Utah Wireless Network Infrastructure

Recommendations for School Wireless Implementation

June 2019

Overview

These recommendations for the school wireless network infrastructure have been developed by the Utah Education and Telehealth Network (UETN) and in collaboration with the Utah State Board of Education (USBE), Technology Coordinators Council (TCC), Utah Wireless Administrators Group, and other educational and technical experts in the state of Utah. The purpose of this document is to provide general guidelines to assist LEAs in effectively planning, implementing and maintaining school wireless networks. These recommendations have been reviewed and vetted by educational technology and technical professionals in the public and higher education community. Implementing these recommendations thoughtfully and appropriately, using engineering best practices, will assist LEAs in providing robust, reliable and stable network environments in support of a positive educational technology experience for teachers and their students.

Recommendations for Wireless School Networks

These recommendations are based on industry standards, experience, empirical data and knowledge of the network capabilities required to support Digital Teaching and Learning at scale in schools. LEAs may choose to exceed these recommendations but UETN, LEA technology personnel in the state, believe these recommendations to be appropriate minimum standards for the majority of schools. Some exceptions, such as very sparse building layouts or a very high number of students per square foot in the school, are possible and even likely. Building materials will also have an impact on the performance of LEA networks. Please note that these recommendations are based on typical cinder block/concrete wall construction. Engineering studies and practices should be implemented to meet local level needs. These recommendations and guidelines will help to provide a foundation and give general direction for schools implementing and updating wireless LAN technologies for digital teaching and learning.

These recommendations will require time and effort to implement. An LEAs cannot be expected to completely adopt all recommendations in a set period of time or even in a given year.

RECOMMENDATIONS:

LEAs should:

- Engineer wireless capacity to support 2.25 devices per student simultaneously in use (based on school policy).
- Specify all new APs should include at least one 5GHz radio.
- Specify all new APs should support and follow the latest FCC requirements for all of the channels in the U-NII-1, U-NII-2A, U-NII-2C, U-NII-3 bands.
- Where possible wireless networks and school owned devices should primarily support 5GHz bands.
- Ensure at least two access points are visible in every instructional space, including classrooms, library, etc.
- Have a post install validation survey for each school showing that all APs are needed to provide coverage and capacity. These surveys should be refreshed each time the wireless requirements change.
- No more than three 2.4GHz radios should be visible at any one point at a signal level over -82dBm in these cases. Only use channels 1, 6, 11 in the 2.4 frequency.
- Provide, at a minimum, 1 AP per 50 people allowed by fire code in cafeteria, auditorium or other common areas that are used for instruction or testing.
- Engineer wireless systems to provide -62 to -65 dBm 5GHz signal level in all classrooms as measured by Site Survey Software (Ekahau or Airmagnet), Fluke AirCheck, Netscout Aircheck G2, or similar survey grade equipment.
- Engineer wireless systems to provide -68 to-70 dBm 5GHz signal level in all common areas as measured by the aforementioned wireless survey software.
- Provide and implement support for IEEE 802.1X authentication and future integration with identity management systems (Implement per user authorization with unique key/certificate per device or user).
- Verify that APs are not on conflicting frequencies. Verify that controller is making correct frequency and power choices.
- Avoid placing APs in hallways unless needed. Hallway APs can degrade roaming capabilities of clients.
- Disable basic rates on 2.4GHz below 12 Mbps to shrink cells and improve roaming.
- Use DFS channels in 5 Ghz when possible.
- Implement solutions that support between 28-32 simultaneous 720p video streams in each classroom.
- Specify that all **new** network cable support 10 Gbps at 100 meters for both APs and backbone installations between switches (CAT6A or other supported standard).
- Specify at least 1.0 Mbps per student from client device to school building edge WAN connection, with no oversubscription inside the school building.

- Specify one Gigabit Ethernet (switch port) connected to every new AP, with future upgradeability to multi-gigabit Ethernet preferred as utilization needs require.
- Establish a goal of 99.95% network uptime during school hours, and 99% network uptime after school hours and weekends and in support of best practices to realize these goals.
- Provide filtered guest network access, that is given lower priority to ensure it does not indirectly interfere with instruction related traffic (guest access is based on school policy).
- Specify current up-to-date IEEE 802.11 standards are implemented.

We recommend that LEAs support 2.4GHz only as required to provide network access for legacy client devices. We also suggest that LEAs should only purchase devices with 5GHz radios. Over time all LEA devices should use 5GHz. 2.4GHz should only be used by legacy systems like security cameras, projectors and other embedded devices and should be phased out as quickly as possible. (Not a recommendation for this project, but an observation and a best practice.)

