

INFORMATION TECHNOLOGY SERVICES

NETWORKING ANNUAL REPORT

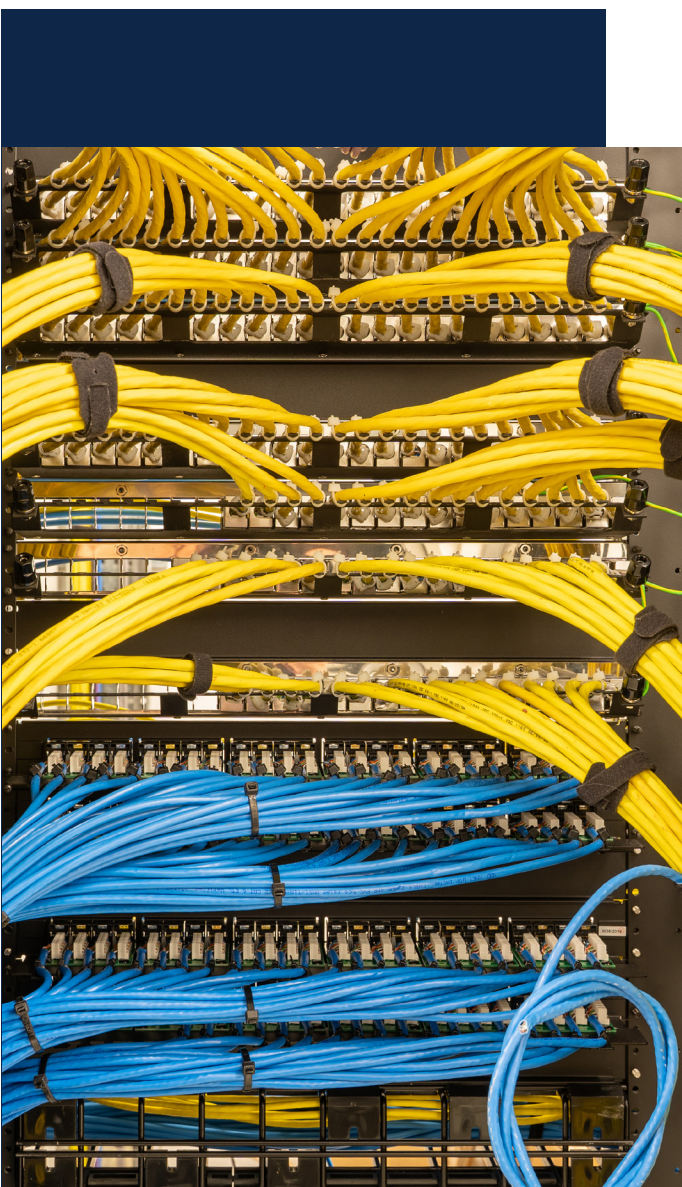


INFORMATION
TECHNOLOGY SERVICES

CALENDAR YEAR 2023

REPORT DESIGNED BY KERRY O'SULLIVAN

NEWS AND INFORMATION



For the 2023 calendar year, we decided to collapse the networking report into an annual report. Therefore, the metrics on the following pages are yearly data. This report has grown in the information provided, and a yearly format may persist into the future.

Wifi 6e is here and is being deployed on campus! We have included a special report that goes over the significant investment we are making to bring the campus up to the new standard as well as the upcoming Wifi 7.

UNC-Guest is going pervasive. Very soon we plan to announce a date where UNC-Guest will be broadcasted in all buildings with the potential exception of University Housing. This also means the elimination of UNC-Guest-PSK for on-campus buildings. We hope this will improve and unify our guest experience and make administrative staffs' lives a little easier.

HIRING NEWS



John Valenti

We added another position focusing on wireless and have hired John Valenti. John previously worked at Grand Canyon University where he was responsible for managing their wireless network. John has a B.S. in I.T. from Grand Canyon University. We now have 3 full-time wireless engineers.

UNC - GUEST IS GOING PERVASIVE!



Haley Bodhaine

Haley Bodhaine joined us as an Operations Center Analyst. She worked for several years at Cisco Systems and has a B.S. in I.T. from Brigham Young University.



Dan Raney

Dan Raney was hired to replace Cindy Henshaw (retired in 2022). Dan joined us from Colorado College where he was solely responsible for maintaining their network. Dan is also a veteran of the U.S. Air Force. He received his B.S. in Technical Management from Embry-Riddle Aeronautical University.



Mansur Nubee

Mansur Nubee transitioned from the Operations Center to the Network Deployment group to replace Chad Wade who moved back to the Fiber and Cable Transport group under Chad Ray. Mansur has worked at NC Central and UNC Chapel Hill since 2012. He holds a B.S. in Computer Information Systems from NC Central.



We have paused on hiring a Wireless Architect for the moment. We will restart our search later.



