Motorola AP 6522 and AP 8132

802.11n Performance in High-Density Deployments vs. Ruckus ZoneFlex 7363 and 7982

EXECUTIVE SUMMARY

Most enterprises now rely on wireless LANs (WLAN) as the de facto network connectivity standard to deliver enterprise applications, including video. With WLAN playing an ever important role in the infrastructure, it has become the norm to expect wireless networks to support a high number of multiple types of applications like video and data simultaneously.

In addition, designing for dense environments, such as meeting rooms, auditoriums, banquet halls, classrooms and conference centers, requires proper planning, taking radio frequency channel and transmit power into consideration. A defining characteristic of dense deployments is close proximity of APs. Improper selection of channel and power settings can create what is known as adjacent channel interference (ACI), which degrades the overall network performance. The explosion of WiFi-enabled smartphones and tablets pose more challenges to the wireless network. According to Gartner, "Without proper planning, enterprises deploying iPads will need 300% more WiFi".

Motorola commissioned Tolly to evaluate the Motorola mid-range AP 6522 and high-end AP 8132 versus comparable offerings from Ruckus Wireless, the ZoneFlex 7363 and 7982. The Motorola APs outperformed Ruckus in ACI management, offering greater downstream throughput as well as better performance in video applications. See Figure 1.

THE BOTTOM LINE

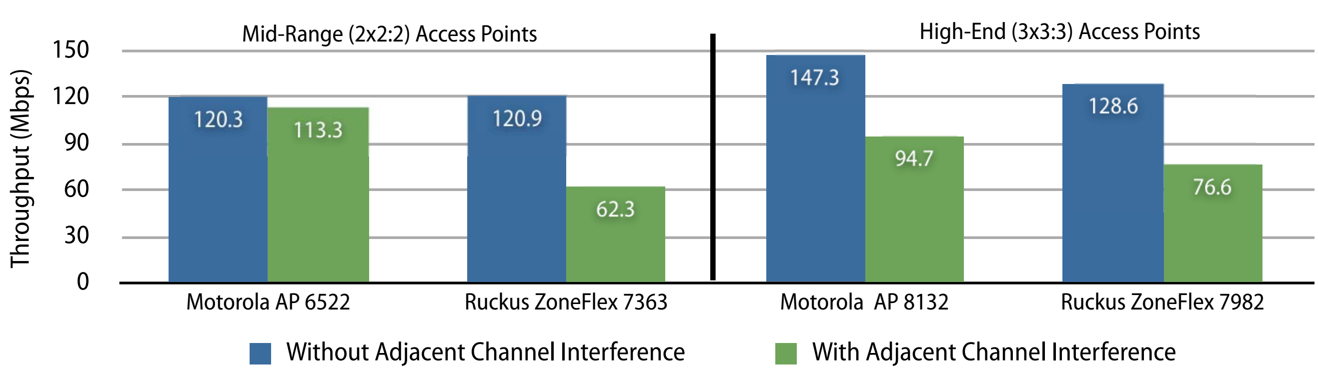
Motorola AP 6522 and AP 8132 provide:

1 Up to 81% more throughput compared to the beam-forming and antenna array-enabled Ruckus access points in high density environments

2 Up to 30 simultaneous video clients with acceptable quality when background traffic present, compared to fewer than 15 clients for Ruckus

3 Up to 6.5X faster power and channel selection time through Motorola SMART RF technology, compared to Ruckus' ChannelFly

5GHz 802.11n WLAN Dual AP, 48 Client Aggregate Downstream Throughput
(as reported by IxChariot 7.30 EA)



Source: Tolly, April 2013

Notes:24 clients per AP. 2.4GHz radios disabled for duration of test. APs on channels 157 and 165 for non-ACI test, channels 157 and 161 for ACI.

Figure 1

The Motorola AP 6522 and Ruckus ZoneFlex 7363 are multiple-input, multiple output (MIMO) access points that provide two transmitters, two receivers and two spatial streams (2x2:2 in MIMO parlance).

