



Best Practices for Deploying WF28 Wireless Site Planning & Implementation

Rev 1.0 / 2007-12-13

WideFly Ltd.
<http://www.widefly.com>

Copyright © 2007 WideFly Limited. All rights reserved.

This guideline is published by WideFly Limited without any warranty. Improvements and changes to this guidelines necessitated typographical errors, inaccuracies of current information, or improvements to programs and/or equipment, may be made by WideFly Limited any time and without notice. Such changes will, however, be incorporated into new editions of this guidelines.

Document Revision History

To facilitate reading of new or changed content, please see the change mark (vertical line) showing at the left hand side of the paragraphs.

Doc version	Release Date	Author	Major Changes
Rev 1.0	2007-12-13	James	■ First release of Best Practices for Deploying WF28 - Wireless Site Planning & Implementation

Contents

Chapter 1:Overview	1
Introduction	1
Chapter 2:Signal Strength & Placement of AP	2
Signal Strength & POS Connectivity	2
Signal Strength Magic Number.....	3
What Cause Signal Strength Degrade?.....	3
Where to put the AP for best Signal Coverage?	3
Chapter 3:Signal Interference	4
Signal Interference	4
Non-overlapping Wi-Fi Channels	4
Chapter 4:Multiple APs & Wi-Fi Roaming	6
Introduction	6
Wi-Fi Roaming	6
Prerequisites of Roaming	7
Neighbor APs: Tips & Tricks	8
Chapter 5:How to Choose a Good Access Point	9
Good Access Point (AP).....	9
Criteria of a Good AP	9
Some Recommended APs	9
High gain Wireless Antenna	9
Chapter 6:Typical PDA & Access Point Configurations	10
Typical PDA Configurations.....	10
Typical Access Point Configurations.....	11
Chapter 7:Wireless Site Survey Tools	12
Introduction	12
WF28 Inbuilt Wireless Site Survey Tool.....	12
Free Windows based Wireless Site Survey Tool	13
Ultimate Checking of Wireless Coverage	14

Chapter 1: Overview

Introduction

A successful wireless POS PDA solution lies in a good wireless site planning and implementation as well as a robust PDA with always-on & speedy roaming capability like WideFly's WF28 POS PDA. A well configured wireless site ensures maximum signal coverage, minimum dead spots and uninterrupted connectivity for online POS applications.

Wireless Site Planning & Implementation is a guideline of "best practices of deploying WF28" document series with major focuses on:

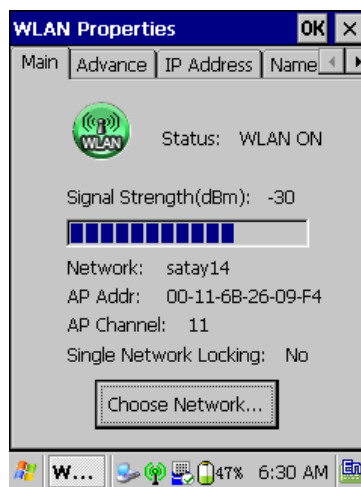
- General rule of thumb of selecting a good AP (access points)
- What causes interference & signal lost and how to avoid it
- Data rate, signal sensitivity and high gain antenna
- How to deploy multiple APs in a big customer site and ensure seamless roaming by PDAs
- Typical configuration of AP
- Typical configuration of WF28 PDA
- Tools for performing wireless site survey

Chapter 2: Signal Strength & Placement of AP

Signal Strength & POS Connectivity

Signal strength is presented by negative dBm unit. The more its negative value (i.e. the smaller its value), the weaker of the signal it is sensed by the AP or PDA. When PDA is very close to AP in few meters, signal strength can be as strong as -30dBm to -40dBm. In general, better signal strength also means better online POS connectivity provided that there is no significant signal interference.

In WF28 when connected to an AP, goto **Start > Settings > Control Panel > WLAN** to see the active signal strength.



Check signal strength in connected state

To better illustrate the signal strength characteristics & its impact to POS application, we firstly ignore the signal interference factor and assume there is only single AP in a customer site. We shall come back to this topic in next chapter: Signal Interference. From POS application perspective, network connectivity and traffic remain in good condition as long as signal strength is greater than -68 to -70dBm. When the signal is approaching -72dBm, it becomes marginal. The application would experience noticeable delay, i.e. slower data throughput and slightly signal lost. It becomes unstable if signal is weaker than -75dBm and is subject to connection drop. Then, Wi-Fi module may start searching of another AP with stronger signal. The chart below summarizes some key indications of signal strength and its implication to POS application.

