engineers want to modify DEF_WLANn_WSC_ENC and WLANn_WSC_ENC other than the recommended value. Please follow the instructions below.

In infrastructure-client mode:

1. If DEF_WLANn_WSC_AUTH and WLANn_WSC_AUTH are set to 0x 2 (WPAPSK) and DEF_WLANn_WSC_ENC and WLANn_WSC_ENC are set to 0x4 (TKIP), DEF_WLANn_WPA_CIPHER_SUITE and WLANn_WPA_CIPHER_SUITE must be set to 1.
2. If DEF_WLANn_WSC_AUTH and WLANn_WSC_AUTH are set to 0x 2 (WPAPSK) and DEF_WLANn_WSC_ENC and WLANn_WSC_ENC are set to 0x8 (AES), DEF_WLANn_WPA_CIPHER_SUITE and WLANn_WPA_CIPHER_SUITE must be set to 2.
3. If DEF_WLANn_WSC_AUTH and WLANn_WSC_AUTH are set to 0x 20 (WPA2PSK) and DEF_WLANn_WSC_ENC and WLANn_WSC_ENC are set to 0x4 (TKIP), DEF_WLANn_WPA2_CIPHER_SUITE and WLANn_WPA2_CIPHER_SUITE must be set to 1.
4. If DEF_WLANn_WSC_AUTH and WLANn_WSC_AUTH are set to 0x 20 (WPA2PSK) and DEF_WLANn_WSC_ENC and WLANn_WSC_ENC are set to 0x8 (AES), DEF_WLANn_WPA2_CIPHER_SUITE and WLANn_WPA2_CIPHER_SUITE must be set to 2.

In AP mode: The modified parts are the same as infrastructure-client mode except in the case that DEF_WLANn_WSC_ENC and WLANn_WSC_ENC are set to a bitwise OR of TKIP and AES.

If the authentication algorithm is WPAPSK, DEF_WLANn_WPA_CIPHER_SUITE and WLANn_WPA_CIPHER_SUITE must be set to 3. Moreover, if the

authentication algorithm includes WPA2PSK, DEF_WLANn_WPA2_CIPHER_SUITE and WLANn_WPA2_CIPHER_SUITE must be set to 3 as well.

4.2.7 DEF_WLANn_WSC_MANUAL_ENABLED and WLANn_WSC_MANUAL_ENABLED

Function : WLANn_WSC_MANUAL_ENABLED will be modified to 1 if users manually change SSID or any security setting on webpage.

Value : either 0 or 1.

Default Value : 0.

4.2.8 DEF_WLANn_WSC_UPNP_ENABLED and WLANn_WSC_UPNP_ENABLED

Function : enable(1)/disable(0) the UPnP function of WPS. If engineers disable this function, their products will not pass Wi-Fi certification program.

Value : either 0 or 1.

Recommended Value : 1.

4.2.9 DEF_WLANn_WSC_REGISTRAR_ENABLED and WLANn_WSC_REGISTRAR_ENABLED

Function : enable(1)/disable(0) the internal registrar of AP. If engineers disable this function, their products will not pass Wi-Fi certification program.

Value : either 0 or 1.

Recommended Value : 1.

4.2.10 DEF_WLANn_WSC_PSK and WLANn_WSC_PSK

Function : It provides the key of WPAPSK or WPA2PSK. It is controlled by the webpage or WPS daemon.

Value : The maximal length is 64 characters. If the length is smaller than 64, the value could be any characters; otherwise, the value must be 64 hex characters.

Default Value : Null.

NOTE : If the default security setting is set to WPAPSK or WPA2PSK, then DEF_WLANn_WSC_PSK and WLANn_WSC_PSK must be assigned a legal key which is the same as DEF_WLANn_WPA_PSK and WLANn_WPA_PSK.

4.2.11 DEF_WLANn_WSC_CONFIGBYEXTREG and WLANn_WSC_CONFIGBYEXTREG

Function : This parameter reflects which kind of devices invokes the generation of current security setting.

Value : It could be one of the following.

Value	Description
0	The SSID and security is the same as the out-of-box setting.
1	The SSID and security is generated by internal registrar.
2	The SSID and security is generated by external registrar.
3	The SSID or security is modified via webpage and at least one enrollee had successfully done the WPS handshake and joined the network.

Default Value : 0.

4.3 MP program related to WPS

If the flash layout of your product is programmed by Realtek MP nfjrom, then you need to update the file “apmib.h” of your MP source tree. For more detail, please see the document of Realtek MP.

5. Reference

Wi-Fi Protected Setup Specification 1.0h.pdf. Wi-Fi Alliance.