Customer Case Study

Cisco Live - Orlando 2013
Behind the Wi-Fi Network

Business Solution

Cisco Live is one of the world's largest annual networkers' conferences. Cisco Live Orlando 2013, held at the Orange County Convention Center, had a record attendance of 20,000 attendees, more than 200 technology and solutions partners, and over 750 information sessions over a period of five days. It was a challenge to build and sustain a highly consistent wireless network that met the demands of these Internet and bandwidth hungry users and their devices.

Wireless infrastructure deployed at the Orange County Convention Center & Peabody Hotel provided free Wi-Fi connectivity to all Cisco Live attendees in approximately 7 million square feet of floor area.

A reliable wireless network is a prominent requirement when it comes to serving such a large audience, each person carrying more than one Wi-Fi enabled device. There were challenges beyond the usual wireless interference, exceeding channel utilizations, and bandwidth constraints. From the regulated propagation of the RF that enables connectivity to mobile devices, to optimizing the wireless infrastructure for dense connectivity, to designing the wireless architecture around the aesthetics and physics of the environment, every complication was worked through to provide a an enriched wireless experience.

Cisco's Network Operations and Advanced Services teams joined with a group of Cisco Network Academy interns to deliver a pleasing, robust, and pervasive Wi-Fi experience to all the participants. The team successfully managed a dense wireless network peaking over 13,300 unique & active Wi-Fi connections with a 0% network downtime.

Wireless Network Infrastructure

Pre-staging of the wireless network infrastructure began months before the event, at Cisco's headquarters in San Jose, California. Determining the placement of the network's access points was a crucial aspect of the planning. The Advanced Services team used tested strategies including directional antennas and designing for capacity over coverage. Members of the team made multiple trips to the site to survey and take precise RF measurements.

To implement the best-in-class high density deployment it was necessary that the task force select the right WLAN infrastructure equipment. The final RF design was based on the wireless site-surveys and factors such as small cell size RF propagation, SNR degradation, RF gain, high capacity, and coverage.

10 x Cisco **5508 Wireless Controllers** with High Availability, 1 x **Cisco Prime Infrastructure** to manage, control, and monitor the wireless infrastructure, with **Cisco Mobility Services Engine** to acquire user analytics and locations

180 x Cisco **3502P Access Points** with dedicated **Stadium Antennas AIR-ANT25137NP-R** (7 to 13 dBi) to cover the Keynote and World of Solution Areas.

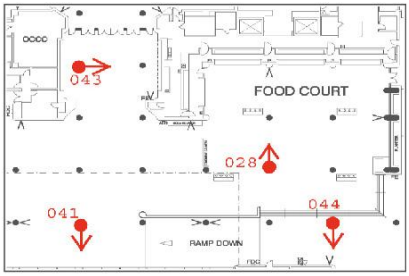
410 x Cisco **3602E Access Points** with dedicated **Patch Antennas AIRANT2566P4W-R** (6 dBi) to cover the hallways and session rooms. The infrastructure also comprised 87 wall and ceiling mounted access points to provide additional capacity in session rooms

Wireless Network Optimization

A key requirement was to optimize Wi-Fi connectivity on both 2.4 GHz and 5 GHz bands. Besides following Cisco's best practices to configure the controllers and access points, it was necessary to combine solid RF optimization techniques.

The access points with patch antennas were mounted 10 feet high on poles with a distance of 50 to 100 feet between each AP, aligned to the walls of the hallways and session rooms. This configuration forced the RF propagation at an angle of 60 degrees, focusing more RF energy in that particular area, thus eliminating any bleeding of the wireless transmission in neighboring cells and allowing an optimized wireless communication.

Patch antenna at an angle of 60 degrees toward the ground



An example of patch antenna deployment focusing RF in different directions to optimize coverage and capacity

