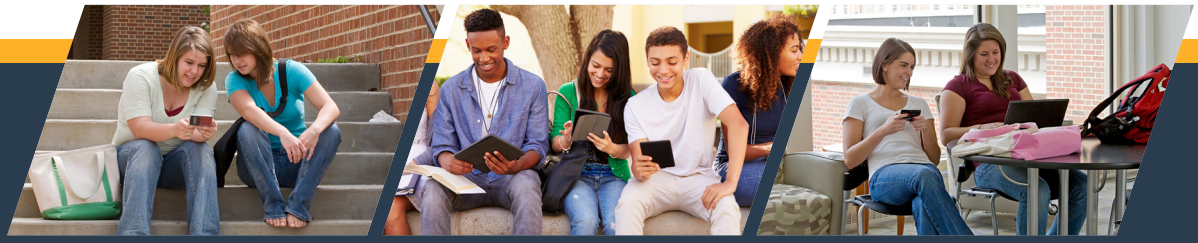

# How Software-Defined Networking will Redefine the Intelligent Campus

While colleges and universities have begun using 802.11ac to address networking capacity gaps, it may be time to architect a move away from a campus deployment focus altogether and embrace a new, open approach for meeting networking demands.

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CAMPUS TECHNOLOGY

Take the size of your current student population and triple it or quadruple it. That will give you a sense of how many computing devices your campus infrastructure needs to support right now. But wait. There's more. Now imagine that one morning many of those students wake up and realize they can upgrade their primary devices to a new operating system, and they plan to do so during breakfast over your network. If your Wi-Fi setup can sustain that kind of explosive pivot in demand, even as you still sit in your car on the way to work, that is the measure of an "Intelligent Campus."

If, however, you worked for one of the multitude of colleges and universities that experienced Wi-Fi crashes in September 2013 when mass downloads of Apple's iOS 7 crippled campus networks all over the country, it may be time

to take serious stock of how you approach the future-proofing of your IT infrastructure to make it more intelligent too.

*Campus Technology* explores the most promising new approach for designing the next generation of networking infrastructure in this special report commissioned by Meru Networks. The report examines how the university wireless network is advancing from a "coverage" model, where connectivity is available in almost all corners of a campus, to a "capacity" model, which uses the latest Wi-Fi standard, 802.11ac, to ensure adequate connectivity and bandwidth in high-density areas. The next phase will be a "user experience" model, which shifts away from a campus deployment focus altogether and puts the emphasis on building an end-to-end infrastructure that can deliver an appropriate user experience no matter how radically different the networking demands may be from one day or one hour to the next.

## A 75-SECOND RECAP OF THE EVOLUTION FROM COVERAGE TO CAPACITY

In the not-too-distant past, the primary goal of the wireless network was to provide extensive coverage that enabled a person to get online with a mobile device no matter where he or she was on campus — in a classroom, in a library, on the quad, grabbing lunch or heading to the parking lot. In those initial heady days around the turn of the 21st century, when laptops and phones were outfitted with 802.11b/g, the IT organization considered it a success story when a student could roam from one end of the campus to the other end without the network connection being dropped.

A decade later, just as 802.11n began appearing in products, that goal was becoming outdated. According to Educause research arm ECAR, smartphone usage between 2004 and 2012 had grown by an eye-popping 5,545 percent. Laptop usage had nearly doubled. Tablets started showing up. Students had begun doubling and tripling up on devices, using a smartphone for their social backchannels, a tablet for FaceTime and a laptop for course work. Although a number of institutions were finally announcing completion of their coverage models, those schools at the head of the pack had already figured out that coverage was not always sufficient. In certain areas on campus, where students were congregating and connecting in big numbers, the wireless network needed to be constructed to support capacity.

Colleges poured more access points onto the problem to accommodate more usage. But this approach could only get them so far. APs stacked up on each other tend to get their signals crossed, and the resulting co-channel interference knocks AP efficiency to the lowest common denominator — or, more specifically, the lowest common wireless standard.

Leading network vendors redesigned their wireless

products to shift the intelligence out of the APs and into central controllers for better management of the wireless network. They started working with campuses in performing finer-grained site surveys to deploy the wireless equipment more effectively.

