Virginia Information Technologies Agency

Enterprise Architecture Insight
Wireless Access Points (WAPs)

DATE: 11/16/2016

LESS TECHNICAL SUMMARY

BACKGROUND:

Wireless access points (WAPs) are used to connect user devices (laptops, tablets, smart phones) to a network (internet, etc.) without having to connect a physical cable to the device. In offices, they are typically small boxes, less than a foot per side and 3 or less inches deep, with antennas typically installed on or above the ceiling. A WAP can serve the data needs of multiple devices within a defined distance. Newer WAPs can handle more data and more user devices and they can even connect through walls.

In order for WAPs to work, they also need power, a data cable and other devices such as wireless controllers, switches, routers, hubs and the ability of the end user devices to connect to the WAP. There are standards for this entire infrastructure. Overtime, user needs increase and technologies respond by getting faster and sometimes cheaper. The standards change to both support and drive the changes in technology and in the case of WAPs, it takes several years for the suppliers' implementation of new standards (new features and capacity) to mature. This can make purchasing decisions challenging. The purpose of this document is to provide guidance for those decisions.

GUIDANCE SUMMARY:

The recommended standard that applies when purchasing and deploying WAPs is 802.11ac (backwards compatible with previous standard 802.11n). There are two versions of how this standard can be implemented: wave one and two. Wave one is considered a transient technology and only wave two devices should be considered for deployment. Even though much that wave two promises may not be available today, it is still the best technology approach to protecting investments (future proofing). Recommendations as to what to deploy for the rest of the WAP supporting infrastructure vary depending on the following three use cases:

1. *Greenfield*: (New building or renovation, clean sheet of paper.) Utilize Category (Cat) 6 cable to be able to meet future bandwidth needs of up to 7 gigabytes (GB). It is likely the standards will change to allow increased bandwidth of Cat 5 (e) cabling; but it is unlikely that the capacity will match wave two limits. Notes: wave two enhanced and increased capabilities can allow you to meet user needs with less WAPs. It is also possible, although not recommended at this time, to utilize this technology to eliminate the need for end user cabling (physical network connections for employee personal computers (PCs) and voice over internet protocol (VoIP) telephones). The new WAPs and support infrastructure can fully support data and voice via the wireless connectivity. Video is not included.
2. *Brownfield*: (Existing infrastructure needed update or modification.)
    a. *No current performance issues:* (Current WAPs no longer have support.) Upgrade WAPs now as recommended above. As other supporting infrastructure components need upgrading (wireless controllers, switches, routers, and hubs), implement technologies consistent with wave two capacity. As long as you are using Cat 5 or newer cabling and user needs do not have significant growth, that component should be ok.

b. *Current performance issues:* (Colleges and other heavy wireless use environments.) Upgrade WAPs now as recommended above. Evaluate all other supporting infrastructure components (cabling, wireless controllers, switches, routers, and hubs) for probable upgrading. The wireless service needs to be examined from end-to-end and it is probable that much if not all will need to be upgraded to meet user needs.

TECHNICAL SUMMARY AND DETAILS

RECOMMENDATIONS:

Embracing newer technological advancements that can improve mission objectives is a Commonwealth of Virginia (COV) strategic intent. However, embracing immature/evolving technologies is not without business and technological risks; COV's risk profile is a conservative posture for purposes of technology adoption. The following are some best practice recommendations and suggestions for COV network decision makers:

1. Agencies and higher education institutions (AHEI) running 802.11n should carefully assess their current solution situation to determine if all their business, not technology, needs are being met.

2. AHEI having determined that there is a need to adopt 802.11ac technology should not invest in wave one devices, but instead, focus on deploying wave two devices thus future proofing network investments.

3. Consider wired switching and cable upgrades commensurate with wave two technical requirements to leverage 802.11ac benefits.

4. Avoid at all costs premature and out-of-cycle network upgrades – upgrades must reflect end-to-end performance integrated solutions.

5. When considering 802.11 ac wave two adoptions, it is prudent to explore solution options as either Greenfield or Brownfield projects.

SUMMARY CONCLUSION:

802.11AC is a promising wireless local area network (WLAN) solution when deployed in a manner that would allow AHEIs to realize the full benefits of the technology. Because of this, the supplier community is touting their products as providing substantial improvement in speed and capacity. However, network decision makers should exercise due care when talking to suppliers – ensuring their claims are not just hype and that AHEIs businesses will benefit[1]. It is imperative that the solution space is addressed from the perspective of Greenfield or Brownfield to determine the network architecture design and deployment approach. As VITA explores new technology partnership opportunities, solutions such as

[1] See Gartner Don't Let the New WLAN Standard Break the Bank or Your Wired Network, ID: G00272193 published 27th July 2015.

managed WLAN, software defined wide area network (SDWAN), and cloud managed local area network (LAN), to name a few, are worthwhile considering.

