Raising a Ruckus in the Google Classroom

DELIVERING UNRIVALED PERFORMANCE FOR CHROMEBOOK AND GOOGLE APP ENVIRONMENTS

Executive Summary
A few years past, Chromebooks were little more than a murmur, a Google experiment with full-fledged computers. And though some industries have yet to express interest in the Chromebook movement, the education market is taking notice in a big way.

In Q3 2013, 20% of the devices shipped to US K-12 education were Chromebooks, according to Futuresource Consulting. That number rose to 25% in Q4, and is certainly continuing to increase in 2014. Compare with 1% Chromebook market share in 2012, and you have a sharp and provocative trend.

Given the low initial price and ongoing cost, full keyboard experience, and cloud-enabled application ecosystem provided by Google, Chromebooks strike the right chord for a broad swath of the education market, both K-12 and higher ed. And it seems that Chromebooks are taking their share at the expense of a steeply declining Microsoft/Windows solution and a stationary (or slightly declining) iPad solution.

Figure 1: Q3 2013 Device Market Share for US K-12 Education (source: Futuresource Consulting)
Raising a Ruckus in the Google Classroom

DELIVERING UNRIVALED PERFORMANCE FOR CHROMEBOOK AND GOOGLE APP ENVIRONMENTS

Figure 2: A Sample of Chromebook Devices

Predictable Connectivity, Scalable Performance
The first priority for a school Wi-Fi network must be connectivity. If the WLAN can’t scale to support the client densities and application load of the network, nothing else matters.

Ruckus is focused on optimizing the network at this level with features like BeamFlex, which intelligently adapts the signal and optimizes it for each packet and each client. BeamFlex has a number of advantages over static legacy antenna designs:

• Improved signal quality at the client’s antenna, which maximizes data rates and reduces errors/retries
• Increased airtime efficiency, which ultimately leads to greater capacity
• Reduced interference with neighboring APs, making high density networking much easier to deploy with less congestion (due to directional antenna transmission)
• Equal benefit for all clients at all distances; client support not required

802.11ac Optimization
As 802.11ac comes into prominence, customers should scrutinize each vendor to ensure that they have a full product portfolio of 11ac devices. They should also evaluate unique 11ac technologies like 80 MHz channels and 256-QAM to make sure they can get the most from their AP.

Expect 1:1 initiatives to instigate even more demand for Chromebooks and the Google app ecosystem that comes with them. As educators have seen, the bliss of cloud-based apps is that they’re scalable and reliable, but the catch is that the device requires robust connectivity for reliable use of those apps. And as Google changes the competitive landscape for student computing, it should also shift network administrators’ approach to wireless connectivity.

Google Classroom Requirements
So what should the Wi-Fi experience for the Google classroom look like?

1. First and foremost, it must provide predictable connectivity. If wireless access is a prerequisite for student engagement, make sure it works.

2. Second, APs should deliver scalable performance with the capacity to support classroom apps, even with the entire classroom (and neighboring classrooms) actively using the network.

3. Third, classroom-friendly features should make Chrome network services, like Chromecast, simple and secure to use, regardless of the school’s deployment topology.

4. Finally, much like the Chromebook client devices, the WLAN deployment should be easy to configure and manage without breaking the bank.
80 MHz channels may be one of the key benefits of 11ac, but due to challenges with spectrum reuse, the benefits of wider channels may not be realized in many networks. Technology like BeamFlex can actively reduce interference with neighbor APs by steering energy only where it's desired (to the client). This ultimately makes 80 MHz channels more effective with better spectral reuse and less self-interference. This is critical for high capacity networks, especially those in education, where there's both a huge demand for data and a large number of devices.

256-QAM is another 11ac feature that potentially boosts data rates by 33%. But, more complex modulation requires an incredible signal-to-noise ratio, which you get from directional antenna transmissions. All the little optimizations amount to a better end-user experience with less helpdesk frustration.

**Band Balancing**

Nuanced network optimization features often have enormous implications for network performance. One such critical optimization for education deployments is band balancing. In recent years, it was enough to simply perform band steering, where all dual-band clients are steered to 5 GHz—because there were always too many clients on 2.4 GHz. Now that 5 GHz support is more common, it's possible to have an imbalance of clients on either 2.4 or 5 GHz spectrum.

The solution is to identify a proper balancing ratio between the bands and then let the AP control client distribution during the client connection process.