Rationale

The devices per student calculation is intended to be inclusive of teacher devices, embedded devices, Chromecasts, Apple TVs, VoIP, teachers, staff and guests as well as some level of smartphone usage by students. Over time the number of devices per student is expected to steadily increase, as more and more devices are Wi-Fi enabled. It is up to each district to determine by policy if student-owned devices are allowed to attach to the school network. This will have a significant impact on the network design.

The ratio of APs per classroom is based on ensuring each classroom device can see at least three APs, a minimum of two APs in common areas, offices, media centers and other spaces where network coverage is needed. Issues and circumstances that affect this ratio include the layout of the building, building and ceiling height, construction materials, student density, number of devices per student and other variables. This is a harsh and sensitive environment that is made more difficult by the sheer numbers of devices and increasing bandwidth needs.

It is recommended that the most current network cable certification be used for all **new** installations. As the IEEE 802.11 standard continues to evolve, with higher data rates, it is likely in the next few years that manufacturers will develop multi-gigabit APs. If a classroom is already wired with CAT5e, there is not an immediate need to upgrade to a higher certification cable at this time. We leave it to each school or district to decide how to best optimize their network. Many classrooms with correctly installed CAT5e cable could continue to function effectively for several more years before requiring an upgrade to 10 Gbps capable cable.

Tools

Suggested wireless tools below are for use in engineering and verification of a wireless design. These tools are **not** UWAG endorsed but are only listed as options that may help in the implementation and support of wireless networks. These tools may be free or commercially available. This is not a complete list of all wireless tools available.

Android	Wifi Analyzer	https://play.google.com/store/apps/details?id=com.farproc.wifi.analyzer&hl=en
Android	iPerf	https://iperf.fr/
Android	Speedtest	https://play.google.com/store/apps/details?id=org.zwanoo.android.speedtest&hl=en
Android	Wifiman	https://play.google.com/store/apps/details?id=com.ubnt.usurvey&hl=en
Android	Dioptra	https://play.google.com/store/apps/details?id=com.glidelinesystems.dioptra
IOS	Theodolite	https://itunes.apple.com/us/app/theodolite/id339393884?mt=8
IOS	Ekahau Survey	https://itunes.apple.com/us/app/ekahau-survey/id1238070997?mt=8&ign-mpt=uo%3D2
IOS	Wifiman	https://itunes.apple.com/us/app/ubiquiti-wifiman/id1385561119?mt=8
Mac	Wifi Explorer Pro	https://www.adriangranados.com/
Mac	Ekahau	https://www.ekahau.com/
Mac	Ekahau Connect	https://www.ekahau.com/products/ekahau-connect/overview/
Mac	Wi-Spy	https://www.metageek.com/products/wi-spy-air/index-2.html?utm_expid=190328-262.w1RqaMwXTWGiM4-hvnf_zg.1&utm_referrer=https%3A%2F%2Fwww.google.com%2F
Mac	Wifi Signal	https://www.adriangranados.com/apps/wifisignal
Mac	Wireshark	https://www.wireshark.org/

Mac	Airtool	https://www.adriangranados.com/apps/airtool
Windows	Putty	https://www.putty.org/
Windows	Ekahau	https://www.ekahau.com/
Windows	Ekahau Connect	https://www.ekahau.com/products/ekahau-connect/overview/
Windows	Wi-Spy	https://www.metageek.com/products/wi-spy-air/index-2.html?utm_expid=190328-262.w1RqaMwXTWGiM4-hvnf_zg.1&utm_referrer=https%3A%2F%2Fwww.google.com%2F
Windows	Wireshark	https://www.wireshark.org/
Linux	Horst	https://insights.dice.com/2013/12/30/monitor-wi-fi-signals-horst/
Linux	kismet	https://www.kismetwireless.net/
Appliance/Device	Netscout AirCheck G2	https://enterprise.netscout.com/products/aircheck-g2-wifi-tester
Appliance/Device	Netscout OptiView XG	https://www.netscout.com/product/optiview-xg-network-analysis-tablet
Appliance/Device	Netscout One Touch	http://bit.ly/2JH62Eq
Appliance/Device	Netscout LinkSprinter	https://enterprise.netscout.com/network-testing/linksprinter-network-tester
Appliance/Device	Ekahau Sidekick	https://www.ekahau.com/products/sidekick/overview/
Appliance/Device	Wlanpi	https://www.wlanpi.com/
Appliance/Device	WLANPiShark	http://wifinigel.blogspot.com/2019/01/wlanpishark-wireless-capture-with.html