Challenges of Wi-Fi interoperability testing and need for measuring performance

By: Dr. Farouk Zanaty

CTO, Wi-PerforMax Inc.

Goals for Interoperability Testing

Ensuring connectivity between different wireless components in both “infrastructure” and “Ad-Hoc” configurations

Unifying the Encryption and authentication methods:

- WEP
- WPA-PSK
- WPA (Enterprise)
- WPA2-PSK
- WPA2 (Enterprise)

Satisfaction of average transmission rates (Mb/S) as experienced with the reference “golden” units

Roaming between different wireless APs for the client cards

Caching and Pre-authentication for APs

Detection of unauthorized access; MIC attacks

OTA decodes and Measurements

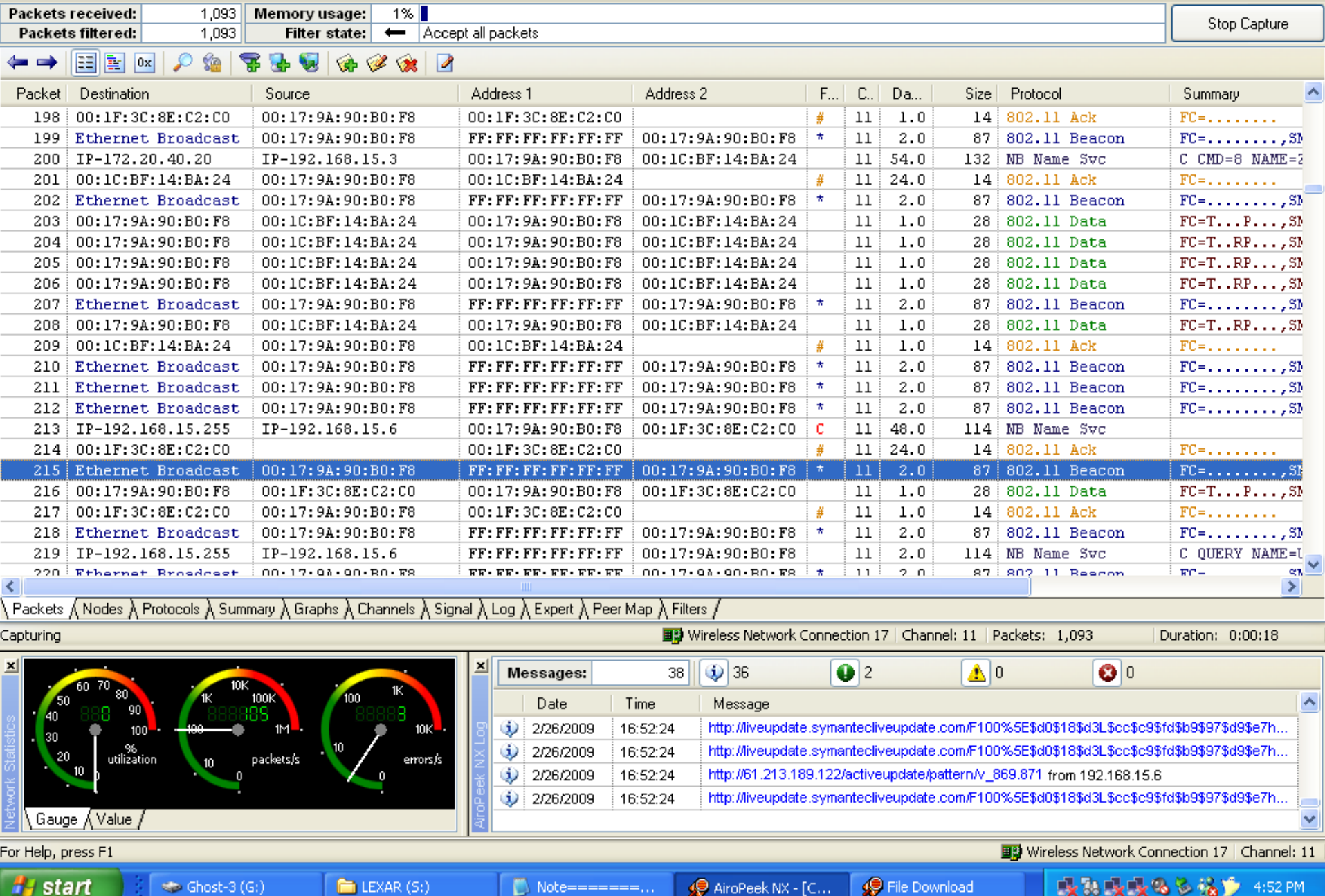
Beacon contents

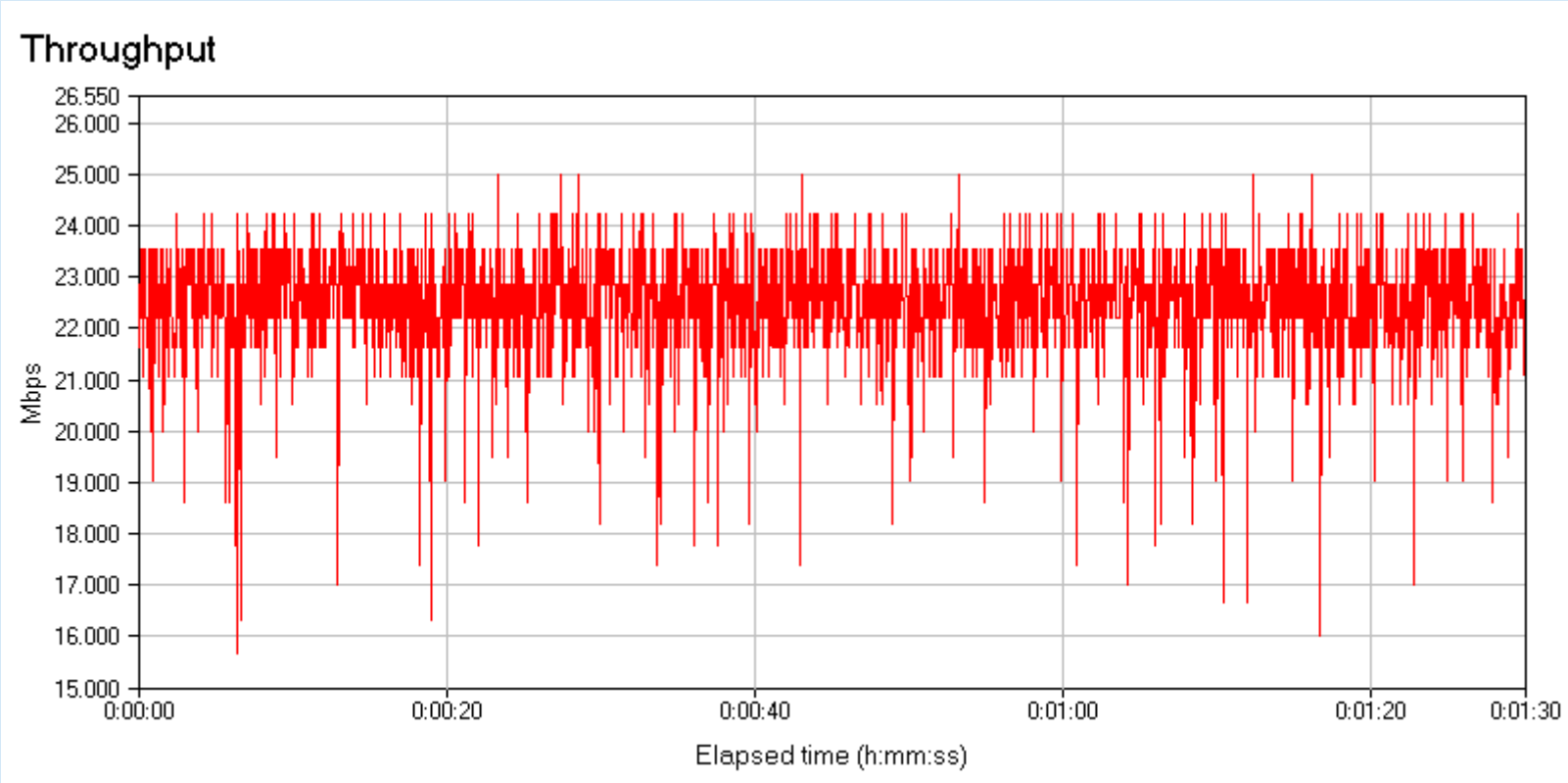
Supported rates

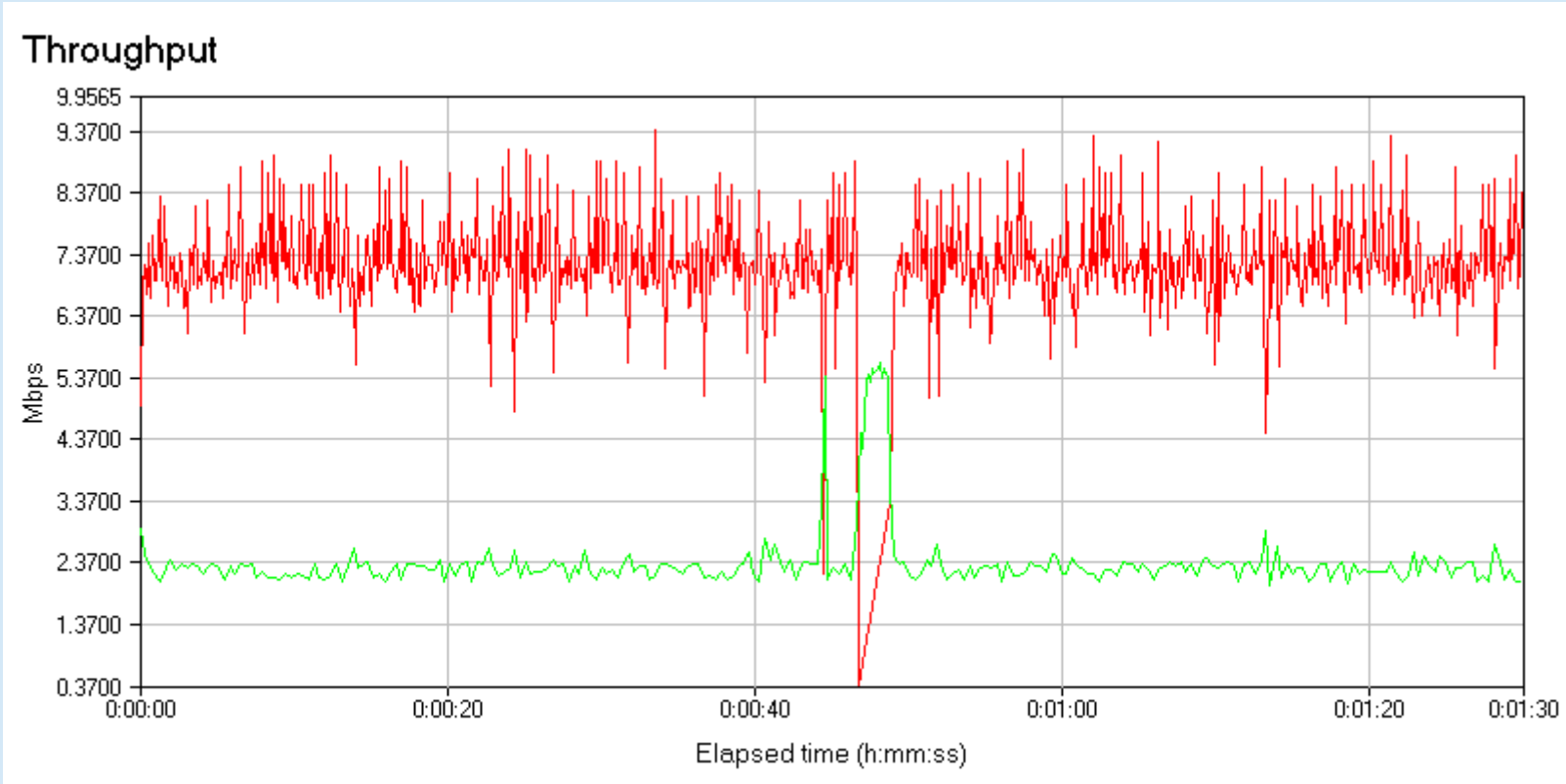
Supported QoS (multimedia); background, best effort, voice, and video

Throughput?

