ConnectWaukegan - Fixed Wireless Proof of Concept

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Overview

ConnectWaukegan is a public private collective impact effort committed to ensuring that all residents, businesses, and institutions in the community have access to robust, stable internet in an equitable, reliable, and sustainable manner. ConnectWaukegan conducted a CBRS Fixed Wireless prototype with assistance from Kajeet and Baicells during the summer of 2022. This whitepaper will present the findings and recommendations for potential leverage CBRS Fixed Wireless capabilities to increase access to broadband by underserved residents in Waukegan, Illinois.

Waukegan Fixed Wireless Opportunities

Waukegan Community Broadband Taskforce (WCBT), founders of ConnectWaukegan, commissioned a Digital Equity Strategic Plan in 2021 to better understand the challenges and solutions to achieve a vision of a more connected community. One of the clear findings from the Strategic Plan was the challenges of access to broadband services due to the high cost for low-income residents and difficulties in obtaining any services for undocumented residents. The broadband survey results found that even those families who were eligible to take advantage of programs targeted for low-income residents were reluctant or incapable to do so because of their transitory living arrangements or immigration status.

Recognizing these issues, in order to provide the support needed for remote schooling to address Covid protocols in 2020 and 2021, the Waukegan Public School System entered into a contract with T-Mobile to provide 2,000 MiFi devices to students to enable internet access from their homes. The T-Mobile MiFi portable broadband device allowed multiple end users and mobile devices to share a 3G or 4G mobile broadband Internet connection and create an ad-hoc network. Observed benefits of the MiFi devices compared to traditional wired approaches included:

- School resources were able to provide effective IT support to the students by having the students bring in the devices along with their school provided Chrome books replicating Apple's "Genius Bar" approach for support. In this

manner, the schools were able to selectively meet the connectivity needs of those students remotely (i.e., no expensive and difficult at-home service calls).

- Students were able to have access when moving between different locations. As a community that has 55% renters according to census data, some students change home locations as much as 4 times during a given year. Having access that can move easily with the student, is critical to closing the homework gap.
- Students were able to understand the interface of the MiFi device (e.g.,, no bars means no service).

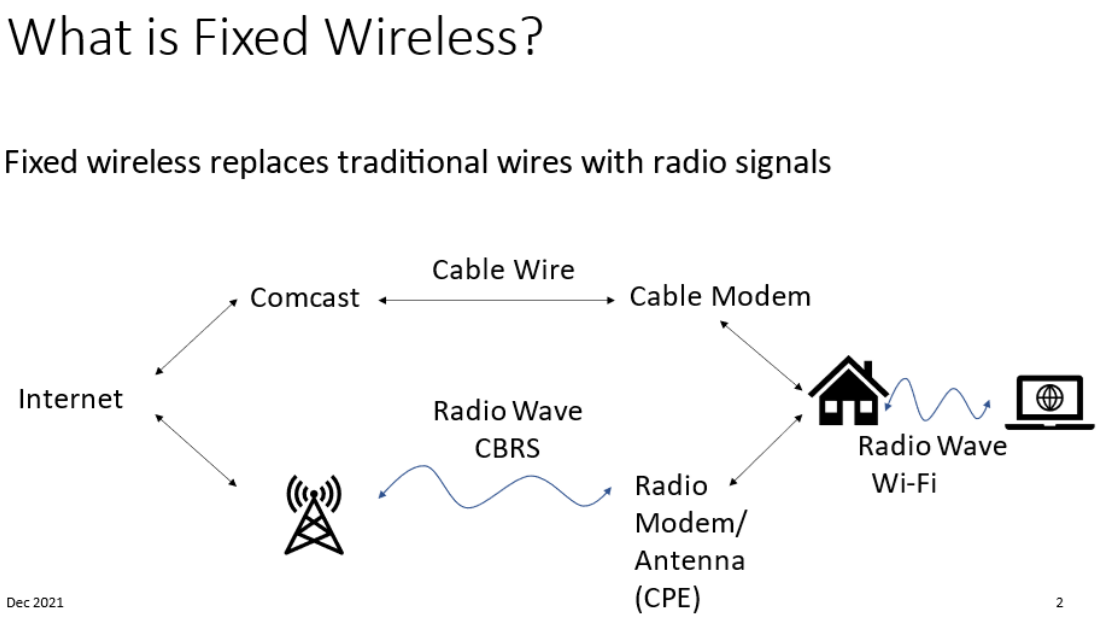
Although the MiFi devices met the needs of the individual students during the pandemic, it often did not address the larger needs of the family or address non-student families. Households that had multiple students, needed more than one MiFi or a more robust service. The associated cost of the MiFi solution was viewed as prohibitive for a long-term solution. As a result, one of the approaches of the WCBT is to provide additional affordable and accessible wireless broadband solutions to address gaps in access by our residents.

CBRS Fixed Wireless Background

Citizens Broadband Radio Service (CBRS) is a 150 MHz wide broadcast band of the 3.5 GHz band (3550 MHz to 3700 MHz) in the United States. On January 27, 2020, the FCC authorized full use of the CBRS band for both priority as well as general authorized access. Fixed Wireless internet is a type of internet service that uses broadcast towers to transmit and receive signals in the form of radio waves. Based on a different radio spectrum than typical WiFi, fixed wireless is approved for greater power that can provide for significantly greater distances. Fixed Wireless is shared spectrum, and relies on communication with a central Spectrum Access System (SAS) administrator to coordinate sharing of the radio spectrum as well as an Evolved Packet Core (EPC), a framework for providing data on a Long-Term Evolution (LTE) network, just like cell phone company. Similar to how the internet was opened up to the public during the 1990s, Fixed Wireless CBRS now gives any business/entity the ability to create services on private 4G and 5G networks.

