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N-Wave News

NOAA N-Wave

The N-Wave Program, under the NOAA Office of the Chief Information Officer, supports both operations and research enabling NOAA's mission of science, service and stewardship through highly available, secure, high-speed network transport and services.

Mission

N-Wave is committed to providing innovative networking capabilities with integrity, transparency and flexibility, to enable NOAA's missions through the implementation of:

- Quality, advanced high-speed connectivity both internally and externally to NOAA
- Portfolio of secure, flexible, available, high-bandwidth network services
- Retention and recruitment of exceptional operations and engineering staff.

Our Vision

To provide reliable, secure and sustainable enterprise network services for NOAA, which enables NOAA's mission of science, service and stewardship.

NOAA ENTERPRISE NETWORK

in this edition:

From the N-Wave Program Manager

Celebrating 50 years of NOAA and 10 Years of N-Wave

Robert Sears

While NOAA celebrates 50 years of science, service and stewardship in 2020, N-Wave has reached its 10-year anniversary spanning a path from engineering and research to NOAA enterprise network operations. As we celebrate this anniversary at a distance during COVID-19, I would like to take this opportunity to reflect on N-Wave's journey over the past 10 years—our many milestones and accomplishments, and the challenges and opportunities that remain on the horizon.

Looking back to N-Wave's inception, a very special combination of circumstance, opportunity and leadership unfolds to illustrate a story about the successful building of an infrastructure supported by an equally successful program. It was a confluence of a once-in-a-career opportunity, invaluable partnerships and a vision to build something bigger.

In 2009, NOAA received one-time funding through the American Recovery and Reinvestment Act for climate research. Supercomputing resources were instrumental in that research, so a portion of the funding was allocated for supercomputing interconnectivity. The original task for the program that would eventually become N-Wave was to interconnect four NOAA research and development high performance computing sites: Boulder, CO, Fairmont, WV, Oak Ridge, TN, and Princeton, NJ.

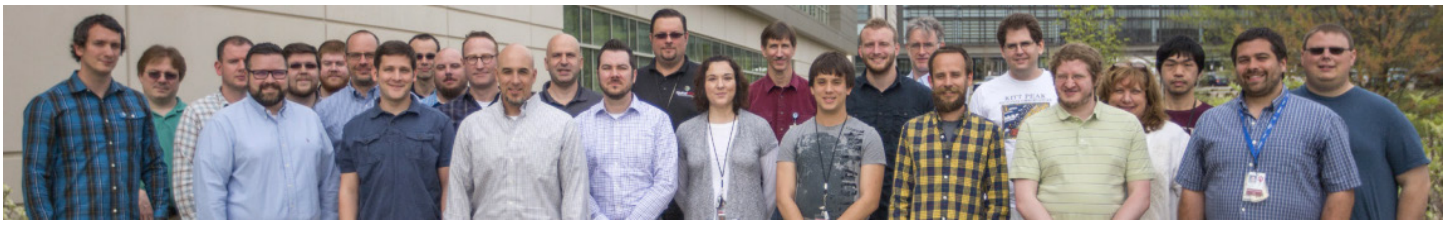
That was the task, but from day one the vision was to do something bigger. We wanted to take advantage of this slight window of opportunity and build a network that would support all of NOAA—from research to operations. NOAA's data needs are vast and varied, but they ultimately center on four drivers: bandwidth, data delivery assurance, security and cost. These drivers substantiated the need for NOAA to build its own network, leveraging its unique partnerships within the science, research and education (SR&E) community. N-Wave was built on those partnerships from the Layer 1 infrastructure up, and that is one part of the formula that makes N-Wave unique.

Looking back at what the N-Wave team achieved in 2010—lighting the national network backbone and interconnecting the first of those supercomputing sites—and all of the milestones reached since then, we have a lot to celebrate.

In 2010, NOAA and N-Wave celebrated first light on the N-Wave network during the annual SC Conference. Jerry Janssen, N-Wave visionary, cut the N-Wave cake as part of the festivities in the NOAA exhibit booth.

During the last 10 years, N-Wave has grown in the scale of our operations, the size of our network, the span of our service portfolio and the scope of our stakeholder community. In 2010 we established a cost-effective foundation for future NOAA-wide use of the N-Wave network, and since then the initial vision has been realized as N-Wave has become a NOAA-wide network service provider.

N-Wave held its first annual Stakeholders Summit in July 2019, with more than 80 attendees participating in person and remotely. The event featured 27 unique sessions presented by 30 speakers, including NOAA's Assistant CIO-Satellites Irene Parker (left photo).



2016 photo from the N-Wave engineering summit, including team members from N-Wave engineering and the GlobalNOC Service Desk, Tier 2 and Tier 3 Engineering, and Systems, Monitoring, Measurement and Visualization.

The N-Wave backbone now supports interconnectivity across all NOAA Line Offices at 10 times its original capacity, currently capable of operating at 100 gbps. In collaboration with the NOAA Cyber Security Division, N-Wave is the Trusted Internet Connections (TIC) provider for NOAA and has also started delivering TIC services to other bureaus in the Department of Commerce. In service to the NOAA community and the American public, N-Wave is a bridge for science missions in the field and timely data delivery to the cloud for broader access. The N-Wave team has also extended our network services to the campus level to meet NOAA's mission and operational needs from the campus to the cloud.

Looking toward the future, the N-Wave team has a fair share of challenges and plentiful opportunities on the horizon. Like other high-performance networks, N-Wave continues to face the challenges of capacity planning, as we strive to stay ahead of our customers' bandwidth needs. This includes technical efforts to monitor and alert on traffic patterns. It also involves administrative efforts focused on our stakeholder relationships. We have taken cues from our colleagues in the SR&E community on how to engage the NOAA science community in this process and gather customer feedback and input. Those efforts include facilitating annual gatherings for our stakeholder community (see p. 24) and technical interchanges for engineers across NOAA and DOC (see p. 30). Our objectives are to develop a deeper understanding of what's happening within NOAA's science community and our DOC bureau partners; how that science and those partner requirements will drive the next generation of instrumentation, products and services; and how those factors will ultimately impact the network as a gateway for delivering data and connecting people with the resources they need.

N-Wave and our growing stakeholder community continue to see many opportunities on the horizon. From new partnerships within the Department of Commerce (see p. 7) to collaborative efforts to expand connectivity in Alaska (see p. 5), scale the network through automation (see p. 9), develop innovative solutions to transport NOAA to the cloud (see p. 10), bolster network security (see p. 13), and expand services (see p. 14) and the network (see p. 20)—looking ahead, we have a lot to be excited about.

In 2016, N-Wave Program Manager Robert Sears and NOAA CIO Zachary Goldstein presented Indiana University Vice President for IT and CIO Brad Wheeler with a plaque of appreciation for the GlobalNOC, one of N-Wave's valued partners in the SR&E network community.

In 2019, the team behind NOAA's Secure Ingest Gateway Project (SIGP) was awarded a Commerce Gold Medal for scientific and engineering achievement. Left to right: Commerce Deputy Secretary Karen Dunn Kelley; SIGP team members Chi Kang, Cameron Shelton, Robert Sears, James Yoe, Kate Becker, Doug Whiteley, Irene Parker, Matthew Jochum, Joseph Mangin and Michelle Detommaso; Commerce Secretary Wilbur Ross and NOAA administrator Neil Jacobs.

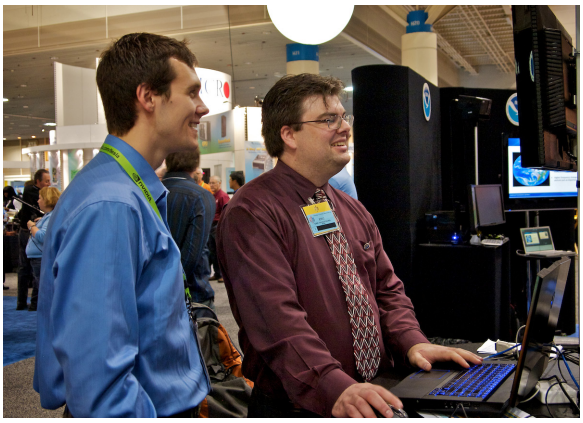
Words cannot convey how proud I am of the continually growing N-Wave family of professionals spanning dozens of technical disciplines who work tirelessly across the country to deliver the best possible customer experience, be it rain, shine or the extreme circumstances of a global pandemic. The N-Wave team is truly world class!

Looking Back 10 Years: More of N-Wave's First Light Celebration at SC10

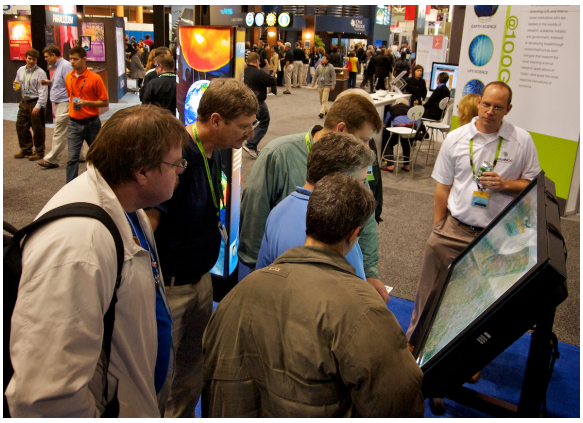
In 2010, NOAA and N-Wave celebrated first light on the N-Wave network at SC, the International Conference for High Performance Computing, Networking, Storage and Analysis.

Meteorologists from local broadcast stations and the National Weather Service's Weather Forecast Office were invited to give weather forecasts from the SC10 show floor using NOAA's Science On a Sphere®.

SC10 attendees gathered at the Science On a Sphere® with NOAA's Office of the CIO leadership, including former NOAA CIO Joseph Klimavicz (right). Among the crowd were members of the N-Wave team, including Jason Wilsey, Robert Sears and Matt Smith.



Matt Smith of N-Wave and Eric Hackathorn of the Office of Atmospheric Research were part of the team that helped plan and build the NOAA booth at SC10, including the Science On a Sphere®.



Attendees gathered while staff from N-Wave's partner, the GlobalNOC, demonstrated the Worldview display in NOAA's SC10 exhibit booth.

Tom Carey and Keith Holub of the N-Wave team checked out the display of a first generation N-Wave network core rack at SC10.

Credit: NOAA photos courtesy of Will von Dauster.

