

BI-ANNUAL REPORT JULY – DEC 2021

CREATED JAN 11, 2022

Information Technology Services
Infrastructure and Operations: Networking



THE UNIVERSITY
of NORTH CAROLINA
at CHAPEL HILL

News and Information:

- We have placed orders for a significant inventory of switches and access points to be used for campus upgrades/life cycle. However, the supply chain issues are causing significant delays in receiving that equipment. Orders made for switches in October are expected by end of March. Orders made for WAPs in October are expected in late January. These delays vary depending on part number. **This means that orders for significant capital projects must be made many months in advance.** It also means that we may not be able to provide a quick turnaround for small requests. You must contact us as soon as possible if you have upcoming networking needs and understand that we may be forced to use old, recycled stock to complete a request until newer inventory arrives.
- Wireless across campus appears very stable after the code fix from the vendor was installed in November. **DO NOT ACCEPT POOR INDOOR WIRELESS COVERAGE.** If you see issues, send us a request.
- Reid Bradsher was promoted to Manager of the Network Deployment group, taking over from Len Needham who has recently retired.
- Will Allen has been hired as a Network Analyst within the Network Deployment group. Will comes from the Operations Center.
- We are currently in the process of recruiting a new Wireless Engineer and hope to be posting an opening for a Senior Network Engineer in the next quarter.
- Our group continues to be divided between on-site and work from home. The Network Deployment group has maintained full presence on campus since the start of the pandemic while the rest of Networking works primarily from home. The exception is the Wireless group which has operated on a hybrid and individual by individual basis.
- Campus DNS, DHCP and IP Address Management are delivered on the Infoblox platform. It currently tracks 1,529 VLANs, 2,061 IP networks, 1,641 DNS zones, and 80,631 IP allocations to support campus and affiliated organizations. Delegated administrative access, which allows administrators management of their data directly and potential reductions in their own IT server footprint, has been granted to 48 teams with 2 new departments added in the second half of 2021. The ability to define MAC based DHCP Reservations has been of high interest since it allows endpoints to be configured dynamically over the network avoiding manual static configurations.

- In 2020, a centrally managed web proxy service based on the A10 Networks platform was established. The service goal is to facilitate patching and administrative functions on servers without Internet access. New functions have been identified over time growing service demand. In 2021 this doubled and brought usage to approximately 16,500 unique proxy clients with up to 1,000 concurrent sessions through the proxy.
- We would like to personally thank Chad Ray and his entire team for all the work they do to provide physical connectivity for our campus. So many of our projects rely on the work that Chad and his team do, and we consider Transport Operations a partner in our success.

Is there a service you think we should be offering? Is there something we can do better? Are there different statistics or information you would like in this report? Please let us know.

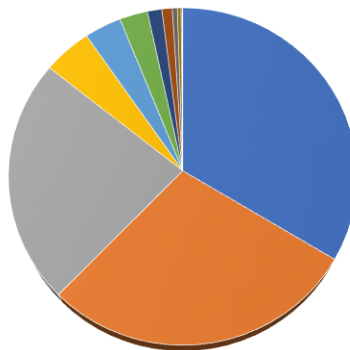
*Sincerely,
Ryan Turner
Head of Networking*

Key Campus Metrics

WIRED

Number of switches on campus:	2,919
Number of ports:	175,456
Peak download rate:	20 Gbps (Nov 16)
Peak upload rate:	30 Gbps (Nov 17) *new record for the report
Traffic sent to Internet:	14 PB
Traffic received from Internet:	10 PB

Switch Distribution - Entire Campus



■ Extreme 460 (976)	■ Legacy Enterasys (830)	■ Enterasys 7100 Series (681)
■ Extreme 440 (135)	■ Extreme 690 (103)	■ Extreme 5520 (78)
■ Cisco (40)	■ Arista (29)	■ Extreme SLX (14)
■ Extreme 870 (10)	■ Extreme 670 (3)	■ Extreme 695 (2)

- I have updated this graph to group all legacy switches together as knowing the precise model is no longer relevant. As a result, I have broken out the newer model switches.
- Due to the current supply chain issues, we are warehousing G3 switches that were pulled out of service to serve as emergency stock.
- We carried very low inventory during 2021 to aid University cash flow and have a lot of catch up to do over 2022-2023.
- The record upload rate happened to correspond with the same day we had our VPN outage. I haven't unpacked that to figure out why, but I doubt it was a coincidence.

