Outdoor Wireless Networking – Discovery and Recommendation Report

This document collects the initial steps taken by DoIT Network Services and UW-Madison Campus partners toward the goal of establishing direction and formalizing prospective efforts surrounding outdoor wireless network service offerings.

Background

Outdoor wireless network services at UW-Madison were historically established by explicit requests from UW Departments by way of projects, or less-formally from Staff and Student correspondence. Some of these initiatives saw successful implementation, while others were met with challenges in the areas of budget, scoping, and aesthetic considerations. Considering those previous inconsistencies alongside emerging use-cases and increasing demand, there exists a demonstrated need for an informed and widely supported approach to outdoor wireless networking.

This initiative sought to evaluate current and expected demand for outdoor wireless networking services on campus. Steps were taken internally to enumerate service types and capabilities. That information gathering was enhanced by communications and interactions with campus partners, vendors, and peer institutions. A desirable outcome of these efforts would see movement beyond purpose-built or courtesy wireless services at discrete locations. A more contiguous topology with capabilities for further reach at the edges would enhance our ability to nimbly deliver solutions, in addition to offering a more consistent campus wireless user experience.

Internal Efforts

DoIT Network Services gathered a listing of locations (see Appendix) that are known to have existing requirements for outdoor wireless networking, regardless of whether a solution has been implemented. Additionally, listing of current and potential future use-cases was done to detail a community survey.

Investigation was done into potential service offerings that could arise within our current ecosystem of the Aruba 802.11 wireless environment. Key elements are listed here:

802.11 Wireless

- Serves varied client base and an unknown set of applications. Many different devices, doing many different things
- Deployment scenarios:
  - Traditional exterior AP within 100 meters of existing Telecom Facility
  - Fiber-to-the-AP beyond 100 meters, requiring power local to the AP
  - Application of mesh topology, suffering reduced operating modes and lower resultant performance
  - Point-to-Point including 802.11ad with traditional far-end distribution
  - 802.11ah HaLow
    - https://www.wi-fi.org/discover-wi-fi/wi-fi-halow

Investigation into capabilities and limitations of Private-LTE and Carrier-Based Cellular services was also conducted. General depiction and some UW-specific considerations are outlined here:

Private LTE/CBRS

- For known client base and critical applications requiring adherence to SLA (camera, robot, machines, vehicles)
- Use-cases which aren't met by Cellular (outside firewall) or WiFi (insufficient speed, latency, coverage)
- Spectrum acquisition/registration/coordination
  - Benefit of pseudo-dedicated spectrum
- Possible backhaul (multi-pointed) applications
- Conceivable greater coverage-per-node vs. 802.11 WiFi
  - Higher ceiling for FCC Regulations vs. 802.11 WiFi
- Limited set of CBRS-capable devices (need some level of control to program SIM/eSIM)
  - https://docs.celona.io/en/articles/3484781-cbrs-capable-devices-in-the-market

Carrier-Based Cellular/5G

- Significant existing coverage, currently used for some applications
- Exterior DAS, NextG/CrownCastle
- Contract/Terms/Purchase with Carrier for client access
- 'PassPoint / Air Pass' integration
  - https://www.arubanetworks.com/assets/so/SO_Air-Pass.pdf
- Future promise of High Throughput, Reliable Low-Latency, and High Connection Density
- May be most appropriate for short lead time access
- Limited set of Cellular-capable devices (SIM/eSIM)

External Efforts

A Qualtrics survey solicited input from the perspective of UW-Madison Network Advisory Group and Information Technology Committee members. The responses served primarily to quantify the relative level of desire for service offerings and to expand the inventory of campus locations with outdoor wireless networking requirements.

Direct interactions with various campus entities also provided us direction on areas of need and suitable solutions. FP&M - Campus Planning Landscape Architecture provided information around campus open spaces, scheduled-event locations, and associated usage restrictions -- all of which will aid in identifying and prioritizing expansion efforts. University Health Services has seen several urgent requirements related to outdoor wireless networking develop over the course of the COVID-19 Pandemic. Interactions with UHS provided us with a better understanding of how we'll meet requirements for future outdoor clinics. RecWell projects for outdoor networking have previously and must continue to overcome challenges for distribution over large areas that lack proximity to a traditional UW Campus Facility.

Though not an area that received much focus in our gatherings, one of our peer institutions in the Big Ten Academic Alliance reported piloting Private-LTE (specifically, Citizen's Band Radio Spectrum)

equipment beginning Summer 2020. They reported in the later Winter 2020 meeting that they had not yet encountered a use-case for their CBRS system.

