Designing High Density, Multipurpose Venue Wireless Networks

- a three-phased approach -

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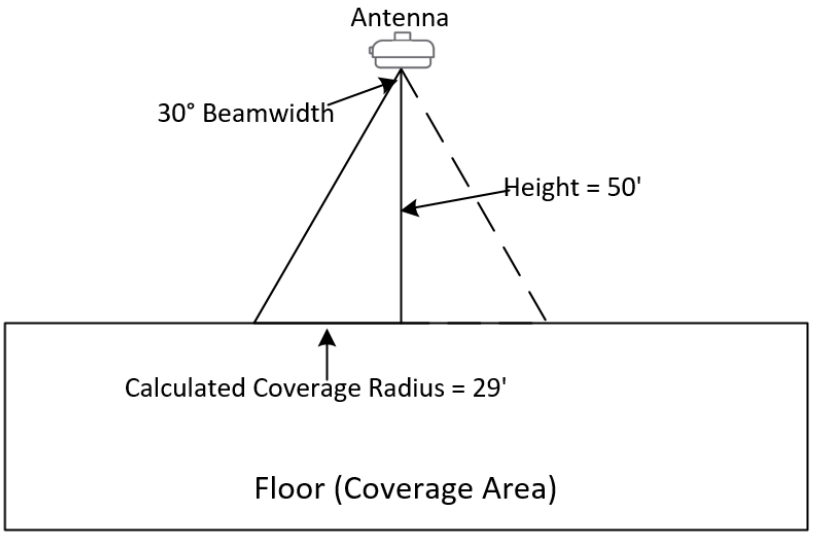
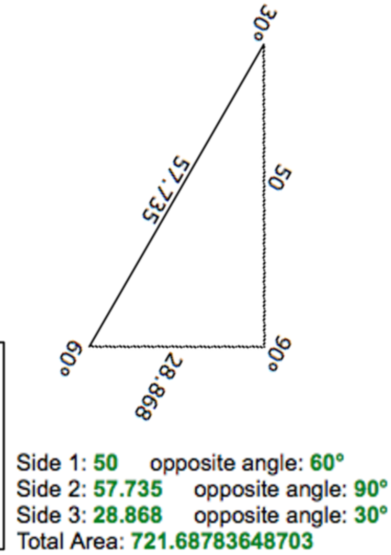
As with any new wireless project, it is best to break the project into three phases that are taught in the CWDP studies. The phases in this approach include designing the network, implementing the network, and validating the final product. This three-phase approach helps to ensure that all necessary steps are taken to ensure a quality product at project completion. The information included here details my efforts during a recent project where I designed a wireless network for a large arena.

The design phase of this project involved several steps, the two most important of which included meeting with the customer to determine the network requirements and performing a hybrid site survey that included predictive and APoS methods. After the requirements meeting with the customer, I acquired scaled drawings of the venue and used the network requirements to determine the venue would require two coverage models within the space. The necessity of two coverage models was due to the space being a multipurpose facility used for sporting events and trade shows. The first coverage model was for high density 5GHz coverage for 10,000 seats within two levels of bowl seating that would be predominately for BYOD (bring your own device) users. The second coverage model would be for floor coverage for trade shows and would require both 2.4GHz and 5GHz coverage, as many of the customer devices expected to be used in this space contained only 2.4GHz wireless chipsets. The customer meeting and requirements information was critical to the design process, as typical venues like this include very little 2.4GHz due to the lack of available channels and overcrowding of those channels.

Once these steps had been completed, I conducted onsite visits of the facility to examine the facility and confirm that the digital drawings were accurate. This involved counting the number of seats in each section and taking/comparing physical measurements of the space with the digital drawings. Once this information was confirmed, a second site visit was needed to determine access point mounting locations. Based upon the number of expected users and the wireless hardware manufacturer recommendations, coverage would be provided from access points with directional antennas placed approximately 50 feet from the users. After examining the antenna radiation patterns for the antenna selected, I calculated the rough coverage area for the antenna main lobe based on the antenna beamwidth. Due to the special design of this antenna that greatly suppressed the side lobes, I knew that I could place the antennas closer together for the coverage needed without causing a large noise floor increase in the adjacent coverage cells. In order to approximate the main lobe coverage area of each antenna, I used a formula to calculate the size of a triangle. The known height above the coverage area of the antenna and beamwidth were used to calculate the triangle size that would approximate the anticipated coverage area as shown in the figures below.





The figure on the left shows a sample drawing of the antenna above the coverage area and the measurements used to calculate the expected coverage radius. The formula calculations are shown in green text on the right. By calculating the approximate expected coverage radius, I used that measurement to form estimated coverage cells and place them onto the drawings of the arena to provide pervasive coverage. This draft coverage model was then used to count the estimated number of AP & antennas needed to provide coverage for the venue.

After I performed these calculations, I again visited the site to perform an APoS survey to determine if the calculated coverage was correct. I confirmed the actual coverage area of this AP & antenna combination in the venue by temporarily mounting the gear at a single location above a portion of the coverage area. Once the AP was online and configured to output the same power level to be used by the AP & antenna in the production network, I utilized a WLAN discovery tool (Netscout AirCheck G2) to measure the coverage area and found that the calculations preformed previously were accurate within 3 feet. This information was then used to modify the coverage cell sizes from the draft coverage model and create the final AP & antenna location map for hardware installation in the facility.

The implementation phase was monitored closely to ensure that the AP & antennas were mounted in the exact locations determined during the design phase. As mentioned previously, external antennas were used that required precision aiming to ensure areas were covered correctly. Prior to aiming the antennas, I utilized the calculations from the design phase in order to map out the center point of each AP & antenna in its coverage area, and placed high visibility stickers on the physical point the antenna would need to be aimed. In order to ensure precision aiming, I created an antenna template with a laser sight mounted in the center of the template that was strapped to the radome of each antenna. This aided me in the fine tuning of the antenna by providing visual feedback as to where the antenna was aimed.

After the APs & antennas were deployed during the implementation phase, a post installation validation survey was completed throughout the venue. This survey included utilizing Ekahau Site Survey in passive survey mode while walking the coverage area to ensure that pervasive coverage was achieved. It was also utilized to ensure that the APs were broadcasting using the expected channels based upon a channel plan I created for the building that ensured maximum channel reuse to prevent ACI & CCI as much as possible. Also used for validation of power levels was a Netscout AirCheck G2 to ensure that the needed requirements for SNR and coverage overlap were obtained throughout the coverage area. Finally, iPerf testing will be completed during a few large events to ensure that the expected performance levels are obtained.

Following the three-phase approach was critical to designing the wireless network for the arena. If I had not followed the steps and obtained the customer requirements on a greater level than simply “provide high density wireless access to the arena” it is possible that the final product would have not been able to provide the level of service needed by the customer. Post installation validation testing was also critical to confirming that the predictive modeling for the venue was correct, and that the expected coverage and capacity requirements were met.