# LAMPIRAN

**Lampiran 1**

# iPerf user documentation

| GENERAL OPTIONS | |
|---|---|
| **Command line option** | **Description** |
| -p, --port n | The server port for the server to listen on and the client to connect. This should be the same in both client and server. Default is 5201. |
| -f, --format [kmKM] | A letter specifying the format to print bandwidth number in. Supported format are<br>'k' = Kbits/s 'K' = KBytes/s<br>'m' = Mbit/s 'M' = MBytes/s<br>The adaptive formats choose between kilo- and mega- as appropriate. |
| -i, -interval n | Sets the interval time in seconds between periodic bandwidth, jitter, and loss report. If non-zero, a report is made every interval seconds of the bandwidth since the last report are printed. Default is zero. |
| -F, --file name | Client side : read from the file and write to the network, instead of using random data.<br>Server side : read from the network and write to the file, instead of throwing the data away. |
| -v, --version | Show version information and quit. |
| -h, --help | Show a help synopsis and quit. |
| -d, --debug | Emit debugging output. Primarily of use to developers. |

| SERVER SPECIFIC OPTIONS | |
|---|---|
| **Command line option** | **Description** |
| -s, --server | Run iPerf in server mode. (This will only allow one iPerf connection at the time). |
| -D, --daemon | Run the server in background as a daemon. |
| -I, --pidfile file | Write a file with the process ID, most usefull when running as a daemon. |
| -u, --udp | Use UDP rather than TCP. |
| -P, --paralel n | The number of simultaneous connections to make to the server. Default is 1. |

| CLIENT SPECIFIC OPTIONS | |
|---|---|
| **Command line option** | **Description** |
| -c, --client | Run iPerf in client mode, connecting to an iPerf server running on host. |
| -u, --udp | Use UDP rather than TCP. See also the -b option. |
| -b, --bandwidth n[KM] | Set target bandwidth to n bits/s (default 1 MByte/s for UDP, unlimited for TCP). If there are multiple streams (-P flag), the bandwidth limit is applied separately to each stream. You can also add a '/' and a number to the bandwidth specifier. This is called 'burst mode'. It will send the given number of packets without pausing, even if that temporarily exceeds the specified bandwidth limit. |
| -t, --time n | The time in second to transmit. iPerf normally works by repeatedly sending an array of len bytes for time seconds. Default is 10 seconds. |
| -n, --num n[KM] | The number of buffers to transmit. Normally, iPerf sends for 10 seconds. The -n option overrides this and send an array of len bytes num times, no matter how long that takes. |
| -k, --blockcount n[KM] | The number of block (packets) to transmit. |
| -l, --length n[KM] | The length of buffers to read or write. iPerf work by writing an array of len bytes a number of times. Default is 128 KB for TCP, 8 KB for UDP. |
| -P, --paralel n | The number of simultaneous connections to make to the server. Default is 1. |
| -R, --reverse | Run in reverse mode (server sends, client receives) |
| -w, --window n | Sets the socket buffer sizes to the specified value. For TCP, this sets the TCP windows size. (This gets sent to the server and used on that side too). |
| -M, --set-mss n | Attempt to set TCP maximum segment size (MSS). The MSS is usually the MTU - 40 bytes for the TCP/IP header. For ethernet, the MSS is 1460 bytes (1500 byte MTU). |
| -N, --no-delay | Set the TCP no delay option, disabling Nagle's algorithm. Normally this is only disable for interactive applications like telnet. |

**Lampiran 2**

**Data Sheet AirView Spectrum Analyzer**

TECHNOLOGY
DATASHEET

UBIQUITI NETWORKS

## AIRVIEW SPECTRUM ANALYZER

- Optimize Wireless Network Design and Performance
- Analyze Frequency Usage and Activity Levels Onsite
- Energy Data Points Collected in Real-Time Spectral Views

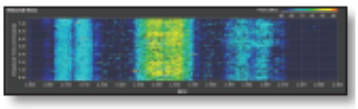
### Optimize Wireless Network Design and Performance

To optimize the performance of a wireless network, the network designer should seek the best SNR (Signal-to-Noise Ratio) possible. Signal level can be predicted and planned based on the transmit power, antenna gain, distance, and frequency band. However, a common problem with unlicensed wireless bands (2.4 GHz, 5 GHz, etc.) is that noise cannot be predicted, and clean spectrum is not guaranteed on any certain frequencies. Previously, an off-the-shelf spectrum analyzer (which may cost upwards of $10,000) was required to conduct a site survey or spectrum analysis at the installation site of the wireless equipment. Now integrated on all Ubiquiti Networks™ airMAX® M products, airView® provides powerful spectrum analyzer functionality, removing the need to rent or purchase additional equipment for doing site surveys.

