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CPE RMA / Support Training
Utility Layout

Wireless Broadband Access Point

ZCN-1523 Utility Layout

- Management
- Tools
- Status "Information"
- Ethernet "System"
- Wireless
### KEY FEATURES

- **Device Name** – Contains last 6 digits of MAC Address
- **Network Mode** – Define Ethernet port as Bridge or Router
- **Country Region** – Will adjust the frequency channel and output power plan based on selected country
- **Spanning Tree** – Prevent Network Loops using the STP
- **STP Forward Delay** – Adjust how often STP will reassess the network
- **GPS Coordinates** – Manually input the GPS Coordinates for the Radio.
General TCP/IP

TCP/IP – Basic configuration settings

RADIUS – General configuration, other RADIUS options also available as we will see later

Time Settings – Manual or server synchronization
Available Operational Modes

- AP - Access Point
- Wireless Client – Station, CPE
- Bridge – P2P, PXP, WDS Bridge
- AP Repeating – Repeater

Differences Between Modes

<table>
<thead>
<tr>
<th>Function</th>
<th>Operational Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AP</td>
</tr>
<tr>
<td>SSID</td>
<td>✓</td>
</tr>
<tr>
<td>Lock AP MAC</td>
<td></td>
</tr>
<tr>
<td>Broadcast SSID</td>
<td>✓</td>
</tr>
<tr>
<td>HT Protect</td>
<td>✓</td>
</tr>
<tr>
<td>Frequency</td>
<td>✓</td>
</tr>
<tr>
<td>Ex. Channel</td>
<td>✓</td>
</tr>
<tr>
<td>MAC Clone</td>
<td>✓</td>
</tr>
</tbody>
</table>

BW Options: 5 / 10 / 20 & 40MHz
Virtual Access Point Settings

16 Configurable VAP Profiles

802.1Q VLAN ID – VLAN pass through allows the devices user interface to be accessed through a VLAN.

Profile(x) – Each profile can be configured individually as seen on the next slide.
VAP Profile 1 Settings

**Fundamental Settings**—Profile name, SSID, Broadcast SSID, Security including WEP, WPA and WPA2

**Wireless Separation**—Prevent Associated users from connecting to each other over the wireless bridge and by-passing the Ethernet port

**WMM**—(Wi-Fi Multimedia) Support for wireless QoS

**MAX Station**—Number of clients allowed to associate
Advanced settings are best at default

These features can help increase network performance when used correctly, often modifying them without need will negatively impact a network’s performance.

**TDM Coordination** – best used with multiple clients

**Space in meters** – 1000 meter is default and can be used in most situations
Available in Wireless Client Mode – CPE Type

**Situation:** Typical WLAN packet delivery uses 3 Address Fields (DA, SA and BSSID)

**Problem:** Can’t support multiple clients behind client

**Solution: Lan2Lan** Utilizes all 4 available Address fields
- RA – Receiver Address
- TA – Transmitter Address
- DA – Destination Address
- SA – Source Address

**Note:** AP must support LAN-to-LAN mode

**Multi-Client** – Traditional packet delivery method is compatible with all AP’s
Wireless Access Control

Why beneficial? = Added level of security

How does it work? = Based on a MAC address list you can include or exclude clients that attempt to associate to your AP
WDS (AP Repeating and Bridge Modes)

Wireless Distribution System (WDS) is a Bridging protocol that allows multiple bridges to communicate with each other.

**Association** – Association is based on MAC address tables of remote bridges.

**Maximum connections** – Up to 4 remote bridges may associate with each other.

How do you configure a WDS Network?
WDS Examples

WDS applies to Wireless Bridge and AP Repeating modes.