RYAN TURNER
DIRECTOR OF NETWORKING
HEAD OF THE OPERATIONS CENTER

KEY CAMPUS METRICS



KEY CAMPUS METRICS

WIRED

2,880

NUMBER OF SWITCHES

177,055

NUMBER OF PORTS

30 GBPS

PEAK UPLOAD RATE / FEB 17

40 GBPS

PEAK DOWNLOAD RATE / OCT 30

30 PB

TRAFFIC SENT TO INTERNET

20 PB

TRAFFIC RECEIVED FROM INTERNET

108 KW

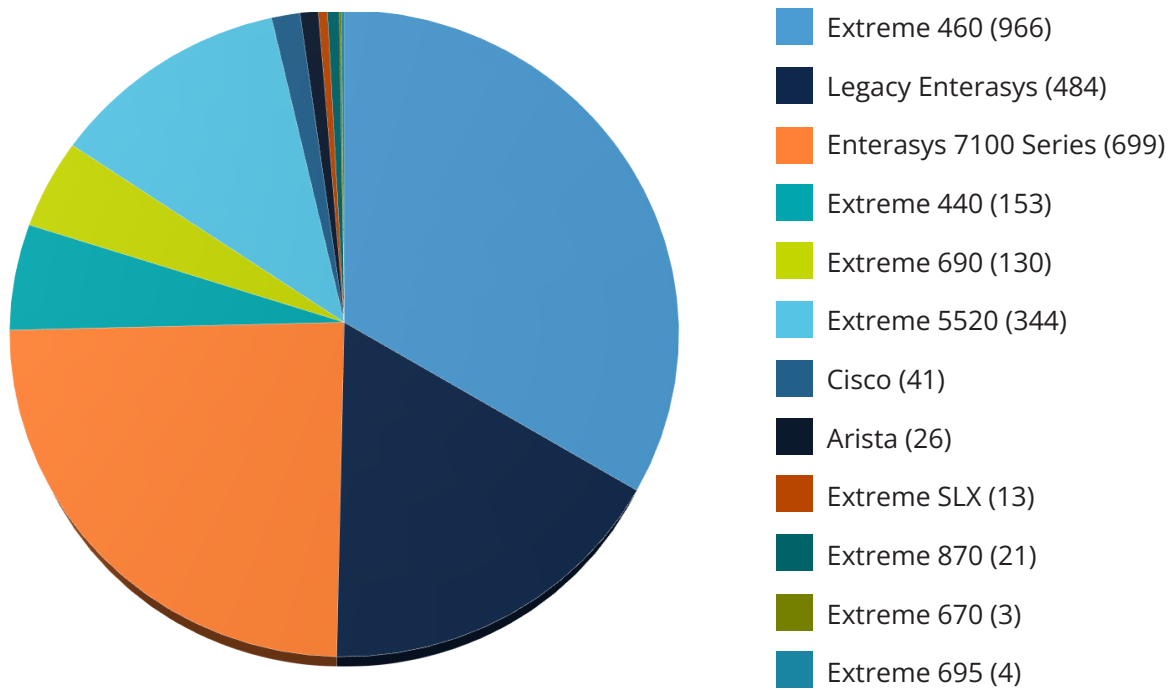
POWER DELIVERED TO POE DEVICES



KEY CAMPUS METRICS

WIRED

SWITCH DISTRIBUTION – ENTIRE CAMPUS



Compared to the first published report in 2019, the number of installed switch assets has remained mostly flat with a mixture of periods of growth and decline depending on the types of network assets we are replacing.

We hit a peak download rate that would have been impossible with our previous 4x10 Gbps connections with Tipping Points doing packet inspection. Our investments in connectivity and architecture are paying off.

1,621 EXTREME XOS SWITCHES ON CAMPUS

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 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 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

This 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 unlinking 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.

KEY CAMPUS METRICS

WIRELESS

ACCESS POINT DISTRIBUTION [ENTIRE CAMPUS]

- 315 (3183)
- 515 (2336)
- 225 (2151)
- 503H (1330)
- 325 (853)
- 635 (456)
- 303H (385)
- 205H (361)
- 224 (247)
- 335 (60)
- 277 (47)
- 275 (46)
- 377 (10)
- 567 (7)
- 575 (7)
- 345 (6)
- 585 (6)
- 514 (5)

2,939
NUMBER OF
SWITCHES

11,504
NUMBER OF APs
ON CAMPUS

~52,000
PEAK CONCURRENT
CONNECTIONS
(NOV 14)

iOS AT 34%
TOP ONBOARDED OS

EXPLANATION OF MAJOR MODEL TYPES

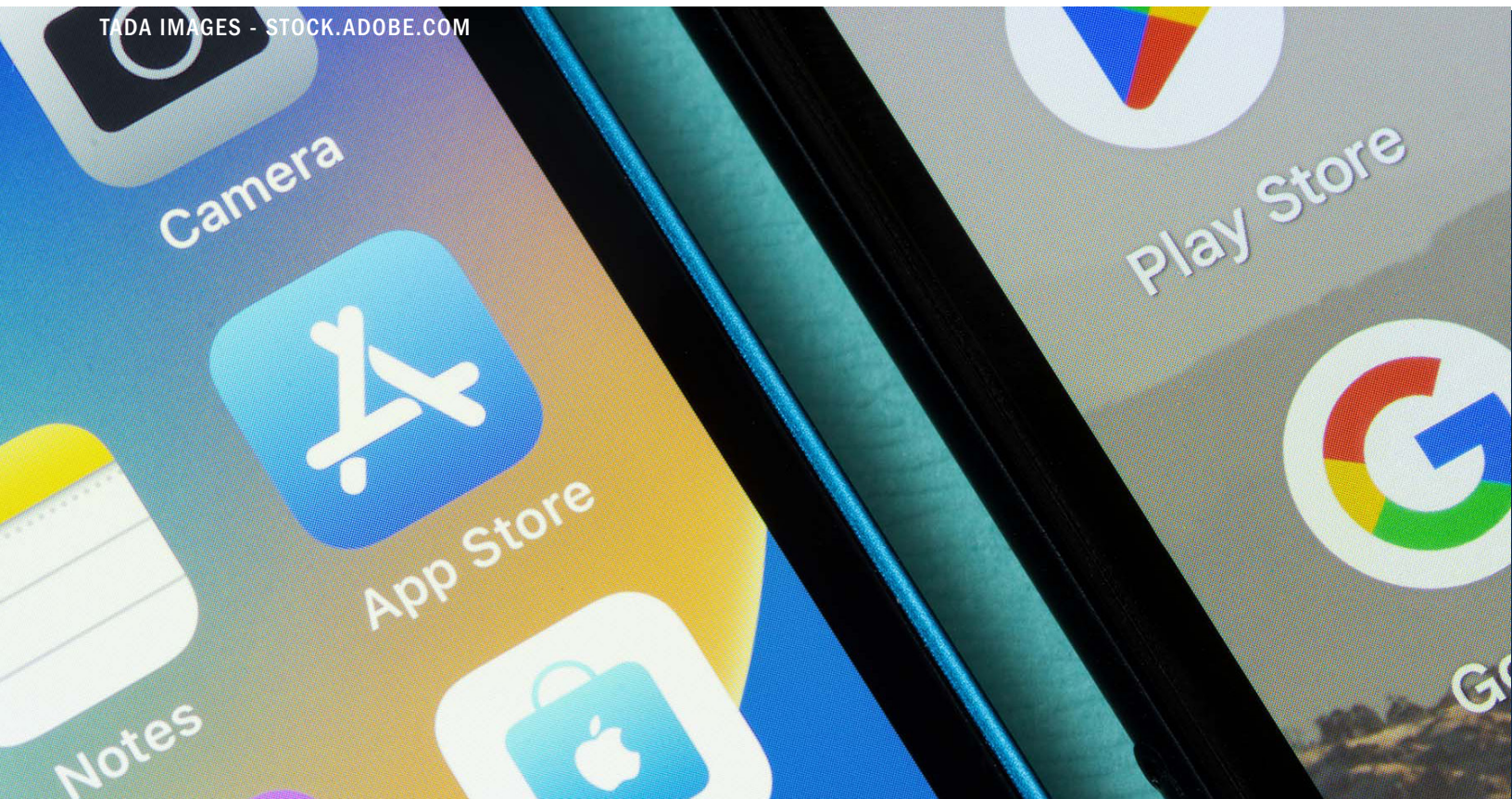
AP-2XX – Aruba access points that feature wave 1 of 802.11ac capabilities. Aruba has set the end of support date for these access points as some time in 2023. We are currently life cycling 200 series across campus.