CBRS Fixed Wireless requires antennas to broadcast a signal to end user devices. Antennas/Radios can be placed at elevation on top of buildings or towers. (60 feet

off ground or 20 feet from the top of the building – whichever is higher). Currently, most end user devices (computer, phone, iPad) which while 'wireless' are not currently enabled to support CBRS so end users require a CBRS CPE (customer premises equipment) device or Antenna to receive the signal from the fixed wireless radio and antenna. The CPE, similar to a traditional internet router, can be used to broadcast WiFi signals in the home for internet connectivity from any WiFi enabled device.



ConnectWaukegan Fixed Wireless Proof of Concept

ConnectWaukegan teamed with multiple providers to create a proof of concept with fixed wireless CBRS. ConnectWaukegan would like to thank these partners whose assistance was invaluable. These vendors and entities included:

- Murray City School District of Utah – During the pandemic, Murray City School District built out a CBRS Fixed Wireless solution for their remote schooling requirements. Jason Eyre, Murray City Schools District's technology coordinator, provided insight into their approach as well as suggestions for the ConnectWaukegan prototype in regards to vendors and suppliers.

- Baicells – provided the outdoor base stations, end user antennas and MiFi devices as critical technical support during our installation.
- Kajeet – as a local services partner of Baicells, Kajeet provided expert advice and assistance throughout the proof of concept on configuration of the Baicells components as well as Google SAS and Baicells CloudCore EPC.

ConnectWaukegan partnered with the Lake County Health Department to install a CBRS antenna on the 3010 Grand Avenue building location in Waukegan. This location was picked based on the height of the building (four stories - 60 feet) as well as easy access to both power and internet access for the Google SAS and Baicells Cloud Core Connectivity. A 72" sled antenna mount was selected for mounting radios and antennas.

Goals of the CBRS Fixed Wireless Proof of Concept

- Understand the current cost, configuration and capabilities of a roof (sled) mounted CBRS fixed wireless radio, antenna and SAS connected solution.
- Understand the cost, configuration and capabilities of the different CBRS CPE (customer premises equipment) devices
- Test the range capabilities and bandwidth capabilities of the CBRS prototype and performance of the different CPE devices.

The POC did not include volume testing of multiple devices to test the capacity of the solution. The team determined early on that replicating the volume/type of usage would be extremely difficult to predict as well as difficult to model and expensive to test.

ConnectWaukegan Fixed Wireless Proof of Concept Results

Leveraging ConnectWaukegan volunteers as well as support from the Lake County Health Department IT and Facilities staff, the CBRS radios and antennas were successfully installed at 3010 Grand Avenue in June of 2022. Components that affected the testing at 3010 Grand Avenue included:

- A four story building with a flat roof for placing a sled antenna mount weighed down on the roof by cinder blocks. Future installations should be permanent and include permanent options such as bolting to the roof joists. Using bolts would also reduce the point load on the roof and would increase the installation time.

- Access to a public internet access point directly below the access to the roof.
- The building is located in a natural geographic rise in regards to the local topography.
- The building has significant trees to the west and north that did block radio signals in those directions but did not have the same blockage to the south and east.
- The building is not located in a heavily populated residential area.

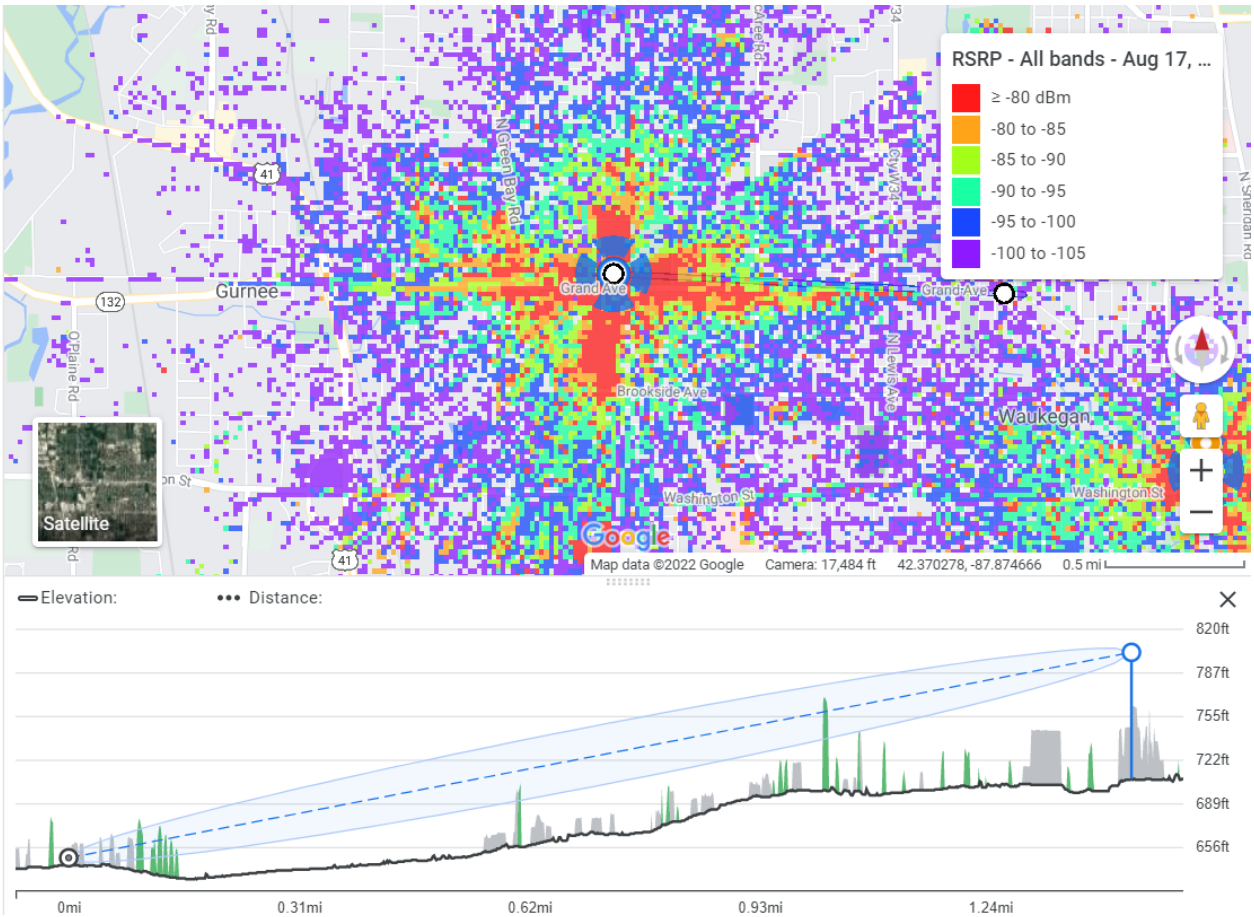
The 3010 location provided a good basis to test the range as well as capabilities of the solution.