Typical Configurations:
• Point to Point (P2P)
• Point to Multi-Point (PXP)
• Access point with repeating (APR)
Wireless Settings

WDS Point-to-Point

Add the remote bridge B’s MAC address into Bridge A’s WDS table

Add the remote bridge A’s MAC address into Bridge B’s WDS table

WDS Bridge link is now Established

Add the remote bridge A’s MAC address into Bridge B’s WDS table
Add the remote bridge C’s MAC address into Bridge A’s WDS table and A’s into C’s.
Wireless Settings

WDS Point-to-Multi-Point

Bridge A
MAC XX:XX:XX:XX:XX:01
WDS Association Table
Remote MAC = XX:XX:XX:XX:00:01
Remote MAC = XX:XX:XX:XX:00:03
Remote MAC = XX:XX:XX:XX:00:04

Bridge B
MAC XX:XX:XX:XX:XX:00:01
WDS Association Table
Remote MAC = XX:XX:XX:XX:00:01

Bridge C
MAC XX:XX:XX:XX:XX:03
WDS Association Table
Remote MAC = XX:XX:XX:XX:00:01

Bridge D
MAC XX:XX:XX:XX:XX:04
WDS Association Table
Remote MAC = XX:XX:XX:XX:00:01
Wireless Settings

WDS RELAY

Bridge A
MAC XX:XX:XX:XX:XX:01
WDS Association Table
Remote MAC = XX:XX:XX:XX:00:01
Remote MAC = XX:XX:XX:XX:00:02

Bridge B
MAC XX:XX:XX:XX:00:02
WDS Association Table
Remote MAC = XX:XX:XX:XX:00:01
Remote MAC = XX:XX:XX:XX:00:03

Bridge C
MAC XX:XX:XX:XX:XX:03
WDS Association Table
Remote MAC = XX:XX:XX:XX:00:01
Remote MAC = XX:XX:XX:XX:00:02

Bridge D
MAC XX:XX:XX:XX:XX:04
WDS Association Table
Remote MAC = XX:XX:XX:XX:00:01
Remote MAC = XX:XX:XX:XX:00:03

Internet

Established Link

WDS Association Table
Remote MAC = XX:XX:XX:XX:00:02
Remote MAC = XX:XX:XX:XX:00:03
Remote MAC = XX:XX:XX:XX:00:04
CAUTION: WDS Is Not Designed To Handle Bridge Network Loops!

What types of Networks can I Create using WDS?

WDS Bridge Networks support Start or tree topologies. Ring or mesh Networks are NOT supported and will create network Loops.

Will STP Prevent WDS Loops?

No, WDS is implemented at the Wireless Driver level and STP works at the Layer 2 Bridge Layer. A loop will create a packet storms at the wireless driver level.

The next couple of slides will show two common loop issues operators can create.
Wireless Settings

WDS LOOP Example 1

Bridge A
MAC XX:XX:XX:XX:XX:01

Bridge B
MAC XX:XX:XX:XX:XX:00:02

Bridge C
MAC XX:XX:XX:XX:XX:03

Bridge D
MAC XX:XX:XX:XX:XX:04

WDS Association Table
Remote MAC = XX:XX:XX:XX:00:01
Remote MAC = XX:XX:XX:XX:00:02
Remote MAC = XX:XX:XX:XX:00:03
Remote MAC = XX:XX:XX:XX:00:04

WDS Association Table
Remote MAC = XX:XX:XX:XX:00:01
Remote MAC = XX:XX:XX:XX:00:02
Remote MAC = XX:XX:XX:XX:00:03
Remote MAC = XX:XX:XX:XX:00:01
Wireless Settings

WDS LOOP Example 2

Bridge A
MAC XX:XX:XX:XX:XX:01

WDS Association Table
Remote MAC = XX:XX:XX:XX:00:02
Remote MAC = XX:XX:XX:XX:00:04

Bridge C
MAC XX:XX:XX:XX:XX:03

WDS Association Table
Remote MAC = XX:XX:XX:XX:00:01
Remote MAC = XX:XX:XX:XX:00:02

Bridge B
MAC XX:XX:XX:XX:XX:00:02

WDS Association Table
Remote MAC = XX:XX:XX:XX:XX:00:04
Remote MAC = XX:XX:XX:XX:XX:03

Bridge D
MAC XX:XX:XX:XX:XX:04

WDS Association Table
Remote MAC = XX:XX:XX:XX:00:01
Remote MAC = XX:XX:XX:XX:00:02

Internet
WDS Association Table

Remote MAC = XX:XX:XX:XX:00:01

Remote MAC = XX:XX:XX:XX:00:02

Remote MAC = XX:XX:XX:XX:00:03

Remote MAC = XX:XX:XX:XX:00:01

AP Repeating Combines WDS bridging + AP Functionality
Does WDS Bridging affect throughput?