Signal Range	-30dBm to -40dBm	-40dBm to -68dBm	-68dBm to -75dBm	-75dBm to -80dBm
POS online connectivity	Very strong and close to AP	Good and safe level of signal strength	Marginal level causes noticeable delay and slightly signal lost	Very unstable and subject to connection drop and searching of another AP

Signal Strength Magic Number

If the chart above may be complicated, simply remember a magic number of signal strength: **-68dBm**. As long as the site is well covered by signal with -68dBm or better, you have already built a good fundamental for stable POS online connectivity. Next, you need to determine and monitor the factors that would cause degrade of signal strength by materials & nearby interference.



What Cause Signal Strength Degrade?

If there is an ideal site with complete open space, signal spreads in all directions evenly and the signal strength would be very constant at a fixed distance from the AP in all angles. In practice, most customer sites for example, restaurants, hotels & clubhouse, are close environment inside a building with different shapes and construction materials, which will cause different degrees of signal degrade.

In a typical restaurant environment, you need to pay extra attention to the following construction materials since they will degrade signal strength noticeably:

- Concrete wall
- Glass wall
- Metal or steel construction
- Any materials that create barrier to radio signals

Signal Interference is also a key to cause signal degrade but this factor is very often overlooked by engineers. For details, it would be described in next Chapter: Signal Interference.

Where to put the AP for best Signal Coverage?

Because of the variety of site environment and situation, there is no simple answer to where to put the AP to attain maximum signal coverage. In fact, most would place the AP by a try-and-error approach like experiment. However, you should refer to some common practices to place an AP:

- Placing AP at the centre of the customer site is generally a good start to provide good coverage. If the shape of the site is quite irregular, e.g. L shape, this rule may not be applicable.
- Place the AP as high as possible to maximize angles of radio signal spreading. It is very common to place the AP on ceiling.
- The surroundings of AP should not be blocked by materials that would degrade signal strength. For example, no metal or steel barrier should be close to the AP. Sometimes, placing on ceiling may not be the best choice because there may be metallic pipes / steel construction creating barrier to radio frequency. In this case, AP should be placed a bit lower.
- Antenna exactly perpendicular to the ceiling / floor will maximize signal in all directions. Placing the antenna slanted or even horizontal would reduce signal strength.
- AP should be far apart from another AP, especially for those APs with close wireless channels as it would create strong interference. For details, it would be elaborated in next chapter: Signal Interference.

Chapter 3: Signal Interference

Signal Interference

It is well known that strong signal strength is important to good signal coverage but it is interesting to note that strong signal strength not necessarily equals to strong POS online connectivity. It is because signal interference could be a key factor affecting the quality of the connection. Significant drop of data throughput or instability of wireless connection would be observed when there is strong interference nearby the AP or PDA.



Strong signal strength doesn't always mean good connectivity

Wi-Fi is by nature subject to interference because Wi-Fi is a wireless standard utilizing open & public 2.4GHz frequency band which any wireless devices could share the same bandwidth and in some cases this bandwidth sharing would create significant signal interference impacting Wi-Fi performance and stability.

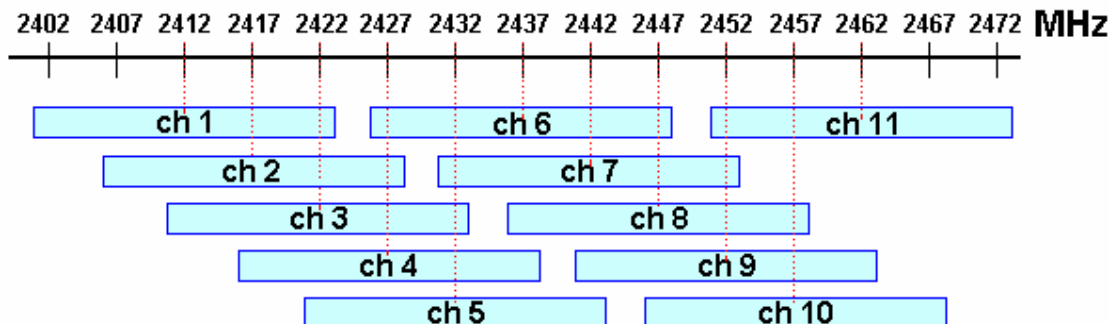
As an extreme case, if you place 2 APs close to each other using the same Wi-Fi channel, performance would be significantly reduced. Even the signal strength could be quite strong because the PDA is close to the AP, such interference could create instability of Wi-Fi connection and signal drop. Therefore, in Wi-Fi implementation & planning, it has to pay extra attention to both factors affecting signal strength, i.e. proper placement of APs, and interference caused by nearby wireless equipments.