Working with dedicated support from Kajeet as well as technical support from Baicells, the antenna was successfully deployed and tested. Findings from the proof of concept included:

- With clear line of vision sight lines, a range of approximately 1.2 to 1.5 miles in the east direction on Grand Avenue with multiple CPE devices was confirmed multiple times with acceptable bandwidth.
- Difficulty with tree interference occurred for west coverage where coverage was limited to .5 of a mile although in the fall, winter and spring we would

anticipate that this coverage would increase when tree leaf interference would be less. Testing of North and South had some dead zones but range of .7 to 1.0 miles was also achieved with acceptable bandwidth.

- Proof of Concept results confirmed the test results leveraging Google's network planning tool giving the ConnectWaukegan team confidence in the Google network's capability to be used for additional site planning. If anything, the tool was conservative in suggesting lesser ranges that may be exceeded in the field.



(Google Network Planner Tool with 3010 Grand Building and Antenna with topography showing 1.5 miles range to the east)

- The team initially struggled with Bandwidth testing and was concerned that our bandwidth was limited by the CBRS equipment but to the back-end internet connection with the shared public WiFi access. After changing a switch as well as making antenna downtilt and frequency adjustments, the solution was able to consistently support 50+MBps for download with 5+

MBps for upload for within a ½ mile and up to 1.5 miles depending on direction and geography (trees, buildings...) interference.

- Installation time was roughly 2 days with significant support from Kajeet and Baicells. Additional sites would be anticipated to take 1 day per location with less support needed if equipment is consistent with 3010 Grand location. Times would increase if permanent installation was required. The installation location of these antennas must meet the City's Ordinance for small cell wireless installation (Sec. 14-1202. - Regulation of small wireless facilities).
- Support time was minimal throughout the prototype effort. Most issues were easily resolved with Baicells Cloudcore interface.
- Total cost of antennas, radios, sled and miscellaneous components was approximately $20,000 although we would anticipate that costs could be reduced with bulk purchases as well as other purchasing and configuration alternatives. In comparison to other references, this price point was considerably lower given our timing (Summer 2022). We would anticipate that prices would continue to fall in the future for all devices.
- CPE devices tested included a large Baicells outdoor home mounted antenna CPE device, Inseego Wavemaker Indoor Gateways and Baicells BC-MiFi Pocket routers. Inseego Gateways were ($660) compared to Baicells MiFi routers ($129) and Baicells outdoor mounted CPE antennas ($280). Based on previous studies, given that the outdoor mounted antenna would require installation, the team added $300 for the effort to install the antenna as well as another $100 for addition of a wireless router for a total cost of $580.
- Testing of range was equal between the home mounted antenna when compared to the Inseego CPE device and MiFi device. Based on the simplicity of deployment of the Inseego and MiFi devices and the mobility given our population of renters, the MiFi and Inseego devices were seen as the most viable solution for our population with the home mounted antennas only being deployed for larger building solutions (housing project) where putting a support person onsite to install and tune the antenna would be cost effective.
- The price difference between the Baicells Mifi and Inseego Gateway was substantial without noted differences in range access during our testing. Successful comparisons for both devices range was approximately 1 – 1.5 miles. We had anticipated that the Inseego would be better from a range perspective but did not witness any major difference. We would anticipate

that Inseego would provide much better household use for multiple people but did not test that capability.

- Testing focused on the range and bandwidth of the CPE devices and did not include robust outdoor WiFi extension of the CPE device for use in public areas (beach, parks, marina…). The team plans that a full roll-out would include public access WiFi locations shared with multiple households as well as individual households with CPE devices.