Yes, the impact on performance depends on the Network setup. Point to Point networks suffer little to no effects. Point-to-Multipoint networks Vary. Adding a relay point or a repeater will cut performance about 50% as it needs to Receive and Transmit every packets.

The next few slides will show some real examples.
Wireless Settings

WDS P2P Performance

Bandwidth

Output

<table>
<thead>
<tr>
<th>Time</th>
<th>Bytes</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>[180] 0.0-100.0 sec</td>
<td>35.3 MBytes</td>
<td>2.96 Mbits/sec</td>
</tr>
<tr>
<td>[212] 0.0-100.0 sec</td>
<td>35.3 MBytes</td>
<td>2.96 Mbits/sec</td>
</tr>
<tr>
<td>[172] 0.0-100.1 sec</td>
<td>35.4 MBytes</td>
<td>2.97 Mbits/sec</td>
</tr>
<tr>
<td>[SUM] 0.0-100.1 sec</td>
<td>527 MBytes</td>
<td>44.2 Mbits/sec</td>
</tr>
</tbody>
</table>
Wireless Settings

WDS P2P Relay Performance

Bandwidth

- Radio 
  - 
  - 
  - 
  - 

Output

- [196] 0.0-100.1 sec 17.6 MBytes 1.47 Mbits/sec
- [252] 0.0-100.1 sec 12.8 MBytes 1.07 Mbits/sec
- [204] 0.0-100.1 sec 16.4 MBytes 1.37 Mbits/sec
- [SUM] 0.0-100.1 sec 252 MBytes 21.1 Mbits/sec
Wireless Settings

WDS AP Repeating Performance

Bandwidth

<table>
<thead>
<tr>
<th>Time (sec)</th>
<th>MBits (BW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70.0</td>
<td>3.0MBits/s</td>
</tr>
<tr>
<td>72.5</td>
<td>2.9MBits/s</td>
</tr>
<tr>
<td>75.0</td>
<td>2.8MBits/s</td>
</tr>
<tr>
<td>77.5</td>
<td>2.7MBits/s</td>
</tr>
<tr>
<td>80.0</td>
<td>2.6MBits/s</td>
</tr>
<tr>
<td>82.5</td>
<td>2.5MBits/s</td>
</tr>
<tr>
<td>85.0</td>
<td>2.4MBits/s</td>
</tr>
<tr>
<td>87.5</td>
<td>2.3MBits/s</td>
</tr>
<tr>
<td>90.0</td>
<td>2.2MBits/s</td>
</tr>
<tr>
<td>92.5</td>
<td>2.1MBits/s</td>
</tr>
<tr>
<td>95.0</td>
<td>2.0MBits/s</td>
</tr>
<tr>
<td>97.5</td>
<td>1.9MBits/s</td>
</tr>
<tr>
<td>100.0</td>
<td>1.8MBits/s</td>
</tr>
</tbody>
</table>

Output

- [244] 0.0-100.0 sec 33.5 MBytes 2.81 Mbits/sec
- [212] 0.0-100.0 sec 33.9 MBytes 2.84 Mbits/sec
- [268] 0.0-100.0 sec 33.7 MBytes 2.82 Mbits/sec
- [SUM] 0.0-100.0 sec 519 MBytes 43.5 Mbits/sec
Wireless Settings

WDS 3 AP Repeaters Performance

Bandwidth

Output

- [212] 0.0-100.1 sec 15.6 MBytes 1.31 Mbits/sec
- [180] 0.0-100.1 sec 15.3 MBytes 1.28 Mbits/sec
- [244] 0.0-100.1 sec 16.8 MBytes 1.41 Mbits/sec
- [SUM] 0.0-100.1 sec 239 MBytes 20.0 Mbits/sec

Done.
Information

This page shows the current status and some basic settings of the router.