The Motorola AP 8132 and Ruckus ZoneFlex 7982 provide three transmitters, receivers and spatial stream (3x3:3).

Auto Power and Channel Selection

With two pairs of a given vendor's APs in a controlled environment (i.e. RF chamber), engineers verified the channel/power selections. While both vendor's APs chose appropriate power levels and channels, Motorola's AP did so in four minutes compared to more than 30 minutes for Ruckus.

Data Throughput

In multi-client tests without ACI, the Motorola and Ruckus mid-range APs provided similar throughput. With the high-end APs, Motorola's aggregate client throughput was ~19Mbps greater than Ruckus.

When ACI was introduced, results differed significantly. The throughput of the mid-range Ruckus ZoneFlex decreased by nearly 50% compared to only a 5% decrease for the Motorola AP 6522.

For the high-end APs, Ruckus experienced greater degradation with the Motorola AP 8132 delivering 18.1Mbps greater throughput than the Ruckus 7982.

Video Scalability & Quality

Video performance tests sought to benchmark quality as the number of clients increased with and without non-video background traffic. Excessive delay, jitter and frame loss impact the quality of video streams and, thus, the number of simultaneous streams that can be transmitted with acceptable quality.

Tolly engineers ran video traffic to up to 60 clients with varying background loads.

Tests showed that, with background traffic present, both Motorola APs could support 30 video streams of acceptable quality levels (see Test Methodology section for details) where Ruckus APs could only support fewer than 15 simultaneous clients within the bounds of acceptable quality. See Table 2.

Detailed Test Results

Auto Power and Channel Selection

In high density deployments, APs are positioned very near each other - as close as 10 to 15 feet in some cases. This AP setup will cause them to operate at very low power if they are set to select power levels automatically.

Motorola Channel and Power Selection

Access Point	Channel	Power (dBm)
AP1	36	4
AP2	153	4
AP3	48	4
AP4	161	4

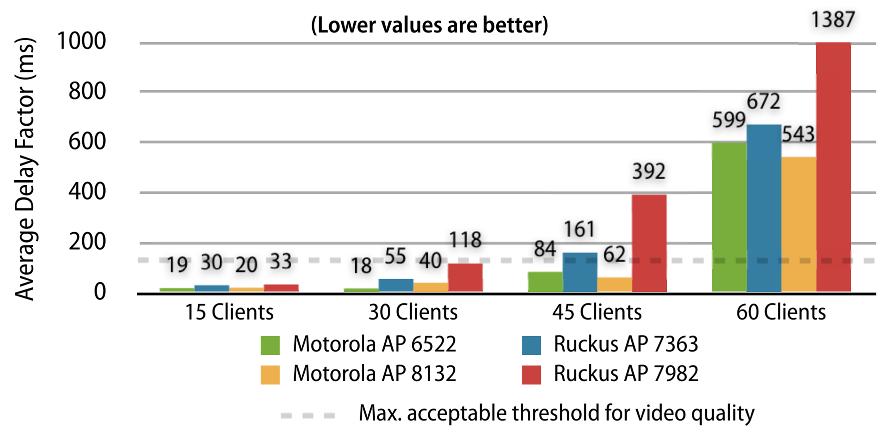
Note: Two each, Motorola AP 6522 & AP 8132.

Source: Tolly, April 2013 Table 1

In this test, Tolly engineers evaluated the the automatic channel and power selection capability of the Motorola and Ruckus APs.

Tolly found that both Motorola AP models selected the optimum power and channel settings very quickly and stayed consistent until another external source of interference was introduced. Motorola APs also avoided picking adjacent channels and

802.11n WLAN Video Streaming Performance - Average Delay Factor Without Background Traffic (as reported by IxChariot 7.30 EA)



Notes: For the purposes of this evaluation, a delay factor of 150ms was used as the threshold for acceptable video quality.

Source: Tolly, April 2013 Figure 2

operated at the lowest configured power of 4 dBM. See Table 1.