Signal strength + Interference are key factors to Wi-Fi Implementation

Non-overlapping Wi-Fi Channels

Because of signal interference, Wi-Fi standard provides 1 to 11 (some countries may allow max 14 channels. e.g. 14 for Japan, 13 for Europe) different wireless channel such that multiple APs, if placed close to each other, could be configured with non-overlapping wireless channels to minimize interference and thus improve the quality of POS connectivity. The following depicts the combinations of non-overlapping Wi-Fi channels.



In the diagram, it is very obvious that channels 1, 6, 11 is the best combination of non-overlapping channels and because of this, most would deploy adjacent APs using this combination. Note also that channel combination with 5 channels apart also has the least signal interference. If a smaller customer site which requires only 2 APs, combination of 2&7, 3&8, 4&9, 5&10, 6&11 are the best choice of non-overlapping channels.



Magic combination of Wi-Fi Channels: 1, 6, 11



Combination of Wi-Fi Channels with 5 channels apart has least interference

Chapter 4: Multiple APs & Wi-Fi Roaming

Introduction

This is quite common to hear that wireless PDA solution could only be successfully deployed if the customer site is small and needs only single AP. It is also heard that, for a bigger site, even deployed with multiple APs, it doesn't help much on overall signal coverage and quality of connectivity. No wonder there are few successful examples of implementation of wireless PDA solution in a large area site. In fact, this is largely due to:

- Inability of seamless Wi-Fi roaming by PDA (the most important factor)
- Deploy an unstable AP (not all APs are equal, please refer Chapter 5: How to choose a good AP)
- Incorrect / not optimized placement of AP & Antenna
- Neglect signal interference
- Incorrect parameters settings in both PDA & AP.

Since WF28 POS PDA is designed with seamless & speedy roaming, wireless issues in big site with multiple APs are largely reduced. End result is that overall POS connectivity improved and there would be few support call due to Wi-Fi issues.

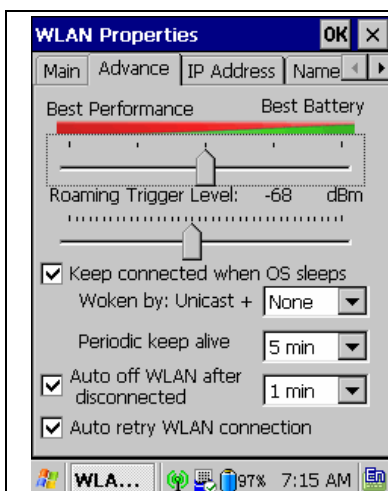


Seamless Wi-Fi roaming by PDA is critical to large area site

Wi-Fi Roaming

Wi-Fi roaming is a process needs cooperation between PDA and multiple APs. However, PDA plays a more important role because roaming is in fact initiated and controlled by PDA whereas AP is in passive mode.

WF28 PDA is designed to support seamless and genuine Wi-Fi Roaming. When we say genuine, it should be able to roam across multiple APs yet network session (data downloading or uploading) remains unchanged and stays connected as if nothing happened. See the screen below at **Start > Settings > Control Panel > WLAN > Advance (tab page)**.



The "Roaming Trigger Level" is defined as -68dBm, the magic number of signal strength as mentioned in Chapter 2.

This is a roaming trigger threshold when signal strength becomes weaker than -68dBm, and thus POS application may start experiencing delay and signal drop, Wi-Fi module would turn on automatic background searching of another AP with better signal strength and would finally roam to that better AP, completely transparent to online POS application. During this roaming transition, the network session remains without being dropped and thus the application should not aware of this transition.

This is a critical requirement for application requires maximum Wi-Fi connectivity, like Microsoft Terminal Services Client / RDP Client or some other thin client solutions.