New Aggregation Project to Deliver Connectivity for NOAA Science in Alaska

NOAA's National Marine Fisheries Service (NMFS) and N-Wave are partnering to initiate a new Alaska Aggregation project, with a vision to provide higher bandwidth and lower cost connectivity in support of all NOAA science and operations in the region. The approach facilitates sharing of infrastructure and costs for the most expensive portion of the connectivity—the circuits between Alaska and the contiguous United States (CONUS).

Multiple NOAA Line Offices currently maintain separate circuits from their Alaska sites to CONUS, and only some of those connections offer built-in redundancy. The aggregation approach will provide diverse N-Wave connectivity to CONUS that can be leveraged by all Line Offices with operations in Alaska, offering all participants the benefit of redundant, high-speed connectivity.

New Aggregation Sites in Anchorage and Juneau

During the initial phase of the aggregation project, N-Wave will install two aggregation sites: one at the Alaska Communications East Wire Center (EWC) in Anchorage and the other at the Juneau Federal Building. The design includes 1 gigabit per second (gbps) circuits on 10 gbps physical handoffs between Anchorage, Juneau, and N-Wave's core node in Seattle, WA, thereby allowing flexibility to increase capacity up to 10 gbps to accommodate future participant needs.

NOAA Fisheries First to Participate

NMFS provided initial funding for the project and will be the first N-Wave customer to participate in the new aggregation service in Alaska.

As part of the project, the following NMFS sites will migrate to N-Wave:

- Alaska Regional Office – Anchorage
- Alaska Regional Office – Juneau
- Ted Stevens Marine Research Institute – Juneau
- Alaska Fisheries Science Center Kodiak Laboratory – Kodiak
- Office of Law Enforcement, Gibson Cove – Kodiak

These remote sites have varying bandwidth needs ranging from 10 to 200 megabits per second (mbps), and the connectivity delivered to these sites will be via 1 gbps physical handoffs, thereby offering the option to increase capacity up to 1 gbps if needed. With these larger capacity handoffs in place, N-Wave can easily provision increased bandwidth to meet growing demand without needing to procure or install new hardware.

Looking Forward to Future Participation and Benefits

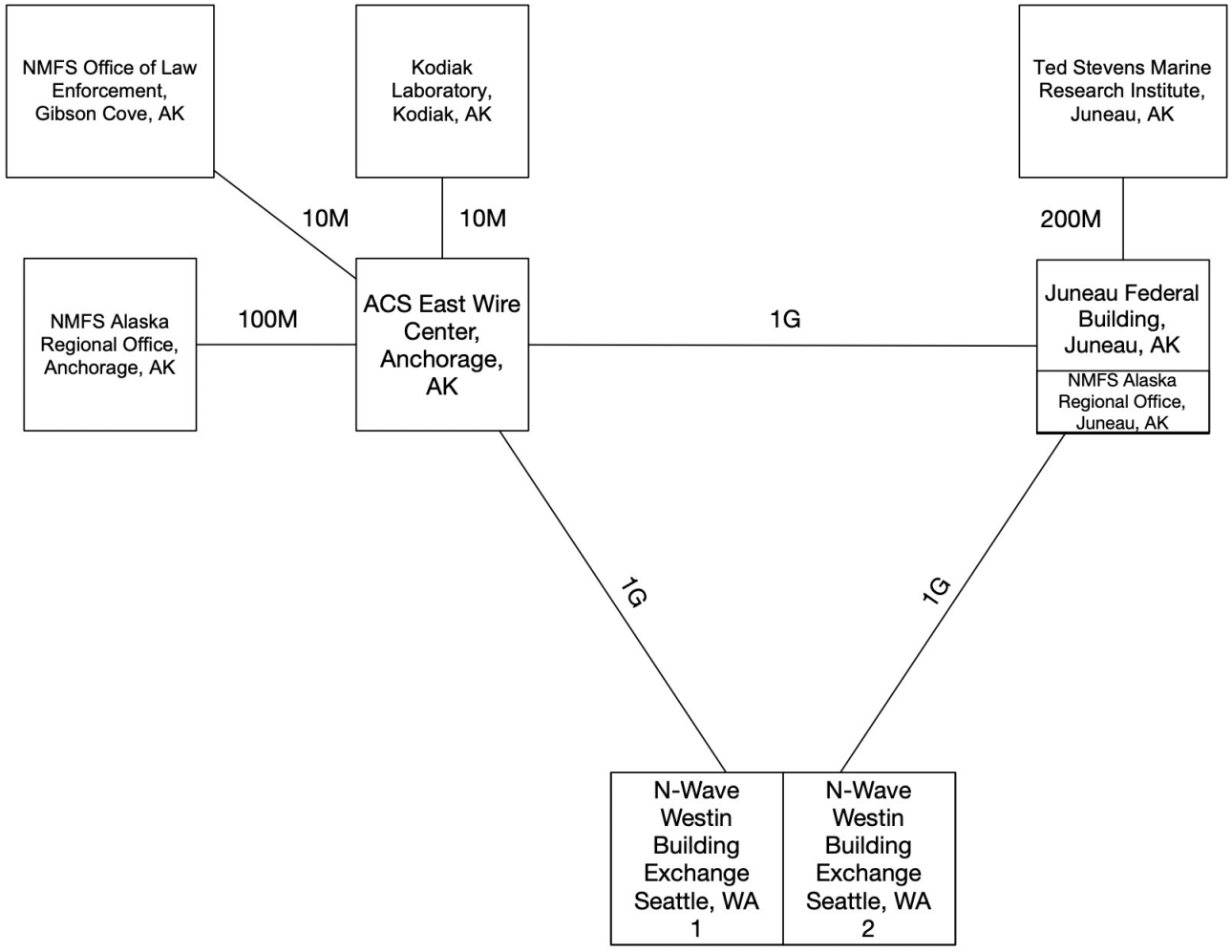
The anticipated timeline to complete the first phase of the Alaska Aggregation project is by September 30, 2021. N-Wave and NMFS provided the initial funding for the Alaska Aggregation project with the intent for other Line Offices to participate in the service as well, establishing an equitable shared cost model and paving the way for larger Alaska region integration.

Even with added costs for hardware and colocation space, aggregating the long-haul connections to CONUS will reduce overall connectivity costs for all participants. As evidenced by previous N-Wave aggregation projects, lower costs teamed with increased bandwidth and redundancy can offer new growth potential for science in the area. These benefits can facilitate improvements to process flows—for example, transitioning from the slow and risky process of moving data via sneakernet to transporting data over the secure, high-speed network. In light of these benefits of resource savings and risk reduction, N-Wave anticipates future expansion of services and new participants in the Alaska area in the next phases of the Alaska Aggregation project.

Partnerships Lead to Progress

Partnerships with external organizations and within NOAA play a key role in N-Wave's continued efforts to expand connectivity across the U.S., including in Alaska. For this aggregation project, N-Wave is working with Internet2 and Alaska Communications (ACS) to establish the connectivity to remote NMFS sites in Alaska.

Within NOAA, Per Pedersen of the National Weather Service Alaska Region Office of Dissemination, and Daniel "Dune" Rothman of the NMFS Alaska Region Information Services Division shared significant insight to help determine the best options for N-Wave's aggregation points in southern and southeastern Alaska. Their knowledge, experience and connections in the area were invaluable to the process of selecting and establishing the aggregation sites.



The current network design for the Alaska Aggregation project includes 1 gbps circuits on 10 gbps physical handoffs between Anchorage, Juneau and Seattle, thereby allowing flexibility to increase capacity up to 10 gbps to accommodate future participant needs. Current bandwidth requirements among NMFS remote sites range from 10 to 200 mbps, but each site has the ability to increase capacity up to 1 gbps if needed.

New Partnership Spotlight: U.S. Patent and Trademark Office

N-Wave is engaging in a new partnership within the Department of Commerce with the United States Patent and Trademark Office (USPTO) to deliver network services in support of the USPTO headquarters and other strategic initiatives. This feature spotlights USPTO and its Office of the Chief Information Officer (OCIO).

USPTO—America's Innovation Agency

The USPTO and its OCIO power human ingenuity with cutting-edge information technology (IT) tools for innovators. At the heart of the agency's work is a relentless focus on value for the economy and for the entrepreneurial work that fuels it. As Chief Information Officer Jamie Holcombe explained, "Our founding fathers set our mission 'to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries.' In the OCIO, we work every day to ensure that America's Innovation Agency has the best technology to support our stakeholders."

The USPTO's technical strides not only support and help propel digital business operations, they also lay a foundation to put in place more modern systems to fuel agency efficiency. Technology is a fundamental enabler of the vital work the USPTO does, and the OCIO team helps drive enterprise innovation by building new systems for better productivity and user experiences.

The building blocks for innovation include stable, secure, modernized systems. In recent years, the OCIO accelerated efforts to stabilize critical IT systems and infrastructure as it moved many filing systems online. Such efforts help set the technical stage for more IT modernization to come.

Like other agencies, the USPTO faced technical challenges arising from the public health crisis. Prior to the pandemic, the agency relied on a robust legacy telework program, with over 80% of staff working remotely at least one day per week. In the urgent shift to mandatory telework in March, the agency's IT infrastructure had to quickly accommodate nearly 13,000 secure VPN connections, many more than before the pandemic. New, additional servers and an incremental bandwidth boost helped make this sudden shift appear seamless.

Innovating with N-Wave

Another innovation milestone for the USPTO is its new relationship for enhanced telecommunications with NOAA's N-Wave. The N-Wave network will deliver higher-speed connectivity for USPTO operations. Deputy CIO Debbie Stephens shared the USPTO's enthusiasm for this cooperative effort: "We are excited to collaborate with NOAA, having created an inter-agency agreement. We recognize NOAA has blazed new trails that will provide the USPTO and other federal agencies with an almost limitless capability that alone would not have been financially possible. We appreciate our partnership and would encourage other agencies to take advantage of this technological and financial savings opportunity."

USPTO Deputy CIO Debbie Stephens.

What is the value of USPTO's partnership with NOAA N-Wave? How will USPTO leverage the N-Wave network, and what are the benefits?

Based on a collaborative project plan, the USPTO OCIO and N-Wave teams estimate delivery of N-Wave transport and NOAA Trusted Internet Connection (TIC) services toward the end of 2020. Overall, N-Wave will provide a lower-cost, powerful internet connection that delivers the bandwidth and security the USPTO needs. The OCIO team projects an annual cost savings of approximately 50% with this network choice, versus the current provider. N-Wave will also deliver direct connectivity for USPTO applications hosted in the cloud. Therefore, N-Wave will enable not only a faster connection to the cloud, but applications that run more quickly given this direct connection.