The Ruckus APs took more than 30 minutes to pick the appropriate channels. Tolly engineers also noted that the Ruckus APs changed channels often, even though the APs were placed in a clean environment without any external source of interference. When changing channels, one Ruckus AP picked up a channel that another AP was using, thus triggering a chain reaction where the second AP was forced to change its channel. Constant changing of channels can be very disruptive to connected clients, forcing the clients to drop their connection and re-associate.

The Ruckus ZoneDirector user interface does not provide detailed information about the current operating power of the AP. Without knowing the actual transmit power, designing for a wireless deployment could become challenging.

Performance: Data Traffic

To test the impact of adjacent channel interference on performance, Tolly engineers placed two access points of each type 20 feet apart. 48 clients, spread across both APs, were benchmarked without ACI and then again with both APs deliberately configured to adjacent channels.

As shown in Figure 1, the Motorola AP 8132 access point provided 15% more throughput as compared to the Ruckus 7982 in a high density environment when the APs were operating on non-adjacent channels. The Motorola AP 8132 provided 25% more throughput when neighbor APs were operating in adjacent channels.

The throughput of the Motorola AP 6522 and Ruckus AP 7363 was comparable when the APs were operating on non-

Motorola Solutions, Inc.

AP 6522 and AP 8132

Tolly. Certified

Video Quality and Performance Evaluation

Tested April 2013

WLAN Video
Maximum Number of Clients Supported with Acceptable Quality

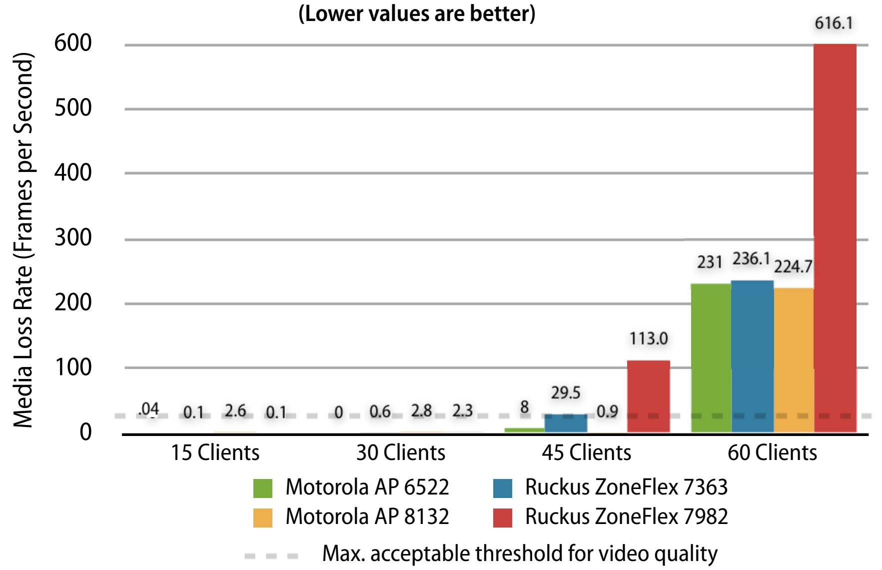
Without Background Traffic	
Access Point	# of Clients Supported
Motorola AP 6522	45
Ruckus ZoneFlex 7363	30
Motorola AP 8132	45
Ruckus ZoneFlex 7982	30

With Background Traffic	
Access Point	# of Clients Supported
Motorola AP 6522	30
Ruckus ZoneFlex 7363	fewer than 15
Motorola AP 8132	30
Ruckus ZoneFlex 7982	fewer than 15

Source: Tolly, April 2013 Table 2

802.11n WLAN Video Streaming Performance
Average Media Loss Rate (in Frames per Second)
Without Background Traffic
(as reported by IxChariot 7.30 EA)