Recommendation

In reviewing different consultant studies and recommendations on CBRS fixed wireless solutions, many provide cost benefit analysis comparing CBRS fixed wireless compared to other solutions based on a large population. (example 19,000 residents). The approach of ConnectWaukegan is to provide a variety of broadband alternatives working with both our commercial providers (Comcast, AT&T, Verizon and T-Mobile) as well as providing public options and access points to provide a variety of different solutions and capabilities.

CBRS fixed wireless could be used selectively to fill bandwidth access gaps in different low-income neighborhoods or public areas throughout Waukegan with a mobile public access alternative where traditional wired vendors or wireless vendors are not available or cost-effective. CBRS Antennas could be deployed on geographically strategic buildings or locations with cost-effective access to a high-speed internet backend that is already being paid for by a private partner, the school, town or county. CPE devices could be loaned to local residents as part of the school, library or town programs. CPE devices could also be positioned as WiFi access points for both public areas within Waukegan as well as selective neighborhoods. From talking to references as well as from our on proof of concept, we would think planning for ½ mile of range would be typical with at most 1 mile if geographic conditions (height, trees….) are optimal.

Rather than create an expensive plan to blanket Waukegan with CBRS access points for all residents, ConnectWaukegan is recommending a gradual and cost-effective targeted neighborhood by neighborhood roll-out plan based on demand as well as access to cost-effective back-end broadband and radio mounting locations. Based on initial reviews, we would anticipate these locations would be other public locations including schools, town, county or library locations.

ConnectWaukegan CBRS plan could look to fill a gap but not wholesale replace commercial partners offerings in different neighborhoods. While the solution could allow for bandwidth access to be configured per subscribed client as well as filtering on internet access, the team decided against limiting bandwidth as well as any content restrictions to position the solution as open to all bandwidth uses as well as competitively against other options. For those areas that might be enabled with free public Wifi (parks, beach, marina...), the team discussed coordinating free WiFi with the public areas operating hours and preventing after hours access.

The Affordable Connectivity Program (ACP) is an FCC benefit program that helps ensure that households can afford the broadband they need for work, school, healthcare and more. The benefit provides a discount of up to $30 per month toward internet service for eligible households. ConnectWaukegan has been working with eligible Waukegan residents that lack broadband to sign up for commercial broadband and receive the $30/month benefit. As an internet service provider, ConnectWaukegan would be able to capture the $30/month benefit to repay the cost of the CBRS solution as well as fund additional efforts.

Payback - Return on Investment Model

In picking a neighborhood for deployment as well as payback calculation, the following factors were used for evaluation:

- Antenna mounting and support of $25,000 for 360 degree coverage (180 degree coverage would be approximately half).
- Assumption that the ACP program of $30/month is a value that is provided to our residents. Model assumes that ConnectWaukegan can receive this $30 or provides $30 in value. (Benefit is $30/month/subscriber).
- MiFi devices (4G and 5G capable) for $130 that provides WiFi access to household. Other references mentioned that these devices can be procured for less cost.
- $1 Cost per subscriber per month for Spectrum Access System (leveraged Google SAS for POC)
- $1 Cost per subscriber per month for Evolved Packet Core rental (leveraged Baicells Cloudcore for POC)
- 5 year life span for all equipment.
- Model does not include WiFi mesh to extend WiFi past a single household.

- Model does not include cost for back-end internet access. (Assuming public access available at location already).
- Model does not include any device(s) for subscribers to connect to CPE (i.e. laptop, Chromebook, iPad, phone.....)
- Model does not calculate shared WiFi access for multiple households and assumes each subscriber has their own CPE device.

Over the 5 year life-time of the equipment, the chosen location would require

- 16 households in the neighborhood signing up for the service for five years for the solution to break-even.
- 40 households in the neighborhood signing up for the service for five years to result in a payback of 2.2 years and generate a surplus of $37,00 over the life of the equipment.
- 80 households in the neighborhood signing up for the service for five years to result in a payback of 1.3 years and generate a surplus of $99,000 over the life of the equipment.

Technical Detail - Configuration and Installation

Hardware components of the proof of concept included:

1	Baicells 846Q starter kit - Nova846 * - Atom OD06 3.5GHz 14,11,6.5dBI	Radio and 3 Home mounted CPE Antennas
4	KP Performance KP-3SX4-65 3GHz 18dBi Sector Quad Port 7/16 DIN	Antennas for mounting on roof
16	Gamma Electronics TNM-SFLEX-TNM-72-BT NMale-NMale 6FT 1/2 inch superflex/boot	Connections for radios to antennas
2	Baicells BC-Mifi-010411 LTE Pocket Router TDD 38/40/41/42/43/48	MiFi CPE devices
2	Inseego Wavemaker PRO 5G Indoor Gateway FX2000e Enterprise	Home Router CPE devices
1	EZ NP-72-200 Non-Penetrating Roof Mount with 2" x 72" Mast w/Roof Mat (+ extra Roof Mat)	For mounting antenna and radios on roof

