KOMODO SYSTEMS

The Connected Stadium

komodo SYSTEMS

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Komodo Systems – Revealing Network Issues Only Visible to End Users

Wi-Fi is often mission critical and when end users complain, it can be very difficult to recreate an issue and perform root cause analysis. Komodo Systems addresses this by deploying small, cost-effective devices – Komodo Eyes – that simulate a user on the network by performing the same workflow as any mobile phone or laptop. The results of this workflow test are documented and reported back to the Komodo Dashboard and provide otherwise hidden information about network performance. The Komodo Eyes make network administrators aware of issues before the end users experience them. The Komodo Dashboard is accessible from anywhere in the world.

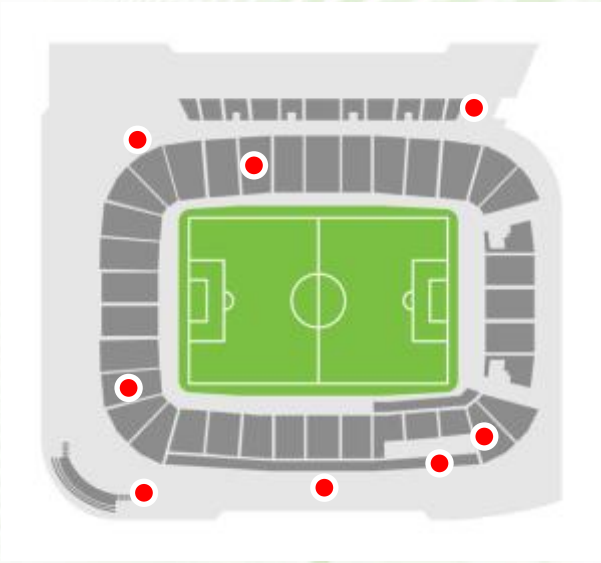
Background

The stadium has seating capacity for 20,000 soccer fans or 25,000 concert attendees. Aside from open air seating, there are luxury boxes, beer gardens, and media booths that all draw Internet from various SSIDs and hard wired connections. There is a 500Mbps circuit that serves the stadium as well as other co-owned properties in the area. The stadium has a 'cat-walk' above the open air stands, on which the majority of the access points are placed. All outdoor access points offer a high powered, directional beam targeted at specific fan sections. Other 360-degree coverage access points are used to cover press and luxury boxes.

Prior to deployment, the stadium had received poor reviews via social media regarding the Wi-Fi experience and even cell coverage. Press had issues with poor Wi-Fi coverage in the media box. Ticketing agents at the gates occasionally had issues with their Wi-Fi enabled ticket scanning devices, causing disruptions in traffic flow for fans and concert attendees.

Deployment

Komodo deployed 10 Eyes in two phases, covering vendor stands, ticket booths, media boxes, and fan seating. One Eye was placed in the main server closet to test the LAN connection and validate the ISP circuit speeds and packet routing. As the access points broadcast a very directional beam, each Eye was only able to see two to three access points in any given airspace. Of the hundreds of deployed APs roughly 10 access points and three SSIDs were targeted for testing. The goal of the deployment was to sample performance information in each of the target areas and extrapolate the data to all access points.



Because Komodo Eyes can test and report data over the same Wi-Fi channel, the Eyes only required a power source to function. Eyes testing vendor stands were hidden under tables or cash registers on available power strips. Eyes covering the media boxes were temporarily placed under desks and work benches in the hours leading up to and following a soccer match.

In order to cover ticket booths and fan seating, Komodo used small, USB battery packs providing power for roughly six hours, covering before, during and after matches and concerts. Eyes were hidden near ticket booths and gates in order to measure access point coverage and Wi-Fi performance in those hard to reach areas. Velcro was used to secure battery powered Eyes to the seat brackets in the fan seating areas, targeting sections that were thought to have poor access point coverage.

During deployment, each Eye was powered on and connections with one or more target access points were verified. The test assignments were set and loaded onto each device's memory. In this manner, each Eye could simply be placed in the

designated area, and as soon as it was powered on, would search for the target access point and SSID and begin testing immediately; no need for reconfiguration or calibration.