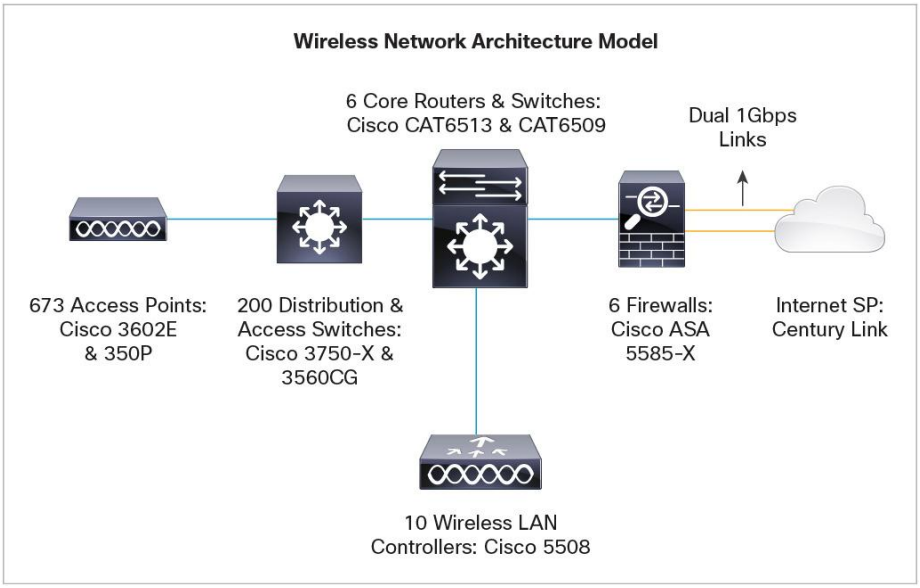
The Keynote Conference Hall and the World of Solution Booths Hall were equipped with access points and stadium antennas mounted on a 46 feet high ceiling, focusing RF at a 30 degree angle in micro-cell size to allow for maximum connectivity and performance in the user-dense environment. The entire wireless network supported both IPv4 and IPv6 traffic communications. In the World of Solutions and Keynote areas, IPv6 was passed over IPv4 so as to curb IPv6 traffic and reduce wireless network overhead. For maximum efficiency, three Cisco 5508 Wireless Controllers were used to control and manage the 180 access points deployed in these areas, while seven more managed the 410 access points deployed in the remaining hallways and session rooms.

Radio resource management (RRM) was enabled on the controllers to automatically adjust the power and channel assignments across all the access points, which allowed better frequency reuse through micro-cells. Due to the presence of an airport and weather radar near the vicinity, the DFS band for the 5 GHz network was not used to avoid any channel changes once the RRM set the channels. All 5 GHz channels were running on 20 MHz frequency, giving a total of eight channels to optimize for non-overlapping channels in the high-density environment.

All wireless users were aggregated on a single/16 subnet, to allow for roaming between the different locations and network management traffic on a/21 subnet. Additional management traffic overhead was eliminated by broadcasting only a single SSID “Ciscolive2013” across the entire event.

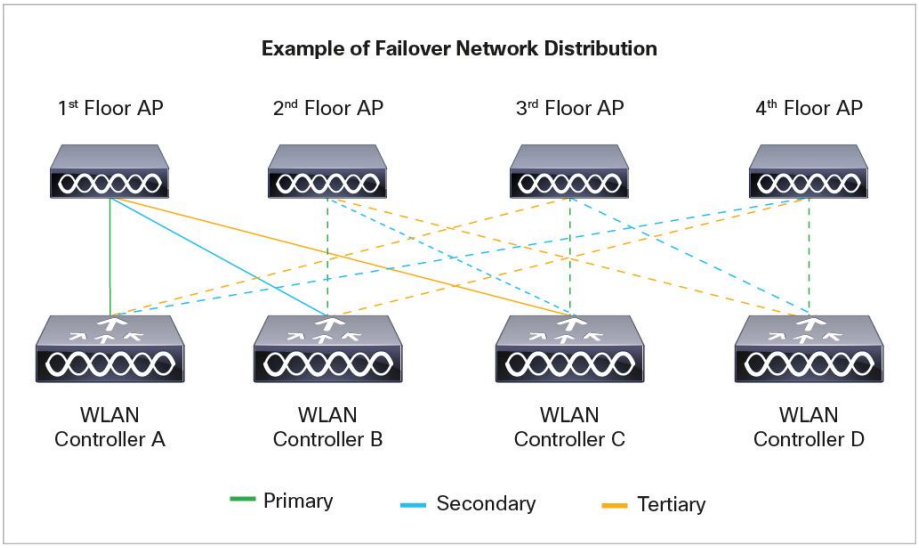
Wireless Network Architecture

The core network comprised of six network racks, placed on display for all Cisco Live attendees in the World of Solutions Hall. The wireless network model is shown below.