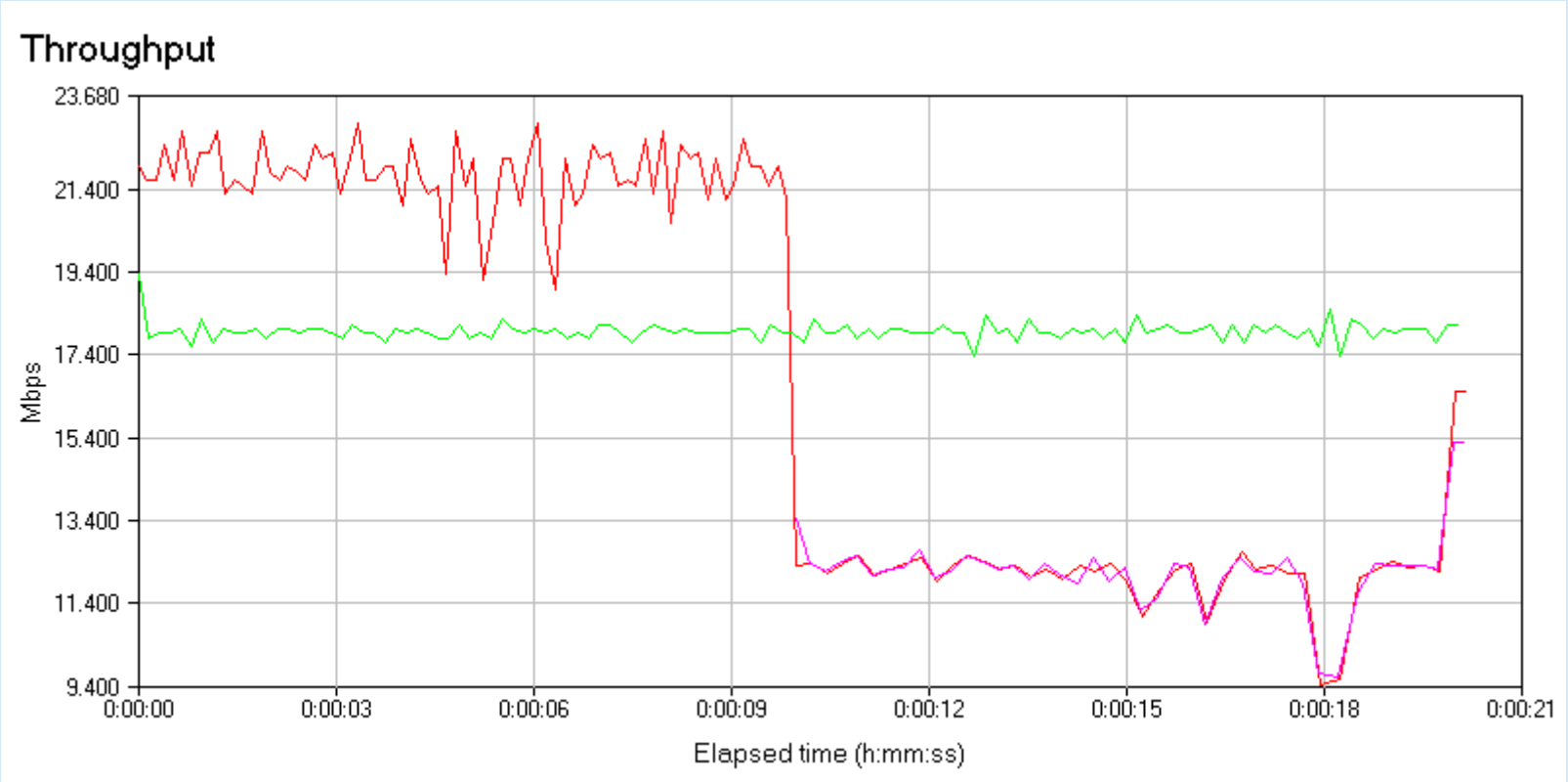
The average rate of exchanging the contents of a stationary file between two wireless endpoints during 90 seconds