Prerequisites of Roaming

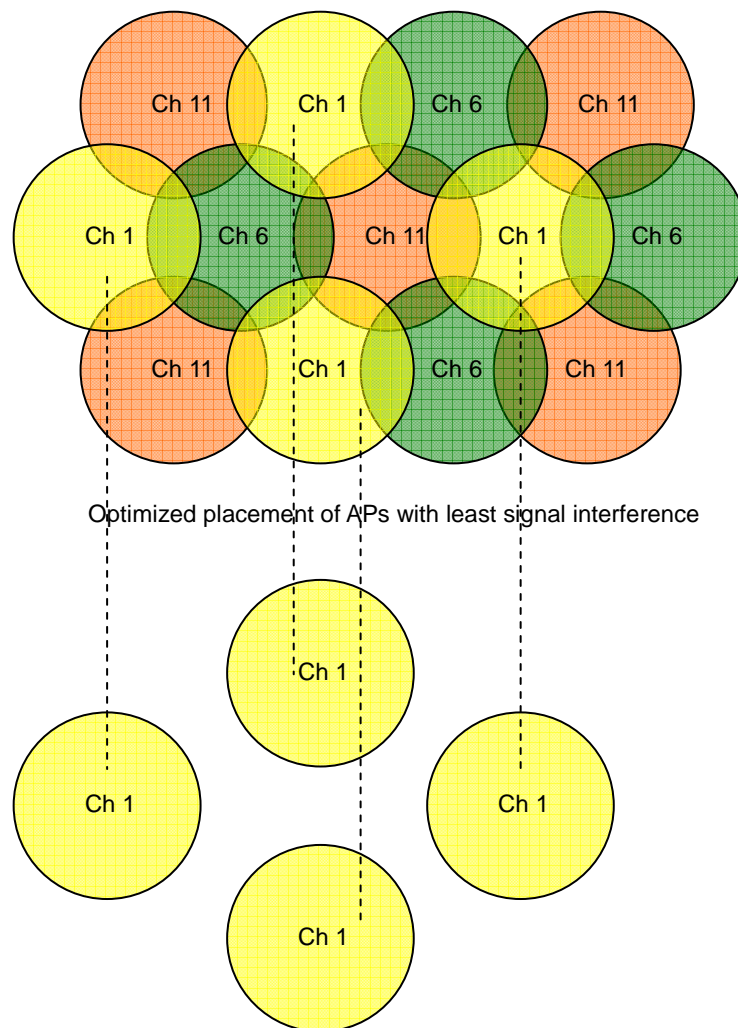
This is important to configure multiple APs properly in order to enable Wi-Fi roaming by PDA. Please see below the prerequisites:

For PDA configurations

- Configure optimized roaming trigger, e.g. -68dBm, i.e. start searching for better-signal AP if existing connection is weaker than -68dBm
- SSID is locked (This is a standard feature of WF28 that locks to one and only one designated SSID)

For AP configurations

- All APs use same SSID & security settings, e.g. WEP, WPA & etc
- All APs are located at the same network subnet, e.g. 192.168.1.X
- All APs are of same model or the behavior is unpredictable
- All adjacent APs are configured to avoid signal interference, i.e. 1,6,11 channels or 5 channels apart to each other. See diagram below.
- At every single point of location of a customer site, there is at least one AP provides signal strength better than or equal -68dBm, i.e. the site is fully covered by multiple APs and PDA at every single location could roam to a strong signal AP to maintain online POS connectivity.