ISSUE:

The notion of an all-wireless office is becoming a reality[2], driven by new technologies such as 802.11ac which can result in sufficient WLAN bandwidth to handle all foreseeable loads. It is also conceivable that an organization could pursue a hybrid approach consisting of a mix of Internet and carrier-grade WAN connectivity for enterprise WAN[3]. Embracing this new technology must be viewed from two network architecture models – new implementation (Greenfield) and updating existing environments (Brownfield).

CURRENT OPERATING ENVIRONMENT:

Infrastructure components (access points (AP), wireless controllers, switches, routers, and hubs) provisioned by our infrastructure technology program (ITP) align with 802.11a/b/g/n standards, and the Northrop Grumman technology roadmap does not indicate any movement beyond current deployment – at least through 2017[4]. It is fair to say that moving to 802.11ac wave one and two is unlikely at the enterprise level by our current ITP. On the other hand it is feasible that agencies and higher educational institutions could consider 802.11ac as either a Greenfield or Brownfield opportunity.

Information Technology Resource Management (ITRM) Enterprise Architecture (EA) Standard 225.06 requirement NET-R-04 – Cabling Requirement (ANSI/ITA/EIA 568-B-.3, Commercial Building Telecommunications Cabling Standard, Part 3: Optical Fiber Cabling Components Standard) documents COV agencies conformance requirements. It is presumed that existing agency facilities conform to these minimum cabling requirements and that the currently deployed infrastructure components are fully supported – there are no reported deficiencies either from our ITP and or customers.

WHAT YOU NEED TO KNOW:

802.11ac wave one and wave two is the Institute of Electrical and Electronic Engineers (IEEE) standard for WLAN ratified in 2004. Wave one implements four channels bonding thus improving performance to 1.3 gigabits per second (Gbps) on 5 gigahertz (GHz) - radio bandwidth improvement over previous 802.11n standard. Wave two, the next implementation that is still considered emerging is the latest generation higher speed WLAN and only operates on 5GHz extending channel bonding to eight resulting in performance greater than 6Gbps; MU-MIMO (Multiuser-Multi input/multi output) is possible thus allowing up to four simultaneous clients access point connections.

Wave one market penetration is low to moderate and Gartner classifies this as “early mainstream” maturity[5]. Notwithstanding early mainstream for wave one and emerging for

[2] See Gartner IT Market Clock for Enterprise Networking, 2015, ID: G00289784 published 9/15/2015.
[3] Ibid
[4] Northup Grumman Product Roadmap version 2015-H2 revised 9/30/2015.
[5] See Gartner Hype Cycle for Networking and Communications, 2015 ID: G00277750 published 27th July 2015.

wave two, suppliers are implementing wave one and two standards in their AP appliances; mobile device suppliers are implementing wave one chipsets for improved radio communication but not higher bandwidth due to the lack of additional antennas. The same is true for wave two chipsets products are being launched based on this standard that do not currently provide all of the functionally that wave two could provide.

ANALYSIS:

Gartner's 2015 Hype Cycle for Networking and Communication classifications are as follows: 802.11n is in its plateau stage; 802.11ac wave one will plateau in less than two years moving from the slope of enlightenment; 802.11ac wave two is in the early stage of innovation trigger and will plateau within five – 10 years[6]. Network architects must exercise due care when considering updating current wired and wireless network (Wi-Fi) fabric. Design decisions must not be based solely on one set of standards. In this case 802.11ac (wave one and two), must consider connectivity among clients and infrastructure components and cable runs (AP to hub/switches).

Technology strategic and tactical updating assumes a technology environment that does not include wave one and/or wave two components and infrastructure fabric including cable runs that might not utilize and/or benefit from the full functionality of either wave one or two at the client and infrastructure levels. There has been a lot of discussion and excitement surrounding APs (mainly), some clients (laptops and other mobile appliances), and to a lesser extent infrastructure (hubs/switches), do not appear to offer complete end-to-end connectivity that fully utilizes wave one or two products functionally for benefits vs. implementation costs. Buy decisions must be carefully weighed and most importantly architected before committing information technology investment dollars. So while it is tempting to jump on board, please note that it comes with enormous risks and costs for solutions still not holistic or architecturally coherent.