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 – Aruba access points that are certified for Wifi 6. These access points were installed into 2023, and will be supported for many years, but are no longer being installed.

AP-6XX – The current generation of Aruba Wifi 6 access point with 6 Ghz capabilities. This is the currently installed standard for campus

AP-7XX – The upcoming generation of Wifi 7 APs.



Our customers prefer Apple devices to other operating systems. Apple devices dominated the eduroam onboarding statistics with over 68% of all devices in the last year.

Windows came in third place with 24%.

Android came last of the major operating systems with just under 6%.

Enormous efforts were made in installing Wi-Fi 6e access points during the last year (400+)



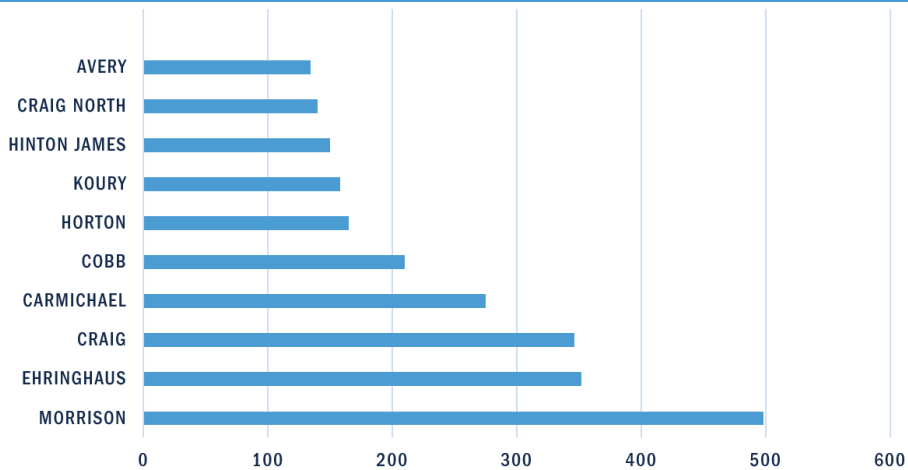
KEY CAMPUS METRICS

WIRELESS

TOP 10 HIGHEST AP COUNT FOR MAIN CAMPUS



TOP 10 HIGHEST AP COUNT FOR HOUSING



Networking at scale: The
UNC network visualized as a
constellation

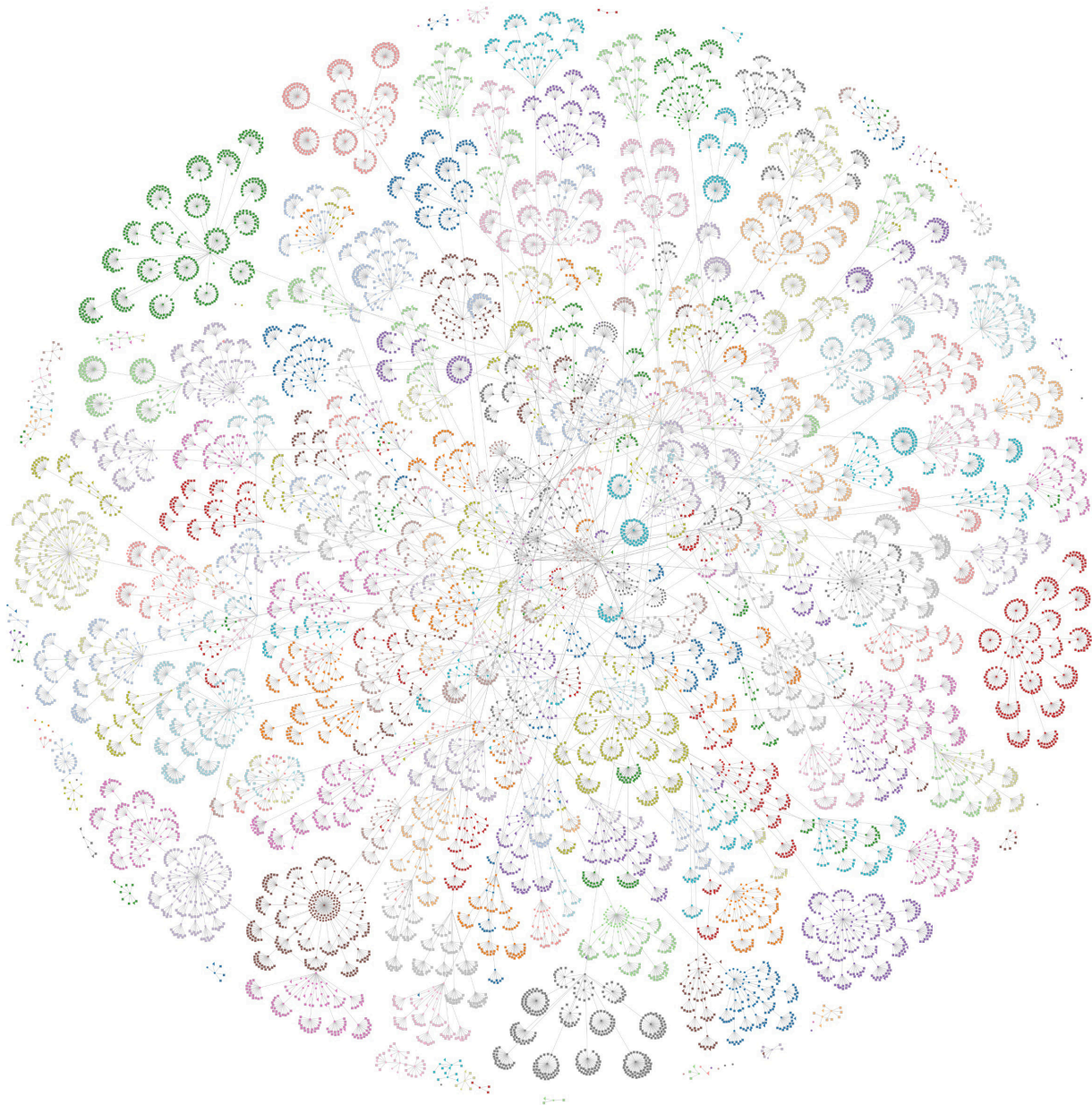
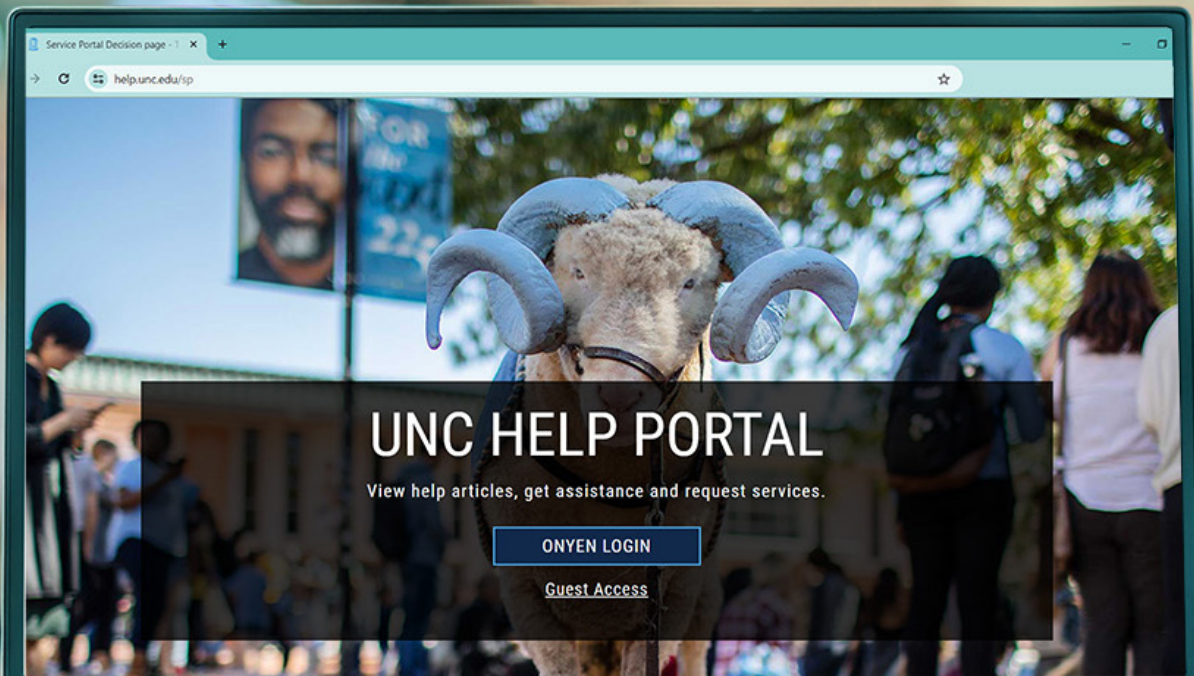


Image credit: Chris Florio

SERVICENOW METRICS



SERVICENOW METRICS

CALENDAR YEAR 2023

GROUP NAME	SERVICE REQUEST	INCIDENT	COUNT
IP Services	481	53	534
Deployment	740	513	1253
Wireless	29	28	57
Operations / Engineering	607	729	742
Count	1,857	729	2,586

UNC has selected TeamDynamix to replace ServiceNow. Metrics will be combined as we transition to TeamDynamix through 2024.