System Information
- Device Name: ap27dcb3
- MAC Address: 00:19:70:27:dc:b3
- Country/Region: United States
- Firmware Version: 3.0.8

LAN Settings
- IP Address: 192.168.1.1
- Subnet Mask: 255.255.255.0
- Gateway IP Address: 0.0.0.0
- MAC Address: 00:19:70:27:dc:b3

Wireless Settings
- Operation Mode: AP
- Wireless Mode: 802.11B/G/N
- SSID: Wireless
- Encryption: Open System
- ACK Timeout: 35 us
- WMM Enable: On
- Noise Floor: -96 dBm

Association List

<table>
<thead>
<tr>
<th>VAP Index</th>
<th>MAC Address</th>
<th>Signal Strength</th>
<th>Noise Floor</th>
<th>Connection Time</th>
<th>Last IP</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5c:0a:30:4d:64:49</td>
<td>-52</td>
<td>-96</td>
<td>2010-1-1 00:07:37</td>
<td>296.214.62.102</td>
<td>Kick</td>
</tr>
</tbody>
</table>

Statistics
This page shows the packet counters for both transmission and reception over the respective wireless and Ethernet networks.

ARP Table
This table displays ARP information.

<table>
<thead>
<tr>
<th>IP Address</th>
<th>MAC Address</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>192.168.1.2</td>
<td>00:0c:87:01:cf:dc</td>
<td>br0</td>
</tr>
<tr>
<td>192.168.1.5</td>
<td>20:0a:9a:4d:aa:BA</td>
<td>br0</td>
</tr>
</tbody>
</table>

Bridge Table
This table displays bridge information.

<table>
<thead>
<tr>
<th>MAC Address</th>
<th>Interface</th>
<th>Aging Time(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:09:87</td>
<td>L/H</td>
<td>5:00</td>
</tr>
<tr>
<td>00:62:be</td>
<td></td>
<td>0:22</td>
</tr>
<tr>
<td>7a:70:97</td>
<td></td>
<td>2:87</td>
</tr>
</tbody>
</table>
### Tools – Wireless Client

#### Site Survey – For client mode

<table>
<thead>
<tr>
<th>SSID</th>
<th>Frequency/Channel</th>
<th>MAC Address</th>
<th>Wireless Mode</th>
<th>Signal Strength</th>
<th>Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>linksys</td>
<td>2412MHz(1)</td>
<td>00:1d:7e:40:03:72</td>
<td>802.11B/G</td>
<td>-41</td>
<td>WPA2</td>
</tr>
<tr>
<td>L-COM</td>
<td>2437MHz(6)</td>
<td>00:1f:70:00:55:44</td>
<td>802.11B/GN</td>
<td>-58</td>
<td>NONE</td>
</tr>
<tr>
<td>xfinitywifi</td>
<td>2437MHz(6)</td>
<td>18:af:63:b3:06:01</td>
<td>802.11B/G</td>
<td>-93</td>
<td>NONE</td>
</tr>
<tr>
<td>fabwifi</td>
<td>2437MHz(6)</td>
<td>00:25:9:ac:4:c:0</td>
<td>802.11B/G</td>
<td>-76</td>
<td>WPA</td>
</tr>
</tbody>
</table>

#### Wireless Site Survey

This page provides a tool to scan the wireless network.