### Analyze Frequency Usage and Activity Levels Onsite

airView allows network designers to identify noise signatures and plan their networks to minimize noise interference. airView accurately depicts the frequencies currently in use by other devices, how active the devices on those frequencies are, and how much noise or interference may be expected if a wireless network operates on or near certain frequencies. Using airView, network designers can avoid highly used channels and set up new access points on channels showing the least usage. In airView, there are three spectral views, each of which represents different data.

#### Waterfall View

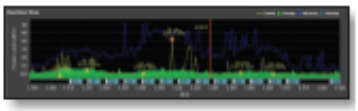


A time-based graph shows the aggregate energy collected since the start of the airView session for each frequency. The power of the energy (in dBm) is displayed across the frequency span, and a new row is inserted every few seconds. The color of the energy denotes the amplitude (or strength) of the signal.

#### Waveform View

An activity-based graph shows the aggregate energy collected since the start of the airView session. The power of the energy (in dBm) is shown across the frequency span. The spectral view over time essentially displays the steady-state RF energy signature of a given environment.

#### Real-time Chart



A graph displays a traditional spectrum analyzer in which energy (in dBm) is shown in real time as a function of frequency. There are three traces in this view: ***Max Hold***, which updates and holds maximum power levels across the frequency since the start of an airView session; ***Average***, which shows the running energy average across frequency; and ***Real-time***, which displays the real-time energy seen by airView as a function of frequency.

**Lampiran 3**

# Access Point Ruckus ZeoneFlex R600

| PHYSICAL CHARACTERISTICS | |
|---|---|
| Power | • DC Input: 12 VDC 1.0A<br>• Power over Ethernet 802.3 af |
| Physical Size | • 15.8 cm x 15.8 cm x 4 cm (6.2 in x 6.2 in x 1.57 in) |
| Weight | • 364 g (0.8 lb.) |
| Data Ports | • 2 auto MDX, auto-sensing 10/100/1000 Mbps, RJ-45, POE port (on one port) |
| Lock Options | • Hidden latching mechanism<br>• Kensington Lock Hole<br>• T-bar Torx<br>• Bracket (902-0108-0000) Torx screw & padlock (sold separately) |
| Environmental Conditions | • Operating Temperature: 0°C ~ 40°C<br>• Operating Humidity: 10% ~ 95% non-condensing |
| Power Draw | • Idle: 4W<br>• Typical: 6.2W<br>• Peak: 11.2W |

| PERFORMANCE AND CAPACITY | |
|---|---|
| Concurrent Stations | • Up to 512 clients per AP |
| Simultaneous Voip Clients | • Up to 30 clients per AP |

| RF | |
|---|---|
| ANTENNA | • Adaptive antenna that provides up to 512 unique antenna patterns per radio<br>• Full omnidirectional polarization diversity |
| PHYSICAL ANTENNA GAIN | • Up to 3dBi |
| BEAMFLEX® SINR TX GAIN | • Up to 6dB |
| BEAMFLEX® SINR RX GAIN | • 3-5dB (PD-MRC) |
| INTERFERENCE MITIGATION | • Up to 15dB |
| MINIMUM RX SENSITIVITY | • Up to -101dBm |

| WI-FI | |
|---|---|
| Standards | • IEEE 802.11a/b/g/n/ac<br>• 2.4GHz and 5GHz |
| Supported Data Rates | • 802.11n/ac: 6.5Mbps – 260Mbps (20MHz)<br>• 13.5Mbps – 600Mbps (40MHz)<br>• 29.3Mbps – 1300Mbps (80MHz)<br>• 802.11a: 54, 48, 36, 24, 18, 12, 9 and 6Mbps<br>• 802.11b: 11, 5.5, 2 and 1 Mbps<br>• 802.11g: 54, 48, 36, 24, 18, 12, 9 and 6Mbps |
| Radio Chains | • 3 x 3 |
| Spatial Streams | • 3 |
| RF POWER OUTPUT (Aggregate) | • 28 dBm for 2.4GHz†<br>• 27 dBm for 5GHz† |
| Channelization | • 20MHz, 40MHz, 80MHz |
| Operating Channels | • US/Canada: 1-11, Europe ( ETSI X30): 1-13, Japan X41: 1-13<br>• 5 GHz channels: Country dependent |
| Frequency Band | • IEEE 802.11 b/g/n: 2.4 – 2.484GHz<br>• IEEE 802.11a/ac: 5.15 – 5.25GHz; 5.25 – 5.35GHz; 5.47 – 5.725 GHz; 5.725 – 5.85GHz |
| Power Save | • Supported |
| Wireless Security | • WPA-PSK, WPA-TKIP, WPA2 AES, 802.11i<br>• Authentication via 802.1X with the ZoneDirector, local authentication database, support of RADIUS, and ActiveDirectory |
| Certifications** | • US, Europe, Argentina, Australia, Brazil, Canada, Chile, China, Colombia, Costa Rica, Egypt, Hong Kong, India, Indonesia, Israel, Japan, Korea, Malaysia, Mauritius, Mexico, New Zealand, Pakistan, Peru, Philippines, Russia, Saudi Arabia, Singapore, South Africa, Taiwan, Thailand & UAE.<br>• WEEE/RoHS compliance<br>• EN-60601-1-2 (Medical)<br>• Wi-Fi Alliance<br>• EN50121-1 Railway EMC<br>• EN50121-4 Railway Immunity<br>• IEC 61373 Railway Shock & Vibration<br>• UL 2043 plenum rated<br>• 5GHz UNII-1 (2014) |

