



N-Wave: A Year in Review

The N-Wave team has accomplished much over the past fiscal year (FY), enabling the vast range of missions across all N-Wave stakeholders. This year in review photo collage highlights a small portion of the engineering, communications, outreach, business operations, and other important ventures of the N-Wave team. The N-Wave team is already full speed ahead entering into FY23 - testing and developing new services, and supporting multiple customer service requests.

About N-Wave

N-Wave delivers stable, secure, high-speed network services to enable the vast missions of its stakeholder community within the federal government. Our national network infrastructure extends across the contiguous U.S., Alaska and Hawaii — reaching remote field sites, major campuses, data centers and supercomputing facilities. Combined with our scalable cloud solutions, robust catalog of enterprise managed services and advanced network operations.

N-Wave supports all stakeholder missions with integrity, transparency and employs a unique partnership approach to provide the best customer experience. The N-Wave Program Office operates under the Office of the Chief Information Officer within the National Oceanic and Atmospheric Administration.

N-Wave is NOAA's network service provider and has expanded to serve other federal government agencies.

CENIC Support for NOAA
Cultural & Scientific | RENS & NRENS

MAY 05, 2022

We have come to expect much from those who predict and forecast weather as our ever-changing climate impacts our lives. And those whose job it is to provide us with that information rely on NOAA, the National Oceanic and Atmospheric Administration, within the US Department of Commerce. Today NOAA's predictive strength is linked to N-Wave, it's network service provider that ensures high quality, highly scalable connections and network solutions to its federal agency via science, research, and education partners across the country.

[Read More](#)

Which N-Wave services have you heard about?

Service	2020	2021	2022
Wide Area Transport (WAN) TICAP	87%	91%	94%
Enterprise Wireless	60%	66%	66%
Enterprise Remote Access VPN (ERAV)	53%	72%	68%
Managed Local Area Network (LAN)	43%	50%	50%
Cloud Transport	30%	50%	47%

Keynote Speaker - "IPv6 - Now What?"

Vinton G. Cerf
Google's Vice President and Chief Internet Evangelist

Alaska Federal Networking Coordination Meeting
September 13-15, 2022 | Anchorage, AK

Keynote Presentation - "The U.S. Government's Strategy on Zero Trust"

Eric R. Mill, Senior Advisor to the Federal Chief Information Officer, Executive Office of the President (EOP)/Office of Management and Budget (OMB)

IU's GlobalNOC strengthens response to the changing climate

Blumentown - Indiana University's Global Network Operations Center (GlobalNOC) is now receiving \$4.25 million annually - a new record - for services as part of the 10-year agreement with the National Oceanic and Atmospheric Administration.

Pamela Whitson

"This announcement couldn't come at a better time. Across our world, we see the impact of our changing climate in floods, fires, and severe storms that alter landscapes and even claim precious lives," said Indiana University President Pamela Whitson. "As a leader in research and education technology, IU is uniquely suited with resources like the GlobalNOC to support efforts to predict natural disasters and strengthen our response to them."

87% partnership with NOAA advances the rollout of environmental science and weather prediction, helping the communities program for the impact of severe weather, improve warnings and save lives. The GlobalNOC keeps thousands of climate researchers, scientists, and engineers across the world connected, ensuring a high-speed and secure network that links NOAA's network, N-Wave, to the data and resources required for severe storm modeling, and weather forecasting, and conservation of coastal and marine ecosystems.

IPV6 Virtual Conference
February 10, 2022

Robert Sears
Director N-Wave, Enterprise Network Program, NOAA

Ivor D'Souza
CIO, National Library of Medicine

Latif Ladid
Chair at SG World Alliance & President, IPv6 Forum

Ralph Wallace
IPv6 Transition SME, ACT/AC

Agency Story: National Oceanic and Atmospheric Administration

Insights from N-Wave, the National Oceanic and Atmospheric Administration's e-Hear about the agency's experience with configuring and deploying IPv6 across provider environments.