<table>
<thead>
<tr>
<th>SSID</th>
<th>Frequency/Channel</th>
<th>MAC Address</th>
<th>Wireless Mode</th>
<th>Signal Strength</th>
<th>Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>linksys</td>
<td>2412MHz(1)</td>
<td>00:1d:7e:40:03:72</td>
<td>802.11B/G</td>
<td>-41</td>
<td>WPA2</td>
</tr>
<tr>
<td>L-COM</td>
<td>2437MHz(6)</td>
<td>00:1f:70:00:55:44</td>
<td>802.11B/GN</td>
<td>-58</td>
<td>NONE</td>
</tr>
<tr>
<td>xfinitywifi</td>
<td>2437MHz(6)</td>
<td>18:af:63:b3:06:01</td>
<td>802.11B/G</td>
<td>-93</td>
<td>NONE</td>
</tr>
<tr>
<td>fabwifi</td>
<td>2437MHz(6)</td>
<td>00:25:9:ac:4:c:0</td>
<td>802.11B/G</td>
<td>-76</td>
<td>WPA</td>
</tr>
<tr>
<td>TWCVIFI</td>
<td>2437MHz(6)</td>
<td>18:af:63:b3:06:02</td>
<td>802.11B/G</td>
<td>-92</td>
<td>NONE</td>
</tr>
<tr>
<td>CableWiFi</td>
<td>2412MHz(1)</td>
<td>58:b:6:ba:6a:43:03</td>
<td>802.11B/G</td>
<td>-92</td>
<td>NONE</td>
</tr>
<tr>
<td>optimintwifi</td>
<td>2412MHz(1)</td>
<td>58:b:6:ba:6a:43:00</td>
<td>802.11B/G</td>
<td>-92</td>
<td>NONE</td>
</tr>
<tr>
<td>xfinitywifi</td>
<td>2482MHz(11)</td>
<td>ac:a6:16:5c:37:01</td>
<td>802.11B/G</td>
<td>-92</td>
<td>NONE</td>
</tr>
<tr>
<td>CableWiFi</td>
<td>2482MHz(11)</td>
<td>ac:a6:16:5c:37:03</td>
<td>802.11B/G</td>
<td>-92</td>
<td>NONE</td>
</tr>
</tbody>
</table>
Ping Watchdog

Why?
- Increases reliability
- Reduce field service calls

How?
Monitors its connection to a reference point
Data Rate test

Check the performance of available data rates.

- Increase reliability
- Increase performance
Antenna Alignment

Proper Antenna alignment is essential for a reliable and efficient wireless network.

- Make sure Signal Strength is stable and strong enough for intended network.
- RSSI is based on 802.11 standard.
Tools – Speed Test

Measuring Throughput:

Simple and easy to run

• one Pair test
• Tx, Rx, Duplex testing
• Enter user name and password for remote device
Management:

- Remote Management options
- Hotspot
- Updating Firmware
- Backing up config files
- Password
- Certificates
LAN2 Overview

- Originally developed to support IP Cameras
- Power is supplied from the power supplied through LAN 1
- Lan2 has a power protection circuit, but do not insert PoE power into port, it won’t work.
LAN2 Power Overview

Warning! Do not exceed 18V at the input

LAN2 power output comparison

<table>
<thead>
<tr>
<th>L1 Cable Length (M)</th>
<th>L2 Cable Length (M)</th>
<th>LAN2 Max PWR (W)</th>
<th>LAN2 Min Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>5</td>
<td>11.92</td>
<td>15.82</td>
</tr>
<tr>
<td>15</td>
<td>5</td>
<td>11.07</td>
<td>15.18</td>
</tr>
<tr>
<td>20</td>
<td>5</td>
<td>10.22</td>
<td>14.51</td>
</tr>
<tr>
<td>25</td>
<td>5</td>
<td>9.37</td>
<td>13.9</td>
</tr>
<tr>
<td>30</td>
<td>5</td>
<td>8.52</td>
<td>13.26</td>
</tr>
<tr>
<td>35</td>
<td>5</td>
<td>7.67</td>
<td>12.62</td>
</tr>
<tr>
<td>40</td>
<td>5</td>
<td>6.82</td>
<td>11.99</td>
</tr>
</tbody>
</table>

Note: Based on Cat5e 24AWG Ethernet Cable
Once the load device is connected, you need to enable the power to the LAN2 port by enabling it in the firmware under basic settings.
External Antenna

ZCN-1523H-5-16 - Antenna Connector = 2 SMA RP female connectors.

Step 1 – Turn off power
Step 2 – Remove enclosure cover.
Step 3 - Remove 2 rubber plugs from enclosure.
Step 4 – Connect 2 adapter cables to antenna connectors.
Step 5 – turn on power switch and replace cover
Step 6 – enable external antenna feature in firmware.

Warning – Do not over tighten, tighten with fingers until snug.