In the longer term, N-Wave will provide a foundation for future, higher-speed cloud connections, faster data center connections, better connections to the USPTO's regional offices, and higher-speed access to DOC's intranet applications.

Is there anything else you'd like to share?

N-Wave's national footprint of services aligns well with the USPTO's map of satellite offices. Not only are N-Wave services available in its data center sites in Denver, CO, and Manassas, VA, but also in cities with regional offices such as Dallas, TX, and San Jose, CA. The OCIO will work with NOAA's team to install N-Wave at these locations for higher-speed connections from USPTO headquarters.

Credit: NOAA/NMFS/National Marine Mammal Laboratory

Automating the Network for N-Wave Scalability

To drive scalability and overcome the challenges of substantial network growth, N-Wave is expanding its use of network automation with a solution available through its partnership with Indiana University's GlobalNOC.

The solution uses the open-source configuration management and application deployment software, Ansible, along with the web-based interface and task engine, Ansible Tower (AWX). Github's repository, which is tied into Ansible, is used to store N-Wave's configurations and playbooks for repeatable and reusable deployments.

As N-Wave has grown in the scale of its operations, the size of its network, and the scope of its customer base and their missions, modernizing through automation becomes increasingly critical for our scalability, reliability, security and efficiency.

Near-term Objectives for Automation

- *Baseline standardization.* N-Wave can enforce standard baseline configurations across all devices and detect any deviations. One-off configurations will be easy to document and retain. Engineers are able to assess configurations of newly-deployed devices, and report on and/or automatically deploy fixes.
- *Mass changes across devices.* For mass changes across devices—vulnerability fixes, updates to baselines, password resets for break/fix support accounts—N-Wave can deploy changes to many devices at once. Engineers can select multiple devices, filtering by role, type, function, etc., and then run the commands across those devices.
- *Data gathering and reporting.* N-Wave can run commands against devices and use scripting to generate data reports. Examples include gathering data to show Link Layer Discovery Protocol (LLDP) neighbors on selected devices to generate reports on suspicious activity, or gathering data on all devices running IPv6 to generate a report for IPv6 vulnerability patching.
- *Software upgrades.* Engineers can push appropriate software versions and upgrades to devices, so installations on many devices can be completed more quickly. With the correct image loaded within the automation tool, the risk of engineers using versions of code that differ from N-Wave's current standard is mitigated.

Long-term Objectives for Automation

- *Building new configurations.* Engineers would use automation tools to pull information from N-Wave's database to build new configurations for devices.
- *Provisioning new services.* Engineers would use the AWX web-based interface to select the service-deployment objective and provide needed information. Automation would then build the configuration and provision the service connection. This would greatly reduce risk of misconfigurations and would shorten the time to provision a new service.
- *Reporting on changes.* When completing a change, the automation tool would pull all relevant outputs before and after the change. This change report would save many hours of engineers going through outputs after a change to detect any discrepancies.

Ultimately, N-Wave anticipates many more opportunities to leverage automation will arise after the short-term milestones are achieved. These capabilities are both a product of and a propellant for the innovative skills of N-Wave's developers and engineers. As N-Wave implements more automation to speed up routine tasks, engineers will be freed up to execute more sophisticated tasks and focus on new initiatives to advance the network.

Cloud Transport Updates

Cloud Transport Updates

N-Wave first offered cloud connectivity services to NOAA in 2017. Since then, N-Wave's cloud networking team has been focused on meeting customers' needs through customer engagement and design sessions, supporting complex use cases, and making infrastructure improvements to support higher bandwidth and increased resiliency.

N-Wave's Cloud Transport Services Timeline

2017

VPN Tunneling

N-Wave offers its first cloud connectivity solution for NOAA customers, turning up VPN tunnels for many customers to AWS and Azure.

2018

Direct Connect Circuits

N-Wave operationalizes its first Direct Connect circuits, offering higher-bandwidth connections to AWS using dedicated 10 gbps infrastructure for specific customers.

2019

Cloud Brokerage Network

N-Wave launches the N-Wave Cloud Brokerage Network to provide customers the flexibility to quickly and easily provision high-bandwidth connections to AWS, Azure and GCP.

2020

Capacity Upgrades

N-Wave upgrades its VPN infrastructure to provide more capacity and expands the Cloud Brokerage Network to 100 gbps aggregate capacity in D.C. and Denver.

Customer Consultations and Turn-ups

N-Wave's cloud networking team has been working alongside the NOAA Office of the CIO's Service Delivery Division (SDD) to enable cloud connectivity for a large and growing set of customers. This has taken the form of providing consultations about networking with cloud infrastructure, virtually collaborating with customers to turn up new connectivity, and facilitating research and proof-of-concept testing with customers and vendors.

N-Wave engineers participate alongside SDD in the initial requirements-gathering meetings with customers to discuss use cases and connectivity options. These conversations are critical to establishing shared understanding of the details of customers' on-premises networks and transport across the N-Wave backbone. Many of these discussions have turned into projects, while others are still being developed by customers or have not yet led to procurements requiring network connectivity. N-Wave is available throughout this process to provide consultative guidance on the networking components, working directly with customer network engineers and application teams. When customers are ready to start building in the cloud, N-Wave is directly involved in most customer turn-ups of network connectivity to the cloud, via screen sharing or by shadowing work being performed by customers.

N-Wave is actively supporting the following customer cloud connections:

- 82 cloud-based virtual private network (VPN) tunnels
- 30 cloud-brokerage circuits delivered as virtual local area networks (VLANS), including redundant links
- 5 dedicated 10-gbps circuits

These connections include links to Amazon Web Services (AWS), Microsoft Azure, Google Cloud Platform (GCP) and Oracle Cloud Infrastructure (OCI).

N-Wave's Cloud Transport is currently serving 23 customers, some with multiple connections, representing distinct entities at the Department of Commerce (DOC) bureau, NOAA Line Office (LO) and LO program levels. Customers now span every LO within NOAA, as well as the DOC's HCHB facility. N-Wave is also actively testing with the United States Patent and Trade Office to support the cloud components of its migration to the N-Wave network before the end of 2020.

Engineering New Cloud Connectivity Models

In addition to the high degree of activity around consultations and customer turn-ups, N-Wave is performing back-end engineering to enable new connectivity models. The initial two N-Wave use cases were private network extension and internet hair-pinning for Trusted Internet Connections (TIC) compliance (see *Transporting NOAA to the Cloud* in the November 2018 newsletter). As cloud service providers' routing has evolved, N-Wave has begun offering a hybrid model that supports connections from customer cloud environments both to their private NOAA networks and simultaneously routed directly through the TIC to the commodity internet. While the NOAA Cyber Security Division under the auspices of TIC 3.0 guidance develops and makes operational a cloud access security broker (CASB) service, this hybrid solution will provide a bridge for customers to more direct internet routing without hair-pinning through on-premises networks, while still supporting the requirement for private network connectivity back to customers' local premises-based networks.

N-Wave is also engaging directly with the cloud vendors through non-disclosure agreements to understand network features more deeply and test features on behalf of customers, in some cases before general availability. The cloud providers have all been extremely helpful in their own ways, contributing to the success of DOC and NOAA customers.

VPN Upgrades

VPNs are an easy-to-deploy and relatively low-bandwidth method of connecting to any cloud provider. To meet growing demand for this cloud connectivity option, N-Wave is upgrading some of its cloud-supporting VPN concentrators to much higher capacity.

The original deployment of N-Wave-managed VPN concentrators were general purpose Juniper SRX1500 devices, supporting cloud connectivity and VPN tunnels for other purposes within N-Wave. The concentrators support both "trust" connections behind the TIC and "untrust" connections in front of the TIC. In working with N-Wave, customers may hear the trust-side concentrators referred to as AVPNs, where "A" refers to connections to the aggregation routers, and BVPNs, where "B" refers to connections to the border routers.

A total of six of these SRX1500s are deployed close to the TIC infrastructure in Denver, CO, Washington, D.C., and Honolulu, HI, serving both AVPN and BVPN functions. Customer connections to cloud service providers using these devices tend to be on the D.C. and Denver AVPNs. While still serviceable, the SRX1500s are limited to approximately 4 gbps aggregate VPN throughput, across all customers who connect.

To meet the growing needs of current and new customers, the N-Wave team is in the process of upgrading the D.C. and Denver AVPNs to newer Juniper SRX4600s, each with an aggregate of 35 gbps of VPN throughput. In 2019 N-Wave and Juniper collaborated in Juniper's lab to validate this throughput on the devices for N-Wave use cases. At the time of this writing, the new Denver AVPN device has been installed, and engineers have begun cutting over IPSec tunnels from the older device. The upgrade of the D.C.-based AVPN is expected by the end of 2020.

The addition of these higher-bandwidth devices in Denver and D.C. will open up some interesting possibilities for more localized backups of circuit-based solutions, as some providers have begun supporting equal-cost multipathing (ECMP) across multiple VPN tunnels. The upgrades will also free up two of the SRX1500s, which may be repurposed to augment services in the Seattle, WA, TIC region.

Cloud Brokerage Network Enhancements

N-Wave continues to benefit from its initial cloud broker, Megaport, and is now in the process of augmenting with additional cloud broker vendors to enable even faster connections and easier provisioning. Cloud brokers are network providers that sit between clouds and premise networks.

These brokers enable faster connectivity to many cloud providers and prevent customers from having to negotiate dedicated circuits individually to each cloud provider.

While previously using the terms "cloud broker" and "Megaport" interchangeably, N-Wave now refers to this component of the service as the N-Wave Cloud Brokerage Network to take into account all current and future cloud brokerage providers. N-Wave works with customers to design the best connectivity solution based on their requirements, capacity needs and available options. This tends to be very specific to each customer's use case and what cloud services they need to reach.

The initial strategy with Megaport was to deploy a pair of 10 gbps circuits from Megaport to N-Wave in D.C. and Seattle. Depending on the cloud provider, customers could stitch one or more circuits from 50 mbps up to 5 gbps across a public or private virtual routing and forwarding (VRF) instance on N-Wave, through Megaport's layer 2 network, to the customer's cloud provider of choice. One of the chief benefits of Megaport is its rich set of partnerships with a large number of cloud providers. This diversity tied in well to NOAA's Cloud Integrated Project Team (IPT) and pilot project, which had the promise of connectivity to any cloud.