Later in this paper, we'll show the results of a test case in which we evaluated Ruckus' band balancing implementation with Chromebooks.

**Smart Roaming**

One component of solid connectivity is mobility and roaming. Though some Chromebook users may be more nomadic than mobile, most education environments also have other devices (including mobile phones) for which roaming may need to be optimized. Features like Ruckus’ SmartRoam, which includes 802.11k/r/v, can help devices with superb mobility transitions between APs, as shown in Figure 5 on the next page.

**Networking Made Easy**

Many IT teams are choosing Chromebooks for their ease of use and intuitive management features. It makes sense to ensure that the network solution provides similar tools for easy networking, straightforward setup and configuration, and simple troubleshooting.

**Chromecast**

In the Google classroom, Chromecast may be an important component to the teaching experience. Chromecast utilizes the same mDNS-based broadcast and discovery mechanisms used by Apple’s Bonjour protocol. For very simple home networks, mDNS works seamlessly, but as these technologies are introduced to multi-subnet school networks, the WLAN infrastructure requires extra intelligence to make the features work seamlessly.

Where Chromecast dongles and Chromecast-enabled client devices (like Chromebooks) operate on separate subnets, an mDNS proxy function may be required to bridge the service advertisements across subnets. Thankfully, due to its similarity to Apple’s use of Bonjour, the Ruckus mDNS proxy feature (sometimes referred to as a “Bonjour Gateway”) is already...
preparing to handle Chromecast discovery and forwarding across network segments. Administrators simply configure a service proxy rule (_googlecast._tcp.) from a specified source VLAN to a specified destination VLAN, and we handle the rest.

However, school deployment topologies vary widely, so make sure that Chromecast service handling is flexible, whether your network is centralized or distributed. With Ruckus, the centralized ZoneDirector appliance can serve as the mDNS proxy agent for a subnet. Bridging rules govern which services are forwarded from source to destination VLANs, as shown in Figure 6.

The AP can also serve as the mDNS proxy agent; AP configuration is as simple as Figure 6. Assuming client VLANs are distributed across a campus, an individual AP per subnet can be nominated as the proxy server for that VLAN.

Note that Chromecast discovery is performed over the Wi-Fi infrastructure, but the Chromecast service itself does not stream from the client to the dongle in all cases.

Test Cases

In the two test cases below, Ruckus set out to evaluate two key components of a best-in-class Chromebook deployment:

1. Chromebook connectivity with intelligent band balancing
2. Chromebook performance scalability in a classroom environment

Test #1: Band Balancing

As discussed earlier in the paper, band balancing is an optimization that seeks to create a healthy ratio of client connections on each radio band. But, configuring an optimal client balance is one thing. Making sure it works is quite another. Figure 7 shows the Ruckus configuration for band balancing in which the administrator simply sets a percentage. In the first test of our case study, we set the ratio to 25% on 2.4 GHz.

For the test procedure, we connected all 30 Chromebooks (Samsung 2) to the AP, then evaluated the client distribution on 2.4 and 5 GHz radios. Shown in Figure 8, the first test result was as expected, where 7 (23%) of the Chromebooks joined on 2.4 GHz and 23 (77%) of the clients joined on 5 GHz. Table 1 shows the results of all band balancing tests conducted at different band balancing ratios. All tests delivered a perfect result.
Raising a Ruckus
in the Google Classroom
DELIVERING UNRIVALED PERFORMANCE FOR
CHROMEBOOK AND GOOGLE APP
ENVIRONMENTS

Test Setup
Though some classes are smaller and some larger, 30 client devices typifies a classroom for our customers. Many such classrooms depend on video for instruction and seamless connectivity for file sharing, collaboration, or testing. Teachers are also utilizing sharing technologies, like Chromecast, to project their laptop to a larger display.

The components and devices of the Chromebook test are detailed below.

Applications and Clients
Our test incorporates these common applications found in classrooms:
• High density MP4 video streaming (29 Chromebook clients)
• Chromecast discovery and streaming (1 Chromebook client, 1 Chromecast dongle)
• 1GB FTP file transfer (3 MacBook Pro clients)

Initial testing revealed that some APs (including Ruckus) were more capable of delivering high quality video streams to the 30-client Chromebook testbed without visual impairment, but others were less capable. Due to the subjective nature of evaluating video quality, we opted to lower the source video quality until all APs could deliver it without noticeable impairment.