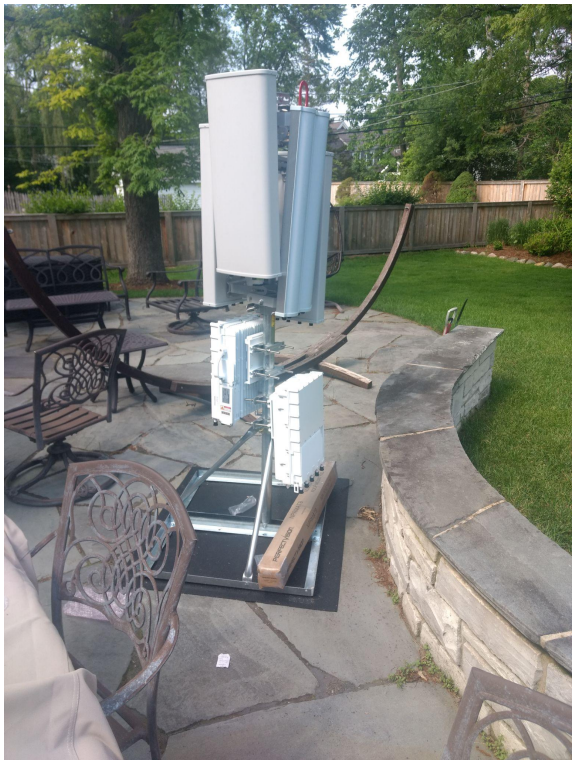
* Baicells provided a second Nova846 radio for evaluation to substantially lower the cost of our proof of concept.

Software components included:

1	Google Spectrum Access Service (SAS)	Controls access to CBRS
1	Baicell's Cloud Core (EPC)	Allows remote management of radios and communication with SAS. Provides Cloud Based EPC (Evolved Packet Core).

For the proof of concept, we chose a 6 foot (72 inch) roof mount. CBRS guidelines allow up to a 20 foot roof mount and those should be considered for pilot and roll-out. The 6 foot roof mount made for easy installation as it did not require ladders on the roof to reach the top of the mount. The 6 foot height was also helpful later on in the proof of concept when it came to adjusting the downtilt of the antennas.

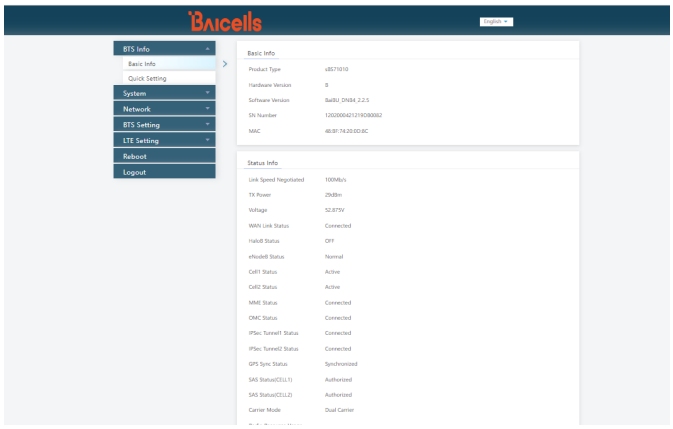
The roof mount with radio and four antennas attached was initially assembled on the ground to reduce the time and effort to install on the roof. Mock-up only required basic tools (wrenches and screwdrivers).



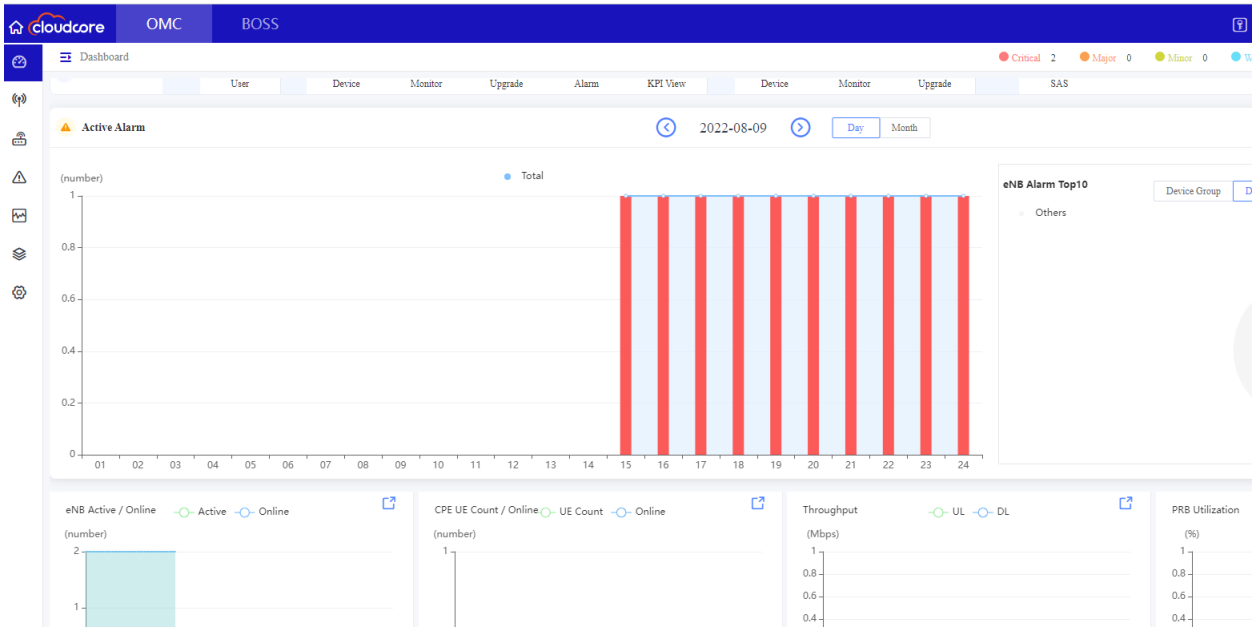
Once mocked up, the radios and antennas were taken off with their mounting hardware left on the mount for transportation to the roof. With help from the Lake County Health Department Facilities resources, the mount, antennas and cinder blocks were moved to the 3010 Grand Location and installed on the roof on July 12, 2020. The radios were left in the top floor or “penthouse” of the 3010 grand for configuration before installation.