Chris Konger
Engineer, National Oceanic and Atmospheric Administration

N-Wave Supports all of NOAA and is Expanding to Serve Partner Bureaus in the Department of Commerce

N-Wave Director Robert Sears credits IU's GlobalNOC with creating a world-class network of engineers, systems and application developers, and a team of customer-experience-centric experts to support its critical operations and the NOAA's mission of science, service, and stewardship.

The GlobalNOC has also recruited nearly 130 highly skilled, full-time engineers, technicians and IT professionals to KU, many of whom joined the Indiana workforce from outside the state. A hub of advanced computer networking activity, the GlobalNOC has some of the fastest, most cutting-edge networks in existence. With its large talent reserve, the GlobalNOC supports more than 20 research and education networks and lends this same expertise to other higher education institutions in the state through the support of Indiana's high-speed fiber-optic 1-Gig network.

"As we respond to our ever-changing world, IU is deepening our connections within the state, nationally and internationally with solutions that will benefit future generations."

Robert Sears

N-WAVE JOINT ENGINEERING & TECHNICAL INTERCHANGE

Issue Highlights:

- *N-Wave Cloud Services* P. 2-3
- *Security Updates & New Initiatives* P. 6
- *N-Wave Service Desk Spotlight* P. 8
- *N-Wave's Journey with Automation* P. 11-12
- *N-Wave's Enterprise Services Updates* P. 16-17
- *Alaska Federal Networking Coordination Meeting* P. 18-19

N-Wave Cloud Services

(April 1 - September 30, 2022)

NOAA Line Offices

Office of the Chief Information Officer (OCIO)

- **IPv6 Routing Support for the Web Operations Center (WOC) in Amazon Web Services (AWS)** - N-Wave recently provisioned IPv6 support for the WOC cloud environment for both AWS Gov and Com realms in the AWS East and West regions. This is one of the first IPv6 provisionings for cloud environments across the NOAA Enterprise.
- **Internet Protocol Security (IPSec) Tunnel Cloud Connection for the Enterprise Platform as a Service (ePaaS)/Information Technology Center (ITC) Environment** - N-Wave recently completed the IPSec Virtual Private Network (VPN) Tunnel connections for ITC within the OCIO ePaaS environment in AWS. These tunnels were configured to land on the ePaaS Firewall devices to supplement the connectivity provided by the general ePaaS Cloud Broker connections.

Office of Oceanic and Atmospheric Research (OAR)

- **Cloud Deployment in Azure (AZU) Landing Com** - N-Wave recently connected six OAR lab environments into the AZU Landing Commercial Zone. OAR labs including the Air Resources Laboratory, Global Systems Laboratory, National Severe Storms Laboratory, Pacific Marine Environmental Laboratory, Physical Sciences Laboratory and IT Management Office are now tenants within the environment, making this the largest customer landing zone migration to date.
- **OAR Headquarters (HQ) Consolidated Private Virtual Routing and Forwarding (VRF)** - N-Wave recently configured and deployed a consolidated OAR HQ private VRF for cloud connectivity within AWS. This consolidated private VRF allows multiple cloud environments within OAR HQ to traverse shared Direct Connect infrastructure for more centralized and cost-effective cloud communication.
- **Enterprise Remote Access VPN (ERAV) Extension to AWS for OAR HQ** - N-Wave recently extended its ERAV access to OAR administrators to access private AWS resources associated with the previously established OAR HQ private VRF. This ERAV access provides secure, private AWS communication to systems without bastion access.
- **Internet Protocol version 6 (IPv6) Routing Support for OAR in AZU Landing** - N-Wave recently provisioned IPv6 support for the OAR tenants in the AZU Landing Commercial Zone. IPv6 address space is available in the AZU Landing hub zone, and corresponding subnets have been extended to individual customer virtual network (VNET) spokes.