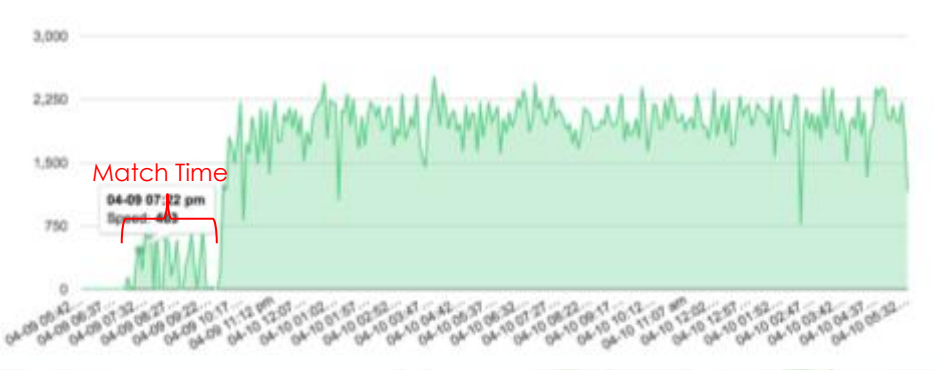
Discovery

Generally, in the first 1-2 weeks following any initial deployment, the Komodo Eyes uncover various areas for network improvement and optimization. The stadium network is robust and well covered by high performance access points. However, Komodo was able to uncover various areas in which the technical staff could optimize performance through access point placement changes, bandwidth allocation among SSIDs, and ISP routing changes.

Access Point Placement

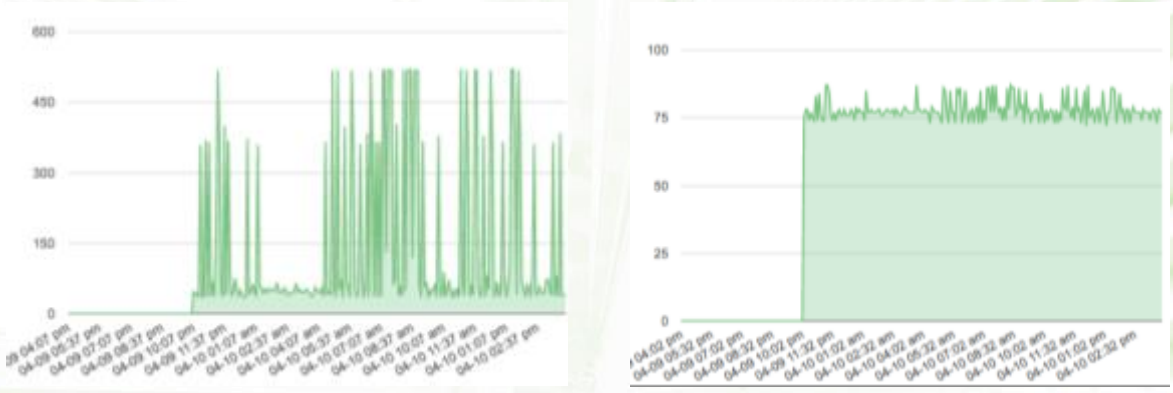
The Komodo Eyes were left in place for a number of weeks where feasible, including the ticket sales office and press box. Through these long term and game day deployments, it was discovered that the most poorly covered areas in the stadium were at the ticket gates and the ticket sales office.

Directional access points are used to broadcast signal down the concourse areas from both corners of the stadium. The majority of the concourse areas are well covered with good signal strength; however, the extreme ends are on the edge of the APs' power range. As a consequence, tests showed poor signal strength at specific fan access gates when the stadium was empty, and a nearly unreachable network when the stadium was full.



Download speeds during match time were roughly 75% lower than non-match time.

The ticket sales office is a small cinderblock building along one of the concourses. The majority of the work done in the office is via wired Ethernet connection. The deployed Komodo Eye discovered extremely poor signal strength from the access points broadcasting down the length of the concourses. Poor signal strength was concluded to be the sole cause of poor test performance in the ticket sales office.



Latency and Speed values, respectively, in an empty stadium

Komodo recommended deploying access points, or changing the angle of existing access points, covering the fan access gates. It was decided that Wi-Fi coverage in the ticket sales office was not business critical, and poor signal strength would be acceptable.