The week of August 9th, 2022, ConnectWaukegan resources, working with remote support from Kajeet support engineers, configured the radios for installation on the roof. Steps involved in configuring the Baicells radios included:

- Configuring each radio via a PC to radio network to set up each radio with a static IP. To test our backhaul internet connection, we wanted to do this from the penthouse rather than on the hot roof. Kajeet advised throughout this step making sure the antennas were off (not powered up).



- The next step in the process was to have the antennas communicate with the Baicells Cloudcore EPC. ConnectWaukegan set up an account and added the radios to Cloudcore.



Cloudcore provided both connectivity to the Baicells radios as well as eventual communication with the Google SAS.

- ConnectWaukegan set up an account with Google SAS and, from the CloudCore interface, was able to connect and register our instance with Google. With the static IP addresses installed on both radios and connected to Baicell's Cloudcore, Kajeet was able to access the Baicells interface remotely to configure other portions of the radio for our set-up. Throughout the proof of concept, we leveraged CloudCore for configurations as well as communication with Google SAS.
- With the radios configured, the radios were moved to the roof for installation with the antennas. The team was able to leverage both network connections and power supplies located just below the roof access. Two 100 foot power supplies as well as 100 foot network connections were needed and were routed through the roof access hatch for our temporary proof of concept. For permanent installation, more permanent roof penetrating locations would be considered. The team was also able to leverage existing ground mounts from other equipment on the roof.

- Initial Configuration of the Antennas placed the antennas at zero physical downtilt as the antennas contain a 4 degree fixed electrical downtilt.
- Once the radios were powered on and working, the team configured three CPE devices for testing.
    - Outdoor CPE Antenna provided in Baicells kit
    - Inseego indoor router
    - Baicells MiFi

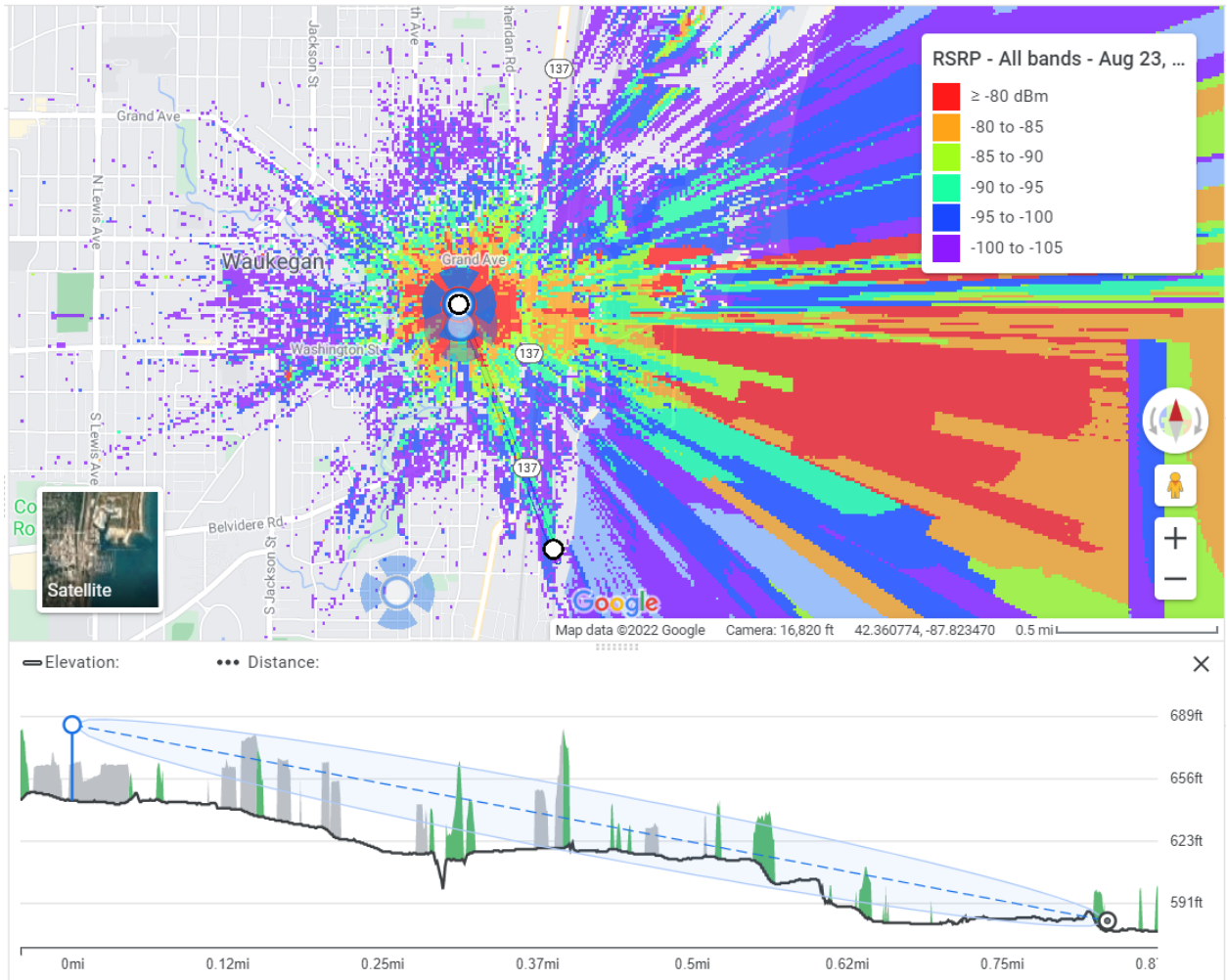
To register a CPE device, Cloudcore provides the BOSS component for managing the subscribers and service. A service plan is set up, SIMs are registered and then each SIM is assigned to a service plan with a specific subscriber identified. (Person/Place by named - stored in Cloudcore). In this manner, each subscriber can be individually activated or deactivated. The team registered 5 SIMs with one for the outdoor CPE device and two each for the Inseego and Baicells devices and successfully tested all devices in the penthouse and on the roof.