National Environmental Satellite, Data and Information Service (NESDIS)

- **Joint Polar Satellite System (JPSS) Mission Support Capability (MSC) Public Cloud Connectivity** - N-Wave recently extended ERAV access and configured VPN Tunnel connections for the JPSS MSC cloud environment to provide secure, outbound communication to public resources for system patches, upgrades and updates. This connectivity established a Trusted Internet Connection (TIC)-compliant path for outbound public communication.
- **Geostationary Operational Environmental Satellite (GOES) GeoCloud AWS Deployment** - In conjunction with the GOES Cloud Engineers, N-Wave recently provisioned redundant, multi-region Cloud Broker connectivity for the GOES GeoCloud environment. Due to a constraint with AWS account auto-provisioning policies, extensive collaboration between N-Wave, GOES and AWS engineers was required to ensure dynamic routing between Cloud Broker and VPN Tunnel connections functioned optimally.

N-Wave Cloud Services (Cont.)

National Weather Service (NWS)

- **Internet Protocol version 4 (IPv4)/IPv6 Address Allocation for NWS - Pacific Region (PR)** - N-Wave recently allocated NOAA-attributable IPv4/IPv6 address space to NWS-PR for connectivity into AZU-West. NWS-PR staff coordinated with N-Wave for the address allocations so that future connectivity options would be possible without address reassignments.

Infrastructure

- **AL2S Circuit Turn-up in Chicago** - In conjunction with partner Internet2, N-Wave recently turned up an 100G AL2S circuit in Chicago. This new connection provides an alternative, low-latency path to Cloud Service Providers for customers in the East region.
- **IPv6 Support in AZU Landing Gov/Com** - N-Wave recently completed the testing and implementation for IPv6 subnet connectivity through the AZU Landing Gov and Com transit hub. AZU Landing tenants can now take advantage of IPv6 addressing within their cloud environments.
- **Enterprise AWS Landing Zone Proof of Concept (PoC) Model** - N-Wave recently completed the testing and evaluation activities for the PoC Model for an Enterprise AWS Landing Zone. The combination of redundant load balancers and firewalls spanning multiple availability zones yielded successful results for each test case evaluated.



Department of Commerce (DOC) Bureaus & Offices

National Institute of Standards and Technology (NIST)

- **NIST Redundant Cloud Broker Connectivity into AWS** - N-Wave recently deployed redundant, multi-region Cloud Broker connections into AWS for NIST. Extensive coordination was required between multiple teams to ensure the complex routing advertisements between on-premises, cloud and multiple operating regions were implemented successfully.
- **Cloud Connection Capacity Expansion for NIST in AWS** - After the initial Cloud Broker connection deployment was completed successfully, N-Wave worked directly with NIST to expand the Cloud Broker Connectivity capacity. The capacity for the AWS East Com connection was expanded to 5 Gbps, where capacity for the East Gov and West Com/Gov connections were each expanded to 2 Gbps.
- **Multi-Region Cloud Connectivity for NIST Enterprise Continuous Diagnostics and Mitigation (ECDM) in AWS** - N-Wave recently deployed Cloud Broker connectivity for the NIST ECDM cloud environments in AWS. Redundancy was provisioned through multi-region connectivity.

United States Patent and Trademark Office (USPTO)

- **USPTO Cloud Connectivity into Google Cloud Platform (GCP)** - N-Wave recently provisioned Cloud Broker connectivity into GCP for USPTO. Extensive coordination was required between N-Wave, USPTO, Internet2 and GCP engineers, to change the supported interface configurations on the GCP cloud side of the connections to support Bidirectional Forwarding Detection (BFD) for faster path failure detection and more responsive connection failover.
- **Cloud Connection Capacity Expansion for USPTO in AWS** - N-Wave recently provisioned additional capacity for the Cloud Broker connections for USPTO in AWS. This provisioning of additional capacity will expand the connection throughput for USPTO to 2 Gbps.