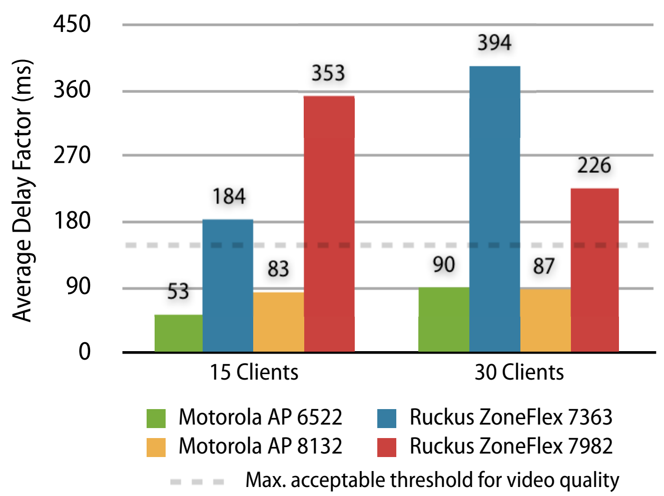
(Lower values are better)



Notes: For the purposes of this evaluation, a media loss rate (MLR) of 30fps was used as the threshold for acceptable video quality.

Source: Tolly, April 2013 Figure 3

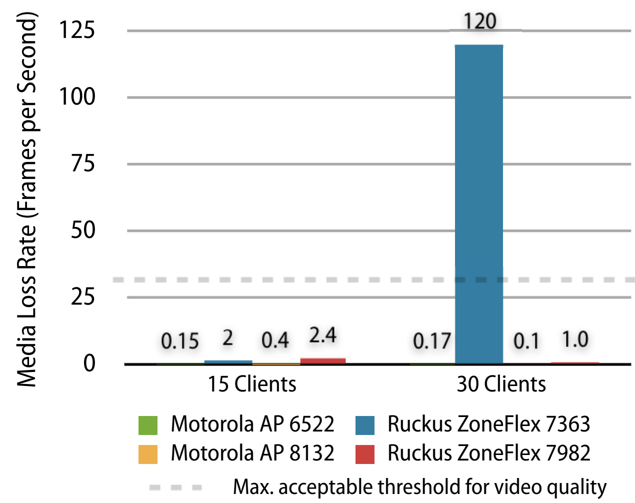
802.11n WLAN Video Streaming Performance
Average Delay Factor
With Background Traffic
(as reported by IxChariot 7.30 EA)
(Lower values are better)



Notes: For the purposes of this evaluation, a delay factor of 150ms was used as the threshold for acceptable video quality.

Source: Tolly, April 2013 Figure 4

802.11n WLAN Video Streaming Performance
Average Media Loss Rate
With Background Traffic
(as reported by IxChariot 7.30 EA)
(Lower values are better)



Notes: For the purposes of this evaluation, a media loss rate (MLR) of 30fps was used as the threshold for acceptable video quality.

Source: Tolly, April 2013 Figure 5

adjacent channels. However, the throughput of the Ruckus AP 7363 decreased by almost 50% when the test was repeated with APs on adjacent channels. The throughput for the Motorola AP 6522 was 81% more compared to the throughput of the Ruckus AP 7363 when the APs were on adjacent channels. See Figure 1.

Performance: Video

The amount of video data consumed over wireless is growing dramatically. A single video stream can consume significant bandwidth. When there are multiple users streaming simultaneously, guaranteeing high quality video delivery can become a challenge.

To evaluate the ability to which each AP under test could prioritize video traffic, Tolly engineers connected a mix of HP Laptops and iPads (3rd and 4th generation) to a single access point under test.

To evaluate the video quality, Tolly engineers measured delay factor (DF)[1] and media loss rate (MLR). A DF of over 150 ms was considered "poor" video quality. A MLR rating of over 30 frames per second is also considered "poor" video quality. Each scenario was tested with 15, 30, 45 and 60 clients without background traffic, and on 15 and 30 clients with background traffic.

Without background traffic, the two Motorola APs consistently delivered better streaming with lower delay factor and media loss rate than the two Ruckus APs for up to 60 clients. See Figures 2 and 3.