Technical Details - Google Network Planner

Factors that affect the range/bandwidth for selecting a location include:

- Access to high speed internet backhaul (and cost)
- Access to roof or other mounting point
- Geographic constraints (on a hill or in a valley)
- Tree and building interference

The team leveraged the Google Network Planner to both confirm the range of the 3010 grand location as well as test additional locations. Below is a depiction of a similar antenna installed at the Waukegan Library located at 128 North County Street.



The team found that being able to quickly analyze a location with the tool helped to understand the limitations of a certain building or location.

Technical Detail - Range and Bandwidth Testing

The team conducted multiple tests in August and September for range and bandwidth with a variety of devices. Our first tests focused on the CPE Outdoor antenna and the Inseego router. The team leveraged speedtest.net for basic bandwidth performance. Given a shared 100MBps internet connection, the team focused on range testing but kept track of bandwidth throughout.

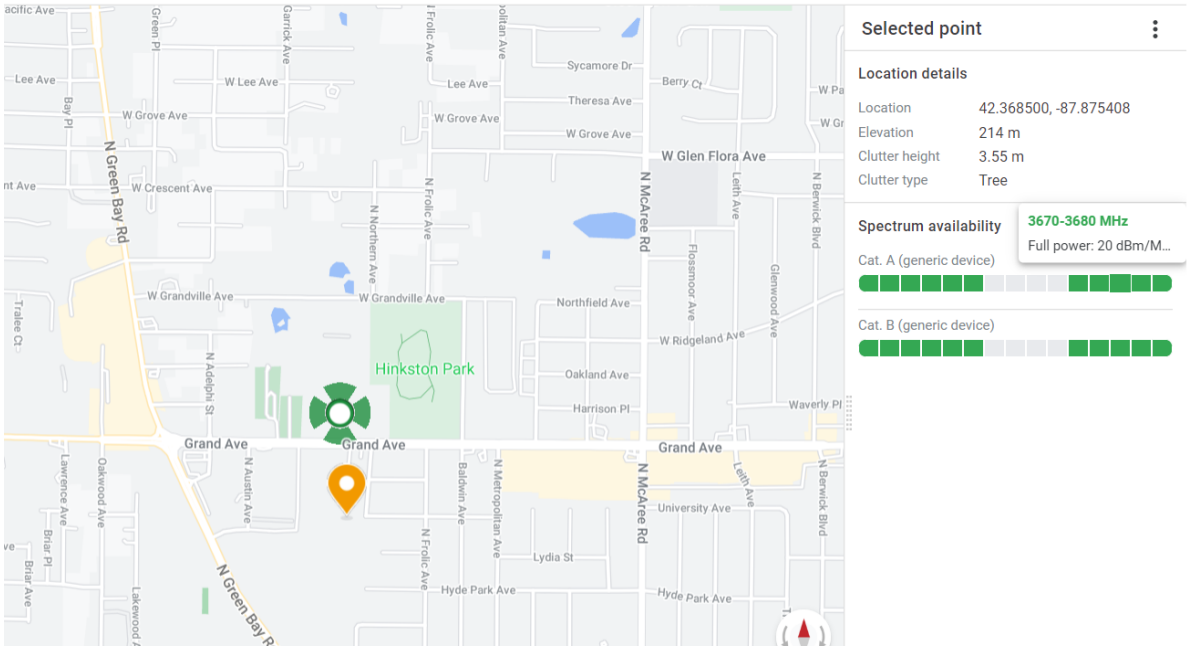
- Initially from just below the antenna in the penthouse we were able to get 72MBps download speeds with 7.45MBps upload speeds with both the CPE antenna as well as Inseego router but were not able to replicate these speeds from the roof.
- Initial testing was successful going west approximately ½ a mile with both devices but limited bandwidth.
- With some advice from Kajeet, the team went back on the roof and adjusted the antennas 3 degrees physical upwards to provide a 1 degree downtilt (the antennas have a 4 degree electronic tilt built in) to get better range.
- The test after the tilt adjustment was very successful with connectivity from 1.2 miles from the building (going east) with 50MBps download and 7.6 MBps upload speeds with connectivity at 1.4 miles as well.
- The team repeated the previous test on August 24th but, while the team got the same range numbers, the bandwidth had dropped considerably. We focused this drive on testing north, south and west directions and were able to confirm 1 mile ranges for north and south (with some dead spots) but still only .5 miles west. We suspect the location on the roof (east side) as well as the large trees directly west of the building caused this limited range.
- On August 29th, the team tested at night to see if the shared bandwidth issue could be resolved as well as detailed testing with Baicells MiFi device. As the test was focused on range, only the east direction was leveraged with the following results. (upload MBps/download MBps)