Explanation of major model types:

Cisco Nexus 7706 – These chassis-based routers act as the core of our network and feature high density 40G/100G capabilities. These switches provide almost all core routing for campus and were the part of our major core redesign in 2018. They also serve as the layer 3 core for ITS data centers, providing an aggregate of 400 Gbps from ITS Franklin and ITS Manning.

Arista – We used a variety of Arista switch models to provide high-density high-speed connections to ITS Research Computing as well as other research entities across campus.

Extreme 440 – Compact low port count switch that is used in limited situations to provide port extensions to classrooms and conference rooms. This switch is generally installed as a 12 or 24 port count switch. It can be uplinked at 10 Gbps.

Extreme 460 – One generation behind the current generation standard fixed format campus edge switch. Standard install is 48 ports of 1 Gbps connectivity with uplinks traditionally spec'd at 10 Gbps but will support 40 Gbps links.

Extreme 690 – Our current generation of Building Entrance switch that is normally ordered with fiber connections to serve downstream edge switches at 10 Gbps. This is also the switch that is used for data center pods. Can support a multitude of uplinks speeds up to 100 Gbps.

Extreme 695 – Will likely be our next generation of Building Entrance switch that will replace the 690. The switch has a different architecture with the ability to support 48 25Gbps links (an improvement from the 48 10Gbps of the 690).

Extreme 5520 – Our current generation fixed format edge switch. Capable of significant multi-rate (2.5 Gbps or 5 Gbps) ports in addition to 802.3bt power in addition to uplinking at up to 50 Gbps.

Extreme SLX series – These high density 40G/100G switches are currently used as spine layer switches in the new data center design. They can support a high number of 100G ports, will support 400 Gbps in the future, and feature a deep packet buffer system that can eliminate packet drops from a congested network. They come in chassis and fixed format, and we will be considering this line for replacement of our current distribution tier 1 switches (S series).

Extreme 7100 series – Two generations behind currently supported edge switch. Fixed format switches that feature 1G to the desktop, 10G to the server, and 10G or 40G uplinks. This switch is no longer available for purchase and runs a network operating system that will eventually be deprecated by the manufacturer. Most will support 802.3at power over ethernet.

Enterasys Legacy – Consists of G3, K Series, S Series, and N series switches which are far beyond support and not adequate for modern networking needs. This equipment is being actively life cycled.

WIRELESS

Number of APs on campus: 10,190
 Peak concurrent connections: 38,961 (Nov 1)
 Devices onboarded to eduroam: 44,735
 Top Onboarded OS: iOS at 41%

AP Distribution - Entire Campus



■ AP-225 (3292)	■ AP-315 (3179)	■ AP-515 (948)	■ AP-325 (834)	■ AP-135 (648) *
■ AP-303H (378)	■ AP-205H (367)	■ AP-224 (295)	■ AP-335 (95)	■ AP-277 (49)
■ AP-275 (46)	■ AP-134 (43) *	■ AP-377 (5)		

* Indicates a platform currently no longer supported by vendor

- We hope to introduce Wifi 6E access points by the end of 2022.

Explanation of major model types:

AP-1XX – Aruba access points that feature 802.11n capabilities. Support for 100 series access points was ended in 2021.

AP-2XX – Aruba access points that feature wave 1 of 802.11ac capabilities. Aruba has set the end of support date for these access points as some time in 2023. We are currently life cycling 200 series across campus.

AP-3XX – Aruba access points that feature wave 2 of 802.11ac capabilities. Aruba has not set the end of support date for these access points, and we consider these still current generation.

AP-5XX – Current supported and installed model of access point which is Wi-Fi 6 certified.

Wi-Fi 6E What is it, and why should we care?

What if I told you that we are on the verge of the most significant upgrade to Wi-Fi in over 20 years? To be clear, that isn't just hyperbole.

In early 2020 the FCC voted to open up the 6GHz band for Wi-Fi and other wireless technologies. During the first week of January 2022, an appeals court upheld the FCC's decision to make the space available, ending the last regulatory hurdle for use.

But what does that mean, and why should you care?