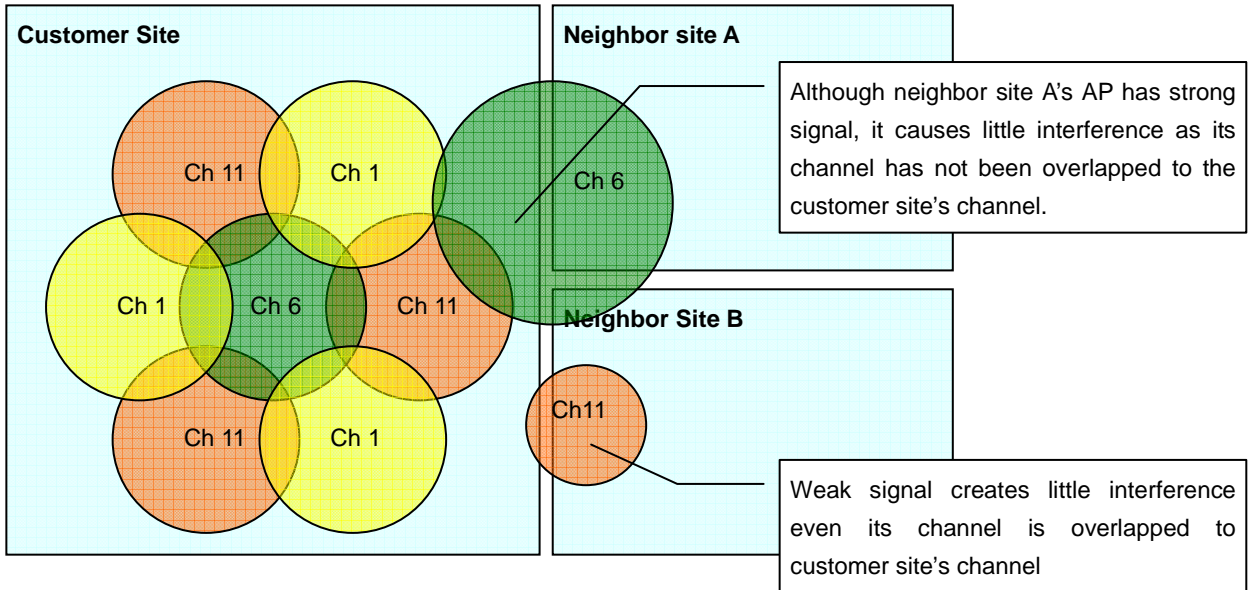


Optimized placement of APs with least signal interference

Channel 1 APs are placed far apart to avoid interference.
Similarly for Channel 6 & 11

Neighbor APs: Tips & Tricks

It is quite common that there are few neighbor APs, configured with different SSID & settings, nearby your site. These neighbor APs are in fact one major source of signal interference. However, it should be bear in mind that only strong signal strength with channel overlapping with your APs could introduce significant interference. Simply apply the “1, 6, 11” rule to avoid overlapping with nearby strong-signal-APs. If the nearby AP has signal strength weaker than -75dBm, it imposes not much interference on your AP even channel would be overlapped. The scenarios are depicted below:



 **Only strong-signal-AP overlapping your AP's channel could introduce significant interference**

Chapter 5: How to Choose a Good Access Point

Good Access Point (AP)

APs are not equal. Commercial grade APs are most often more robust than consumer one as this is designed to achieve maximum uptime, high reliability as well as good maintainability.

Criteria of a Good AP

There are many models of AP with different unique features available in market. The price could be ranged from USD40.0 to over USD500.0. For average use yet robust in hospitality environment, a cost effective one is the most preferable. See below some criteria of choosing a good AP:

- Always use AP instead of broadband wireless router. AP is generally more stable than consumer based broadband wireless router
- Support speedy roaming across APs (You need to test it with WF28 PDA)
- Choose an AP with broad range of antenna support. Antenna could improve signal strength and coverage in some situations, e.g. improve signal strength of an area having narrow angle towards AP.
- POE support (Power over Ethernet): It is useful in case power cord could not be reachable to the location where AP is placed, e.g. very high ceiling.
- AP enables changing to a lower data rate. Sometimes, lower data rate would improve signal quality and coverage.
- AP allows changing to 802.11b. Although 802.11b is slower, it is generally regarded as more stable than 802.11g in terms of connectivity and sensitivity. In fact, most POS applications find no noticeable difference in data throughput under 802.11b & g network.
- A good AP should be site proven to withstand hour long of continuous operations and roaming environment. This is one of the most difficult criteria as you could not prove its robustness unless you really deploy the AP to a real customer site. Because of this, deploying APs which are recommended or certified by WideFly is of minimum risk.

Some Recommended APs

There are 2 cost effective APs recommended by WideFly as follows:

- LevelONE, WAP-0006 AP
- D-LINK, DWL-2100AP

Some more expensive APs are generally considered to be robust in the market:

- Orinoco AP-700 (Proxim solution)
- Cisco AP

High gain Wireless Antenna

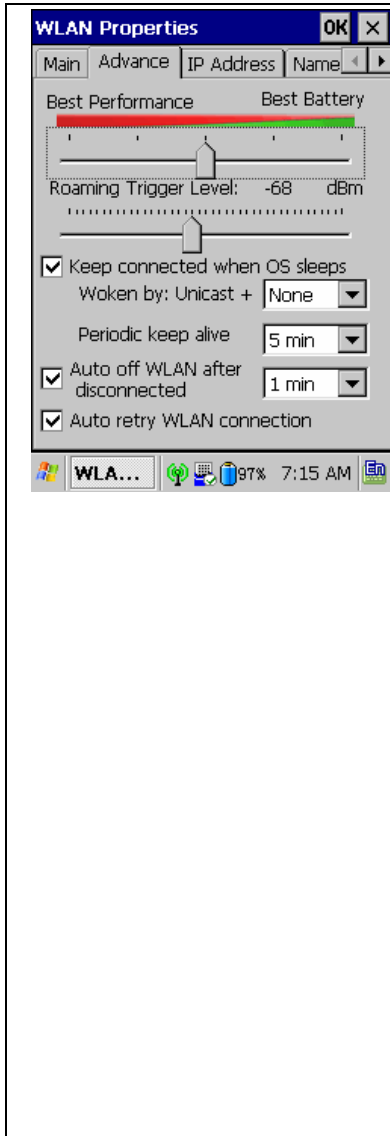
Some tips regarding replacing AP's antenna by high gain antenna to improve signal coverage & quality:

- Always use antenna manufactured by the same company or real performance gain may not be guaranteed.
- In practice, high gain antenna with 7dbi for above could achieve more noticeable improvements.
- Omni directional antenna is more suitable for indoor hospitality environment. Some high gain directional antenna could be very powerful but it is designed for outdoor environment and to bridge two distant network via wireless by a pair of such antenna.

Chapter 6: Typical PDA & Access Point Configurations

Typical PDA Configurations

See below typical PDA configurations to achieve best Wi-Fi performance and stability.



Goto **Start > Settings > Control Panel > WLAN > Advance (tab page)**

1. **Performance vs Battery:** intermediate is the optimal for most cases unless you really need maximum Wi-Fi performance but it also means more battery power
2. **Roaming Trigger Level:** -68dBm is the optimal because it is a very good and safe level for online POS application. When signal becomes weaker than -68dBm, it would trigger roaming process to find another better signal AP.
3. **Keep connected when OS sleeps:** enable it for always-on Wi-Fi even PDA is in sleeping mode to achieve max power saving.
4. **Keep connected when OS sleeps >> Woken by – Unicast:** None is optimal. It means PDA would be woken up in sleeping state only if it received network package by point-to-point connection (i.e. UNICAST) instead of broadcast network packages (e.g. ping).
5. **Keep connected when OS sleeps >> Periodic keep alive:** 3 or 5 minutes is optimal. It is because most AP would kill Wi-Fi connection if it has been idle for 3 or 5 minutes. Enabling this would keep connection between PDA & AP and achieve maximum connection uptime.
(NOTE: This is a feature available for v1.1g or above)
6. **Auto off WLAN after disconnected:** 1 minute is optimal. It means it would keep searching for AP for 1 minute and if it fails, it would stop Wi-Fi module to save power.
7. **Auto retry WLAN connection:** enabled is optimal. If Wi-Fi is auto-off in point 6), it would schedule for next reconnection in 1 minute.

Typical Access Point Configurations

See below typical AP configurations to achieve best Wi-Fi performance and stability.

Settings	Value	Reason
Channels	(depends)	Always follow 1,6,11 rule such that adjacent APs should be configured to minimize signal interference to each other
Preamble	Long Preamble	Long Preamble could improve signal quality although short preamble could achieve higher data throughput
Data Rate / throughput	2Mbps	Lower data rate could improve signal range and quality
802.11b/g	b only	802.11b could slightly improve signal range and quality if 802.11g coverage may be marginal in some environment

Chapter 7: Wireless Site Survey Tools

Introduction

Wireless Site survey is a procedure to gather wireless data, e.g. signal strength, interference, channels, nearby APs & etc, in every location of a customer site. These data would help identify dead spots & high interference area and thus necessary adjustments, e.g. adding / reducing of AP, AP placement, channels, antenna, AP & PDA configurations, would be made to improve overall signal coverage of a site.

There are a number of commercial / professional grade wireless site survey tools to free but limited features tools in the market. Most professional tools are able to collect wireless data in a listening mode called passive probe, which APs would not be aware of being probed and this method could provide a complete picture of all Wi-Fi signal (802.11b & g) because hidden APs could also be discovered. Some references of professional tools are:

AirMagnet: <http://www.airmagnet.com>

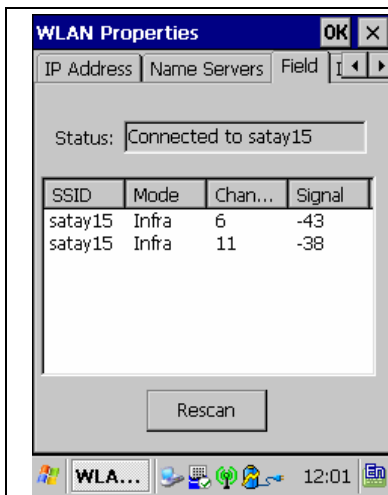
VisiWave: <http://www.visiwave.com/>

CommView: <http://www.tamos.com/products/commview/>

In this section, we shall introduce some inbuilt or free tools, although they are all working in active mode, i.e. they need to connect to an AP and actively sending / receiving wireless packages to check the existence of APs. Because of this, some APs may be hidden if they refuse to answer to unknown packages from these active probing tools.