Servers
Four video servers (using Microsoft IIS) and 3 FTP servers (using Filezilla) were used in the test to distribute server load and avoid any possibility of performance bottlenecks other than the Wi-Fi network itself. All servers were Dell laptops with gigabit Ethernet connections, which were tested to ensure that they delivered gigabit (950+ Mbps) service on the wired network.
Access Points

The APs in the test are dual-band 11ac 3-stream with the latest available firmware at the time of test, summarized in Table 2. Controllers and/or management platforms were used according to architectural best practices for each vendor.

As a visual reference, the test topology, APs, and client devices are shown in Figure 9.

Test Process

The test is designed such that the high-density video streaming serves as a baseline load for the network. Intentionally, we lowered the video quality below 1080p to ensure that all APs could deliver this baseline.

The performance evaluation for this test is determined by an AP’s ability to quickly transfer files while delivering the video to the Chromebooks.

All APs were ceiling-mounted in the same location and powered off until the test run. APs all used the same 80 MHz channel (149 as primary) and all clients were connected to the 5 GHz radio.

We conducted each test 3 separate times over 3 consecutive days to avoid any potential biases in sporadic interference. Each test was comprised of 5 runs for each AP, so there were a total of 15 runs per AP for the downlink test and 15 runs per AP for the uplink test.

To conduct the test, we started the video stream on all Chromebooks, mirrored a video stream to the Chromecast-enabled display, and then initiated the 1GB FTP file transfer on all 3 FTP clients. We ran separate tests for downlink and uplink, and measured file transfer times for each of the three MacBook Pro laptops, which were then averaged together.

Table 2: Vendor Access Points and Controller/Manager Summary

<table>
<thead>
<tr>
<th>Access Point</th>
<th>Controller/Manager</th>
<th>Firmware</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ruckus R700</td>
<td>ZoneDirector 3000</td>
<td>9.8.0.0.369</td>
</tr>
<tr>
<td>Cisco 3700</td>
<td>WLC 5508</td>
<td>7.6.120.0</td>
</tr>
<tr>
<td>Aruba 225</td>
<td>3200 Controller</td>
<td>6.4.1.0</td>
</tr>
<tr>
<td>Meraki MR34</td>
<td>Cloud Controller</td>
<td>Latest Available</td>
</tr>
<tr>
<td>Aerohive 230</td>
<td>HiveManager Online</td>
<td>6.1r6a</td>
</tr>
</tbody>
</table>

Figure 9: Performance Test Topology
Results
The downlink and uplink FTP results were averaged across all runs and are shown in Figure 10 and Figure 11, respectively.

Figure 10: Downlink FTP Transfer Time

<table>
<thead>
<tr>
<th></th>
<th>Ruckus</th>
<th>Meraki</th>
<th>Cisco</th>
<th>Aruba</th>
<th>Aerohive</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>91</td>
<td>111</td>
<td>121</td>
<td>139</td>
<td>140</td>
</tr>
<tr>
<td>80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>120</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>140</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 11: Uplink FTP Transfer Time

<table>
<thead>
<tr>
<th></th>
<th>Ruckus</th>
<th>Meraki</th>
<th>Cisco</th>
<th>Aruba</th>
<th>Aerohive</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>84</td>
<td>95</td>
<td>107</td>
<td>111</td>
<td>129</td>
</tr>
<tr>
<td>80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>120</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>140</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Preliminary testing showed that some APs were more capable of delivering high capacity video streams to a classroom, but our focus in this test on FTP transfer times reveals that Ruckus is indeed the highest-capacity Wi-Fi solution available with the fastest file transfer times.

The same Ruckus performance advantages demonstrated by this test also lead to other real-world benefits:

- better end-user experience, regardless of application
- fewer APs deployed for equivalent capacity and coverage
- lower cost to deploy
- fewer ongoing support requirements
- more margin for network growth, new devices, and new applications

Conclusions
The applications and devices used in today’s classrooms require a fantastic network experience. Chromebooks up the ante with a dependency on cloud-based apps and services that put the wireless link in the line of duty. The good news is that the right set of products, features, and optimizations make robust Wi-Fi attainable, affordable, and easy to use. Want best in classroom Wi-Fi? Ruckus has a degree in that.