An Update on N-Wave's IPv6 Transition Progress

N-Wave is making great strides toward its IPv6 transition goals, while also providing information and assistance to the Department of Commerce's Bureaus and NOAA's Line Offices. As noted in the [N-Wave News 2022 spring edition](#) (p. 6), all federal agencies must comply with the Federal Office of Management and Budget's (OMB) Memorandum ([M-21-07](#)) to complete a multi-year transitional timeline to IPv6-only networks.

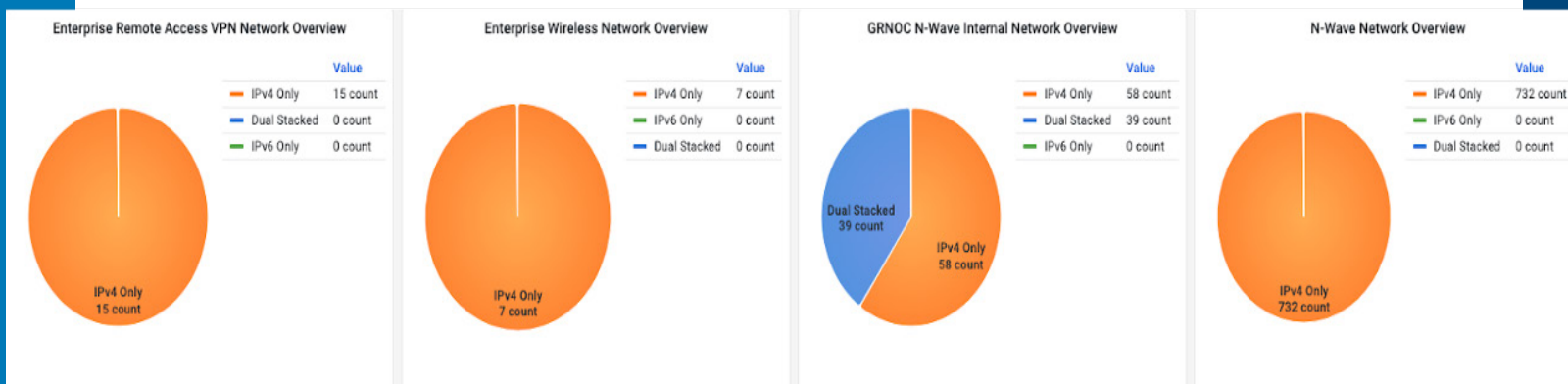
N-Wave's Progress

For N-Wave, the last several months have been primarily focused on the development of various components making up its IPv6 transition plan. These efforts have yielded a progress milestone tracking sheet, new dashboards for easy visualization of specific IPv6-related systems and an in-depth readiness assessment review compiling the numbers of operational IT assets and their IPv6 readiness.

Addressing

N-Wave currently monitors IPv4 and IPv6 usage and collects flow/traffic data for both protocols. N-Wave has a system that counts the number of IPv4 and IPv6 source nodes on the network. This could be used to measure the success of nodes transitioning to using IPv6. Following is an illustration of this graph:

Aggregate Traffic Volume by Protocol Graph



As Chair of the Federal IPv6 Task Force, Robert Sears, N-Wave's Director, has been leading several key projects. The task force was tapped to assist with reviewing federal agency transition plans and offer constructive feedback to assist agencies with preparing for the IPv6 transition. In addition, the federal task force also hosted a virtual IPv6

Summit on June 23, 2022, with many informational speakers and a plethora of stories shared from both companies/organizations in the public and private sector about their experiences, lessons learned, challenges and opportunities in managing an IPv6 transition.

N-Wave continues to lead efforts associated with the DOC/NOAA IPv6 Transition Coordination Team. The team meets regularly to discuss any updates or changes to the OMB mandate, troubleshooting issues or concerns, and actively shares information and resources to help in the transition effort.