A new option will soon be available to customers via N-Wave. Megaport was very early in releasing its cloud brokerage product—to the benefit of NOAA. Since N-Wave's initial deployment with Megaport, Internet2 has released its own compelling cloud solution, which focuses on AWS, Azure and GCP in selected markets. N-Wave has chosen to enable a pair of new 100 gbps connections with Internet2, one each in D.C. and Denver, to round out the N-Wave Cloud Brokerage Network. There are several benefits to this new connectivity:

- *Increased capacity at a lower cost.* With the growing demand for more bandwidth to cloud, these 100 gbps circuits will accommodate customers for the foreseeable future and prevent N-Wave from having to scale out multiple 10 gbps circuits. The cost model is also compelling because it does not require N-Wave to pay per virtual circuit.
- *Ease of provisioning.* N-Wave is already a customer of Internet2's Advanced Layer 2 Service (AL2S) network. These new 100 gbps circuits will consolidate all AL2S connectivity in D.C. and Denver, replacing some existing 10 gbps circuits. All provisioning of cloud connections between N-Wave and the cloud providers will be automated through Internet2's Open Exchange Software Suite portal. (Megaport also utilizes software-defined networking for fast provisioning, but procurement hurdles prevent N-Wave from realizing its benefit.)
- *Streamlined solutions.* N-Wave will be able to use the Internet2 cloud facilities both for its 50 mbps to 5 gbps circuit needs, but also to replace bespoke 10 gbps circuits that up to now had to be provisioned as end-to-end dedicated circuits. N-Wave will be able to use its local 100 gbps AL2S ports to replace the N-Wave-to-Internet2 portion of these dedicated connections. The customer will still need to arrange for the cloud provider-to-Internet2 part of the connection in the same way they have ordered direct connections previously. This will provide cost savings in delivery of the overall solution.
- *Option for increased diversity.* Megaport will continue to be part of the N-Wave Cloud Brokerage Network product, providing options for local connection diversity in D.C. where VPNs are not attractive as backups. Megaport will also be a local option in Seattle and may offer advantages to N-Wave customers in the region.

Engineers have installed the 100 gbps AL2S circuits and associated hardware, and N-Wave expects full integration by the end of the year.

N-Wave Security Updates and New Initiatives

External Service Exposure – Automated Detection

N-Wave's transport network is a complex operational network that supports NOAA's vast and varied mission. The N-Wave security team continuously seeks ways to improve the security posture of this network, and our partnership with Indiana University's GlobalNOC frequently allows us to achieve this goal in creative ways.

As an outcome of last year's Assessment and Authorization (A&A) cycle, we initiated a project to reliably detect and protect against unintended external service exposure on N-Wave managed devices. The GlobalNOC systems team took the lead to develop and implement a new external scanning tool to compare service exposure against what is documented in the N-Wave database.

This tool is now in full production, and it routinely alerts on even the slightest variation in external service exposure compared to what is documented, understood, and expected. The result of this effort is a dramatic reduction in the external attack surface of the N-Wave network and thus NOAA's mission. It also gives a better visibility into which services are and should be exposed through normal operations.

Network Resource Consolidation and Cleanup via ARIN

Network service providers must register and maintain network resources with the American Registry for Internet Numbers (ARIN). These resources include assigned Internet Protocol (IP) network address blocks and Autonomous System Numbers (ASNs), which are critical pieces of information exchanged by routing protocols such as the Border Gateway Protocol (BGP) as packets are routed to their destinations. Each network resource is associated with an organization registered with ARIN, and each organization is responsible for maintaining accurate contact information. This contact information can be queried publicly and used to exchange important communication related to security incidents, abuse or impending operational changes.

N-Wave recently embarked on an endeavor to consolidate and correct information associated with NOAA's network resources with ARIN. In light of NOAA's historically decentralized networking approach—and the fairly recent evolution of N-Wave as NOAA's enterprise network provider—many of NOAA's networks and ASNs are contained within legacy ARIN organization IDs that have outdated contact information or are no longer valid.

Improving the state of NOAA's ARIN network resources will be a long process involving the transfer of numerous network address blocks and ASNs to N-Wave's ARIN registration, requiring coordination with and approval from many historical network service providers across NOAA. In the end, the result will yield many benefits:

- Enable better stewardship of N-Wave's intangible network resources.
- Guarantee accuracy of those resources.
- Enable a more cohesive and logical routing hierarchy for IPv4 and IPv6.
- Allow more timely and accurate communication regarding security and operational network issues.

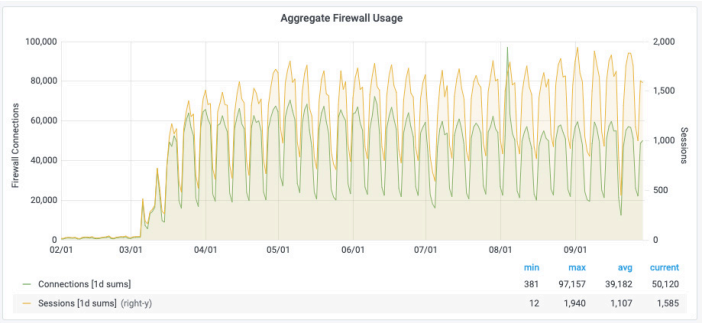
N-Wave Enterprise Services Updates (April - October 2020)

Enterprise Remote Access VPN (ERAV)

As the COVID-19 pandemic persists, many employees continue to work from home. ERAV remains the mechanism for N-Wave customers to complete their missions while teleworking. Customers who are looking for added capabilities over their previous VPN systems continue to onboard to ERAV.

To meet growing demands, N-Wave Is working on a project to implement a major service performance update with additional equipment purchased with CARES Act funding. Currently, ERAV hardware and firewall licenses can support 10,000 users, with 8 gigabits per second (gbps) of available Secure Sockets Layer (SSL) bandwidth across the nodes in Denver, CO, and College Park, MD. After the update, capabilities will be increased to support NOAA-wide use—20,000+ users and up 50 gbps of available SSL bandwidth.

N-Wave also continues to work with customers on final migrations from NOAA's legacy VPN solution to ERAV. The legacy solution will remain in place to mitigate potential problems of migrating during the pandemic. N-Wave has been able to decommission some of the legacy devices as users have moved off of the service, resolving end-of-life equipment vulnerabilities and saving resources.



Aggregate traffic for N-Wave's VPN services. With a major shift to telework in response to COVID-19, these services are now key mechanisms for providing access to NOAA and DOC internal resources.

40+ VPN groups

All **6** NOAA Line Offices and **1** other federal entity use ERAV

7,000+ registered users

CAC Modernization and ERAV

The Department of Defense has implemented their "CAC Modernization" project, and new CACs now use the 16-digit UPN for the identity certificate. While N-Wave receives requests almost daily to add the 16-digit accounts to ERAV, here are some items to note:

- **Old 10-digit UPN CACs will continue to work with ERAV until the CAC expires, but newly issued CACs will only have the 16-digit UPN.**
- **For Line Offices (LOs) that use Active Directory for ERAV authorization, LO VPN administrators will need to deploy a new AnyConnect profile on user devices.**
- **For LOs that use N-Wave's database for authorization, VPN administrators should be submitting the 16-digit UPNs for their users to get their accounts updated and to make it seamless for users getting new CACs. N-Wave engineers will create user accounts using the 16-digit UPNs and then will coordinate with LOs to eventually remove the 10-digit accounts. LO VPN administrators may also need to deploy a new AnyConnect profile on user devices.**

ERAV Service Deployed to Support Gulf Coast Ecosystem Restoration Council

N-Wave recently deployed the ERAV service in support of the Gulf Coast Ecosystem Restoration Council, an independent entity in the Federal Government.

The council was created as part of the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act (RESTORE Act), which was spurred by the 2010 Deepwater Horizon oil spill. Its members include the Governors of Alabama, Florida, Louisiana, Mississippi and Texas, as well as the Secretaries of the U.S. Departments of Agriculture, the Army, Commerce, Homeland Security, and the Interior, and the Administrator of the U.S. Environmental Protection Agency.

N-Wave's ERAV service provides the council with Trusted Internet Connections (TIC) compliant access to the internet to complete its work, along with access to some websites and applications that require a NOAA IP address. Learn more about the Gulf Coast Ecosystem Restoration Council and its work at restorethegulf.gov.

Credit: NOAA/NMFS/WCR

Enterprise Wireless

N-Wave continues to grow the Enterprise Wireless service, adding a new service location at the Barrow Atmospheric Baseline Observatory in Utqiaġvik (Barrow), AK. COVID-19 has delayed other new customer installations, but several sites are in the queue when travel restrictions are lifted and more onsite operations resume. Current use of Enterprise Wireless remains low, as the majority of employees continue to work remotely.

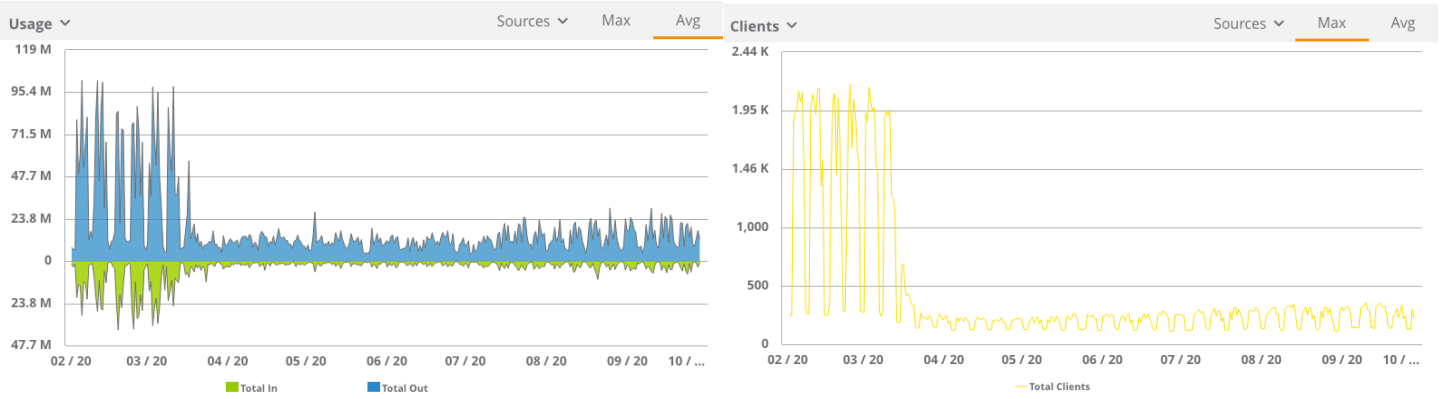
When employees return to sites, they may need to re-onboard their devices to the Enterprise Wireless service based on several factors, including new devices, major device upgrades and wireless certificate expirations. Wireless users who experience any issues with the service when returning to their site should work with their local IT department.