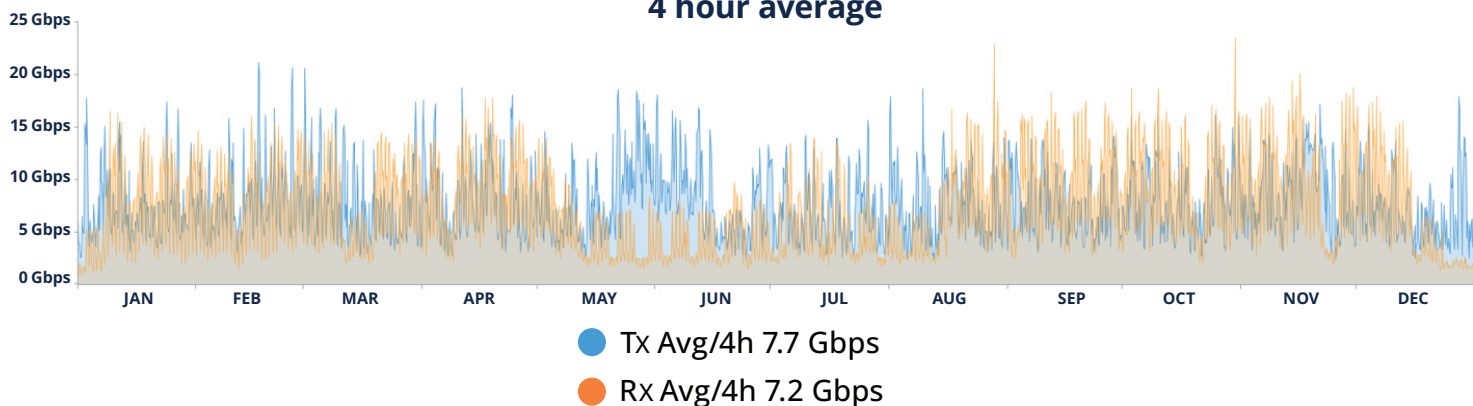
SERVICENOW METRICS

SERVICE GRAPHS

Editor Suggestion: Note that these graphs are best used for assessing trends rather than capturing specific short-term fluctuations.