Reporting

Federal Information Security Modernization Act (FISMA) systems must report their IPv6 status via the quarterly Department of Homeland Security (DHS), Cybersecurity and Infrastructure Security Agency (CISA) [FISMA reporting mechanism](#). These metrics also provide an opportunity to highlight the percentage of agency endpoints, networking devices, and input/output devices that operate in IPv4 and IPv6-only environments.

Milestones

By the end of FY 2025, 80% of all NOAA IT assets must transition from IPv4 to IPv6-only connectivity. NOAA's scientific mission includes sharing information globally with other stakeholders, agencies and partners. This transition is necessary to ensure the collaboration and research along

these internet communication pathways can continue without interruption.

N-Wave is providing leadership for transition efforts and will continue to share guidance and resources to offer best practices and assistance to NOAA Line Offices. See p.24 for available IPv6 transition resources.

N-Wave In the Field or On the Campus

"The N-Wave program has a strong culture of teamwork; embodied in the national spanning team of professionals! N-Wave is always a responsive and willing team, no matter what is needed. Eric Estes and Ronette Pratt (pictured right), you are rock stars" - David Zezula, Deputy Director, NOAA/Earth Science Research Laboratory (ESRL) (Boulder, CO)



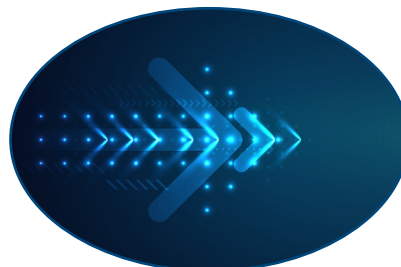
In Fairbanks, AK, on his first installation since joining N-Wave, is Curtis Schongalla (pictured left). Curtis is making his mark early on and Jason Iannone (not pictured), a senior engineer with N-Wave, was there to teach Curtis the N-Wave standards.

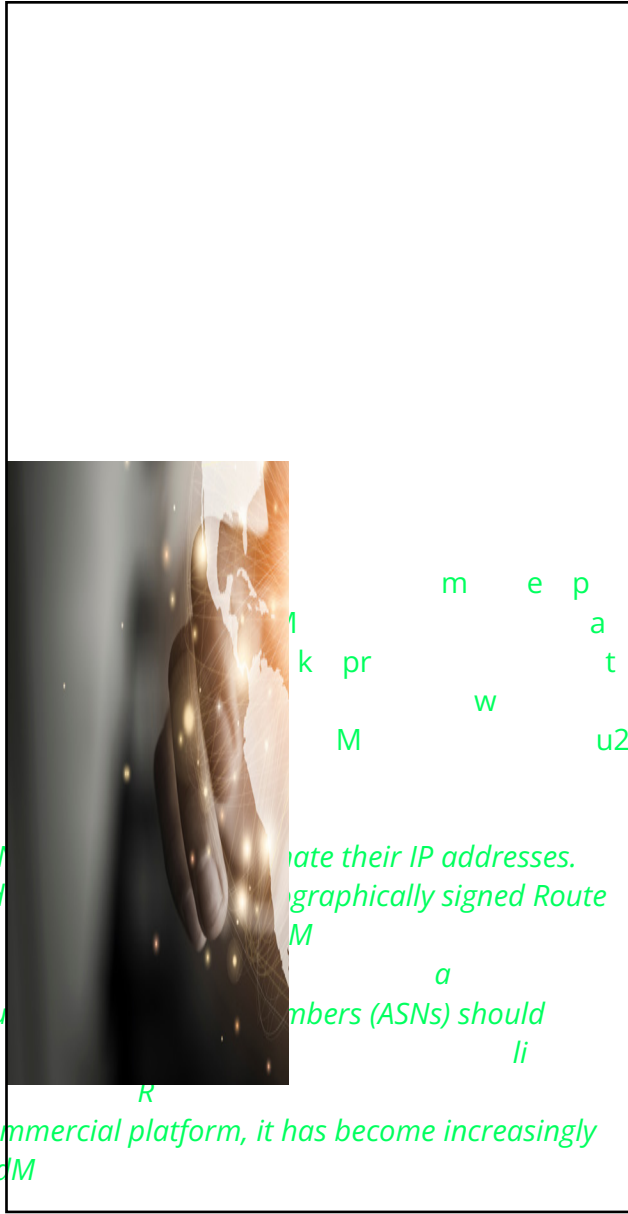
As part of the ongoing support for multiple NESDIS programs, N-Wave engineer Greg Boles completed the installation of the new N-Wave Point of Presence (PoP) at the NASA Goddard Space Flight Center in Greenbelt, MD, in support of JPSS, GOES-R and other programs. This picture shows the largest cleanroom in the world courtesy of Greg. To the right is a wall of HEPA filters. They are changed once every 50 years - whether they need to be or not! Probably wouldn't want to do it more than once in your career anyway. Allergy sufferers, this room is for you!