Click to view entire Cisco Live 2013 Network Topology

Access points were distributed among the three WLAN controllers to give each one a primary, secondary and tertiary controller failover connection. Access points on each floor were configured to join the same controller, and failover links were distributed to controllers on another floor. This configuration allowed an N+1 High Availability architecture for the wireless network. The example below shows the failover route in case the access point CAPWAP connection disconnects from the primary controller.



Wireless Network Statistics

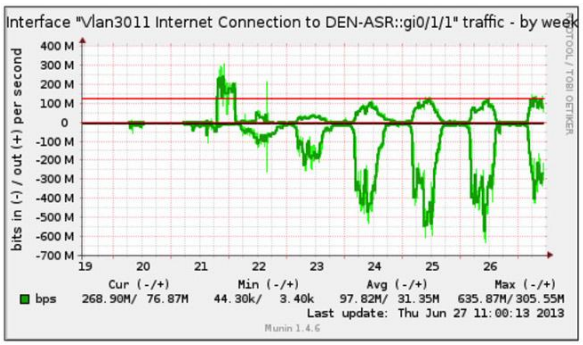
Some interesting data from the Cisco Live Orlando 2013 network:

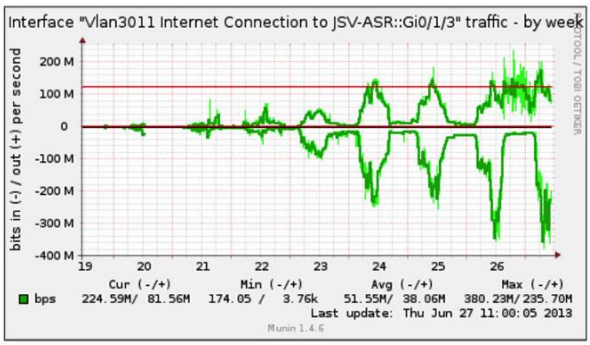
- Peak internet bandwidth usage of entire network was 1.4 Gbps
- Over 13,300 unique Wi-Fi devices observed each day
- Over 50% of the Wi-Fi devices on network were Apple, generating over 50% of traffic
- Nearly 54/46 distribution percentage ratio of 2.4 GHz and 5 GHz wireless devices
- Nearly 35/65 distribution percentage ratio of 2.4 GHz and 5 GHz wireless traffic
- Peak average channel utilization of 2.4 GHz was 85% and 5 GHz was 52%
- Over 690 million DHCP requests and 33,959 max active DHCP leases
- Over 122 million DNS lookups handled by our DNS server onsite
- Reliability for entire network was 99.999%+ with 0% downtime

Internet Link Statistics

Two 1 Gbps bandwidth links were provided from Cisco Live Orlando site to Denver and Sunnyvale; more traffic was observed over the Denver link due to its closer physical location and low latency. The total peak observed on the network was over 1.4 Gbps.

1 of 2: Link to Denver	2 of 2: Link to Sunnyvale
Total Link Capacity: 1000 Mbps	Total Link Capacity: 1000 Mbps
Max peak traffic observed: 615 Mbps	Max peak traffic observed: 940 Mbps

