Wireless Connectivity Enables Remote Education

The unprecedented shift to remote learning from primary schools to universities, coupled with widespread work from home initiatives, induced by the COVID-19 recovery, dictates a rapid response on the part of wireless internet services providers. Never in the history of the internet has there been a seismic shift in capacity demand, and from a distributed network. This application note is for Wireless Internet Service Providers (WISP), Managed Service Providers (MSP) and the school districts whose students and teachers are served by them. The document is a guide to quickly and efficiently enable internet access to underserved students to receive the education they require and the support they deserve during the COVID-19 recovery efforts.

The fundamental problem is students and teachers in households that do not have adequate broadband access to support sustained remote learning. Keep in mind that it is not only the student who requires access but also the teacher to conduct an effective class, particularly for real-time streaming sessions. Causes of the situation vary from economic to the absence of viable networks, e.g., Data Over Cable Service Interface Specification (DOCSIS), Very High-Speed Digital Subscriber Line (VDSL) and Fixed Wireless Broadband, serving the location of the specific household. The challenge is how to address that challenge rapidly and sustainably.

WISPs and MSPs working collaboratively with local school districts are in a unique position to bring forward two immediate solutions to the problem: Drive-In Wi-Fi Access and Fixed Wireless Access to the affected residential addresses.

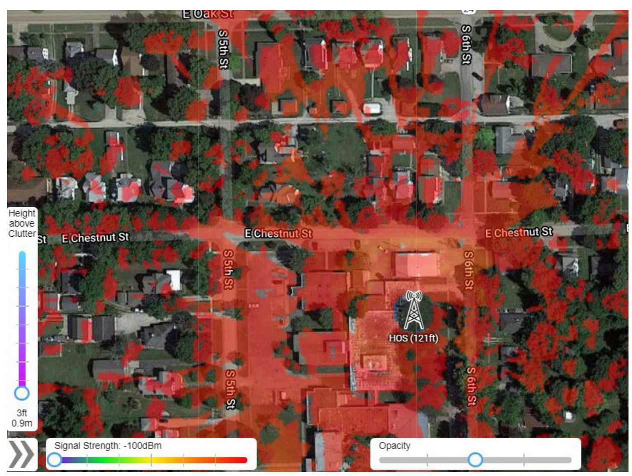
Schools, particularly high schools, typically have large parking lots at the schools themselves and, in some cases, serving remote athletic fields. By placing outdoor Wi-Fi access points (AP), the cnPilot e700 by example, distributed across the parking facilities, the school district can provide drive-up access to the school's intranet. The outdoor drive-up locations will allow students and their families to remain socially separated, and access to download files and upload assignments.

The distributed Wi-Fi access points can be connected by wireless point-to-point (PTP) links or point-to-multipoint (PMP) wide-area networks located on the roof of the school and wired into the school's LAN. Power can be provided to the outdoor Wi-Fi APs from light stanchions or if necessary solar power. In the absence of light stanchions, the outdoor Wi-Fi APs can be mounted on temporary tripods or even on the roofs of school buses. The advantage of extending the school's LAN incorporates access control to the student's credentials as well as limited access to approved sites and resources. The following diagram provides a high-level overview of the system architecture.

The Drive-In Wi-Fi is the quickest path to open access to the broadest audience, but dependent on the ability to drive to the local schools, which may not be viable or sustainable, nor is it likely feasible for real-time instruction through instruments like 8x8, Zoom and GoToMeeting™. A more sustainable solution is to bring broadband access directly to the student's home using fixed wireless broadband.

Elementary schools in urban and suburban environments are ideal locations for master sites as they typically serve neighborhoods within a relatively short distance of the school; however, any school facility can serve as host. By placing a relatively short, two- to three-meter, non-penetrating roof mount on the roof of the building, a 3 GHz or 5 GHz point-to-multipoint wide-area network will reach some number of underserved students. Solutions like PMP 450 and ePMP can quickly and economically bring high-capacity broadband to hundreds of homes in a matter of days.

The following diagram reflects the cnHeat-predicted coverage model of a portion of a school district in Illinois composed of a high school, junior high and four elementary schools. As with the Drive-In Wi-Fi model, using the schools as host sites allows the leveraging of the schools existing backhaul to a point of presence (PoP), and the access control processes that are in place.



While the focus of this paper is school campuses, the same approach can be taken with other public buildings like libraries, government administration buildings and public parks. All that is required is "Drive-In" capacity, a remote feed to the outdoor access point and power.