With background traffic, the Motorola AP 6522 and AP 8132 delivered a delay factor of 53ms and 83ms, respectively, while the two Ruckus APs posted a DF of 184ms and 353ms, respectively, well outside of the defined limit for "acceptable" delay of 150ms. See Figure 4.

With background traffic, all APs under test delivered acceptable MLR ratings of well under 30 frames per second, with the exception of the Ruckus 7363 at 120 frames per second with 30 clients.

[1] The Media Delivery Index (MDI), an emerging industry quality measurement, is comprised of delay factor (DF) which measures jitter and 'media loss rate' (MLR) measures the frames loss rate. A delay factor of less than 50ms is considered to be desirable while a delay factor of up to 150ms is acceptable, and a frame loss of zero is ideal, but up to 30 FPS is acceptable.

Test Methodology

Tolly evaluated two enterprise WLAN solutions. Each solution included an enterprise WLAN controller and access points.

The Motorola solution consisted of the Motorola RFS 6000 Wireless Services Controller, version 5.4.2.0-030R, an AP 8132 (3x3:3) and AP6522 (2x2:2), running the same code version as the controller.

The Ruckus solution consisted of the Ruckus ZoneDirector 3025 controller, the ZoneFlex 7982 (3x3:3) and ZoneFlex 7363 (2x2:2), all were updated to code version 9.5.1.0.50. See Table 4.

All testing was conducted on the 5GHz band. 60 wireless clients were used to generate traffic on the network. Each of the 48 HP ProBook 4510 had an Intel Core i5 processor and 4GB RAM, running Microsoft Windows 7 SP1. Each client was equipped with an Intel 5100 AGN wireless chipset. 2 Apple iPad 3s and 10x iPad 4s were also used, all were updated to the latest available release. See Table 3.

Ixia Performance Endpoint 7.30 EA b15 was used on all clients in conjunction with a wired Ixia IxChariot 7.30 EA console on a Gigabit Ethernet network to simulate network traffic loads. For the video performance portion, prioritization options were enabled for both solutions.

Auto Power and Channel Selection

To evaluate the RF management capabilities of each solution, engineers placed each solution in an RF chamber, free from rogue wireless signals.

Test Equipment Summary

The Tolly Group gratefully acknowledges the providers of test equipment/software used in this project.

Vendor	Product	Web
Ixia	**IxChariot v7.30 EA**	IXIA TESTED http://www.ixiacom.com

Client Density Test Configurations
Breakdown of Total Number of Clients by Device Type

Total Number of Clients	Laptops	iPads
15	12	3
30	24	6
45	36	9
60	48	12

Source: Tolly, April 2013 Table 3

Motorola APs and WiNG5 Architecture

Motorola's access points and WiNG5 SmartRF have been engineered to support dense user environments, where more radios have to be deployed to provide reliable client connectivity and capacity for meeting rooms, convention halls and classrooms.

The test results demonstrate Motorola's advantage in an environment of dense mixed clients, with background traffic, while providing low latency for real time applications such as video.

For more information, scan the QR code to go to the Motorola website.