WF28 Inbuilt Wireless Site Survey Tool

WF28 has an inbuilt but simple wireless site survey tool. If WLAN is on and SSID is defined & locked, goto **Start > Settings > Control Panel > WLAN > Field (tab page)**, you will see:

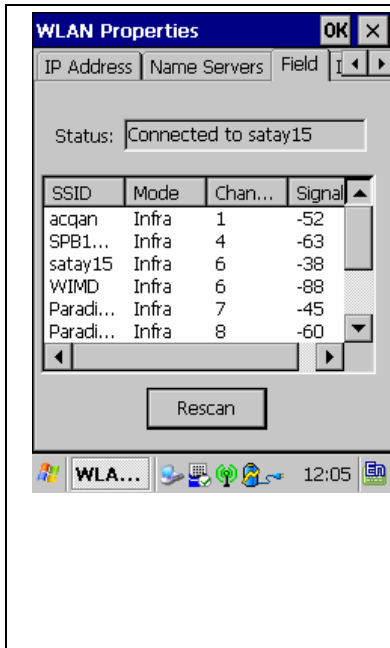


SSID define and locked

This is an example that SSID profile "satay15" is defined and locked. Therefore, it shows only APs with the same SSID.

Look at the Channel. They are 6 & 11, which is 5 channels apart, and thus signal interference could be minimized (assuming no other nearby APs causes significant interference).

Press "rescan" to initiate a full scan of Wi-Fi network searchable by the PDA.



SSID defined but unlocked

This is an example that SSID profile “satay15” is defined but unlocked. Therefore, all nearby APs being actively probed would be listed.

Look at the Channel 6. There are 2 APs, Satay15 & WIMDXX and their signal strength is -38dBm and -88dBm respectively. Although both APs has overlapped on channel 6, WIMDXX should not cause much interference to satay15 because -88dBm is a very weak signal.

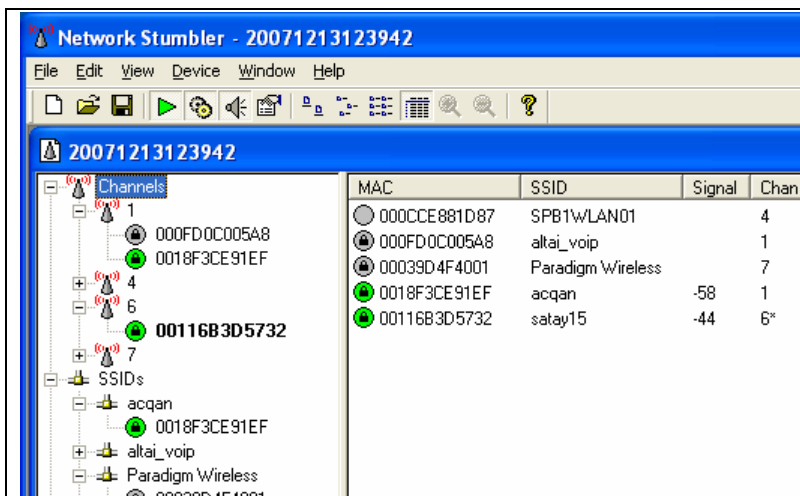
However, if you look at channel 7, ParadiXX with -45dBm. This AP would indeed cause much more interference than WIMDXX to satay15 as its channel 7 is very close to channel 6. In that case, changing to channel 11 should be a good choice.

The complexity of selecting an appropriate channel lies in a fact that some area of your customer site, especially entrance, may be very close to nearby APs which are indeed the major source of signal interference to your wireless network. If there is no perfect non-overlapping channel, choose one far apart from that of the strongest nearby APs.