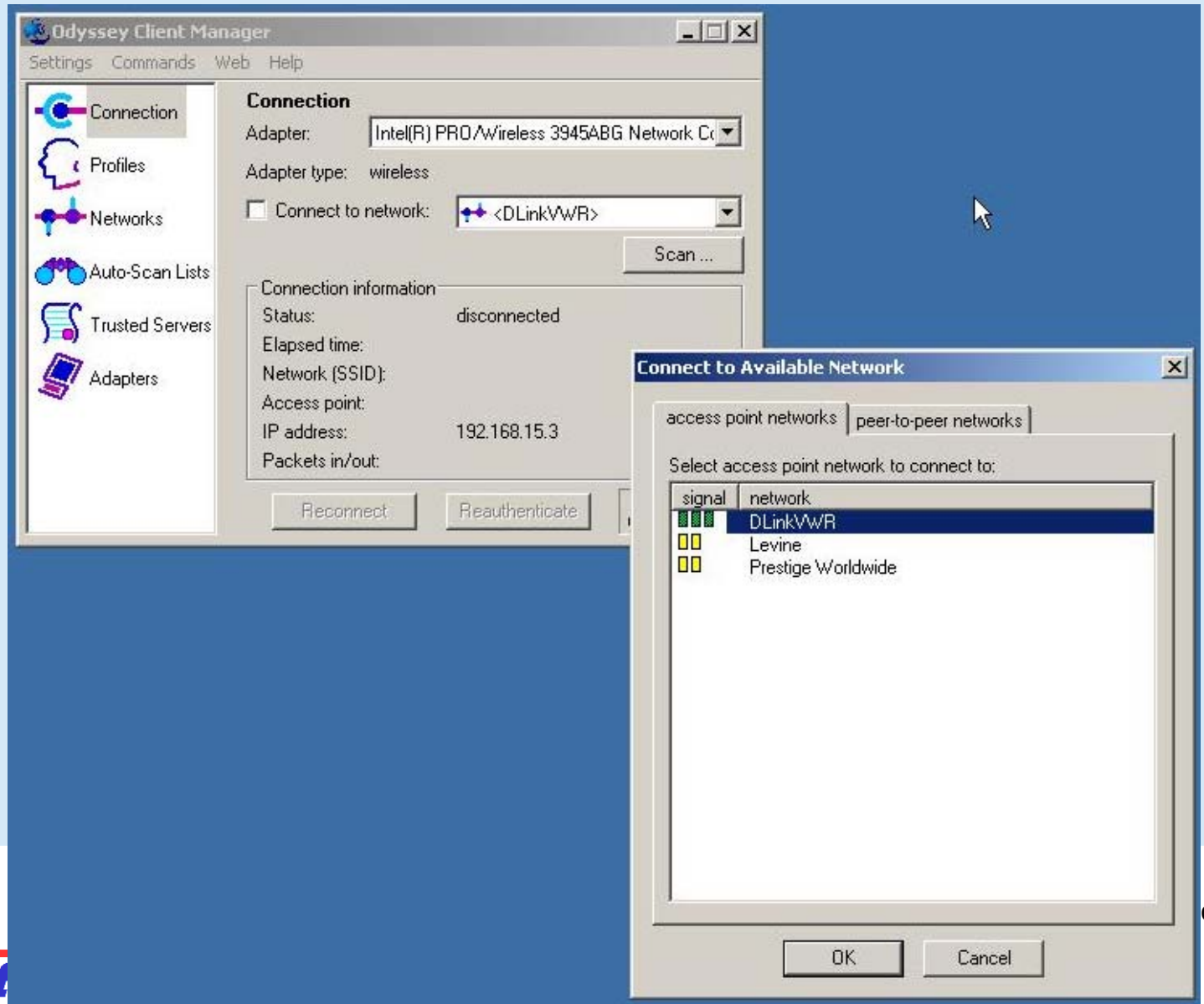




Interoperability-based QoS: WMM: Wireless Multimedia

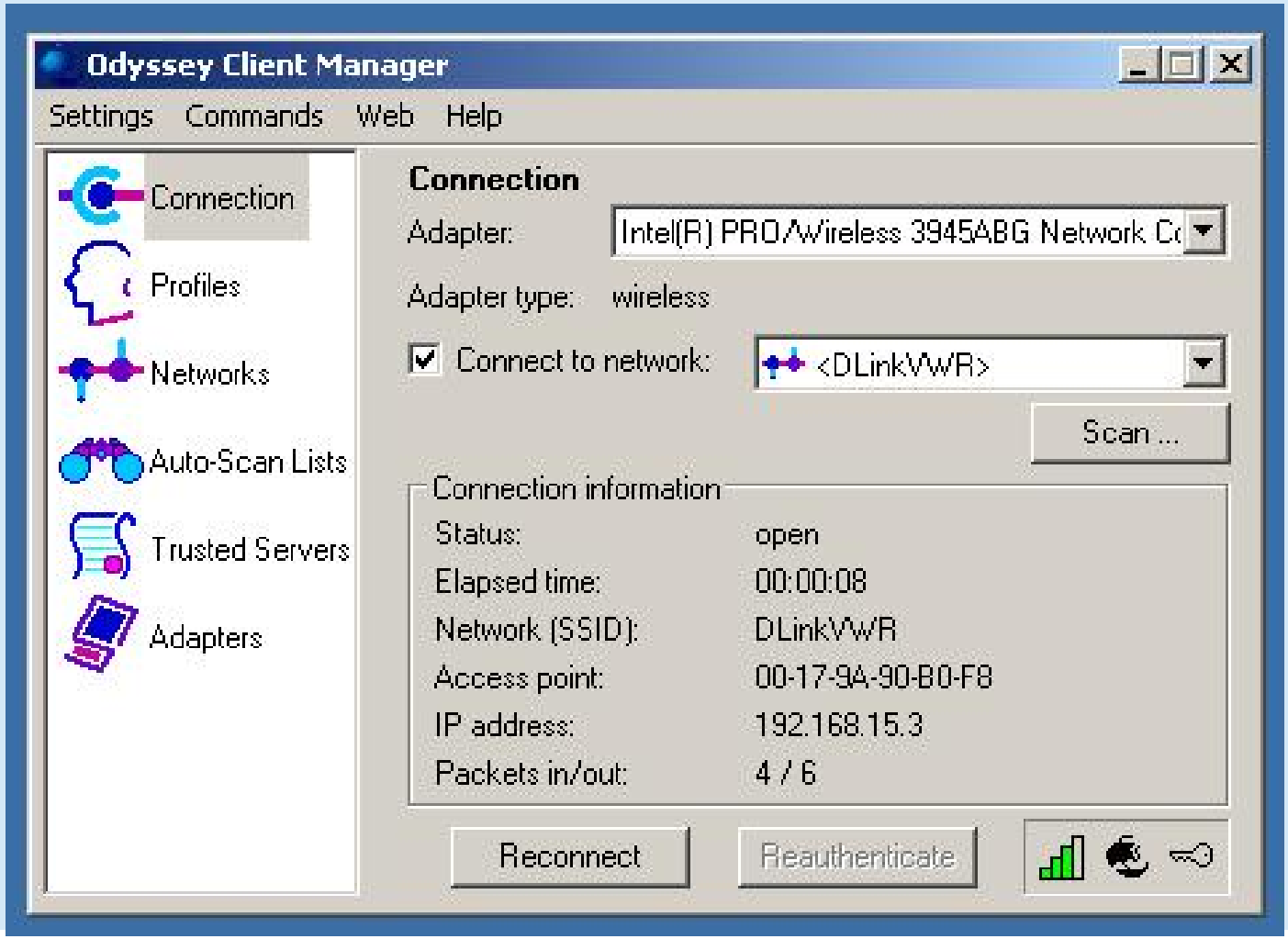


Interoperable (Wi-Fi)
DLink (AP) + Intel client



cessity and

Interoperable (Wi-Fi)
DLink (AP) + Intel client



Performance Measures

Throughput

Maximum rate of transmission of zero loss

Latency

Minimum, average, maximum delay of the transmitted payload

Packet Loss

Measured at all supported rates, at different packet sizes

Back to Back (Burst)

Maximum number of packets (in burst) transmittable without loss

Need for “Performance” measurements

For Comparative and Benchmarking
Between different implementations of the same class of wireless components (APs an clients)

Between different revisions of the same product as h/w or s/w (driver) elements vary.

To classify the wireless devices based on performance metrics
Throughput, Latency, Jitter, and packet loss

Need for “Performance” measurements (cont)

To specify the maximum achievable transmission in different stream types:

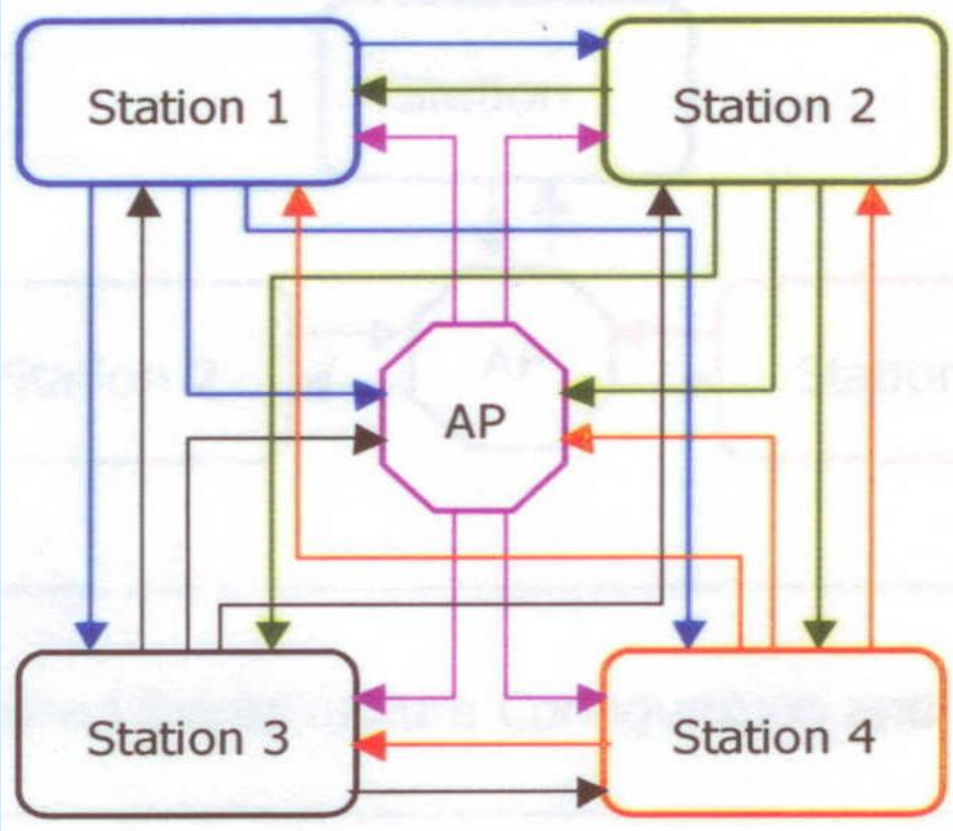
- Maximum number of full video frames vs. reduced size (sacrificing size)
- Maximum number of full size frames per second (sacrificing quality)