Considering current Wi-Fi capabilities, we have three non-overlapping 20MHz channels in the 2.4GHz band. The 5GHz band has up to 25 non-overlapping 20MHz channels, although many of those fall under specific regulatory rules, which may make them unavailable for use.

To drop the geek-speak for a moment, consider each of those channels as a conference room. Ideally, each conference room should only have one meeting taking place at any given time. But, as anyone who has ever lived in an apartment can tell you, it is VERY typical to have many wireless networks reusing the same channels, effectively attempting to hold multiple meetings in the same conference room at the same time! Each additional meeting causes issues for the others occurring in the same room. Attendees must regularly repeat themselves; the pace of progress slows down dramatically; some attendees can even hear the other meetings better than the meeting they are attending!

The new 6GHz band (which starts around 5.925GHz and goes all the way up to 7.125GHz) has 59 non-overlapping 20MHz channels! So we just added 59 conference rooms! We are growing from a total of 28 conference rooms to 87!

As you can imagine, many more effective conversations can take place at any given time, and the speed at which work can occur will increase because of that! More conference rooms equal better Wi-Fi performance!

There are other benefits that 6GHz will also bring to the table. Because the 2.4 and 5GHz bands have been in use for so long, we must consider much older wireless technologies operating on those channels. Even if our AP and our wireless client are cutting edge, they must still accommodate older clients. They do this by starting every transmission by speaking very slowly with information that roughly translates to: "I'm going to speak in a language that some of you won't understand, and it is going to take 10 seconds to say what I need to say, and receive an acknowledgment to indicate that I was understood. Please wait for me to finish, even if you don't understand what I am saying."

That extra declaration before every transmission adds a lot of overhead. This 'management overhead' must be part of the conversation and can consume between 40 and 50 percent of the total conversations occurring in each meeting!

In the 6GHz band, we can assume that all clients are at least Wi-Fi 6 or 802.11ax capable. That means that every exchange will occur at full speed, without additional declarations needed beforehand!

Some experts expect that management overhead for Wi-Fi will decrease from 40-50% to less than 20%. With less overhead, we can have more participants in each meeting and get more accomplished in the same amount of time. Who doesn't love that?

The Chicken, the Egg, and the Transition

There is a right time to begin deployment with any new technology. The Access Points need to be mature enough to support new 6GHz clients and our existing 2.4 and 5GHz clients at the same or better service levels. Further, new 6GHz clients need to be available. While both AP's and clients are beginning to appear on the market, they are still less mature and suffer from a lack of features or stability.

But there is good news at CES 2022. There were many announcements around Wi-Fi 6E, but the most significant was support in Intel's latest chipsets and processors, which is usually a precursor of wider general acceptance and adoption for device manufactures. Further, Aruba, our wireless vendor, has already released their first Wi-Fi 6E access point, and we continue to evaluate products and the market. Our plan and focus are to ensure we can deliver a high-quality and effective Wi-Fi 6E network while also providing consistent service levels for all of our other 40,000+ wireless devices.