N-Wave has been working with Ian Chun at the NOAA Inouye Regional Center (IRC) in Honolulu, HI, to deliver Enterprise Wireless to the IRC campus. Engineers will deploy a core infrastructure site at IRC for the wireless service, in addition to current core sites in College Park and Denver. The new core site will be designed to support wireless access at the IRC and future sites in Hawaii with redundant controllers, policy servers and DHCP servers. With preparations well underway, N-Wave plans to deploy the equipment soon after travel restrictions are lifted. Once the service is in place, users who onboard in Hawaii or at any other N-Wave Enterprise Wireless site will be able to roam seamlessly between campuses.

25+ service locations spanning the U.S.

12 states with service locations

950+ wireless access points



With a major shift to telework in response to COVID-19, N-Wave's Enterprise Wireless service has seen a temporary decrease in usage and clients.

Credit: NOAA/OER/Hidden Ocean 2016: The Chukchi Borderlands

Managed LAN

N-Wave is rapidly expanding the Managed Local Area Network (LAN) service, with a combination of new customers and legacy LAN migrations to the new service. As LOs and LO programs move their LANs to N-Wave, they gain multiple benefits, including the economies of scale offered by a team of N-Wave engineers and a 24/7 network operations center monitoring and responding to their needs—whether the deployment is one switch or 100 switches.

Legacy networks in Fairmont, WV, Lakeland, FL, Silver Spring, MD, Kansas City, MO, and Norfolk, VA, are currently in the process of migrating to N-Wave's Managed LAN service. As part of the process, N-Wave engineers examine each customer's current network architecture, requirements and future needs, and then design an architecture to meet those requirements and align with industry standards.

N-Wave has been providing network engineering contract support to the NOAA Information Technology Center (ITC) in Largo, MD, and recently saw an opportunity to move the networks supporting ITC and Commerce Business Systems (CBS) to N-Wave's Managed LAN service. To ensure ITC, CBS and their customers have a smooth migration experience, N-Wave plans to complete the migration in phases. Ultimately, this change will provide continuity and network expertise, and it will allow ITC and CBS to focus on their missions and shift responsibility for all networking equipment to N-Wave.

7+ Managed LAN deployments since the service was launched in 2019

15+ additional sites use a form of the Managed LAN service in support of NOAA Enterprise Wireless

200+ switches deployed

N-Wave recently moved the Enterprise Data Center (EDC) team to the Managed LAN in Fairmont, WV. EDC previously had three Supervisory Control and Data Acquisition (SCADA) networks supporting multiple critical building systems. To resolve issues of aging hardware and an increased need for network support and monitoring, N-Wave engineers replaced the previous SCADA networks with a single converged network. They also extended the tools to the EDC at Ashburn, VA, using a virtual routing and forwarding (VRF) instance to ensure security. These changes provide flexibility to manage and monitor the SCADA systems at Fairmont and Ashburn from any N-Wave switch on the campus network. By leveraging ERAV for remote access, the EDC team also can access all of their tools from anywhere and are no longer required to be on site and connected to the specific network they are trying to monitor. As N-Wave continues to move other NOAA entities to the Managed LAN in Fairmont, all will see the benefits of a single converged network.

Customers who are interested in N-Wave's service offerings, or would like additional information, can submit the new service request form: https://sn-tools.grnoc.iu.edu/new-noaa-request/

N-Wave Continues to Support Customer Migrations to the NOAA Enterprise Data Center in Ashburn

Following the opening celebration of NOAA's new Enterprise Data Center (EDC) in Ashburn, VA, N-Wave has made great progress this year supporting customer migrations into the data center. N-Wave engineers work closely with customers as they move into the data center to understand their requirements and deliver network services that maximize the benefits they gain from the transition.

National Ocean Service (NOS)

NOS was the first customer to move into NOAA's Ashburn data center, with a total 11 racks and 20 network switches deployed in support of the Line Office and its programs. The successful NOS migration was the result of much collaboration among NOS, the EDC team and N-Wave. Moving production services takes coordination, flexibility, well-defined testing and dedication of engineers to work until the migrated service is fully operational in the new location.

N-Wave is now supporting NOS with a completely N-Wave-managed network, from the wide area down to each device's access port. This allows NOS to utilize the expertise of N-Wave's engineers, advanced tool sets for monitoring, and 24/7 support from the Service Desk and on-call engineering.

Information Technology Center (ITC) and Commerce Business Systems (CBS)

N-Wave has been working with the NOAA ITC and CBS to prepare for their migrations into the data center, which will take place in the first half of FY21. N-Wave will also provide its Managed LAN service to fully support networking equipment for ITC and CBS within the data center.

Updates on Network Services in the Data Center

N-Wave offers multiple connectivity options for customers seeking to utilize the data center, including Managed LAN services, Enterprise Remove Access VPN (ERAV) access to endpoints in the data center, and physical handoffs to customer equipment. N-Wave's standard uplink to customer racks provides dual 40 gbps for redundancy, and the network architecture for the data center offers a fully redundant core, aggregation routers and WAN circuits. This network infrastructure teamed with the data center's robust power and cooling capabilities result in highly available service offerings.

N-Wave installed Enterprise Wireless within the data center to provide WiFi access to NOAA employees working in the data center. Employees who have already onboarded their devices to NOAA Secure wireless at another participating site can connect automatically within NOAA's space in the data center. Others have the option to complete the onboarding process or connect to the NOAA Guest WiFi service.

N-Wave is working with the EDC team to provide network connectivity to the Power Distribution Units (PDU) and to connect the PDUs to a centralized management tool. The current project will link all data centers under EDC management, providing visibility and reporting for power and cooling metrics.

N-Wave will soon install additional out-of-band (OOB) routers to provide OOB management to all top of rack switches managed by N-Wave. To support this, engineers recently installed additional cabling in the data center.

Network Outage in Denver Illustrates Importance of Continued Refinement and Resiliency Planning for N-Wave Infrastructure

Over the past 10 years, N-Wave and its stakeholder community have been fortunate to see significant network growth and adoption of new and innovative solutions for service delivery. With this growth and dedication to technically progressive solutions come complexity and sometimes surprising lessons learned. One of these opportunities for improvement occurred during an incident on June 25 in the Denver Trusted Internet Connections (TIC) region.

What happened, and how did it happen?

One of the more advanced solutions N-Wave has deployed in recent years is the use of a routing technology called BGP flow specification, or flowspec. Flowspec is leveraged to dynamically place individual users or NOAA assets into TIC bypass when required in support of customers' high-traffic data transfer nodes or science flows. When assets are placed into bypass using flowspec, traffic flows to and from these destinations on a dedicated circuit between NOAA's internal network, N-Wave, and external peering network, X-Wave, which does not go through the firewall deployments at the TIC sites.

The incident on June 25 lasted 16 minutes and resulted in the loss of internet services for anyone connected to the Denver TIC. The cause of the outage was a forwarding loop—where a single request is processed repeatedly or indefinitely—local to the affected router and triggered by a very specific set of circumstances. The routers that can be affected by this local forwarding loop are limited to what N-Wave calls its boundary aggregation routers. These are the aggregation routers at each TIC location that connect directly to the TIC firewalls. The special and exact circumstances that can cause this local forwarding loop are communication between an N-Wave participant connecting directly to a boundary aggregation router, and another participant connected elsewhere on the N-Wave network but placed into TIC bypass. During this outage, the forwarding loop led to errors on a line card hosting multiple 100 gbps backbones on the Denver aggregation router, ultimately blocking traffic on these circuits.

Another component of this outage's uniqueness was due to mass teleworking for NOAA employees as a result of COVID-19. Employees working off site access NOAA resources via the Enterprise Remote Access VPN (ERAV) service, which connects directly to the boundary aggregation router in Denver. This has led to much higher traffic, and many more unique users, than what is traditionally present on the boundary aggregation routers deployed throughout the network.

Can this happen again?

Protecting a network as large, complex and mission-critical as N-Wave requires tackling issues from more than one angle and implementing more than one protective measure. After this incident, N-Wave engineers worked with Juniper vendor engineers and conducted extensive lab testing of the current N-Wave environment. This work resulted in the implementation of special rules in the flowspec configuration to mitigate future instances of this exact scenario.

This outage also prompted the purchase of additional 100 gbps equipment for multiple TIC regions to provide more connection diversity. N-Wave engineers not only want to implement solutions to protect against this exact scenario happening again, they want to continue to build the network in a manner that protects from unforeseen future issues that may arise. It is and will always be a goal of N-Wave to document and evaluate outages and to act on recommendations to increase the resiliency and reliability of the network in support of our stakeholders across the country.

Network Changes and New Participants (April 1 – October 31, 2020)

National Ocean Service (NOS) Information Management Office (IMO) and National Geodetic Survey (NGS) transition to the NOAA Enterprise Data Center (EDC) – Ashburn, VA

IMO and NGS migrated their data center footprint from the Silver Spring campus to the new EDC in Ashburn. As part of this transition, N-Wave implemented its Managed LAN service to manage and monitor IMO's and NGS's local area connectivity at the data center.

National Centers for Coastal Ocean Science (NCCOS) – Beaufort, NC, Charleston, SC, and Oxford, MD

N-Wave finished transitioning all of the NCCOS locations—Beaufort, Charleston and Oxford—to the N-Wave Managed LAN service. As part of this change, N-Wave installed new switching hardware and local firewall equipment at each site.

David Skaggs Research Center (DSRC) - Boulder, CO

N-Wave transitioned the DSRC customers from the legacy Boulder NOC infrastructure to a new N-Wave campus core. As part of this migration, existing N-Wave customers with direct connections to the N-Wave aggregation router were moved to the new campus core. This change provides higher bandwidth connectivity and increased redundancy across the DSRC.

NOS Office of Coastal Management (OCM) – Charleston, SC

N-Wave migrated one of OCM's redundant 1 gbps connections to a 10 gbps connection at its office in Charleston.

100 gbps AL2S ports – Denver, CO, and Washington, D.C.

N-Wave has turned up two 100 gbps connections to Internet2's Advanced Layer 2 Service in Denver and D.C. These consolidate several smaller connections and provide capacity for the N-Wave Cloud Brokerage Network.

Joint Polar Satellite System (JPSS) deployment of Amazon Web Services (AWS) for ingest and processing – Denver, CO, and Washington, D.C.

N-Wave completed multiple AWS Direct Connect paths for the JPSS AWS Cloud deployment in Denver and D.C. This is for the JPSS ground system data ingest and processing, as well as data distribution to the various mission partners.