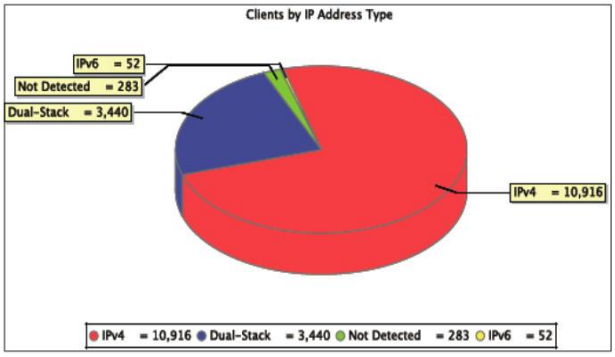


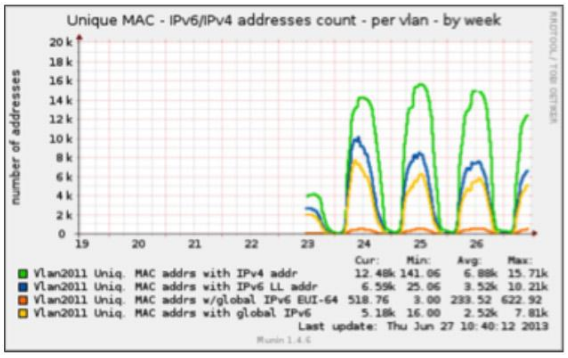


Wireless Clients Statistics

- **IPv4 vs IPv6**

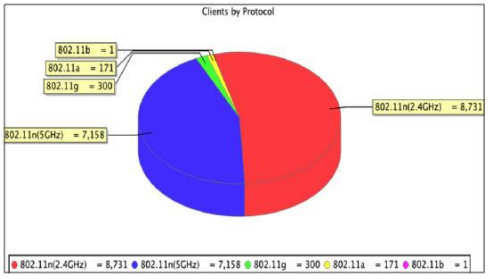
  Over 15,700 unique IPv4 and over 7,800 unique IPv6 MAC addresses.

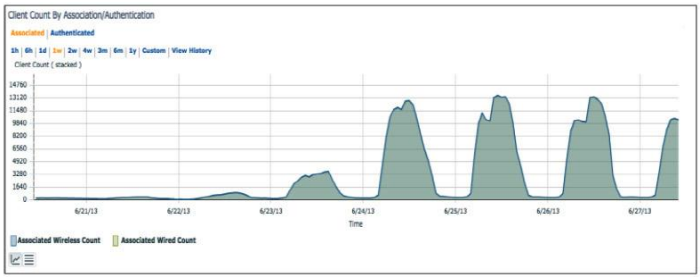




- **Total clients association**

  Nearly equal distribution observed on the 2.4 GHz and 5 GHz frequency bands throughout the event. Peak maximum number of unique client associations: 13,479



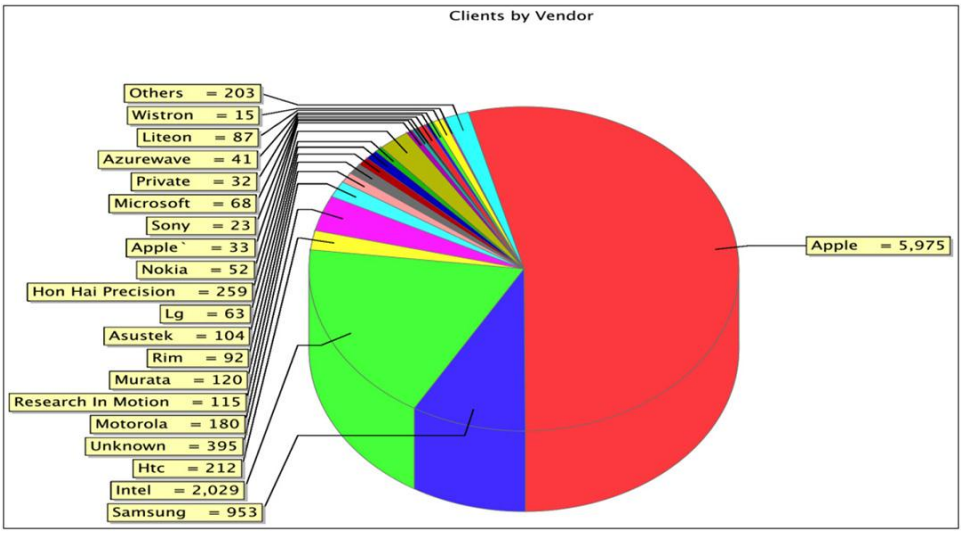


Protocol	Max Number of Clients	Average Number of Clients	Total Traffic (Gb)	% of Clients	% of Traffic
802.11n (2.4GHz)	15644	8731	3102.01	53.36	42.06
802.11n (5GHz)	13114	7158	4093.87	43.75	55.51
802.11g	518	300	116.63	1.83	1.58
802.11a	269	171	62.61	1.05	0.85
802.11b	1	1	0.05	0.01	0

- **Total client association by vendor type**

  Top five vendors

  - Apple: 6008 (57%)
  - Intel: 2029 (18.84%)
  - Samsung: 953 (8.66%)
  - Hon Hai Precision: 259 (2.48%)
  - RIM/BlackBerry: 207 (2%)