  To set scores of outperforming devices
- Leads to gaining market share
- To identify less performing devices and point out to:
  - Sources that contribute to less performance
  - Upgradeable parameters that lead to higher performance

Configurations of Performance Measurements

Fully Meshed

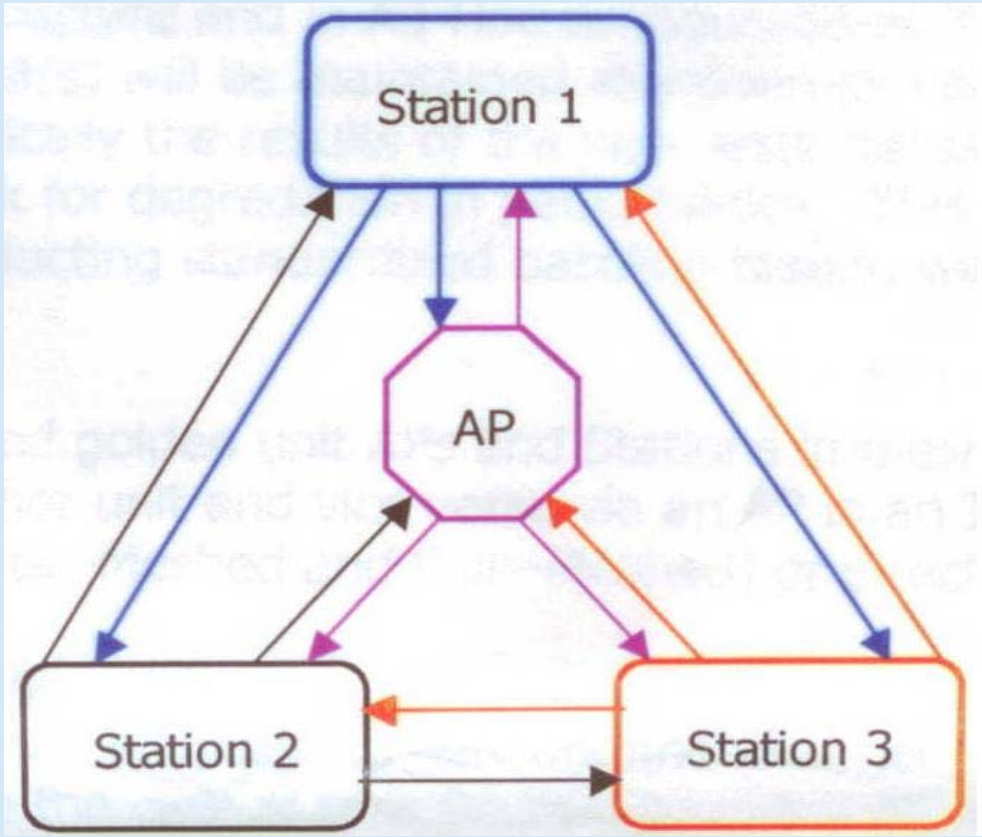
Infrastructure



Configurations of Performance Measurements

Fully Meshed

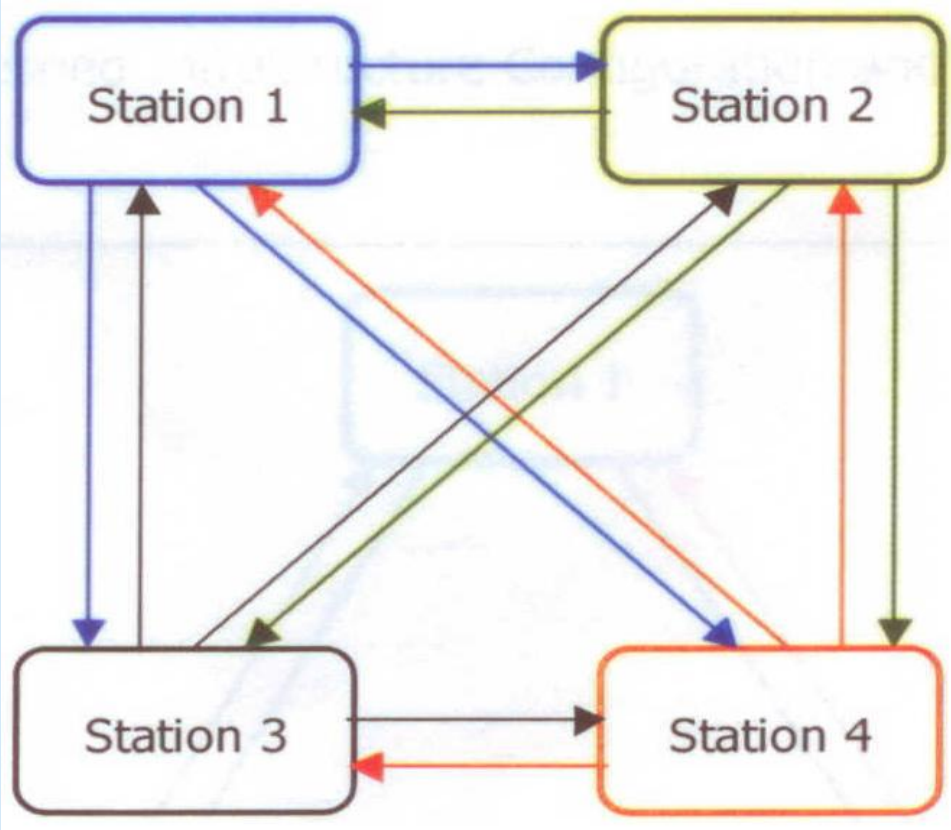
Infrastructure



Configurations of Performance Measurements

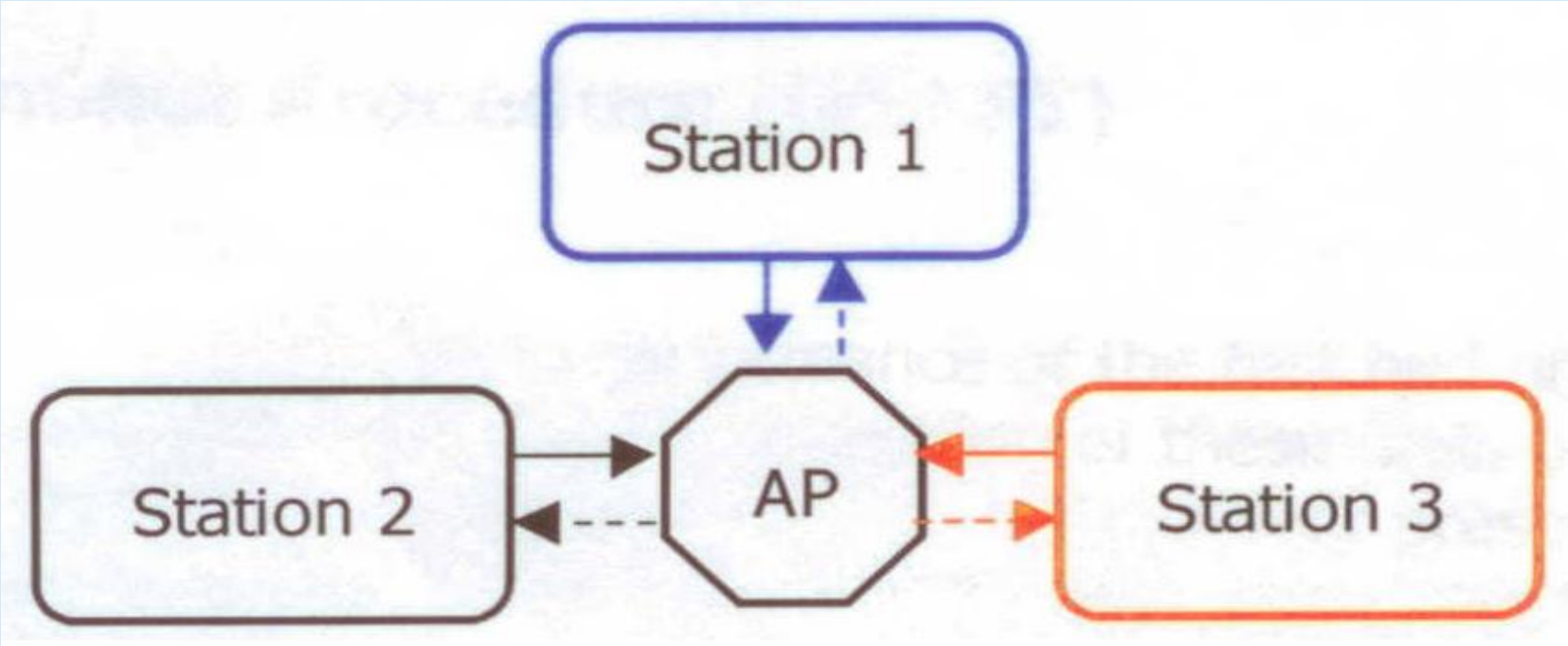
Fully Meshed

Ad-Hoc



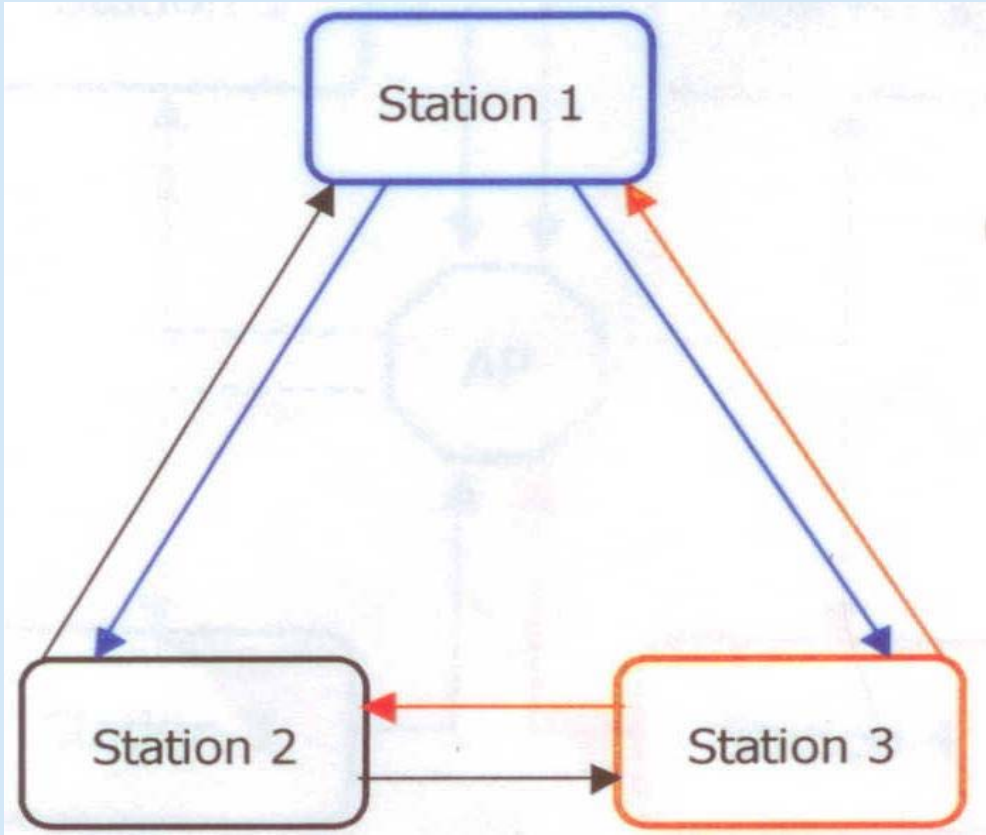
Configurations of Performance Measurements

Star-Meshed



Configurations of Performance Measurements

Delta-Meshed



Need for “Performance” measurements (cont)

To specify the maximum achievable transmission in different stream types:

- Maximum number of full video frames vs. reduced size (sacrificing full size)
- Maximum number of full size frames per second (sacrificing quality)

To set scores of outperforming devices

- Leads to gaining market share

To identify less performing devices and point out to:

- Sources that contribute to less performance
- Upgradeable parameters that lead to higher performance

End User Experience

* Video transmission

* Real time: 35 fps

35 x 1280 x 1024 x 16 = 734003200 bits/sec = 734 Mb/S.