Cable Diameter should be no larger than 5mm
Basic Troubleshooting

Main Testing Areas

- Ethernet
  - Ethernet Connectivity
  - Firmware Not Loading
  - Power Problems

- Wireless
  - Cannot Associate
  - Poor Performance
Ethernet Troubleshooting

- Main problem = no power
- What power supply is being used?
  - Customers
  - OEM
- Length of cable: injector to device
  - 50’ + 12v supply
  - >50’ + 15v supply
- Can each be verified/replaced?
  - Supply
  - Cable
Ethernet Connectivity

Ethernet Connection Testing

- Main problem = cannot access WEB utility
- Check with reference 50’ CAT5e / CAT6 cable from injector to DUT + reference 12V power supply
  - Step 1: Default unit
  - Step 2: Check LED indicator
  - Step 3: Ping 192.168.1.1
  - Step 4: Login to 192.168.1.1
  - Step 5: Power cycle unit multiple times to check for intermittent problem
Firmware Not Loading

Ethernet Is Good but cannot Access WEB Utility

Reported Symptom = cannot access web utility

• Check the following:
  • Power and/or LAN light stay amber color
  • May be able to ping device, but nothing more

• Possible Causes
  • Improper firmware loaded
  • Firmware update was interrupted

• Solution
  • Re-load firmware using TFTP connection
Firmware Not Loading

Re-loading firmware via TFTP connection

Configure PC as follows:

- Change IP Address to 192.168.0.36
- Install and Configure TFTP Server
  - Power and/or LAN light stay Amber color
  - May be able to ping device, but nothing more
- Possible Causes
  - Improper firmware loaded
  - Firmware update was interrupted
- Solution
  - Re-load firmware using TFTP
Wireless Troubleshooting

Cannot Associate

• Access Point Mode
  • Verify settings
  • Verify Station can “see” it (hide ssid)

• Client Mode
  • Scan (site survey)
    • Same channel as AP
    • Same ESSID as AP
  • Verify settings
  • Associate with MAC

• AP Repeater / Bridge
  • Verify WDS settings
  • Verify settings

Acquire from the customer

⇒ Network Diagram
⇒ Configuration Files
⇒ Clear Description Of The Fault and How To Duplicate
⇒ Site Survey / Location Info
Troubleshooting

Fresnel Zone Infringement

Infringement can be indicated by:
- Poor/unstable connections – RSSI values shifting dramatically

Considerations:
- Antenna height
- Curvature of the earth
- Obstruction height
Path Loss

Aggregate signal strength + adequate fade margin needed for successful communication:

- Received Signal = TxPWR - TxCableLoss + AntGain - FSP* + RxAntGain - RxCableLoss

  \[ FSP = 20\log_{10}(MHz) + 20\log_{10}(\text{Distance in Miles}) + 36.6 \]

Fade Margin between 10-20 is normal. Greater distance = greater fade margin

Considerations:

- Refraction – from the atmosphere (changes over time)
- Diffraction – objects near radio path cause this effect
- Reflection – can be caused from objects near and far from path
Troubleshooting

Received Signal = TxPWR - TxCableLoss + AntGain - FSP + RxAntGain - RxCableLoss

-3dB Cable Loss

+20dBm

-20dBm

+15dBi AntGain

-89 dBm = Rx Sensitivity

-60.2 dBm = Received Signal

-28.8 dBm = Operating Margin

FSP = 67.6 + 0 + 36.6 = 104.2

-89 Rx Sensitivity

+15dBi AntGain

-3dB Cable Loss

20dBm

-3dB

+15dBi

-104.2

+15dBi

-3dB

-89 Rx Sensitivity

Received Signal = TxPWR - TxCableLoss + AntGain - FSP + RxAntGain - RxCableLoss
Physical Inspection

- The unit is checked for physical damage
  - Case integrity checked
  - Damage to connectors / jacks noted
  - Missing accessories noted
- The unit is checked for operation
  - Customers power supply used if supplied
  - Known-good power supply used if customer power supply is not available or fails to power unit on
- LED operation verified
- Current draw
  - Typical with 12v supply / 50’ CAT5E = 0.3A on standby
How to tell if customer used wrong power supply?

VR2 / VR3 are voltage regulators as shown here circled in red.