Indian Space Research Organization (ISRO) connection to Fairbanks Command and Data Acquisition Station (FCDAS) – Fairbanks, AK

An ISRO Telemetry, Tracking and Command Network provided circuit that leverages India's national research and education network, the National Knowledge Network, and Internet2 now connects to N-Wave's Denver Trusted Internet Connection (TIC) site. Using a private virtual routing and forwarding (VRF) instance, N-Wave extends ISRO traffic from Denver to FCDAS in Fairbanks for ISRO satellite telemetry, command and control, as well as mission voice.

NOAA Environmental Security Computing Center (NESCC) - Fairmont, WV

N-Wave transitioned the NESCC network connectivity supporting the NOAA Enterprise Data Center team to the N-Wave Managed LAN Service.

National Institute of Standards and Technology (NIST) Transport Transition – Gaithersburg, MD, Boulder, CO, and Charleston, SC

N-Wave migrated NIST from a layer 2 connection to a layer 3 connection. As part of the transition, N-Wave created a private VRF instance between Gaithersburg, Boulder and Charleston to support NIST's routing requirements.

NOAA Western Regional Center (WRC) – Seattle, WA

N-Wave transitioned the WRC customers from the legacy Silver Spring NOC infrastructure to a new N-Wave campus core. As part of this migration, existing N-Wave customers with direct connections to the N-Wave aggregation router were moved to the new campus core. This change provides higher bandwidth connectivity and increased redundancy across the WRC campus.

Conference Room Network Optimization – Silver Spring, MD

N-Wave migrated systems from the legacy conference room network at the Silver Spring campus to alternate solutions, including N-Wave Enterprise Wireless. This change will help with the optimization of networking across the campus's four buildings.

D.C. Area Legacy Optical Migration – Silver Spring, MD, College Park, MD, and Suitland, MD

N-Wave migrated connections off of the legacy Silver Spring NOC fibers in the D.C. area. This included disconnecting dark fibers that connected to N-Wave's core site in College Park from three locations: the Silver Spring campus, NOAA Satellite Operations Facility (NSOF) in Suitland, and NOAA Center for Weather and Climate Prediction (NCWCP) in College Park. The connectivity that traversed these legacy dark fibers has been migrated to the N-Wave metro transport network.

Jet Propulsion Laboratory (JPL) connection to NSOF Jason Ground System – Suitland, MD

A JPL-provided commercial Ethernet circuit now connects to N-Wave's Denver TIC site and is extended via a private VRF to NSOF in Suitland. This new approach replaces legacy T1s with modern technology to provide TIC compliant connectivity and a more robust connection—increasing from 3 to 10 mbps—while lowering costs.

Barrow Atmospheric Baseline Observatory (BRW) upgrades – Utqiaġvik, AK

N-Wave increased capacity at BRW from 10 to 20 mbps during a recent contract change. N-Wave also moved the point of presence at BRW into the data center at the newly constructed Earth System Research Laboratories Barrow Observatory facility.

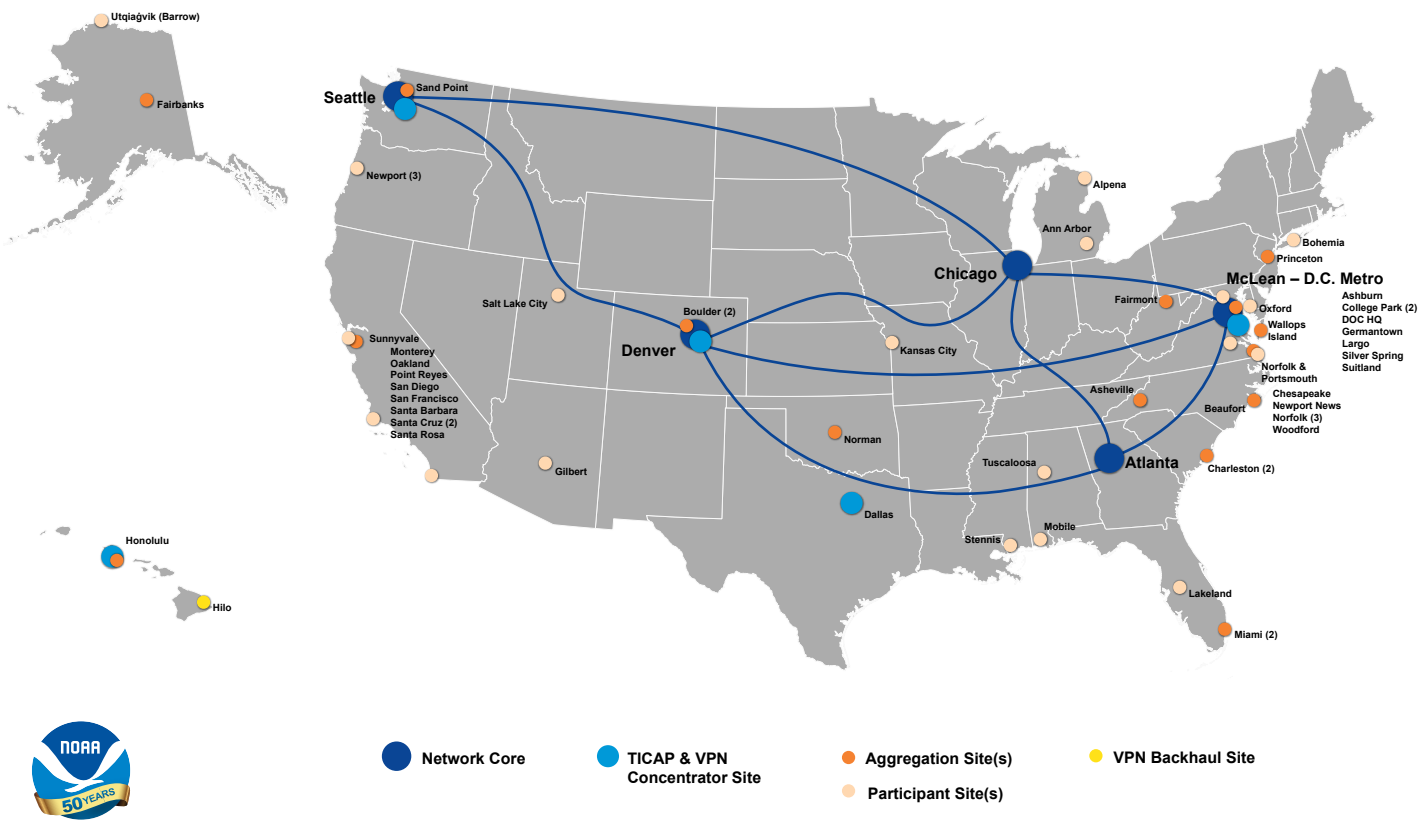
Herbert C Hoover Building (HCHB) POP – Washington, D.C.

N-Wave implemented a second fully redundant and diverse 10 gbps connection to the HCHB facility. This is in addition to the existing 2x10 gbps dark fiber connections. N-Wave also installed network equipment at HCHB and established a point of presence there. As part of these changes, N-Wave is providing the HCHB NOC with TIC services via NOAA's Managed Trusted Internet Protocol Service (MTIPS).

Barrow Atmospheric Baseline Observatory's new facility.

Managed Trusted Internet Protocol Service

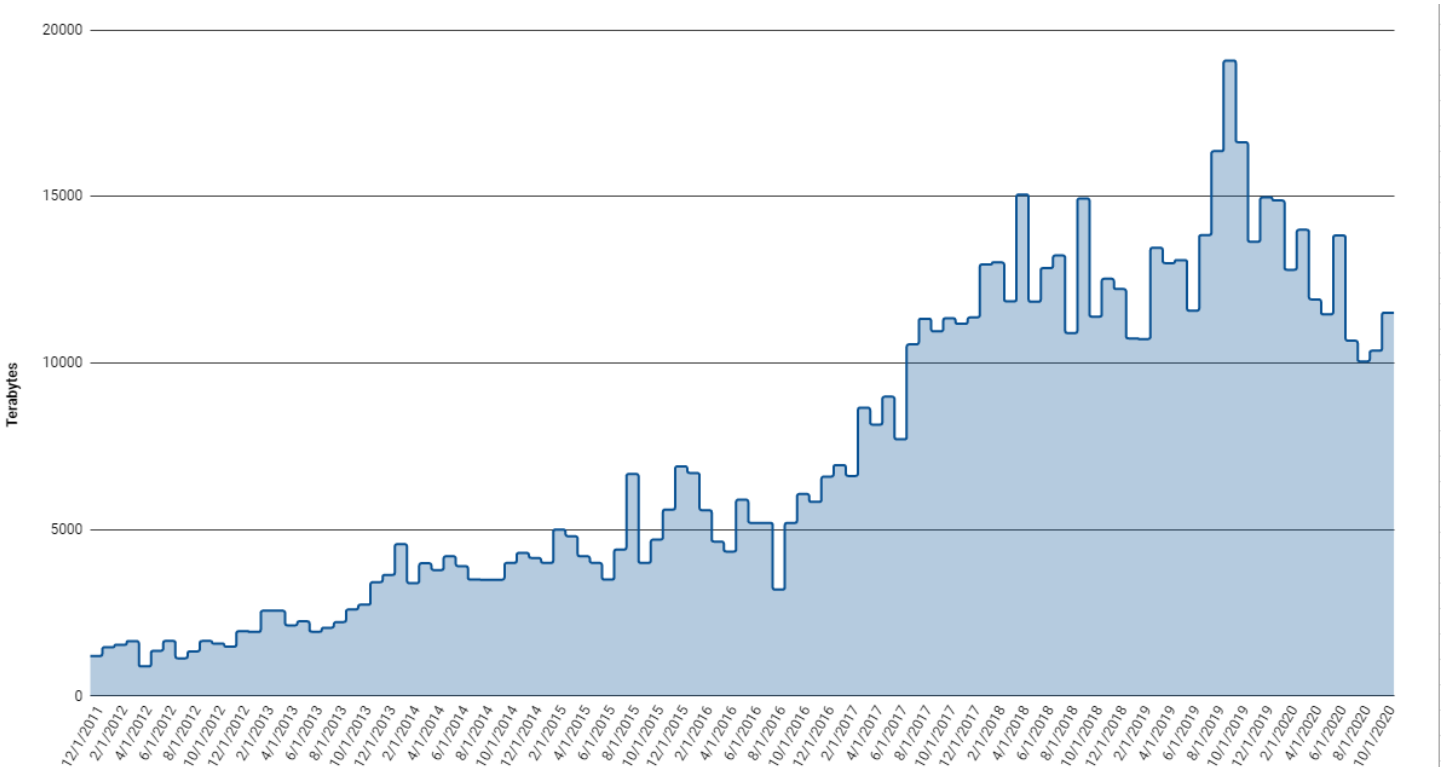
All of NOAA's TIC locations (Honolulu, HI, Seattle, WA, Denver, CO, Dallas-Ft Worth, TX, and Washington, D.C.) are approved by the Department of Homeland Security (DHS) as Managed Trusted Internet Protocol Service (MTIPS) providers. This means that they are able to offer TIC services to agencies outside NOAA. As noted in the accompanying Network Changes and New Participants article, HCHB is the first to make use of this capability.