If there is no perfect channel to achieve 5-channel apart rule, choose one far apart from that of the strongest nearby APs

Free Windows based Wireless Site Survey Tool

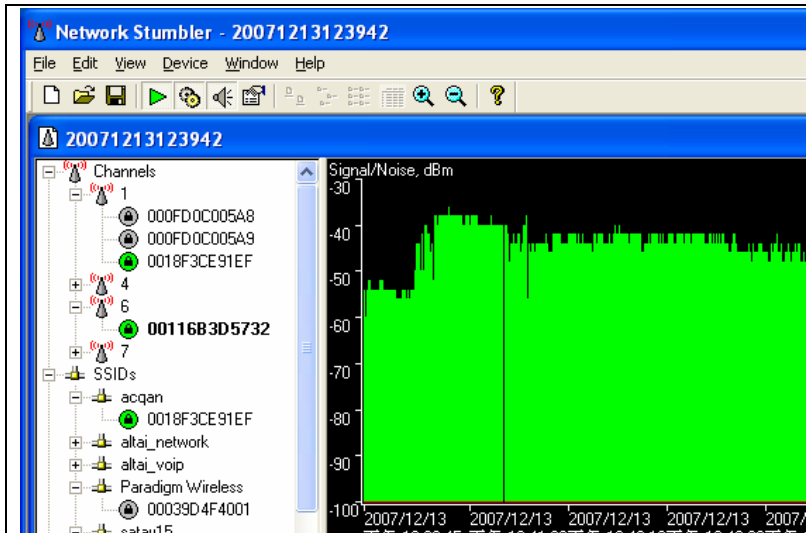
Netstumbler is a well known free Windows based wireless site survey tool worked with most Wi-Fi device in notebook or PC. Download the tool at: <http://www.netstumbler.com/downloads/>



Under top Channels node, all APs, presented by their MAC addresses, are grouped by channels.

Similarly under top SSIDs node, all APs are groups by SSIDs

To list all APs & their info, e.g. SSID, signal strength, Channel & etc, simply click the top Channels node.



The screenshot shows the Network Stumbler interface. On the left, a tree view lists detected channels and SSIDs. The right pane shows a real-time signal strength graph in dBm, with a green area representing signal levels. A red circle highlights a MAC address in the list.

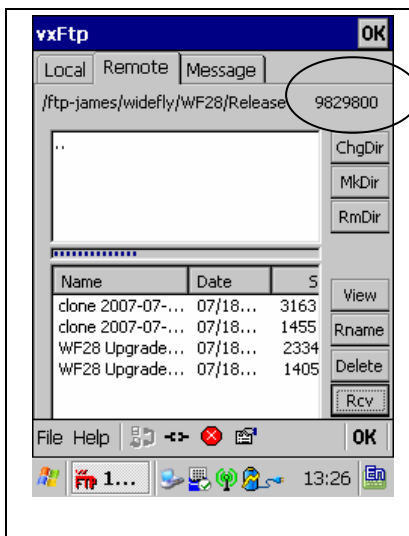
To see real-time signal strength changes, simply click a MAC address of an AP.

Ultimate Checking of Wireless Coverage

After performed wireless site survey and made necessary adjustments to APs & its configurations, the next step, which is also a step most often neglected by engineers: walking through the whole customer site by running your own online application or network tool and performing a real-time checking.

It is important to verify whether, all measures or procedures have been taken to implement a wireless site, coincident with the real end results. To have this ultimate checking, it is highly recommend to use your own POS application or traffic intensive tool to validate signal coverage at every location of a site. If significant program delay is found in some specific locations, it also mean fine-tuning of APs, antenna, configurations are required.

We recommend you install a 3rd party FTP client tool on WF28 for this real-time checking. Download it from <http://www.cam.com/vxftp.html>. This is a trial version will be expired after 30-day evaluation.



The screenshot shows the vxFTP interface. A red circle highlights the '9829800' bytes counter in the top right corner. Below it is a table of files in the remote directory.

Name	Date	S
clone 2007-07-...	07/18...	3163
clone 2007-07-...	07/18...	1455
WF28 Upgrade...	07/18...	2334
WF28 Upgrade...	07/18...	1405

vxFTP: FTP client
 vxFTP is a small FTP client utility to download files from your FTP server (so, you need to have FTP server in your customer site and a big file for testing file, e.g > 30MB)

By walking through every location of your customer site and seeing downloaded bytes counter, located near top right hand, you are able to check:

- Wi-Fi roaming - If you find counter running smooth when you are moving from AP coverage to another one, if means genuine seamless roaming is achieved.
- Dead spots - If you find counter stopped suddenly or slowed down significantly in a specific location, you have identified a signal dead spot.

<< End of Document >>