Industry analysts predicted that by last quarter of 2015 availability of 802.11ac wave two capable APs would be available from more than 65 percent of WLAN suppliers. Wave two products would provide:

- improved performance – capacity could exceed 6Gbps/per user which is an improvement over wave one
- increased density to support more simultaneous users per AP using Mu-MIMO technology[7]. Several references to supplier actions alluded to the fact they are more concerned with 'carving out a niche' position for their products offerings[8].

Agencies and higher education entities who are considering adopting the 802.11ac (wave one and wave two) standard as part of their networking infrastructure will not benefit from wave one and two products functional improvements without investment in updating

[6] Ibid
[7] See Gartner Don't Let the New WLAN Standard Break the Bank or Your Wired Network, ID G00272193 published 27th January 2015.
[8] Ibid

internal cable runs to accommodate WLAN to wired fabric to leverage the full benefits of wave two implementations.

Notwithstanding suppliers push to release products that are wave two capable, industry pundits such as Gartner[9] surveyed their client base to get an assessment of typical bandwidth needs that are greater than the average 5Mbps/user of shared media access to adequately support business application requirements. They noted that less than 1 percent of client interactions indicated a need for bandwidth that exceeds 5Mbps and 802.11n or 802.11ac wave one infrastructure would provide adequate capacity in a typical carpeted environment; exceptions are larger file transfer, graphic-oriented printers, and high-transaction density situations.

As was noted previously, in most cases deployed campus cable runs do not support speeds beyond 1 Gbps. Several supplier alliances are pursuing standards that will allow transmission between 2.5 to 5 Gbps over existing cabling[10]. Alliance efforts are the catalyst for IEEE to start working on 802.3bz (multigigabit Ethernet) 2.5 and 5 Gbps allowing transmission speeds beyond 1 Gbps on existing Cat 5 and Cat 6 cable, but the possibility of an official sanctioned standard before year end 2016 is most unlikely; this could address the potential bottleneck in wired infrastructure between APs and 10/100/1000 switches and support of higher speeds without the need to re-architect cable runs[11].

Version History		
Version	**Date**	**Change Summary**
v1	11/16/2016	Original

[9] Ibid
[10] Ibid
[11] See Gartner Hype Cycle for Networking and Communications, 2015 ID: G00277750 published 27th July 2015.

RELATED STANDARDS:

IEEE Standard	Operating Spectrum	Products Generally Available	Theoretical Capacity
802.11g	2.4 GHz	2003	54 Mbps
802.11n	2.4, 5GHz	2009	450 Mbps to 600 Mbps
802.11ac Wave 1	5 GHz	2013	1.7 Gbps (2 X 2:1)
802.11ac Wave 2	5 GHz	2016 (Anticipated)	6.8 Gbps

Source: Gartner (January 2015)[12]

FUTURE STANDARDS AND INDUSTRY ACTIONS:

- 802.11ad – Is a millimeter-wave wireless technology standard that is being billed as providing higher throughput than 802.11ac/802.11n at shorter range, a continuation of the standards to enhance Wi-Fi speeds. The primary target for this technology, because of its reach, is wireless video, docking, storage, in-room gaming, and projection
- 2.5/5 Gbps – see prior discussion under analysis
- SD WAN – is an approach that the enterprise can use to implement and manage enterprise WANs; the purpose of this emerging solution is to create a simpler and more cost effective branch office WANs, faster and easier to deploy and manage than existing solutions
- CLOUD MANAGED LAN – is an alternative to deploying wired and wireless infrastructure in remote offices while retaining centralized management and administration capabilities.

RESOURCES FOR FURTHER READING:

802.11ac: A Survival Guide (2013):
http://chimera.labs.oreilly.com/books/1234000001739/index.html

802.11ac: The Fifth Generation of Wi-Fi Technology White Paper (Cisco 2014):
http://www.cisco.com/c/en/us/products/collateral/wireless/aironet-3600-series/white_paper_c11-713103.html

[12] See Gartner Don't Let the New WLAN Standard Break the Bank or Your Wired Network, ID: G00272193 published 27th January 2015.

IEEE Standards Association – IEEE 802.11 Wireless LANs (2012): http://standards.ieee.org/about/get/802/802.11.html

PC Mag – Wireless Witch: Should you buy an 802.11ac router? (2013) http://www.pcmag.com/article2/0,2817,2416612,00.asp

Study on the use of Wi-Fi for Metropolitan Area applications (2013): http://stakeholders.ofcom.org.uk/binaries/research/technology-research/2013/wifi-report.pdf

Efficient MAC for distribution multiuser MIMO systems (2013): http://www-bcf.usc.edu/~kpsounis/Papers/wons13.pdf