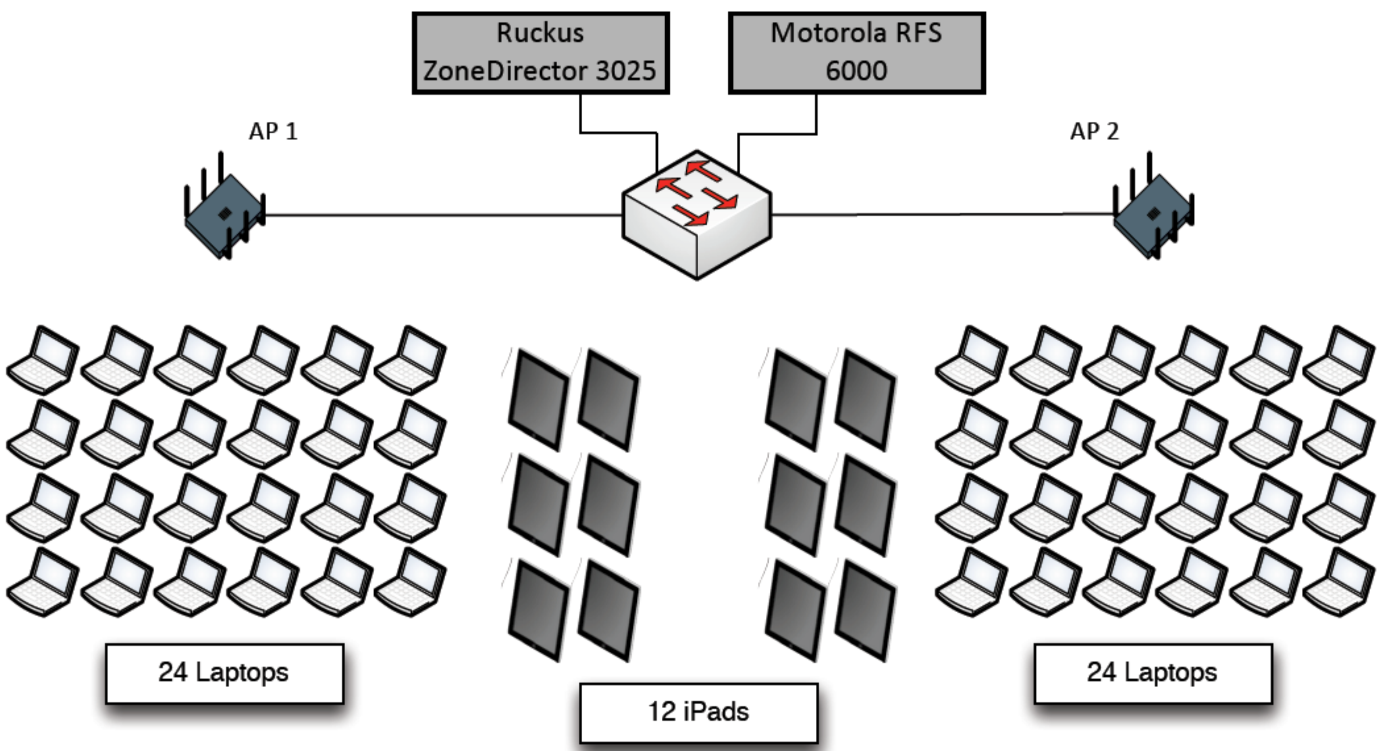
Source: Motorola, June 2013

802.11n WLAN Solutions Evaluated

Vendor	Controller		Access Point(s)	
	Model	Version	Model	Version
Motorola Solutions, Inc.	Motorola RFS 6000 Wireless Services Controller	5.4.2.0-030R	AP 8132 / AP 6522	5.4.2.0-020R
Ruckus Wireless, Inc.	Ruckus ZoneDirector 3025	9.5.1.0.50	ZoneFlex 7363 / ZoneFlex 7982	9.5.1.0.50

Source: Tolly, April 2013 Table 4

Test Bed Topology



Source: Tolly, April 2013 Figure 6

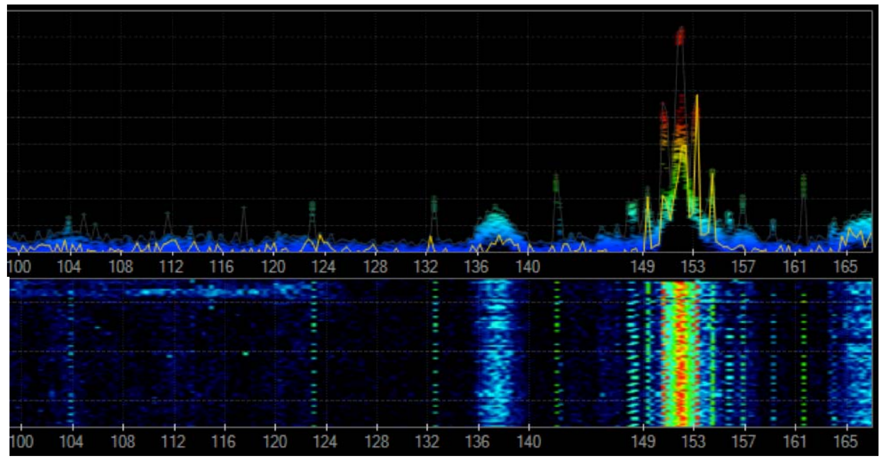
Tolly engineers defined the available channels on each of the solutions as 36-48 and 149-165, providing a total of 9 channels for the APs to spread over.