School districts are not wireless internet services providers and are unlikely to be able to plan, deploy and commission a network in a timely fashion. Therefore, the solution dictates a public-private partnership that local WISPs are ideally suited to make happen with local school districts. The school district making their facilities available, providing the point of presence, and coordinating the students in need of access. The WISP supplying and managing the infrastructure and deployment of the client premise equipment.

The WISP's existing network coverage could also extend the coverage area beyond that achievable from the school district's network. In this case, the school district and the WISP could coordinate a VLAN to allow secure bridging between the WISP's network and the school districts LAN.

There are a couple of additional considerations worthy of mention as school districts and WISPs embark on connecting the unconnected student.

Spectrum. 5 GHz spectrum can be a scarce commodity in individual communities. Where viable, consider the use of 3 GHz. The U.S. is fortunate in that the FCC just opened up the Citizens Broadband Radio Service (CBRS), and there is 100 MHz of exceptionally clean spectrum readily available and perfect for this application. The use of CBRS bands will also allow the ability to reach the hard-to-reach locations due to 3 GHz propagation characteristics and higher EIRP levels. Cambium Networks provides an end-to-end CBRS solution using the PMP 450 platform in conjunction with our cloud-based SAS embedded in cnMaestro.

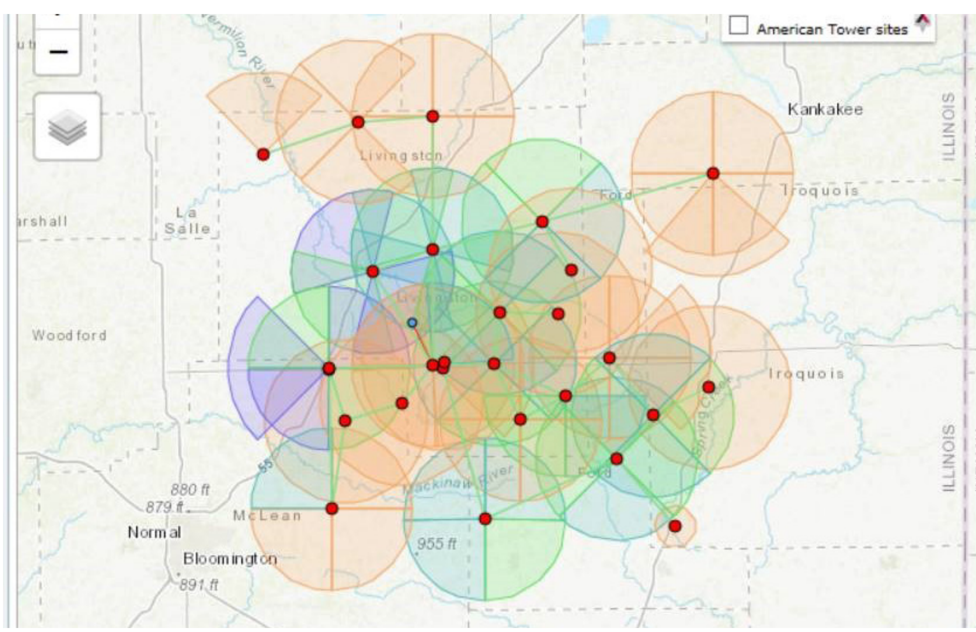
Coverage Modeling. There is no sense in deploying a network if the effected students cannot be reached. Cambium Network's cnHeat uses LiDAR or equivalent geodata to accurately predict coverage from targeted site locations allowing schools and WIPSs to quickly evaluate network coverage. cnHeat can also provide specific addresses that are covered, allowing the school to perform a reverse lookup to identify specific students that can receive access.

In-Home Distribution. A fixed wireless broadband network will deliver high capacity to a home, but the WISP should consider providing an end-to-end solution and including a home gateway/Wi-Fi hotspot as part of the solution. Cambium Networks' cnPilot r195 is an ideal solution and managed by cnMaestro with the balance of the network.