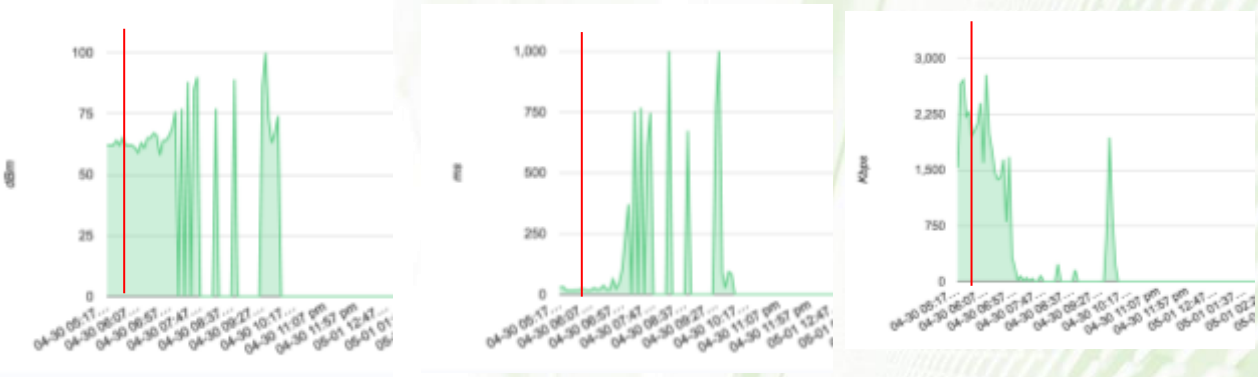
Bandwidth Allocation

At the stadium there are three wireless networks. The press is given a suite with indoor and outdoor seating, and Ethernet connections under each desk. Additionally, the press is given access to a specific SSID only broadcast in the press areas. A separate network is also provisioned for staff use, largely utilized before matches and on non-match days. A third network is open to all fans, without password authentication, and is broadcast on all access points.

During match day deployments, it was discovered that bandwidth before and after the match was more than sufficient for normal Internet browsing on all three networks. Staff and media networks were impacted during matches with a roughly 40% downturn in download speeds, largely due to the overall impact on the stadium circuit.

The fan network appeared to be the most significantly impacted during matches. Download speeds and latency readings were very fast before and after matches. As the stadium filled with fans, performance dropped precipitously.

Signal Strength *Latency* *Speed*



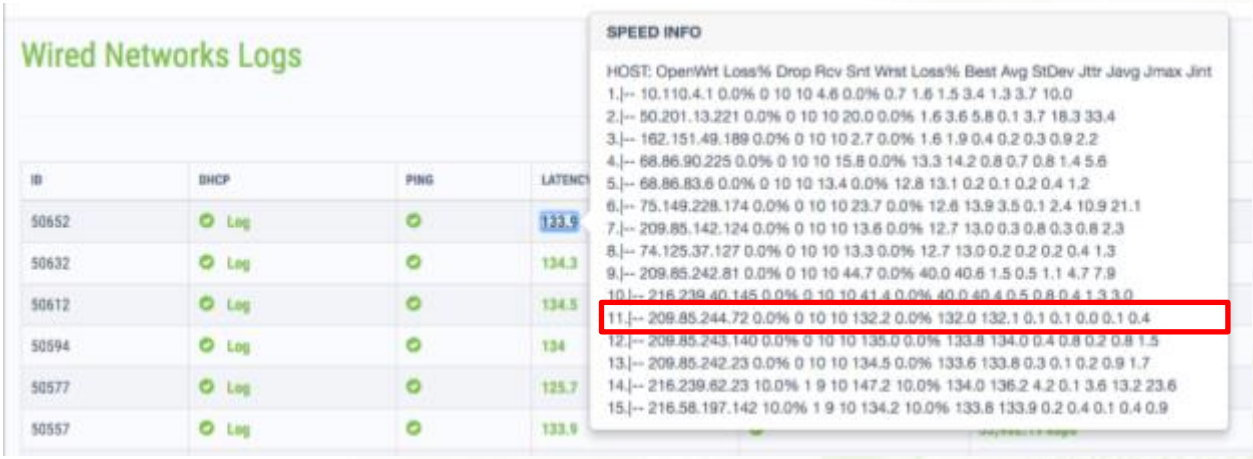
Red lines indicate match day gate opening. As the stadium fills with fans, tests results decline dramatically.

As the staff and media networks were not heavily utilized during matches, Komodo recommended service management staff re-allocate bandwidth among the three networks to favor the fan network more heavily during matches.

ISP Routing Changes

Using the trace route test from the Eye in the main server closet, it was discovered that during matches latency to www.google.com increased from 20ms to 130ms. The largest latency injection was consistently on Google servers. As these latency injections strongly correlated with match days, it was assumed that Google was gathering user data during matches.

Komodo recommended that the stadium managed service provider work with the ISP and Google to ensure that traffic is appropriately routed around servers that may be gathering information on stadium usage.



Looking Forward

Armed with data from the Komodo System the stadium IT service provider has the tools to fill coverage gaps around ticket agents, allocate available bandwidth to the fan network during matches, and work with the ISP and Google to ensure appropriate routing without significant capital expenditure. The Komodo System provided value immediately after implementation and will continue to provide value in perpetuity, as the Eyes remain in the environment, performing tests every 5 minutes to alert network engineers of issues in real time.