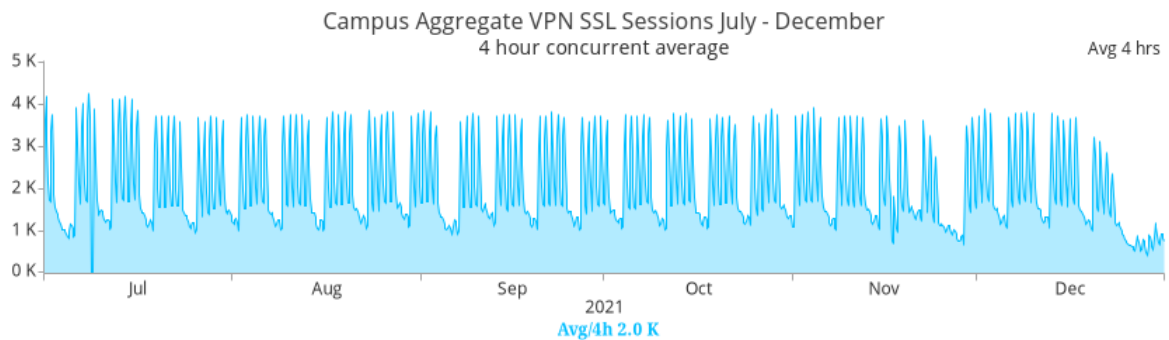
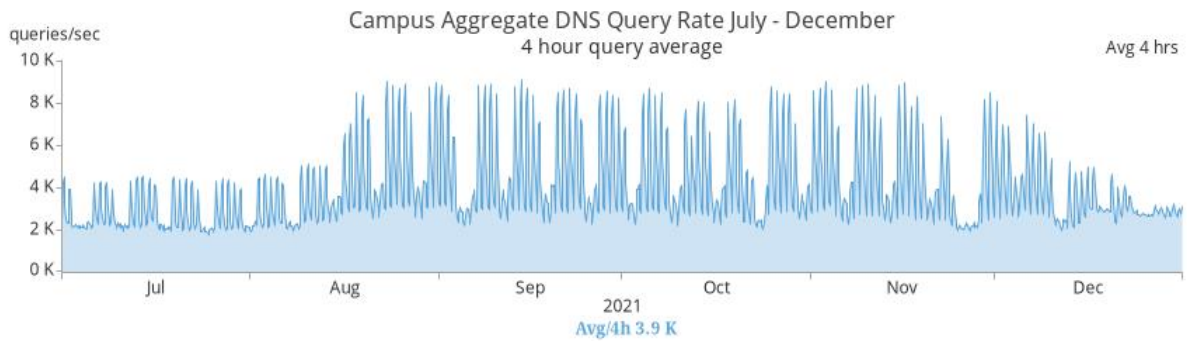
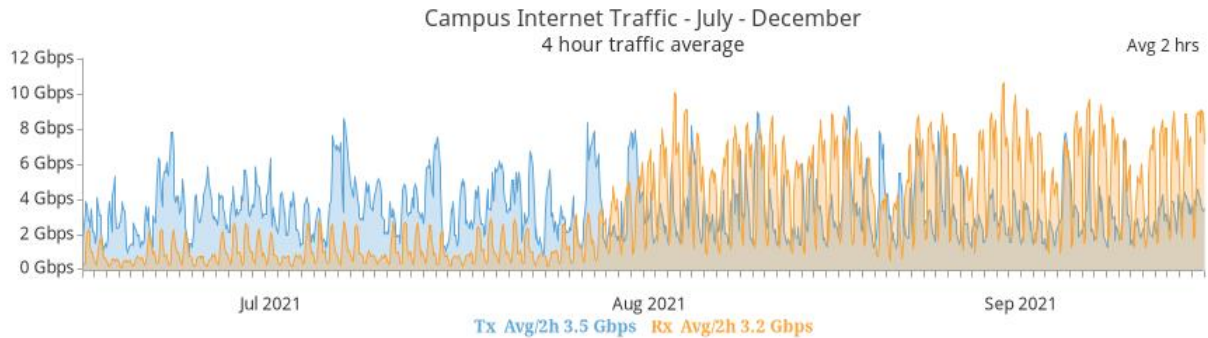
Jonathan Davis, Wireless Architect

Service Now Metrics

July through December 2021

Group Name	Service Request	Incident	Count
IP Services	206	22	228
Deployment	432	203	635
Systems	1	2	3
WAN	6	8	14
Wireless	25	68	93
Operations / Engineering	318	202	520
Count	988	505	1,493

ADDITIONAL GRAPHS



- When you stretch a graph across 6 months on a fixed width, significant data averaging occurs. For all these individual data points, that is the average over a 4-hour period. That means that you could have a 30 Gbps spike in traffic and it does not show averaged out over 4 hours. These graphs should be used to judge trends.

Major Initiatives Review:

Border Connectivity Upgrade

We have upgraded half of our connectivity to MCNC to 100 Gbps. We will be upgrading the second link to 100 Gbps within the next month. This will place us at 200 Gbps for total throughput to our Internet provider. Related to this project, UNC will be connecting to a new MCNC fiber ring that has been installed in preparation for their existing long term fiber lease that will expire at the end of 2023.

Campus Core Upgrade

100G line cards have been installed in all our campus routers and we are in the process of making them live. We plan on retiring our main campus router (fluffy) within the next year with a new virtualized 40G capable core on our Nexus 7706 platform. Danny Shue is responsible for most of this work.