Credit: NOAA/OMAO/AOC

N-Wave Network Performance Metrics

Network Traffic (December 2011 – October 2020)



N-Wave's peak traffic remains the 19.08 petabytes spike in September 2019. With the COVID-19 pandemic causing delays in both new site deployments and capacity increases on circuits from the N-Wave backbone to participating sites, anticipated traffic growth enabled by the backbone capacity boost to 100 Gbps (completed in late 2019), along with the related increases to the Boulder, CO, and Fairmont, WV, sites (completed in early 2020) has not yet occurred. As the N-Wave network continues to be an instrument for facilitating NOAA's move to the cloud and expands to serve a growing number of DOC bureau customers, N-Wave is working on revised metrics collection methods to better reflect its evolving traffic patterns.

Credit: NOAA NMFS SWFSC

Next N-Wave Stakeholders Summit

Next N-Wave Stakeholders Summit

The next N-Wave Stakeholders and Science Engagement Summit is scheduled for February 23-25, 2021. The event will be fully virtual, in light of the latest DOC and NOAA health and safety guidance during COVID-19.

N-Wave's Stakeholders Summit is a yearly gathering of NOAA's leaders, campus technology coordinators, data producers, data managers, information security officers, network engineers, researchers, scientists, and system administrators. They are joined by N-Wave's partners from the science, research and education network community. Participants will hear about new network technologies to better support NOAA's mission, N-Wave's future plans and new services, and stakeholder initiatives that will drive capacity planning for network backbones and NOAA's Trusted Internet Connections. With the agenda under development, there may also be sessions with other federal agencies' perspectives and NOAA's international partnerships.

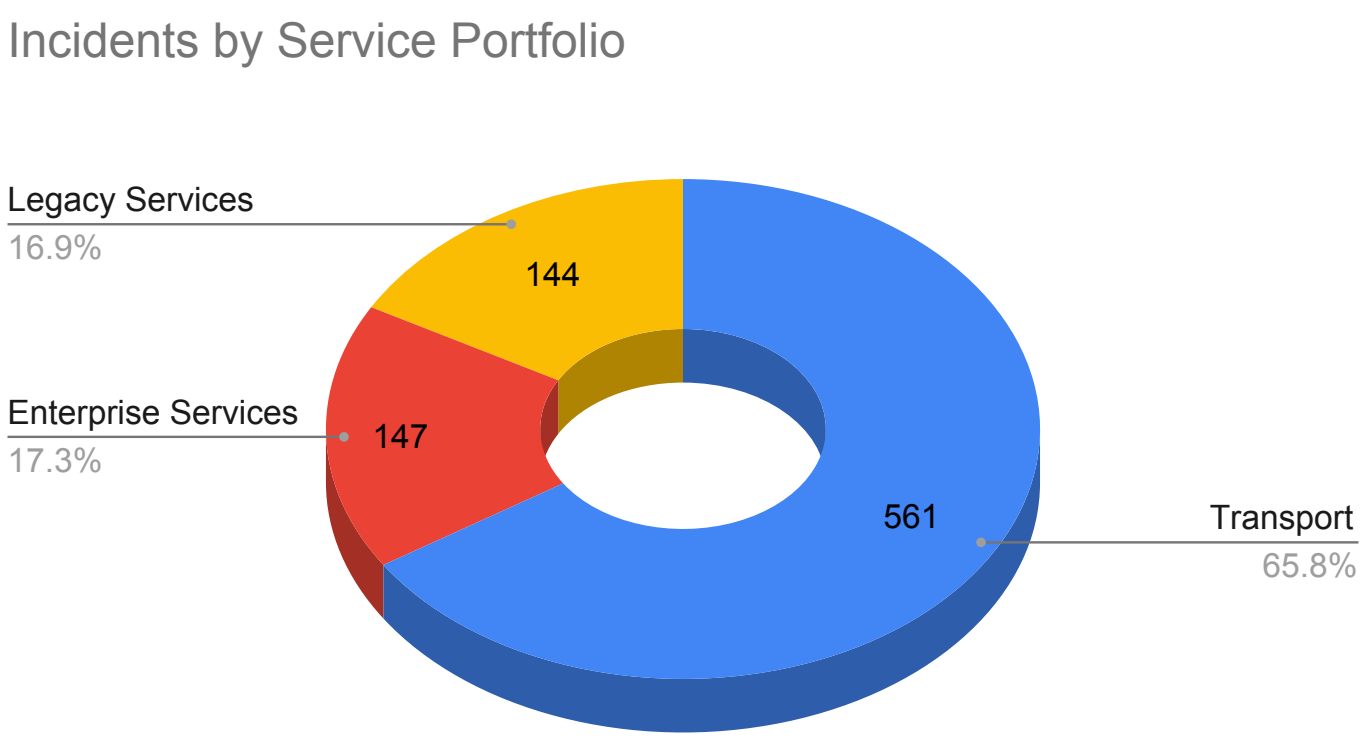
More Information

More information about N-Wave outreach events is available at:
https://noc.nwave.noaa.gov/nwave/public/events.html

Credit: NOAA/NMFS/PIFSC

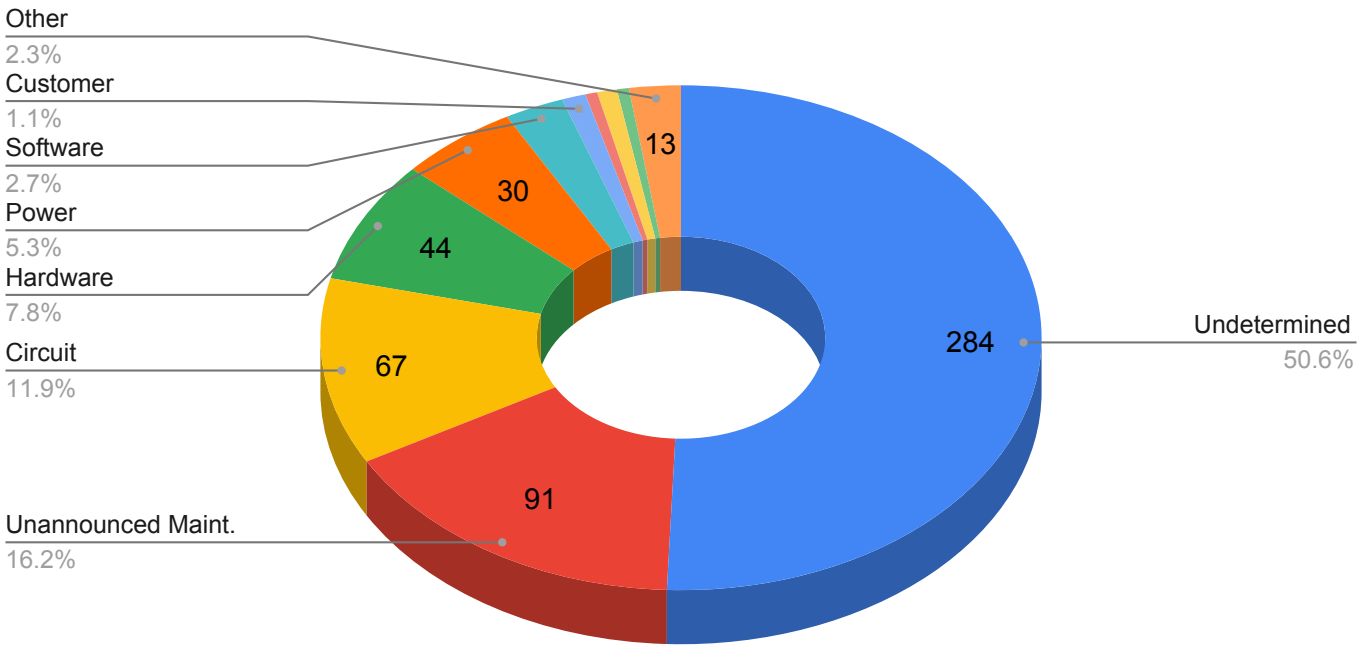
Network Operations Center Metrics and Updates

The N-Wave Network Operations Center (NOC) provides support 24 hours a day, 365 days a year. Support metrics gathered from April through September 2020 indicate that the N-Wave NOC opened 12,769 tickets. That number encompasses all incidents, service requests, change and maintenance events, and customer communication records, such as individual phone calls and incoming and outgoing email correspondence of the NOC. Service requests (16%) and communication records (73%) make up the bulk of those tickets, while incidents and changes account for only 11% of tickets.