Distance (miles)	Baicells MiFi	Inseego Indoor Router	CPE Outdoor Antenna
0.2	1.85/9.07	1.86/8.85	2/9.5
0.3	2.19/6.21	1.94/6.95	2.43/6.72
0.4	2.58/3.41	2.68/.047	2.49/7.12

0.6	2.7/1.64	2.48/0.74	2.72/6.37
1	12.48/.062	16.16/0.23	18.93/0.48

- The team was surprised the CPE Outdoor Antenna didn't do better as well as were surprised by the range of the MiFi device. The team came back at night to retest and got better numbers from locations but still determined that further testing was required. The team began looking for ways to test the bandwidth without relying on the shared 100MBps internet connection.
- The team was impressed with the simpleness of the Baicells MiFi device for remote access. While the Inseego device would seem superior for enabling a location (potentially outside) with WiFi capabilities, for an individual, the MiFi device might be superior as it is smaller and battery powered allowing it to roam with a student/person rather than having to remain plugged in at the location. The team also thought the easy interface with the MiFi (1-4 bars indicating if connecting - No Connection notification) was similar to cell phones and would be easy to train and support residents if they were having difficulties connecting. The Inseego device had a flashing light - red for no connection, flashing red for trying to connect, blue and flashing blue for connection. Fixed Antenna had similar green lights with Low, Medium and High.
- The team started testing with iPerf3. iPerf3 is a tool for active measurements of the maximum achievable bandwidth on IP networks. It supports tuning of various parameters related to timing, buffers and protocols (TCP, UDP, SCTP with IPv4 and IPv6). For each test it reports the bandwidth, loss, and other parameters. By leveraging iPerf3, the team was able to avoid any reliance on the shared 100MBps Comcast internet connection and just measure the capability of the Antennas and CPE devices but did not see any change. From the iPerf3 testing, we determined both adjustment to the internal network (switch) as well as radio/antenna were required.
- On advice from Lake County Health Department IT, the team changed the switch that connected the two radios to the backend internet connection and noticed considerably better back-end performance. With the change of the switch, the team noticed speedtest.net speeds go from 100MBps on the switch to 900MBps download speeds. With the Inseego device approximately 100 feet from the antenna on the roof, the bandwidth doubled going from a old switch of 38/7.5 MBps to 85.93/10.95 MBps.

- Worked with assistance from Baicells and Kajeet to manually set each of the antennas to have different frequencies for North, South, East and West that had previously been set to Auto. Auto. Baicells was able to show how to use the Google SAS to see what frequencies were available in the area.



- With the addition of the new switch as well as frequencies adjustments, the team drove around the area and was able to observe the following results leveraging the Inseego Device with similar results from MiFi and Baicells Antenna (Upload/Download)

Directly South of Building	126/9.14 MBps
½ Mile South	73/9.6 MBps
1 Mile South	32.86/0.6 MBps
½ Mile North	11.68/.035 MBps
¾ Mile East	48.57/3.43 MBps
1 Mile East	52.6/1.23 MBps

- With the successful drive test, the proof of concept was concluded for the 3010 Grand Location.

About Kajeet Private Wireless Solutions

Kajeet provides Smart IoT Connectivity and managed solutions for schools, enterprises, college, universities, communities, Tribal Nations, rural communities and businesses. Kajeet has been connecting schools and companies for over 20 years with a mission to close the digital divide and with internet accessible for ALL. Many of Kajeet's recent deployments are with schools, universities and Tribal Nations that are in rural areas where fiber can't be built out. Kajeet has 365/24/7 support with a call center and engineering team to support our customers.

ConnectWaukegan relied on Kajeet during all phases of this proof of concept and would highly recommend their staff both in regards to technical abilities, availability and professionalism.

Some recent blogs for reference:
https://www.kajeet.net/resource/how-k-12-schools-communities-benefit-from-investing-in-private-5g/
https://www.kajeet.net/resource/customizing-private-5g-wireless-networks-for-tribal-lands-inclusivity/

Some recent press releases:
https://www.kajeet.net/press-releases-kajeet-launches-collaboration-with-onf-private-5g/
https://www.kajeet.net/kajeet-private-5g-platform-launched/

About Baicells

Baicells is an international company, providing disruptively priced and technically innovative 4G LTE and 5G NR Access Solutions that connect more than 50 countries across the globe. With an ever-expanding goal to “Connect the Unconnected” has led to the establishment of offices across five of the seven continents and the development of over 300 patents since our inception in 2014. Working alongside ecosystem partners (like Kajeet), Baicells is setting the pace for 5G and future technologies with wireless solutions. These solutions can serve rural outdoor, urban outdoor, commercial indoor, unlicensed and licensed LTE, and a wide variety of vertical opportunities. Combining open-cloud, mobile edge computing and affordable Radio Access Network devices, Baicells strives to revamp the economics of the Information and Communications Technology Industry in the coming years.

ConnectWaukegan relied on Baicells as the primary supplier of equipment for the proof of concept and heavily relied on technical support throughout the effort.

Website with customer case studies including the Murray City School District in Utah can be found here - https://na.baicells.com/