Campus internet traffic January through December 2023

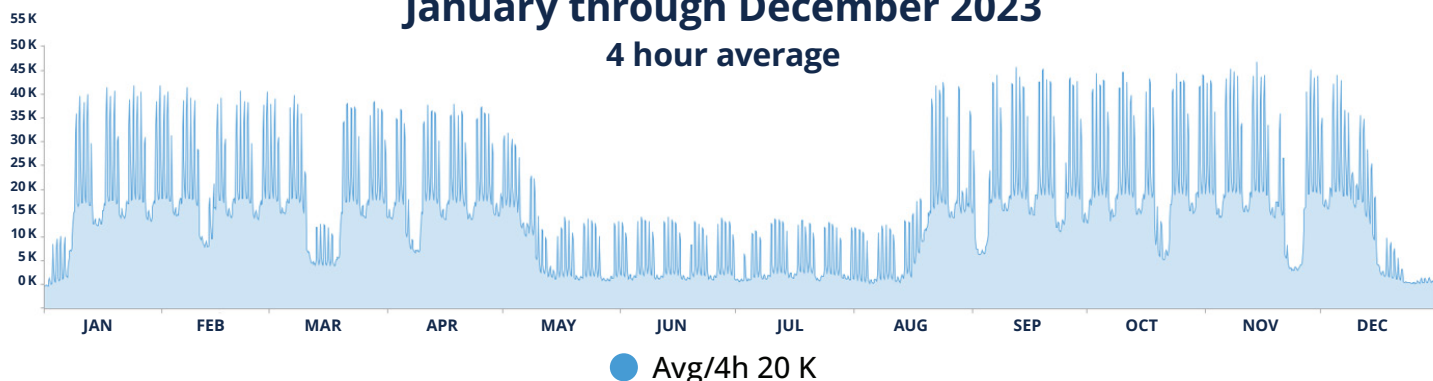
4 hour average



Aggregate campus concurrent wireless stations

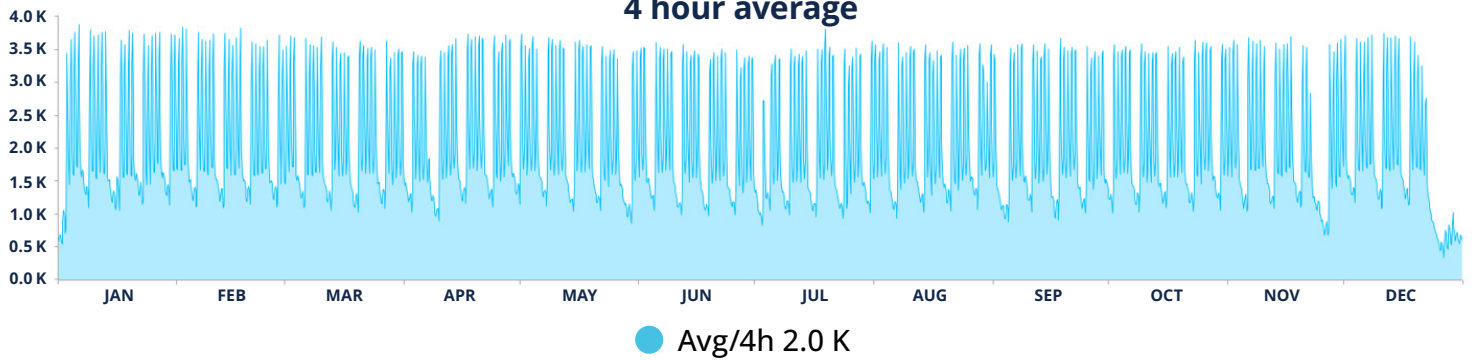
January through December 2023

4 hour average

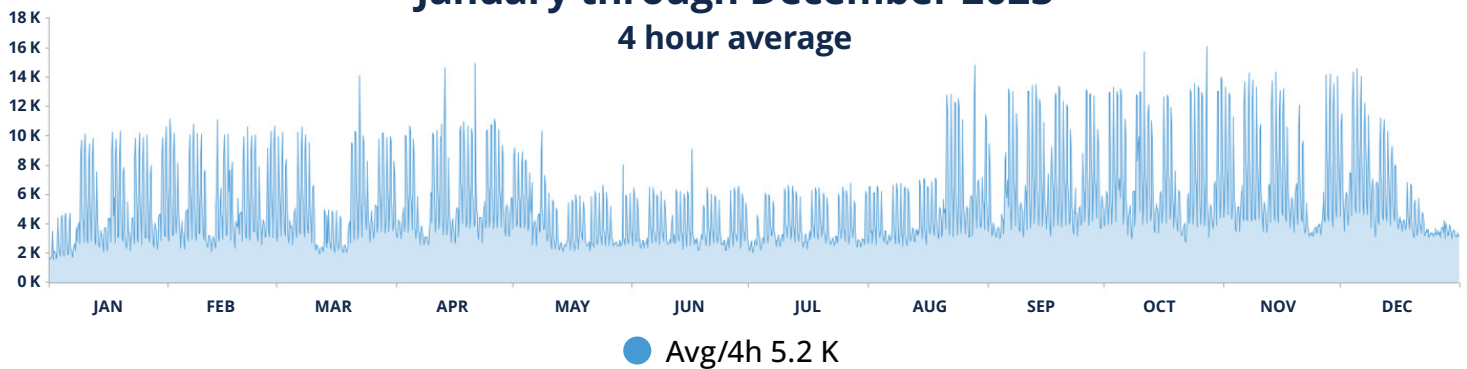




Campus VPN sessions January through December 2023 4 hour average



Campus aggregate DNS query rate January through December 2023 4 hour average



MAJOR INITIATIVES REVIEW

WIRELESS 6e INVESTMENT

Early in 2023, we received approval to move forward with expending significant resources to adapt the campus to Wi-Fi 6e. The FCC allocated the lower 1200 MHz of the 6GHz space for Wi-Fi use with 6e. This spectrum allocation more than doubles the number of previously available channels, which gives us the ability to scale wireless in a way we have not been able to before. It will be especially beneficial in large general-purpose classrooms, once the client devices have fully adopted the new standard. Only a small percentage of the current device population on campus is 6e capable.