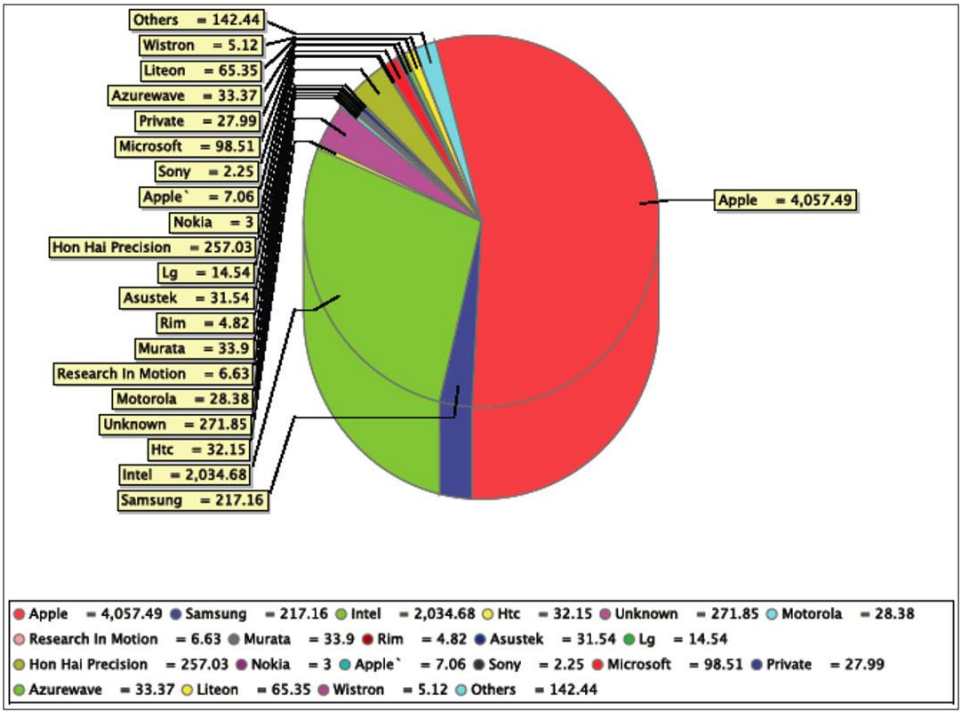


Wireless Data Traffic Statistics

- **Total traffic by vendors in Gb**

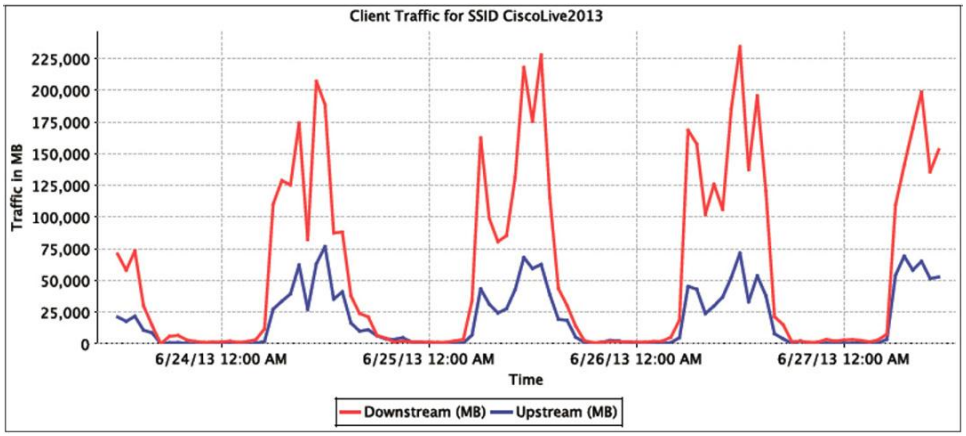
  Top five vendors

  - Apple: 4057 (55.02%)
  - Intel: 2034 (27.59%)
  - Hon Hai Precision: 257 (3.48%)
  - Samsung: 217 (2.94%)
  - Microsoft: 98 (1.34%)