-The maximum measured 802.11n rate is 130 Mb/S

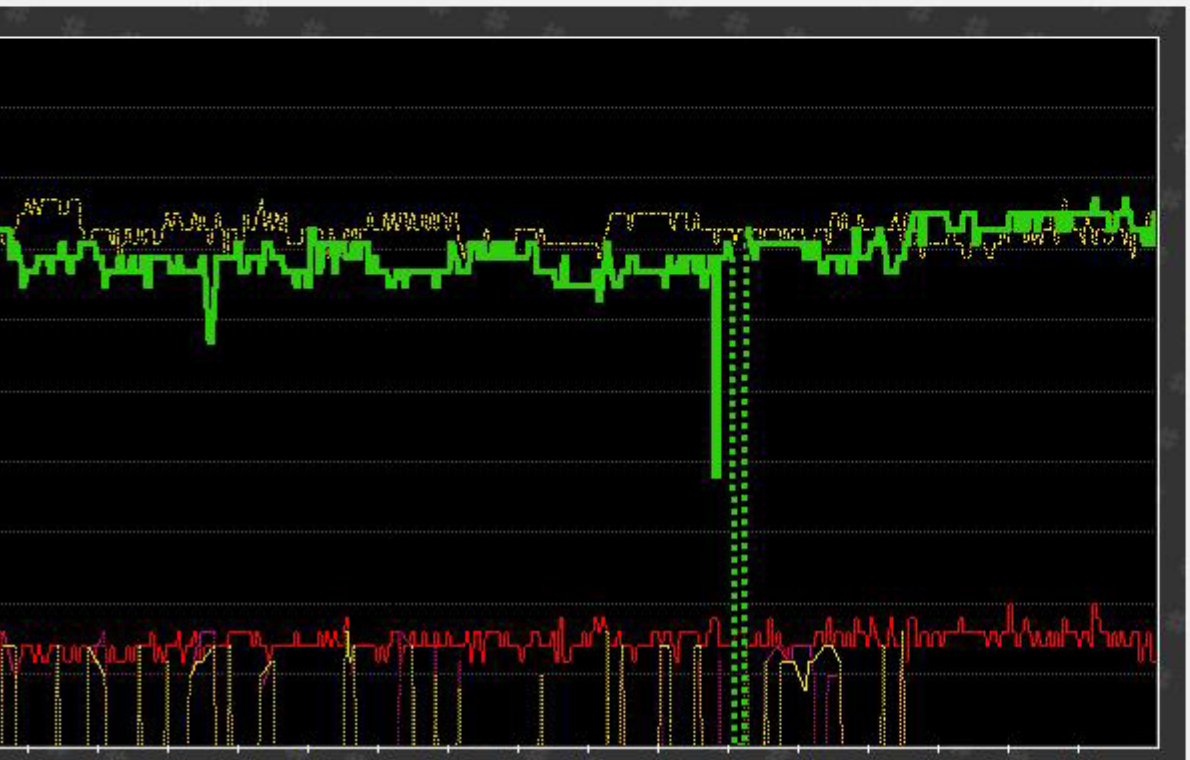
35 x 1024 x 768 x 16 = 440401920 bits/sec = 440 Mb/S.

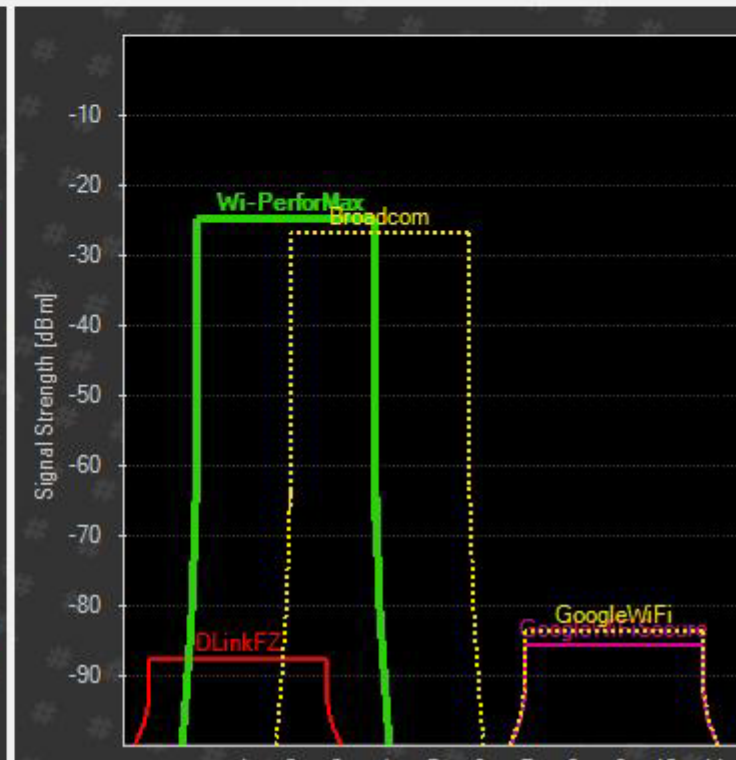
- The maximum measured 802.11n rate is 130 Mb/S

WildPackets Linksys WUSB600N Dual-Band Wireless-N USB Network Adapter #2

Channel Graph

endor	SSID	Channel	RSSI	Security	Network Type	Speed	First Seen	Last Se
opos Networks, Inc.	GoogleWiFiSecure	9	-100	RSNA-CCMP	Access Point	54	2:25:22 PM	3:12:28
opos Networks, Inc.	GoogleWiFi	9	-100	None	Access Point	54	2:25:28 PM	3:12:28
ELKIN COMPONENTS	DLinkFZ	1	-88	WPA-TKIP	Access Point	54	2:25:15 PM	3:16:06
	Broadcom	4	-27	None	Access Point	54	2:50:12 PM	3:16:06
	Wi-PerforMax	2	-25	RSNA-CCMP	Access Point	54	2:25:15 PM	3:16:06