That push to design networks that could accommodate ever growing capacity needs came none too soon. With the proliferation of devices also came greater demand for bandwidth-hungry applications such as video, other forms of multimedia and unified communications. Taking at least one course online became the norm for students. And they were not sitting in their dorm rooms attending those online classes via a desktop computer plugged into the wired network; they were out on campus or at work tuning in via those same portable devices they were already carrying.

When early-adopter mobile devices surfaced running the 802.11ac wireless specification — even before the standard was officially adopted in 2013 — a new era in networking had begun. But it doesn't end there.

## A NEW WI-FI STANDARD

11ac is purpose-built to accommodate the kind of higher capacity, higher bandwidth-intensive deployments needed by higher ed right now. Campuses that have begun their transitions are realizing two obvious benefits.

First, the new Wi-Fi standard has the potential to deliver gigabit-plus performance over the air. Schools are responding by choosing to eliminate whole segments of their wired infrastructure to enjoy the requisite cost savings and simplification of network busy work and management.

Second, as is frequently the case in whole-grade technology refreshes, networking products built on the new specification allow mobile devices built for the old specification to run dramatically better. Testing has shown that an 11n client may download content up to 40 percent faster through an access point using the 11ac chipset.

As many institutions phasing in 11ac have discovered, even in the case where vendors are engineering to standards, how those companies choose to architect their products can have a major impact on network operability. For example, Meru Networks puts the network in control of Wi-Fi transmissions to coordinate access points and generate what it calls a "virtual cell." Once a user is connected to the wireless network, he or she will stay locked onto it and use a single pervasive Wi-Fi channel — even as the user moves around in the environment. The single channel approach optimally exploits the 80 MHz channel width used in 11ac. Other companies have had to downgrade user expectations in order to explain away the challenge of co-channel interference.

That said, 11ac is not the last word in the evolution of the campus network. Even as students gravitate to the newest mobile devices and bandwidth-intensive learning becomes standard fodder, institutions will soon begin feeling the pressure of the Internet of Things — "26 billion things by 2020," if Gartner is to be believed: vibration sensors for managing energy, light, guidance displays and security; wearable sensors; inventory sensors — all of it hurling new mobile data through the wireless network.

At any given moment IT will be the ones who have to sort out the important IP traffic required for the running of the campus from the data that's flowing because of individual desire, personal preference or even idle curiosity. IT will

## U HOUSTON: TRYING 802.11AC WITHOUT A NETWORK NET

The University of Houston is one of the institutions that chose to pursue the advantages of networking hardware built for 802.11ac before the Wi-Fi standard was formally approved. A primary driver: to validate for students that their computing experience was continually being improved. To roll out the 11ac production environment for the first time, the school set up a gaming night with pizza and prizes in its new, heavily populated university center. IT handed out 11ac adapters and students went crazy.

"We didn't know what to expect," recalls one IT participant. "IT was operating without a net." The result: A great student experience. Students demanded another gaming night; the party promoted a sense of community; and IT showed how responsive it could be to the needs of the students.

The Texas university partnered with Meru Networks in that experiment. It has since deployed 11ac gear for capacity in other areas of the campus and continues its wireless network migration.

also be the ones who have to figure out how to swivel the many legs of the campus network quickly and get them running in the right direction to ensure the appropriate user experience. Fortunately, the latest networking innovation promises to help.

## THE POWER OF SOFWARE-DEFINED NETWORKING

The Open Networking Foundation (ONF) was founded by some of the largest tech companies in the world to push for innovation in all aspects of networking. This trade organization's primary purpose is to develop a simpler yet more powerful and open approach to network design, management and operation. ONF calls its aspirational architecture "software-defined networking" or SDN.

Data traffic in a traditional network is directed and forwarded through switches, routers and firewalls using protocols such as OSPF or spanning tree and other functionality planted directly into the network operating system by the vendor. While that approach ensures a certain level of reliability (especially when the networking gear is fairly homogenous), it is not sustainable in the face of the dynamic forces such as virtualization and cloud that are buffeting the networking function today.