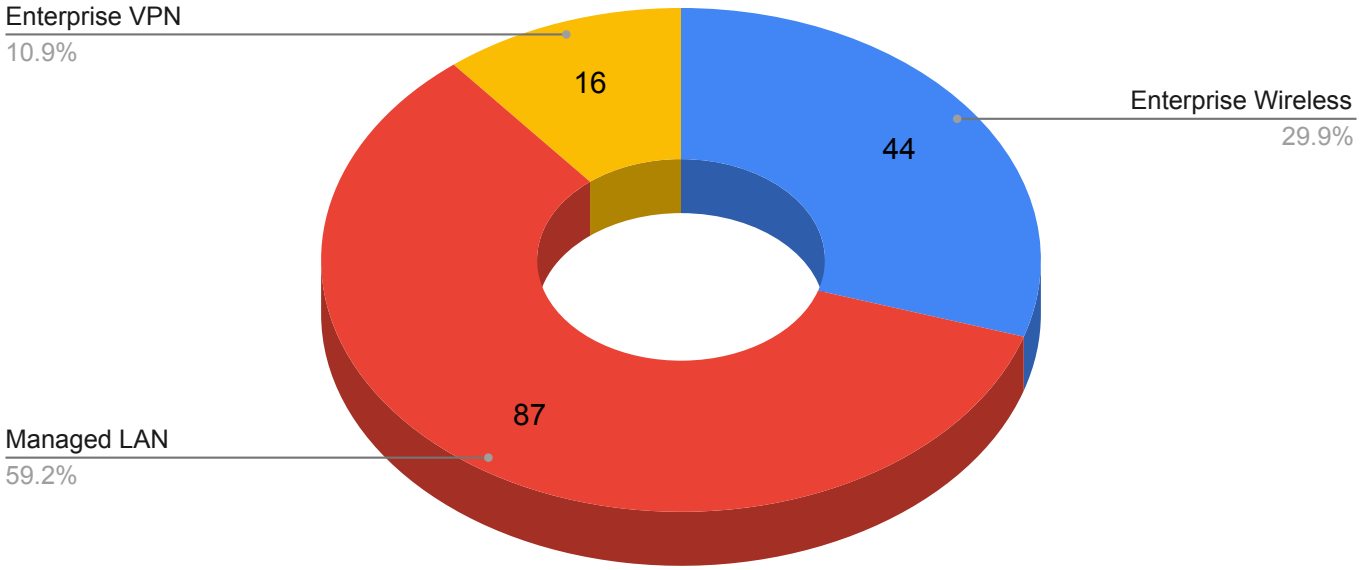
This represents 852 total incidents, broken down by service portfolio: N-Wave Transport, N-Wave Enterprise Services and NOAA Silver Spring Legacy Services. Engineers continue efforts to migrate Legacy Services into the Enterprise Services portfolio.

Transport Incidents by Category



This shows the 561 total Transport incidents, broken down by category. Undetermined incidents mostly comprise very brief, mainly non-customer-impacting observed outages for which a vendor is not able to determine the cause. Unannounced maintenance events typically occur when customers or providers do not announce the maintenance to N-Wave. As a result, the NOC is unable to notify the community and instead has to treat the event as an incident separate from standard maintenance events. Circuit incidents are outages caused by fiber damage, bumped fiber, vandalism or cut fiber.

Enterprise Services Incidents

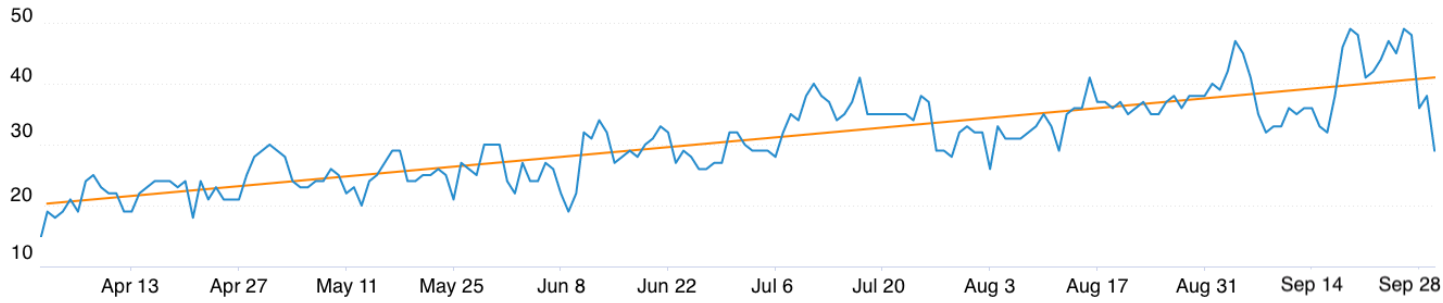


This shows the 147 total incidents related to N-Wave Enterprise Services, broken down by specific service: Enterprise Remote Access VPN (ERAV), Enterprise Wireless and Managed LAN.

Trends in Incidents and Requests

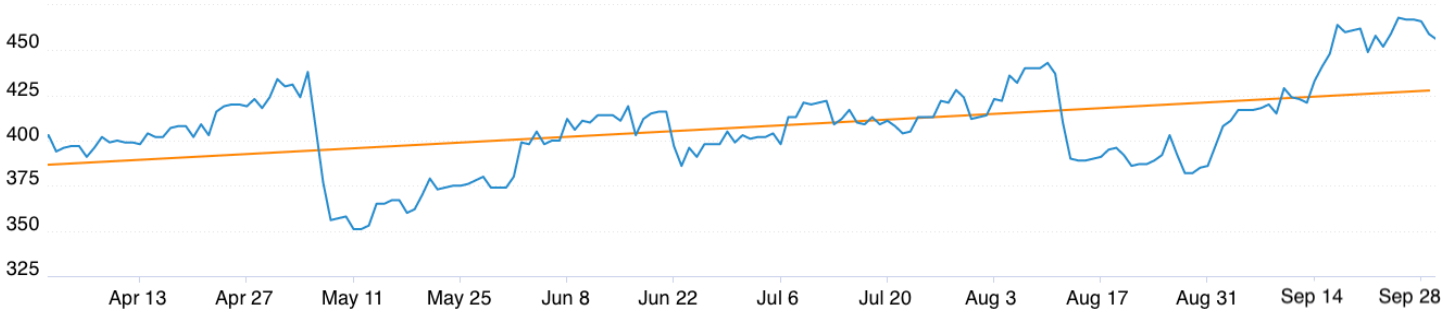
The trend lines for Active Incidents and Active Requests reflect N-Wave's overall growth as it extends services to new sites and customers.

Active Incidents



The Active Incidents metric shows the trend of all incidents active on a given day.

Active Requests



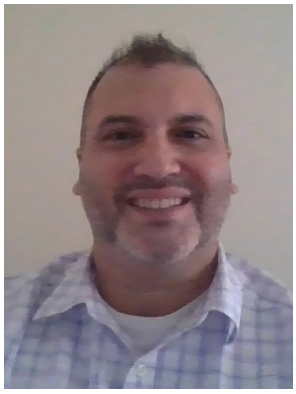
The Active Requests metric shows the trend of all catalog tasks active on any given day.

Credit: NOAA NMFS Image Gallery

N-Wave Welcomes New Staff

Kerry Dunn has been hired as N-Wave's federal budget analyst. She provides budgetary and financial information and insight to help N-Wave make the most of its funding, while expanding the scope of its services and customer reach. Kerry joined N-Wave in September 2020 and is based in Grand Junction, CO. Her career background includes serving as a budget analyst and cost accountant for the Grand Junction Veterans Affairs Hospital. She has a Bachelor of Science in accountancy and a Bachelor of Business Administration in finance, both from the Boise State University School of Business.

Stefan Fouant has been hired as a network architect with N-Wave, joining the team in June 2020. He is currently providing architectural overview of the Department of Commerce Herbert C. Hoover Building's Network Assessment project that spans wide area, core and local area network services, with a focus on reducing costs and streamlining connectivity. Based out of Ashburn, VA, Stefan has over 24 years of experience in the IT industry and spent a good part of his career focused on service providers. He is a Juniper Ambassador, Quintuple JNCIE, author of several Day One Guides focused on Juniper technologies, and is a chapter coordinator for the Northern Virginia Palo Alto FUEL User's Group.



Brandon Hicks has been hired as a network engineer with the N-Wave enterprise network services team. Brandon joined N-Wave in August 2020 and is based in Fairmont, WV. His career background includes working as a program director at West Virginia Junior College, a telephony and data networks analyst at a medical transportation company, and a telecommunications engineer for a financial company. He has a Bachelor of Science in information systems from Strayer University.

Credit: NOAA/OER/Hidden Ocean 2016: The Chukchi Borderlands

Roman Sammartino has been hired as a systems administrator with N-Wave. In this role, he oversees end-user device management across the N-Wave organization. He also provides management and support for other internal IT systems and solutions. Roman joined N-Wave in November and is based in Boulder, CO. Before that he worked as an IT engineer for a local technology consulting and support company. Roman has a Bachelor of Arts in mathematics from the University of Colorado Boulder, where he continues to serve as the head coach for the university's rowing team.

Tamrat Teare has been hired as cloud engineer with N-Wave, providing direct, specialized support for cloud projects managed by the NOAA Office of the CIO's Service Delivery Division and Web Operations Center. In this role, he is currently focused on delivering cloud transport services for the U.S. Department of Commerce's Economic Development Administration. Tamrat joined N-Wave in September 2020 and is based in the Washington, D.C., area. Before that, he worked as an Amazon Web Services (AWS) cloud platform engineer with an information technology consulting company, assisting the Centers for Medicare and Medicaid Services within the U.S. Department of Health and Human Services. He also worked as an AWS security engineer for a mortgage loan company. Tamrat has a bachelor's degree in data science from Bentley University and a master's degree in computer science from Virginia International University.

Credit: NOAA/NMFS/PIFSC

December 1-3, 2020

JOINT ENGINEERING & TECHNICAL INTERCHANGE (JETI)

Hosted by n-wave NOAA ENTERPRISE NETWORK

N-Wave Joint Engineering & Technical Interchange

The N-Wave Joint Engineering & Technical Interchange (JETI) is a new annual series of workshops for network engineers and technical staff who operate and design NOAA and Department of Commerce (DOC) networks. JETI events are designed to provide opportunities to share technical updates across NOAA Line and Staff Offices, DOC Bureaus and N-Wave's network partners, and dive deeper into technical topics.

The fully-virtual inaugural meeting is scheduled for December 1-3, 2020. With single-track sessions spanning three part-days, 12 - 5 p.m. EST / 7 a.m. - 12 p.m. HST, N-Wave hopes to facilitate participation among attendees across the six time zones from the East Coast to Hawaii.

A preview of the agenda is now available online:

- Public access: www.noaa.gov/n-wave-jeti
- Internal event site (registration or NOAA Google account required): https://sites.google.com/noaa.gov/nwave-jeti/

The program will include discussions surrounding new cloud services, NOAA IP address management, a deep dive into IPv6-only networks, and N-Wave infrastructure and services updates from a network engineer's point of view. The Office of Management and Budget released the final version of its revised IPv6 policy memorandum on November 19. It states that 80% of networked devices must be IPv6-only by the end of FY2025. This timely topic will drive much of the discussion during the 2020 JETI event.

For more information:
NOAA N-Wave Program
http://noc.nwave.noaa.gov
Office of the Chief Information Officer
http://cio.noaa.gov

Robert Sears, Network Manager
Paul Love, Newsletter Coordinator
Holly Palm, Design and Layout
Amber Rasche, Editor

n-wave NOAA ENTERPRISE NETWORK
U. S. Department of Commerce
National Oceanic and Atmospheric Administration
N-Wave
325 Broadway
Boulder, CO 80305-3337