Recommendations

Formalize DoIT project for 802.11 wireless network expansion

A significant number of outdoor wireless networking locations and use-cases were documented as part of this investigation (see Appendix). The survey responses and community interactions indicate a level of request-for-service or enhancement to general services (UWNet/eduroam 802.11) at various targeted locations. A natural follow-on is to initiate a formal process which would scope appropriate solutions, prioritize locations, and seek funding for outdoor augmentation of the 802.11 protocol wireless network on campus. NS-Field Services and NS-Infrastructure resources will be required to develop designs and work orders. Solutions in this vein could be delivered inside our current Cisco switching and Aruba wireless ecosystems. Monitoring and performance metrics could be gathered by way of our existing collection of monitoring tools including Aruba controllers, Airwave, NetInsight, VMWare Edge Intelligence, Aruba User Experience Insight, FIDO, and GNMIS stats collection.

Convene a working group of stakeholders to update standards and practices

In the interest of consistent successful implementation of solutions, stakeholders should be brought together in order to review and update practices supporting outdoor wireless networking and outdoor networking in general. There may exist other initiatives (Cooling, Power, IoT, AV, Camera) related to early-stage project planning that could serve as a common medium for this action. At minimum, representation from Leadership, DoIT NS - Infrastructure, NS - LAN, and NS - Field Services would be beneficial. Elements to be considered are listed here:

- Update DoIT Requirements and DOA Division 27 Communications Spec/Guidelines
    - Cabling, Grounding exterior equipment consistently
    - Weather-sealing, Telecom Equipment enclosures, and remediation
- Practices for addressing/avoiding aesthetic concerns
    - Where can we find support in light of previous failed initiatives?
    - What have the Camera and Life Safety projects done?
    - Designing around aesthetics and environments
- Project funding shortages and undesirable scope changes
    - Options to enhance outdoor aspects of projects to the broad benefit of service

Continue evaluation of technologies that enhance or provide solutions

With an eye toward emerging technologies and an acceptance of a rapidly increasing remote site footprint, we should continue to weigh options and solutions. Some avenues may span UW-Madison Campus Departments. Areas beckoning additional investigation are identified here:

- Testbed the Aruba 802.11ad – 60Ghz Point-to-Point Solution
    - https://www.arubanetworks.com/assets/ds/DS_AP387.pdf

- Characterize Private-LTE/CBRS service and supporting networking/firewalling/ownership
  - AIMS-managed UHS Chromebook Fleet
  - DoIT-DS / Campus MDM
  - General multipoint-to-point service to an area in lieu of fiber
- Solicit outside expertise with exchange/hand-off services e.g. Passpoint, Airpass
  - Implication of additional groups like Security, IAM, and others

Appendix

* - The presence of an asterisk (*) below indicates an existing requirement for outdoor wireless service.
! - The presence of an exclamation point (!) below indicates that the site may not be in scope.

Locations (and restrictions on use) appearing in FP&M Spaces resources

- Campus Open Spaces - UW-Madison G Suite View File
- G-5 Green Spaces - UW-Madison G Suite View File
  - Engineering Mall *
  - Henry Mall *
  - Muir Knoll
  - Camp Randall North Lawn
  - Observatory Hill *
  - Allen Centennial Gardens *
  - Botany Garden *
  - East Campus Mall *
  - Humanities Courtyard
  - Ingraham Deli / Bascom Hall West Plaza Deck *
  - Kohl Center Plaza
  - Lakeshore Nature Preserve
  - Library Mall
  - Memorial Union Terrace *
  - Union South Plaza *
  - Orchard Street *
  - Van Hise Plaza Deck
  - Van Vleck Plaza Deck *

Locations identified internally beyond those listed above

- Existing
  - Near West Playing Fields *
  - Residence Hall entrances for seasonal check-in *
  - Veterinary Medicine MRI Trailer *
  - UHS Clinic/Testing Locations *
  - Pyle Rooftop Terrace *
  - Human Ecology Playground and Rooftop Terrace *
  - Steenbock Library *

- ○ Housing Dining Facility Exteriors*
- ● Prospective
  - ○ West Madison Agriculture Research Station !
  - ○ Arlington Farms Complex !
  - ○ WI Crop Innovation Center !
  - ○ McKay Center - Arboretum !
  - ○ Eagle Heights !
  - ○ Picnic Point !
  - ○ Alumni Park
  - ○ Below Alumni Center
  - ○ Bascom Hill *
  - ○ Helen C. White Library
  - ○ Marching Band Practice Field
  - ○ Weeks Courtyard
  - ○ Wendt Library

Locations identified by way of community feedback beyond those listed above

- ● Spaces
  - ○ New Natatorium outdoor areas
  - ○ Practice/Intramural Fields near Dejope
  - ○ Camp Randall Memorial Park
  - ○ Lakeshore Path
  - ○ Sterling Hall Courtyard *
  - ○ AOSS West Lawn, Loading Dock
- ● Parking Garages / Lots
  - ○ Lots 62, 67, 4 surrounding Veterinary Medicine and WVDL *
  - ○ Structures or locations where payment/app/code is required !

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