**Lampiran 4**

# Access Point TL-WA801ND

| Specifications | |
|---|---|
| Model | TL-WA701ND |
| Standards | IEEE 802.11n, IEEE 802.11g, IEEE 802.11b |
| Channels | 11n: Up to 300Mbps(20 & 40 MHz/dynamic)<br>11g: Up to 54Mbps(dynamic)<br>11b: Up to 11Mbps(dynamic) |
| Ports/Buttons | Power On/Off Button<br>WPS Button<br>Reset Button<br>One 10/100M Ethernet Port (RJ45)<br>Support Passive PoE |
| Wireless Modes | AP Mode<br>Multi-SSID Mode<br>Client Mode<br>Repeater Mode (WDS/Universal)<br>Bridge with AP Mode |
| Transmit Power | CE: <15dBm; FCC: <20dBm |
| Wireless Security | 64/128/152-bit WEP, WPA/WPA2, WPA-PSK/WPA2-PSK |
| **Environmental** | |
| Dimensions | 7.1× 4.9× 1.4 in. |
| (W x H x D) | (181× 125× 36 mm) |
| Power | External, 9V DC / 0.6A |
| Certification | CE, FCC, RoHS |
| Operating Temp. | 0℃~40℃ (32℉~104℉) |
| Storage Temp. | -40℃~70℃ (-40℉~158℉) |
| Operating Humidity | 10% to 90% Non-Condensing |
| Storage Humidity | 5% to 90% Non-Condensing |

**Lampiran 5**

# Tabel Hasil Pengiriman Data iPerf

# Tanpa Beamforming (TP-Link TLWA801ND)

TANPA INTERFERENSI

| Jarak | Pengukuran Ke- | Throughput (Kbits/s) | Jitter (ms) | Packet Loss |
|---|---|---|---|---|
| x | 1 | 46084 | 0.365 | 0.160% |
| | 2 | 50318 | 0.618 | 0.110% |
| | 3 | 52944 | 0.731 | 0.154% |
| | 4 | 48179 | 0.661 | 0.057% |
| | 5 | 47385 | 0.132 | 0.003% |
| | Rata-rata | 48982 | 0.5014 | 0.097% |

NB : x = Tanpa Interferensi

Interferensi

| Jarak | Pengukuran Ke- | Throughput (Kbits/s) | Jitter (ms) | Packet Loss |
|---|---|---|---|---|
| 0m | 1 | 38451 | 2.909 | 2.366% |
| | 2 | 40728 | 1.211 | 1.378% |
| | 3 | 41815 | 1.373 | 2.122% |
| | 4 | 40766 | 0.899 | 1.865% |
| | 5 | 39176 | 1.589 | 1.622% |
| | Rata-rata | 40187.2 | 1.5962 | 1.871% |
| 1m | 1 | 45998 | 1.375 | 2.152% |
| | 2 | 40648 | 1.579 | 1.450% |
| | 3 | 39540 | 1.358 | 2.122% |
| | 4 | 38962 | 0.912 | 1.554% |
| | 5 | 40161 | 1.384 | 0.884% |
| | Rata-rata | 41061.8 | 1.3216 | 1.632% |
| 2m | 1 | 45082 | 1.934 | 2.354% |
| | 2 | 38911 | 1.238 | 0.651% |
| | 3 | 40377 | 1.524 | 0.809% |
| | 4 | 40302 | 0.922 | 1.435% |
| | 5 | 41686 | 0.88 | 1.754% |
| | Rata-rata | 41271.6 | 1.2996 | 1.401% |
| 3m | 1 | 40395 | 2.275 | 1.693% |
| | 2 | 45851 | 0.643 | 0.644% |
| | 3 | 42164 | 1.143 | 0.904% |
| | 4 | 42713 | 0.896 | 1.357% |
| | 5 | 40423 | 0.022 | 1.432% |
| | Rata-rata | 42309.2 | 0.9958 | 1.206% |
| 4m | 1 | 42723 | 0.665 | 1.566% |

| | | | | |
|---|---|---|---|---|
| | 2 | 42029 | 0.999 | 1.945% |
| | 3 | 41395 | 0.593 | 0.477% |
| | 4 | 43247 | 1.157 | 0.845% |
| | 5 | 43438 | 0.821 | 0.347% |
| | Rata-rata | 42566.4 | 0.847 | 1.036% |
| 5m | 1 | 47669 | 0.672 | 1.368% |
| | 2 | 42457 | 0.931 | 0.448% |
| | 3 | 44502 | 1.048 | 0.568% |
| | 4 | 42703 | 0.682 | 1.158% |
| | 5 | 43793 | 0.811 | 0.375% |
| | Rata-rata | 44224.8 | 0.8288 | 0.783% |