When one or both units are burned it shows that an unacceptable level of voltage was applied to it.

We recommend power supplies between 12 ~ 15V
Throughput Testing Setup

Throughput Testing - Baseline

• Use CAT5e or CAT6 shielded cables
• Test PxP between 2 PCs to ensure reference
  • TCP overhead = ~8%
  • UDP overhead = ~6%

Throughput Reference:
100Mbps NIC:
  TCP = ~>92Mbps
  UDP = ~>94Mbps

1000Mbps NIC:
  TCP = ~>920Mbps
  UDP = ~>940Mbps
Throughput Testing Setup

Wireless Testing

- Setup should be so that RSSI at either unit is approximately -35~-40 when both units are known reference units (conducted or radiated)
  - If displayed RSSI is ~>8-10dB worse at DUT, the receive is most likely defective
  - If displayed RSSI at the reference unit is ~≤3dB less than reference, the Tx fails (DUT is in AP mode)

NOTE: RSSI should never be higher than -28dB as this can permanently damage the unit.
Throughput Testing Setup

Conducted Testing
- Provide enough cable separation between attenuators
- Use attenuators \( \leq 20\)dB if possible
- If possible, do not string multiple attenuators in sequence
Throughput Testing Config

Throughput Settings

- JPerf Settings
  - 10 parallel streams
- Expected Performance (MCS7-20MHz BW):
  - TCP = ~ 45Mbps

Server Settings
TCP Client Configuration
Wireless Considerations

Poor Performance

• Slow Utility Access
  • Check length of cable vs. power supply
  • Change Ethernet cable
  • Make sure not remotely connected through a wireless device

• Poor Wireless Performance
  • Verify no physical obstruction
  • Scan for wireless interference (site survey)
    • Same channel as AP
    • Same ESSID as AP
  • Exchange unit
  • Check wireless characteristics (VSA)
    • Output power
    • EVM

EVM

Compression

Adjacent Channel Interference
Installation Considerations

Are Channels 1 and 6 truly non-overlapping?
Consider Side bands

Directivity – Some signal will transmit behind the antenna, higher the gain, further the directivity.
Best Practices

Installation

• Preconfigure units before installation
  • This ensures that the unit and accessories will work as expected

• Perform site survey to select optimal channel

• Determine and circumvent obstructions to Fresnel zone
Antenna Directivity

2 Pole mounted Skyport’s

Back to Back with 8" of Vertical separation. Antenna directivity, would be lower if just due to multipath.
Regulatory Overview

Title 47 Part 15 subpart C section 247

Point to Multi-point

- Radio = 30dB Max Peak Power
- Antenna = 6dBi Max Gain
- Antenna > 6dBi, the Radio must be reduced by corresponding amount?

Why would someone want to have a higher gain antenna and reduce the TX power of the radio?
2.400 – 2.483 GHz

If Antenna gain is > 6dBi, then for each 3 dBi of gain requires a 1dB decrease in Radio TX power.

5.725 – 5.850 GHz

Antenna may have > gain than 6dBi without any reduction in Radio TX Power.
<table>
<thead>
<tr>
<th>UNII Band</th>
<th>Max conducted power</th>
<th>Max Antenna Gain (dBi)</th>
<th>DFS + TPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – (5.15–5.25 GHz)</td>
<td>50 mW</td>
<td>6 *</td>
<td>NA</td>
</tr>
<tr>
<td>2 – (5.25–5.35 GHz and 5.47–5.725 GHz)</td>
<td>250 mW</td>
<td>6 *</td>
<td>Required</td>
</tr>
<tr>
<td>3 – (5.725–5.825 GHz) – Multi-point</td>
<td>1 W</td>
<td>6 *</td>
<td>NA</td>
</tr>
<tr>
<td>3 – (5.725–5.825 GHz) – Fixed P2P</td>
<td>1W</td>
<td>23 #</td>
<td>NA</td>
</tr>
</tbody>
</table>

* If Antenna gain is > 6dBi, then the radiator must be decreased by a corresponding amount.
# If Antenna gain is > 23dBi, then the radiator must be decreased by a corresponding amount.