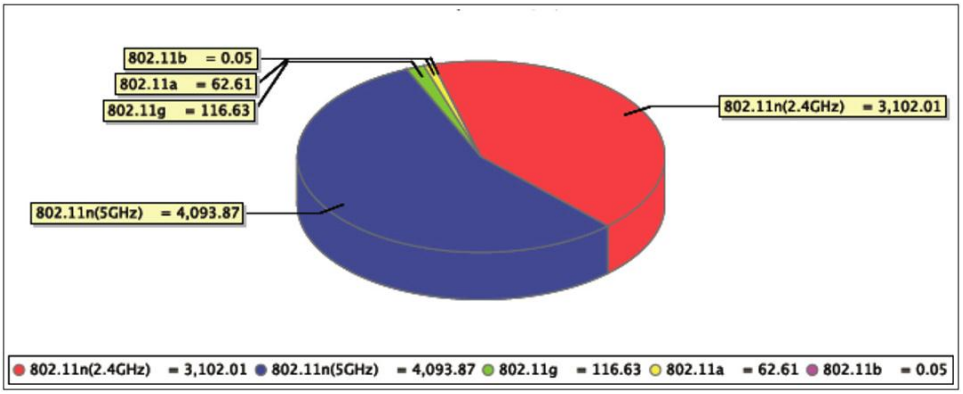


- **Downstream/upstream distribution**

  Downstream to upstream proportion was nearly 3:1 during entire event

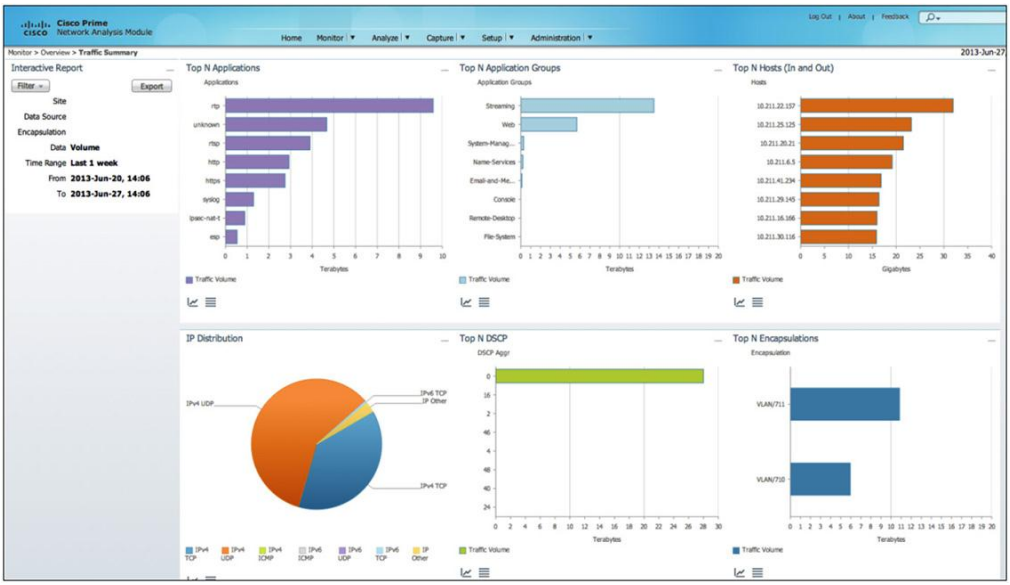


- **Total traffic passed by clients by protocol type in Gb**



- **Traffic type**

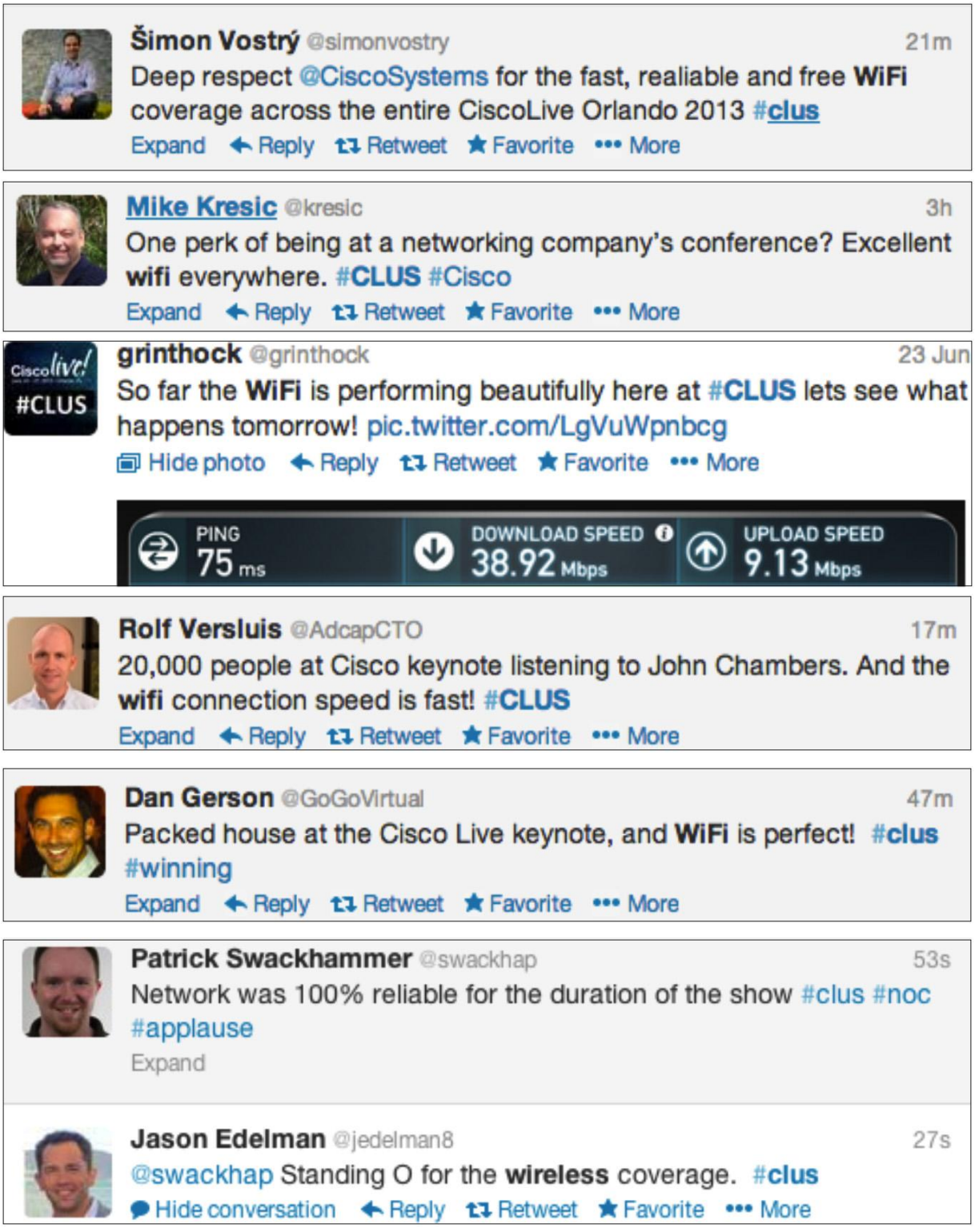
  Overall streaming videos consumed maximum bandwidth



User Feedback

User feedback and evaluating the user experience were important to the success of the wireless network at Cisco Live. During the four days of Cisco Live, we constantly evaluated the user experience through direct feedback, monitoring Twitter, monitoring Cisco Prime Infrastructure, taking over-the-air captures, and of course actually roaming around and using the network.

Almost immediately, attendees took to Twitter to voice their opinion. The tweets were overwhelmingly positive and continued to roll in throughout the show:



Tweets that included the tweeter's location were extremely useful. Based on tweets that came in, and verifying in Cisco Prime Infrastructure, we realized we had several breakout rooms that were underserved. For most of the breakout rooms we relied on the existing house access point in each room, but some rooms had more than 200 seats. So after the first day of breakout sessions, we installed an additional access point in eight rooms to supplement capacity.

Additionally, we also tried to be proactive with monitoring the user experience. This ranged from monitoring Cisco Prime Infrastructure; for instance, if we saw an overloaded access point in a corner, we knew we needed to disable data rates to encourage roaming. We actively surveyed the show-floor areas during the shows using tools from Fluke Networks.

Conclusion

From the beginning, user experience was the most important part of the wireless network at Cisco Live. We took great pains to ensure the best possible connectivity and performance, starting months before the show with initial site surveys and Wi-Fi designs and finishing with the post-deployment site survey. We faced a new set of challenges in extending Wi-Fi coverage into the World of Solutions and Keynote for the first time. Even with all this prep work, we didn't really know how the network would perform. Looking at logs and metrics only tell part of the story. For instance, traffic over the WAN peaked at 1.4 Gbps, which is both a Cisco Live record and the most traffic our ISP had ever seen from a trade show. Based on this, we had a good idea that the wireless network was performing well. It wasn't until the feedback rolled in that we knew for sure - Cisco Live 2013 set a new bar for user satisfaction under the most extreme loads.

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