Jared Schlemmer and Jason Iannone, N-Wave engineers, found time to check out the Georgia Aquarium while in town for the 400G backbone upgrade in the Atlanta, GA, core node. They snapped a great picture of a turtle colliding with a whale shark.

Don't underestimate the strength of N-Wave engineers. Installs aren't immune to manufacturer defects. Sometimes a Return Merchandise Authorization (RMA) request quickly follows a new install, as it did during the Atlanta core upgrade when a screw snapped off of a DC power terminal (see below).





...in routing tables.”

Origin Authorizations (ROAs) that specify the ASNs that are authorized to announce their IP addresses. Resource holders can use ROAs to enhance their routing security. Resource holders can also use ROAs to attest which Autonomous Systems (ASNs) should be used for routing.

...simple platform for sharing information to a commercial platform, it has become increasingly popular.

“In the early Internet, routing was dependent on network relationships based on mutual trust.”

American Registry for Internet Numbers (ARIN)

N-Wave Lab Update

New Lab Manager

Jason Lomonaco transitioned into the lab manager role in June, after joining the N-Wave in 2021 as a senior network engineer on the Transport team. Before joining the GlobalNOC's N-Wave team, he worked on its Internet2 and I-Light network teams in network design roles.

Operational Support System Lab Deployment

As the N-Wave network continues to evolve, so must N-Wave's test lab. The test lab topology and equipment are designed to match the production network as much as possible. The next lab update will encompass the same Operational Support Systems as is used in the production network. These Operational Support Systems perform functions such as monitoring, measurement and visualization, logging, authentication, configuration backup and much more.