New challenges have been presented in adopting this technology. The 6 GHz spectrum attenuates more than 5 and 2.4 GHz, requiring us to densify wireless cells. Roaming between 6 GHz and 5 GHz can be challenging so we are redesigning our wireless spaces to encourage 6GHz capable clients to stay on 6 GHz. The 6e standard introduces newly required security mechanisms, and while the change to support eduroam in the 6GHz space has been minimal, there is currently no interoperability between 2.4/5GHz and 6 GHz on PSK networks. We are not currently providing 6 GHz coverage for any PSK network.

It will be around 6 years before the entire campus has made the switch to 6e capable access points. On average, we are expecting to increase the AP count in buildings upgraded to 6e access points by 18%. This is happening for a few reasons. When we first deployed wireless across campus, the technology was vastly different, and now some locations are inadequate for the needs of today. Over the past years we have been filling in the holes, but Wi-Fi 6e requires a redesign of each building. As we lifecycle buildings, our wireless engineers produce a new design for each space.

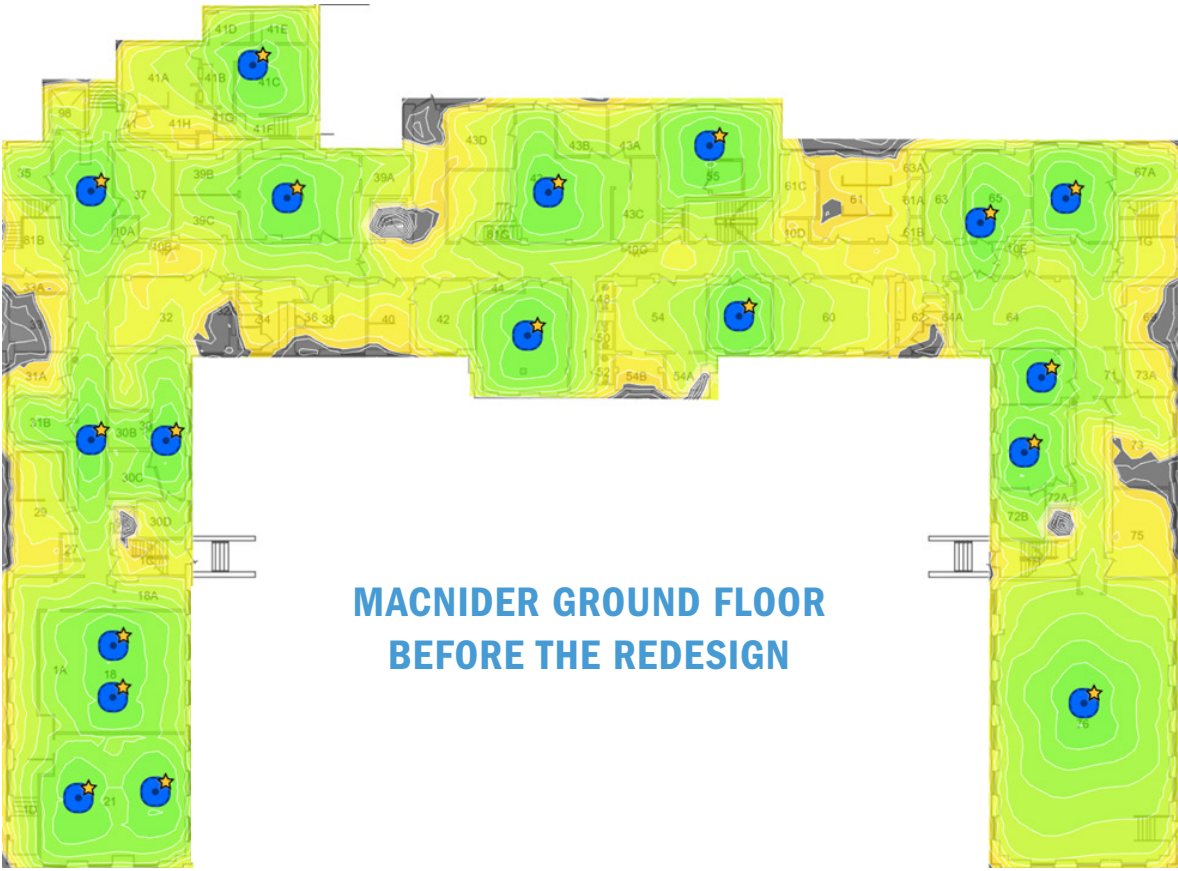
After redesigning the building, Chad Ray's group must come in and cable the new locations. Then the Network Deployment group comes in to replace and install the new access points. This is time-consuming and costly.