Campus Distribution Switch Upgrade

We are finally starting to upgrade our campus distribution switches (tier 1s) to switches that are 40 Gbps and 100 Gbps capable. We have upgraded Phillips and Manning tier 1s and will be upgrading more than 20 more sites. One thing we did not anticipate is how old patch panels were going to slow our progress. We are finding that old fiber patch panels are creating too much reflection at the connector making 10G stability very difficult. As a result, Chad Ray's group is working on upgrading fiber patch panels across campus to resolve this issue. As a result, the work on distribution upgrades may not be completed until sometime in 2024.

F5 Load Balancing Service Upgrade

We are upgrading our Load Balancing Service to have additional capacity. We are expecting to put into service (2) new 11800 series F5 load balancers in the next quarter. We are currently at capacity with our current VIPRION installation which is matching upgrading / patching / growth extremely difficult. Sid Stafford will be leading this project

Medical Education Building

Significant time has been spent working with various stake holders in the planning of the telecommunications infrastructure in this building currently under construction. This building will have the latest generation of networking technology installed. We will be utilizing switch stacking, reducing our vertical fiber runs back to the building entrance switch, and we will be routing at the edge for high end audio video capabilities. We will also be utilizing 2x25 Gbps uplinks from the edge switch stacks to the building entrance switch. The audio video design requirements are causing us to rethink our current

network design philosophy. We are seeing these needs in every new building design, including the Business School expansion and in the Curtis Media Center.

NC System Office Network Integration

The networking team worked with the System Office for many months to take over responsibility for monitoring, supporting, and upgrading their site at UNC Chapel Hill. This included the total migration of all VLANs and wireless networks to campus equipment. We have recently completed our wired and wireless work in the CSLD building. Dawn Douglass, Danny Shue, ITS Security and the Network Deployment group were principally involved in the planning and implementation of this large task.

Large Classroom Wireless Redesign

The demand for wireless device capacity continues to grow on our network. That demand has overgrown our Wi-Fi in some larger lecture halls, where two thousand devices may be active at any time in a single room. To address this, we are utilizing new methods to provide Wi-Fi clients with the best coverage while spreading the load across more AP radios. Once new equipment arrives in June, we expect to deploy, test, and verify performance in a few rooms before expanding the scope to others which may also suffer.

Life Cycle Update:

Life cycles are completed by the Network Deployment and Wireless groups.

The following locations have received substantial new switching gear during the past 6 months:

- Whitehead
- Van Hecke
- CSLD

The following locations have received substantial new wireless gear during the past 6 months:

- Whitehead
- CSLD
- Tate Turner Kuralt
- Greenlaw
- Bingham
- Memorial Hall
- Jackson Hall
- ROTC
- Manning Hall
- Frank Porter Graham
- 1700 Martin Luther King
- Student Affairs B
- Chapman

The following locations are being **targeted for switch and wireless upgrades** in the coming 6 months (subject to change):

- Curtis Media Center
- Knappe Sanders
- Lineberger Comprehensive Cancer Center
- Marsico
- Phillips Hall
- Vance Hall

We may be able to do more life cycle if we are able to receive switches sooner than the estimate from the vendor.

Critical Incidents Review:

Fall Semester 2021

Wireless Performance Issues Across Campus

We received a lot of complaints about wireless across the campus during the semester. We engaged the vendor and identified several bugs that had been introduced to the wireless operating system. We were victims of these bugs like many large, very prominent campuses. We put in mitigating changes to our infrastructure to improve the performance, but we could not mitigate the bugs entirely until the vendor provided us firmware fixes. The firmware fixes were put in place in November, and the fixes appear to have stabilized and corrected the issues we were seeing throughout the semester.

September 29, 2021

Main Campus Network Disruption

Scheduled work was being done to cable up a new Tier 1 for Phillips Hall. A cable was mislabeled, and this caused a loop that degraded performance for parts of main campus. We noticed the problem around 9:50AM and had the issue resolved by 10:03.

November 17, 2021

VPN Outage

On the morning of Wednesday, 17 November 2021, UNC suffered an outage of their remote access VPN service, impacting faculty, staff, and student access to campus resources. This outage lasted for approximately six (6) hours before service stability was restored, albeit in a degraded operational state. The cause of the outage was due to a software bug that only manifested itself after approximately 1.5 hours and at a time in the sequence of the upgrade process that left no quick resolution path. A detailed after-action report is available upon request.