The idea of SDN is to use a logical overlay to shift the intelligence and state of the network previously married to the networking equipment into an SDN-enabled controller. Just as server virtualization has abstracted the heavy lifting and manual work involved in managing servers, SDN is expected to boost the agility and flexibility of the entire network by abstracting the complexity of the underlying physical network.

SDN isn't entirely just aspirational, since several such controllers already exist. One of them — OpenDaylight Hydrogen — took the "Grand Award" at this year's Best of Interop competition. Hydrogen is an open source SDN controller implemented entirely in software and contained within a Java Virtual Machine that can be deployed on any hardware or operating system platform that supports Java.

Also, ONF has released its first programming interface for SDN. OpenFlow is a crucial protocol for doing communications between the control and forwarding functions in an SDN architecture. Its job is to control traffic across OpenFlow-compliant network devices. (http://www.merunetworks.com/press-releases/2014/Meru-Networks-First-to-Receive-OpenFlow-SDN-Conformance-for-Wireless-Networking.html) Just as important, the existence of OpenFlow allows network control to be moved out of networking switches — its customary home — and into SDN software that interacts with SDN-enabled network devices.

Best of all, the architectural approach inherent in SDN encompasses both the wired and wireless infrastructure. No longer is Wi-Fi shunted aside like a demanding younger sibling. It takes its rightful place at the main table as an intrinsic part of the overall networking infrastructure.

SDN holds promise on several fronts:

- IT can mix and match network components from different vendors;
- The wired and wireless infrastructure can be managed through a single view into the network;
- IT policies can be created and enforced network-wide, giving users a uniform experience no matter what their access method; and
- The network can adapt programmatically to changes that are needed.

## SOFTWARE-DEFINED NETWORKING IN ACTION

Meru Networks, a provider of wireless LAN solutions, is fully embracing SDN for the potential it holds in transforming campus IT operations.

To test out the viability of SDN, Meru created a demonstration that shows how to deliver a consistent and satisfying user experience with Microsoft Lync. This component of Microsoft's Office 365 Education plan has an SDN API that allows developers to build applications and services that can monitor, isolate and correct issues on the network that affect Lync quality of experience. Frequently, what happens during Lync conversations is that the video becomes choppy based on what else is taking place on the network during that interaction. Meru created an application that uses the Microsoft SDN API to enable a stutter-free video call between a Lync user at a desktop computer connected

## CEDARVILLE U: COVERAGE TO CAPACITY AND BEYOND

Cedarville University in Ohio faced a unique challenge. Daily over the course of 10 minutes this college gets 3,000 people entering its chapel for services. Trying to get online during that period in that crowded space would become a true exercise in frustration. As Associate Vice President for Technology and CIO David Rotman recalled, the devices could see there was a wireless network; they just couldn't get connected to it — "to the point where some students started complaining that we were turning off the wireless." The coverage model that worked for other campus buildings and a majority of outdoor areas wouldn't suffice here.

So it was the campus chapel where the school first tested out the potential of 802.11ac and the capacity model. The results were highly promising. Once the new implementation proved itself, said Network Engineer Tim Kelly, "we wanted to branch out to the other academic areas. The next phase will expand in our academic buildings and then residence halls." The university has purchased enough 11ac access points from Meru Networks to "do half the campus." That deployment should be finished by August.

None too soon, observed Rotman. Six months ago it was hard to find a laptop that came with 11ac. Over the next six months it could become hard to find a mobile device without 11ac. In fact, a recent summer purchase of laptops for staff and faculty came with the 11ac chipset. "And for the first time there was no extra charge," he added.

Now Rotman and Kelly are pondering how software-defined networking (SDN) might fit into their environment. "We're at the point where server virtualization was in the early days, where I couldn't quite get my head around that," Rotman noted. "Now almost all of our servers are virtualized. I think SDN is the same. I'm so used to having a switch in each closet. [With SDN] they're tied together — almost like a cyborg that figures out for itself what it wants to do."

The IT crew spends a "fair amount of time" on VLAN definition and DHCP management. "If some of that became irrelevant, that would be helpful," Rotman said.