This is an example of the metrics for the most recent redesigns:

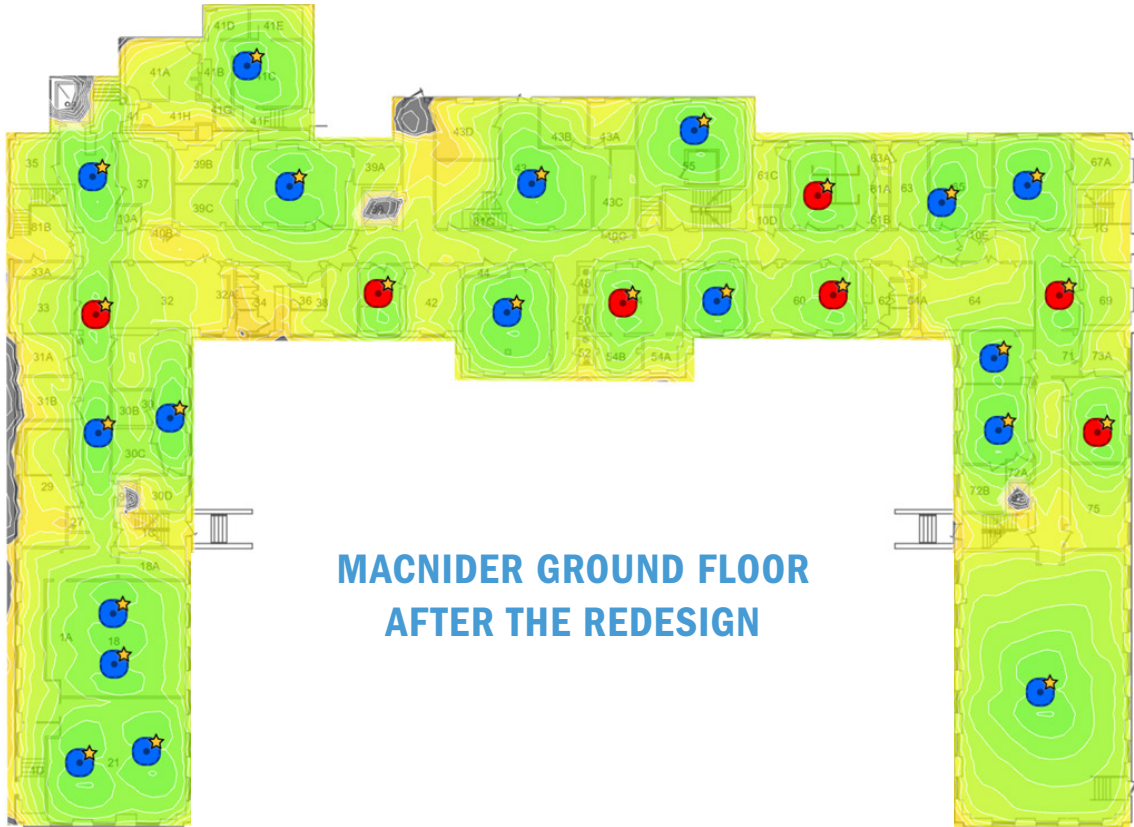
BUILDING	OLD COUNT	NEW COUNT
Bondurant	69	86
Genetic Research	152	189
MacNider	78	105

Because of the campus rate model, this is being done with no cost to our customers. We are currently selecting buildings that have outdated wireless access points as well as being 'on the easier side' of re-cabling. We are progressing through all the 200 series APs, then moving to 300 series.

Special credit to the entire wireless team for their ongoing focus in this area (Brady Ballstadt, Dawn Douglass, and John Valenti)



**MACNIDER GROUND FLOOR
BEFORE THE REDESIGN**



**MACNIDER GROUND FLOOR
AFTER THE REDESIGN**



CLOUD BASED WIRELESS MANAGEMENT

All network vendors have been focusing their efforts on designing management platforms for their assets in the cloud. While we have remained on-prem, this status quo will not last for much longer. Vendors feel as though the cloud approach can bypass restrictions that are often in place with on-prem management, ease management burdens, significantly improve scalability, and provide detailed analytics. Our current wireless vendor, HPE Aruba Networks, has a cloud platform called Central. Over the next year, we are going to test this platform on Main Campus and Housing in carefully chosen buildings. The change is mono-



Image generated by AI

lithic and requires a complete rebuild of our wireless configurations. In addition, access points must be on a different operating system which will require a lot of testing and validation in real world environments. Beginning with the Wi-Fi 7 APs that come out this summer, conversion to Central is a requirement to run the new assets. The change is so substantial that we will also look at alternative vendors if we are unhappy with Central performance.