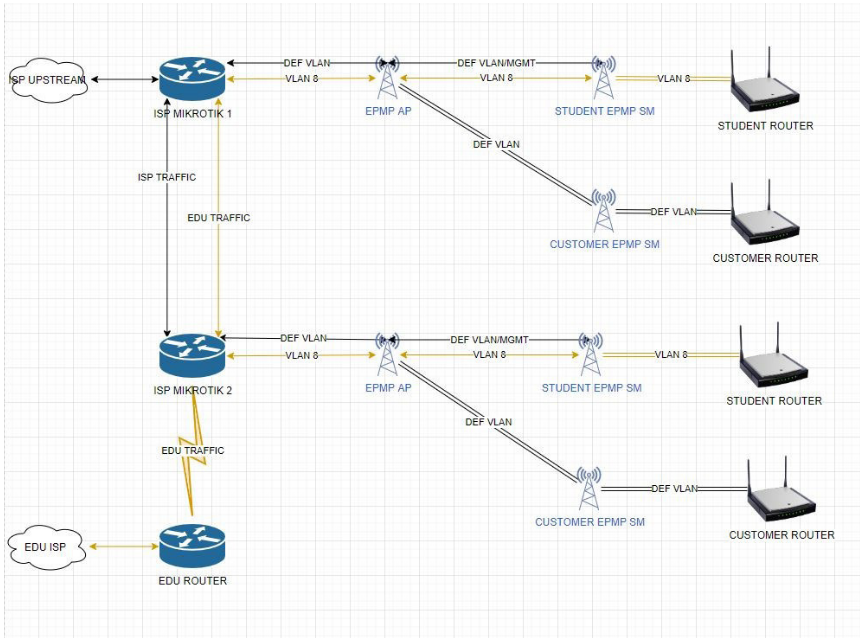
Access Network Capacity. If leveraging an existing network the WISP may find the incremental demand imposed by both additional subscribers and additional load on existing subscribers due to remote learning and work-from-home initiatives; the WISP may need to increase the capacity of their network. One option to address this challenge is clean spectrum like 3 GHz mentioned above. A second option is to leverage Multi-User MIMO, which substantially increases the spectral efficiency of the sector. If the WISP is using a PMP 450 access point or a PMP 450i PMP access point, they can swap it out with the PMP 450m. The PMP 450m provides Massive Multi-User MIMO in a 14x14 smart antenna array, improving spectral efficiency from ##b/s/Hz to ##b/s/Hz. If the WISP is using an ePMP 1000 or 2000, upgrading the AP to the ePMP 3000 improves spectral efficiency from ##b/s/Hz to ##b/s/Hz. In either case, the single sector can handle substantially more subscribers and or higher service levels.

Backhaul Capacity. Inevitably internet access must find its way to a PoP and backhaul can quickly become a constraint with the increase in access demand. For single carrier, 1+0, microwave backhaul links WISPs should consider advanced architectures including 2+0, 4+0 and XPIC to increase capacity. Use of V-Band (70 GHz) paths may also be an option for relatively short paths as well. Cambium Networks' LINKPlanner path planning tool is free and can quickly plan PTP 820 and PTP 850E links under different configurations for scenario planning.

Returning to our case study example, the school district in central Illinois is composed of a high school, a junior high school and four elementary schools serving approximately 2,000 students. In collaboration with a local WISP, Maxwire, in a matter of about 48-hours, we were able to complete coverage modeling from the seven school buildings and seven Maxwire sites. Based on that coverage modeling, the collaborative network can provide broadband access to approximately 1,500 homes within the school district. The following LINKPlanner diagram illustrates the combined network coverage.



The initial Drive-In Public Wi-Fi spots were deployed at two schools within a matter of days, and an additional two schools approximately one week later having received additional equipment. Maxwire is capable of extending their existing network to support approximately 1,500 homes within the school district and has begun to do just that.



As the concept evolved two valuable lessons emerged. First, addressing upfront the networking strategy to allow students to access the schools network remotely as if they were within the school using a Virtual Local Area Network (VLAN). If planed in coordination with the school district's IT team, the student and teachers will have easy access to their typical applications and services in a safe computing and internet environment. The adjacent diagram provides a high-level view of the network architecture used by Maxwire.

The second challenge was accommodating a zero-touch and zero-entry installation, when typically, a tech is placing the home gateway in its proper location, conducting final configuration, and testing, all within the home. Maxwire developed a creative approach that allowed for a window "pass-through" of a bundled, pre-configured solution, that the resident could quickly connect to and rely upon.

In approximately five working days, the school district has been able to extend their intranet and effectively serve a significant percentage of their student body and teacher cadre via remote learning with the use of fixed wireless broadband. The experience speaks well of the public-private partnerships that WISPs are uniquely in a position to exercise at this time, an experience that can be replicated globally.