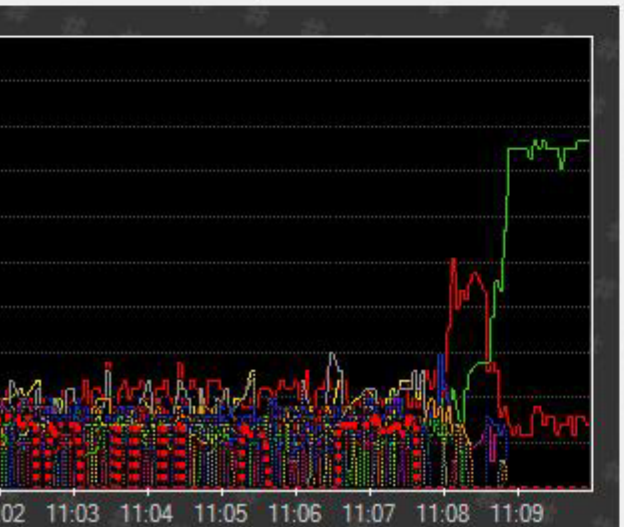


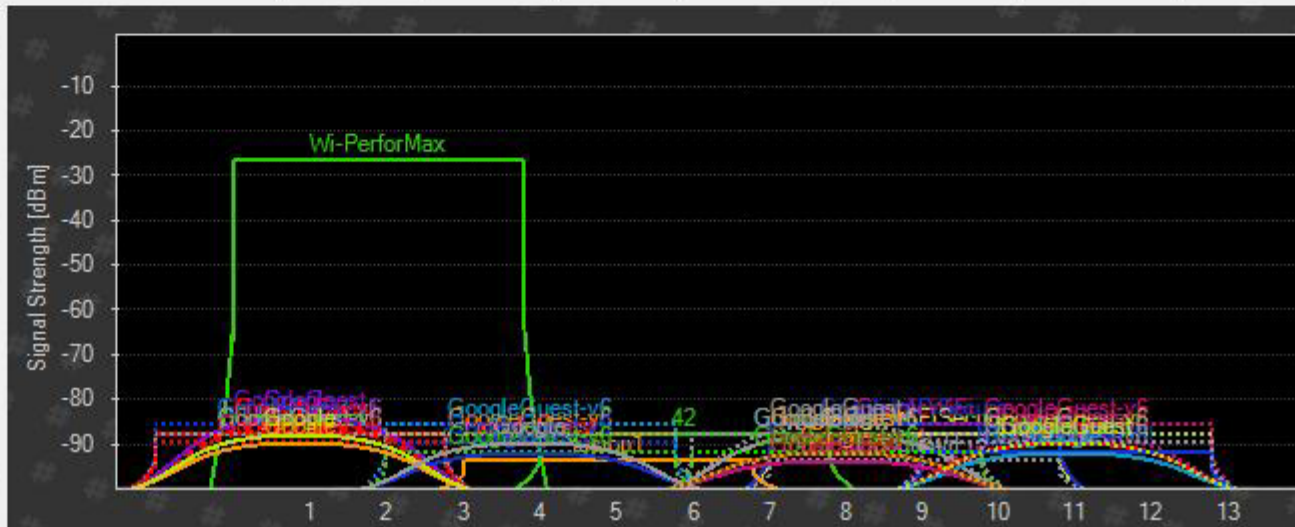


WildPackets Linksys WUSB600N Dual-Band Wireless-N USB Network Adapter #2

Channel Graph

endor	SSID	Channel	RSSI	Security	Network Type	Speed	First Seen	Last Seen
ELKIN COMPONENTS	DLinkFZ	1	-88	WPA-TKIP	Access Point	54	10:58:58 AM	11:09:57 AM
	Wi-PerforMax	2	-27	RSNA-CC...	Access Point	54	10:58:58 AM	11:09:57 AM
opos Networks, Inc.	GoogleWiFi	9	-86	None	Access Point	54	10:59:24 AM	11:08:48 AM
opos Networks, Inc.	GoogleWiFiSecure	9	-100	RSNA-CC...	Access Point	54	10:59:30 AM	11:07:59 AM
opos Networks, Inc.	GoogleWiFiSecure	9	-86	RSNA-CC...	Access Point	54	10:59:30 AM	11:08:48 AM
opos Networks, Inc.	GoogleWiFi	9	-94	None	Access Point	54	10:59:30 AM	11:08:46 AM
elkin International, Inc.	fusion1	5	-94	RSNA-CC...	Access Point	54	11:00:37 AM	11:08:48 AM
uba Networks	GoogleGuest-v6	8	-88	None	Access Point	54	11:00:37 AM	11:07:39 AM
uba Networks	Google	1	-84	RSNA-CC...	Access Point	18	11:00:41 AM	11:07:36 AM
uba Networks	GoogleGuest-v6	1	-88	None	Access Point	54	11:00:41 AM	11:07:36 AM
uba Networks	GoogleGuest	1	-84	None	Access Point	18	11:00:41 AM	11:07:36 AM
uba Networks	GoogleGuest	1	-100	None	Access Point	18	11:00:41 AM	11:08:10 AM
sco-Linksys, LLC	42	6	-100	RSNA-CC...	Access Point	54	11:00:41 AM	11:08:13 AM
uba Networks	GoogleGuest	11	-90	None	Access Point	18	11:00:51 AM	11:07:42 AM
uba Networks	GoogleGuest	11	-100	None	Access Point	18	11:00:55 AM	11:07:01 AM
uba Networks	Google	1	-100	RSNA-CC...	Access Point	18	11:00:55 AM	11:08:10 AM
uba Networks	Google	11	-90	RSNA-CC...	Access Point	18	11:00:55 AM	11:07:42 AM





Conclusions

Satisfaction of Interoperability Conditions is a must, necessary, but not sufficient to meet bandwidth demanding real time applications

- Different manufacturers' chipsets.
- Association and Authentication
- Minimum throughputs within operational ranges.
- Caching and pre-authentication.
- Countermeasure (MIC) attack resistance.
- Legacy mode protection.

Conclusions

Satisfaction of Performance Metrics is a must

- As stated in the IETF standards (RFCs) - 2544 as an example for benchmarking.
  Self characterized:
  * Limits on throughput values
  * Limits on Latency (and Jitter)
  * Limits on Packet Loss rates
  * Limits on back-to-back "burst" transmissions

Conclusions

Maintaining Relative Performance Measures requires performance testing that ensure “End User Pleasant Experience”

* On a unified scale, e.g. percentage scale of a reference golden design.

  Example:

  87.3% throughput of the golden reference design.

  +/- 3 ms of the average latency of the golden reference design.

  +/- 2% of the Packet Loss rate of the golden reference design.

  +/- 150 packets of the back-to-back "burst" size of the golden reference design at packet size 1024.

For more information

http://www.wi-performax.com