Last summer the university upgraded its core and went from a single switch to two redundant switches. That has increased the complexity and made troubleshooting "tougher," he explained. "If a particular building loses connectivity, what triggered it? Was it a building switch? Two core switches losing a connection?"

Or, more likely, said Kelly, "It's easy to blame the wireless, especially when you have students come in in August and the network goes from zero to 60 within a matter of minutes. There are a lot of processes that are running. That just takes time to troubleshoot." An SDN-enabled network could "help cut the variables."

to the wired network powered by an HP switch and a user running Lync on an iPad wirelessly connected to a Meru SDN-enabled controller. As the company explains, the OpenFlow controller it developed chooses the optimal path for the Lync packets as they move across both networks.

The company reports that announcements regarding further support of SDN in its product lines will be forthcoming later this year.

## THE CASE FOR THE INTELLIGENT CAMPUS

The new model of the network envisioned for SDN is worth pursuing, especially in an environment as quickly evolving as higher ed. How could it play out on the ground? Let's examine four use cases.

*Rapid redeployment of the research network:* Campus research labs frequently need networks to be reconfigured quickly for specific projects that come up. Being able to redeploy network resources to support these quickly changing needs would be useful and beneficial for research activities on campus.

*High-density/prioritized access for academic events:* If certain buildings are known to have student testing activities at certain times of the day, either on a schedule or ad hoc, those testing applications and associated traffic flows call

## LEARN MORE

**802.11ac Overview**
http://www.merunetworks.com/products/technology/80211ac/index.html

**Open Networking Foundation**
https://www.opennetworking.org/

**Software-Defined Networking Defined**
https://www.opennetworking.org/

**SDN for Wi-Fi**
http://www.merunetworks.com/collateral/white-papers/sdn-for-wifi-wp.pdf

for high priority and network performance. IT may need to "turn the knob down" on student Netflix streaming during those periods while ramping up priority for testing-related traffic flows. In this scenario, location tagging can help as well. If certain rooms or floors are designated for testing at the end of the term, IT could hastily change the network environment to fit user or staff demands in particular areas.

*Addressing emergency management:* This may be the most compelling use case for introducing SDN into the data center. In a campus emergency, public safety personnel, first responders and administrators require immediate access to all of the relevant details. From a network perspective, this means being able to identify specific applications, users, domains, traffic flows, etc. that are relevant and then dynamically reconfiguring the networks and related systems to respond quickly by identifying current traffic trends and reprioritizing traffic flows based on the emergency and its location. Today, it is not possible to do this end to end across wired and wireless domains campus-wide without a lot of frantic activity, but SDN could change that.

*Management of specific student-initiated network events:* Remember that iOS update referenced earlier? The aggregate bandwidth taken by those student downloads was massive, and to make it worse, it dragged on for days, as new groups of students kept coming to the campus to do their iOS downloads on campus Wi-Fi networks. Financially, universities do not want to pay for large student data downloads, and this needs to be regulated and controlled to avoid interfering with core educational and business needs. The same kind of network saturation happens during major sporting events as students stream them. IT needs to be able to reconfigure the network during special events so that traffic flows can be reprioritized and the campus network does not get bogged down by non-education activities. (It could even set up a scenario where those who want an extra shot of bandwidth pay a small fee out of their student account for priority access.)

Each scenario brings with it a need to provision the wired and wireless infrastructure from a unified control point to support quickly changing conditions and to manage and deploy policies that apply pretty much across the entire network no matter what vendor supplied the gear or what network is doing the work.

That kind of agility is what characterizes the Intelligent Campus. Networking providers such as Meru envision a future where SDN applications for each type of network profile will be pre-built and provisioned with a finger tap on a touch screen or automatically set in motion when certain conditions arise. The result will be an end-to-end network that responds to major change in the campus community and as a result can deliver the appropriate experience to the individual user.

## ABOUT US

### Meru Networks

Meru Networks is a Wi-Fi market leader addressing the ever-growing need for higher bandwidth and higher client densities within the enterprise and education markets. Its new AP832 — the market's fastest 802.11ac access point — can offer gigabit Wi-Fi to faculty and students and enable universities to deliver 21st century learning.

For more information, visit the Meru web site www.merunetworks.com/education

### Campus Technology

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