EXTREME CAMPUS FABRIC EXPLORATION

The Networking team is considering the deployment of a network fabric that will simplify our network core as well as give us some additional options for path redundancy that are difficult to achieve with our current technology. The fabric we are considering will allow us to provide redundant links to every building on campus to multiple distribution networks. What this means is that if we have a problem with a distribution node, building traffic will be uninterrupted as it flows to a different node. Our distribution/tier 1 networks have always been our biggest single point of failure. Accomplishing this redundancy with our existing architecture would be challenging/impossible. The Engineering group, led by Jerry Woodside, as well as Danny Shue will be evaluating this possibility over the next year.

MORRISON RESIDENCE HALL UPGRADE

This past summer the Network Deployment and Wireless group worked to upgrade Morrison Residence Hall. During a period of about a month, these groups worked to install almost 500 access points in this single building. For the past few years, Housing has committed to significantly improving the wireless across all residence halls. For the coming summer, we are expected to work on investing in their switching capabilities, as a significant portion of their assets are beyond support and life expectancy.



Morrison residence hall

MAJOR CAPITAL PROJECTS COMPLETED

The Networking group commissioned networks in the Innovation Center, School of Business Charlotte, and Roper Hall.

CENTRALIZED NETWORK MONITORING PLATFORM 'AS A SERVICE'

We are now one year in with our centralized monitoring platform called Opsview. Most ITS systems have been moved over to this platform. We are now offering it 'as a service'. We are offering departments \$1,000 in free monitoring on the platform, and then we will recover cost on a per-host basis after that. If you are interested in hearing more about this, please contact me at r@unc.edu. Please note that customers currently on Zabbix will need to move over or move off that platform in the future. We have not set a date for decommissioning. Significant advanced notice will be provided.



Statuspage

INSTANT SERVICE ALERTING

We have made major changes to how we notify our customers about service outages. We are now using automation to alert our customers nearly instantaneously when we detect a service is down. When our monitoring platform detects issues with our subscribed services, a series of automations are processed that do many things simultaneously. Most importantly to our customers, itsstatus.unc.edu is updated in near real-time about a service disruption. Simultaneously, the Operations Center is busy validating that the alert is not a false positive. After validation, another series of automations notifies the service owner of an issue, updates the itsstatus.unc.edu website, creates a major incident, and even creates a Teams channel dedicated to the major incident for discussion. Keith Makuck, Will Whitaker and the Networking DecOps team deserve special credit for making this a possibility. Please consider subscribing to alerts at [itsstatus](https://itsstatus.unc.edu).



Image generated with AI - February 27, 2024 at 5:01 PM



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:

Dramatic Art
Marsico
Vance
Morrison
Craig Deck
Bioinformatics
Steele
Bynum
Genome
Koury Dental
Botanical Gardens

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

Swain Hall
Coker
Hamilton
Stone Center
ITS Manning
Mitchell Hall
Marsico
Vance
Pettigrew
Person
Physician's Office Building
Energy Services
Brinkhaus
Bioinformatics
Paul Green Dramatic Art
Hanes Art
Bondurant
Genetic Medicine
Fordham Hall
Wilson
MacNider

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

Murray Venable
Football Center
Student Athletic Center
Botanical Gardens
Davie Hall
Dey Hall
Swain hall
Student Union
Burnette Womack
Old Clinic
Mclean Hall
Brauer Hall
Neuroscience
Taylor Hall
Murray Hall
Kenan Football Center
Davie Hall
Tarson

CRITICAL INCIDENTS REVIEW

JANUARY 12, 2023

Main campus network degradation

Starting around 3:25 PM and lasting until around 4:00 PM, there was a misconfigured client on the network that broadcast over 600k packets per second that resulting in some general disruptions to communication on the network including the ITS Hosted Data Center. That host was isolated.

MARCH 17, 2023

Data Center spine switch issues

From around 9:39AM to just before 10AM one of our ITS spine switches began a continuous reboot cycle after a standard management command was issued on the CLI. Because the SLX continuously rebooted, it caused issues with the data plane that affected many ITS Services. We did not know it at the time but would later find out that there is a memory leak error on all our SLX equipment that would eat away all available memory over a 2-year period of uptime. When we issued a command on the CLI, the command was intensive enough to cause a memory fault. The reboot was not clean. We needed to physically unpower the chassis and bring it back online. After we discovered the root cause, we scheduled a series of reboots to restore all other SLX to low memory consumption. We are working with the vendor on a long-term fix.

APRIL 18, 2023

Wireless disruptions on main campus

Starting around 2:07 PM and resolving around 3:30 PM, we had rolling wireless outages across main campus. This took considerable time to troubleshoot. What ended up resolving the issue was the disabling of a link between the Wi-Fi routers and the wireless

controller switch. There was a link hashing issue that was blackholing traffic. We were never able to find the root cause of why the link went bad. We reseated the transceivers on either end and were able to bring the link back up without disruption during a controlled change window.

MAY 4, 2023

Core router peering link issue

Starting around 2:50 PM and lasting until around 3:00 PM we experienced a disruption to the peering link between our core routers that resulted in a general degradation to campus services. This was a result of fiber work being done in the physical vicinity of the core routers presumably with a fiber being bent/pulled causing the light signal to momentarily be disrupted.

OCTOBER 2, 2023

Main campus wireless degradation

In attempting to troubleshoot a problem, we disabled a feature on the main campus controllers. Disabling this feature during business hours turned out to be an unwise decision as it sent the CPU on all main campus controllers to 100%. They did not process traffic correctly. This caused widespread issues for about a 10-minute time window starting around 10:45AM and ending around 10:55 AM.