The solutions were powered on, and engineers used a MetaGeek Wi-Spy and Chanalyzer to view each APs channel selection. Additionally the controller for each solution was used to record the channel and power selected for each AP.

Engineers used a 5GHz video transmitter to introduce interference on the higher channels in the 5GHz band to evaluate how each vendor mitigates device interference. Upon starting the interference, any AP operating on the same channel would migrate to a new one within 30 seconds.

For another test of interference mitigation, engineers set one AP to operate on channel 153. Using a single client, engineers started a ping to each controller. While the traffic was passing, engineers introduced interference peaking on channel 153 and saw all traffic drop for each AP. Moving the interference to channel 157, engineers still witnessed traffic dropping for all solutions. It was only when the interference was moved to channel 165, that traffic resumed passing on channel 153. It is important to note that the interference was not solely confined to a particular channel, and bled across much of the upper spectrum. See Figure 7.

5GHz Source Interference Waveforms



Source: Tolly, April 2013

Figure 7

Performance: Data Traffic

For each pair of similar APs, engineers configured each on channels 157 and 165, (using 20MHz Bandwidth) and associated 24 clients to each AP.

Downstream traffic was passed to each client using IxChariot, and the results recorded. One AP was then manually assigned to channel 161, such that the APs were on adjacent channels. Engineers passed traffic once again and noted the degradation in performance.

Performance: Video

To test the video density of each AP, Tolly engineers configured one AP at channel 165, and associated 15 clients (12 laptops and 3 iPads). IxChariot was used to create a 1.5Mbps MPEG-2 RTP stream, which would be delivered to each of the clients. The test was run and the delay factor (DF) and media loss rate (MLR) was used to determine the video quality. Another 15 clients were associated to the AP, and the test was rerun with up to 60 clients.

At each client density, after three runs had been executed, Tolly engineers started a separate IxChariot script on a static set of 12 laptops that generated FTP traffic on the network. Prior to running this test, engineers confirmed that the proper QoS settings were enabled for each solution.

The delay factor is a measure of latency and jitter within the video stream, and the general criteria for "good" quality is a delay factor less than 150ms[2]. The media loss rate is essentially packet loss for media applications, reported in datagrams per second that were lost. There is no generally accepted value for wireless applications, however Tolly has decided to limit this to no more than 1% frame loss. Given that IxChariot produces 2,989 datagrams per second for a 1.5Mbps video stream, the acceptable MLR was defined as 30 FPS. With this MLR, a transmission would experience an average loss of one media frame for every 100 frames sent.

[2] According to Ixia/Veriwave "Best Practices" guide for WLAN. See http://www.veriwave.com/gurus/white_papers.asp

About Tolly…

The Tolly Group companies have been delivering world-class IT services for more than 20 years. Tolly is a leading global provider of third-party validation services for vendors of IT products, components and services.

You can reach the company by email at sales@tolly.com, or by telephone at +1 561.391.5610.

Visit Tolly on the Internet at:
http://www.tolly.com

Fair Testing Charter

In accordance with Tolly's Fair Testing Charter, Tolly invited representatives from Ruckus Wireless to participate in the evaluation. Ruckus representatives responded to the invitation and reviewed the test plan and configurations. Upon completion of testing, Tolly sent Ruckus the results as they pertained to their products under test. No response was received prior to publication of this report.

To learn more about the Tolly Fair Testing Charter, please visit:
www.tolly.com/FTC.aspx

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