**Lampiran 6**

# Tabel Hasil Pengiriman Data iPerf

# Beamforming (Ruckus Zoneflex R600)

TANPA INTERFERENSI

| Jarak | Pengukuran Ke- | Throughput (Kbits/s) | Jitter (ms) | Packet Loss |
|---|---|---|---|---|
| x | 1 | 64895 | 0.128 | 0.001% |
| | 2 | 64823 | 0.196 | 0.000% |
| | 3 | 62600 | 0.693 | 0.000% |
| | 4 | 64006 | 0.58 | 0.000% |
| | 5 | 64273 | 0.832 | 0.000% |
| | Rata-rata | 64119.4 | 0.4858 | 0.000% |

NB : x = Tanpa Interferensi

Interferensi

| Jarak | Pengukuran Ke- | Throughput (Kbits/s) | Jitter (ms) | Packet Loss |
|---|---|---|---|---|
| 0m | 1 | 58300 | 0.597 | 0.000% |
| | 2 | 56855 | 0.767 | 0.014% |
| | 3 | 56103 | 0.647 | 0.006% |
| | 4 | 57967 | 0.956 | 0.003% |
| | 5 | 56134 | 0.899 | 0.013% |
| | Rata-rata | 57071.8 | 0.7732 | 0.007% |
| 1m | 1 | 57801 | 0.679 | 0.002% |
| | 2 | 56857 | 0.596 | 0.001% |
| | 3 | 58446 | 0.776 | 0.005% |
| | 4 | 58028 | 0.686 | 0.007% |
| | 5 | 57268 | 0.87 | 0.006% |
| | Rata-rata | 57680 | 0.7214 | 0.004% |
| 2m | 1 | 60420 | 0.627 | 0.002% |
| | 2 | 61123 | 0.359 | 0.000% |
| | 3 | 58397 | 0.615 | 0.003% |
| | 4 | 56735 | 0.74 | 0.000% |
| | 5 | 59256 | 0.722 | 0.005% |
| | Rata-rata | 59186.2 | 0.6126 | 0.002% |
| 3m | 1 | 61180 | 0.904 | 0.008% |
| | 2 | 61006 | 0.738 | 0.000% |
| | 3 | 59538 | 0.147 | 0.000% |
| | 4 | 57961 | 0.608 | 0.000% |
| | 5 | 59226 | 0.613 | 0.003% |
| | Rata-rata | 59782.2 | 0.602 | 0.002% |

| | | | | |
|---|---|---|---|---|
| 4m | 1 | 62892 | 0.498 | 0.000% |
| | 2 | 62522 | 0.533 | 0.003% |
| | 3 | 60287 | 0.696 | 0.000% |
| | 4 | 61142 | 0.676 | 0.000% |
| | 5 | 63101 | 0.605 | 0.000% |
| | Rata-rata | 61988.8 | 0.6016 | 0.001% |
| 5m | 1 | 61790 | 0.414 | 0.000% |
| | 2 | 62288 | 0.677 | 0.000% |
| | 3 | 60385 | 0.849 | 0.002% |
| | 4 | 63588 | 0.066 | 0.000% |
| | 5 | 62754 | 0.801 | 0.000% |
| | Rata-rata | 62161 | 0.5614 | 0.000% |

**Lampiran 7**

# Perhitungan Kekuatan Sinyal (dBm dan dBW)

- dBm

$$P\ (\text{dBm}) = 10\ Log_{10}\left(\frac{P\ (mW)}{1\ mW}\right)$$

Contoh : berapa daya pada dBm jika penggunaan daya sebesar 100 mW

$$P\ (\text{dBm}) = 10\ Log_{10}\left(\frac{100\ mW}{1\ mW}\right)$$

$$P\ (\text{dBm}) = 20\ dBm$$

- dBW

$$P\ (\text{dBW}) = 10\ Log_{10}\left(\frac{P\ (W)}{1\ W}\right)$$

Contoh : berapa daya pada dBm jika penggunaan daya sebesar 100 W

$$P\ (\text{dBW}) = 10\ Log_{10}\left(\frac{100\ W}{1\ W}\right)$$

$$P\ (\text{dBm}) = 20\ dBW$$