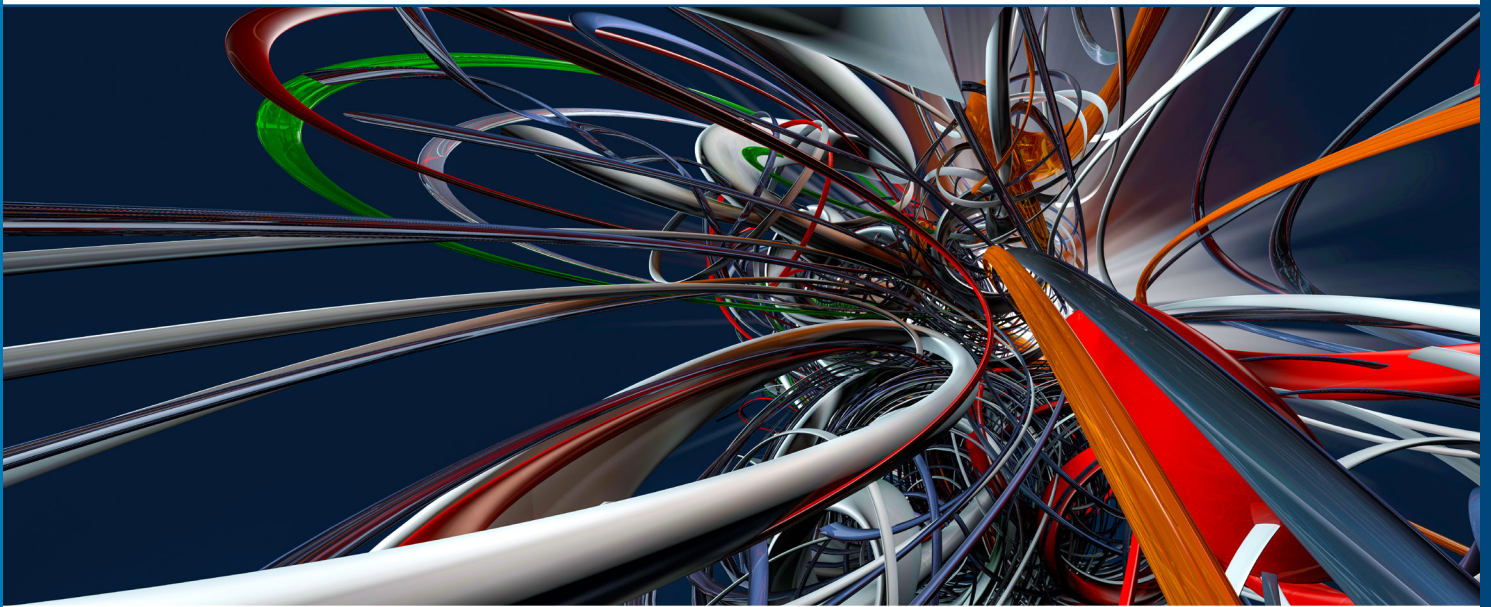
The GlobalNOC Systems Engineering team has deployed a server inside of the test lab to run these functions. When fully online, this will allow the test lab to utilize the same tools used in production with the network devices in the lab. Network engineers can then fully verify all aspects of a new network device against the same Operational Support Systems used in production. Any issues or incompatibilities will be found sooner, before being deployed into the production network, and can be remedied ahead of deployment. This is a big step toward unifying the lab with the production N-Wave network design.

Network Lab Testing Frameworks

One of the challenges for a large and growing network such as N-Wave is keeping current with software upgrades on network devices, such as routers and switches. These upgrades can provide new capabilities, stability enhancements, support of new hardware and patch security vulnerabilities. N-Wave is regularly performing network maintenance to apply these updates. With software updates occurring so regularly, testing the updates in the lab can take a significant amount of network engineering time.

The N-Wave lab is exploring options to automate portions of the software upgrade verification process. When a network device is upgraded there is a large list of verification data points to confirm pre- and post-upgrade. The lab will be taking that list and looking at automation frameworks that can perform the verifications, allowing engineers to perform verification of software versions quickly, reliably and pre-deployment.

A similar challenge occurs when N-Wave is evaluating a new network device. For a new device, the checklist of items to verify is extensive. Not only is the engineer verifying that the specifications provided by the vendor are accurate but also that the device is compatible with N-Wave's design and existing production devices. The lab is going to evaluate creating a similar automation testing framework that can perform many of the verifications for engineers. This will make the process used for testing new devices much more streamlined.



N-Wave Service Desk Spotlight

The Indiana University's Global Network Operations Center (commonly referred to as GlobalNOC) has provided Service Desk support for NOAA's N-Wave network since 2010. Located in both Indianapolis and Bloomington, IN, the GlobalNOC provides redundant operation centers — both of which actively support the N-Wave network.

Currently, the Service Desk's primary responsibilities are alarm triage and event monitoring, fielding customer inquiries, community notifications/updates, change management coordination, and operations reporting and trend analysis.

The Service Desk uses the ServiceNow ticketing software to track network events and requests, and interfaces with N-Wave Services engineering, N-Wave Transport engineering and administrative roles on a daily basis with the shared mission of N-Wave's continued success.

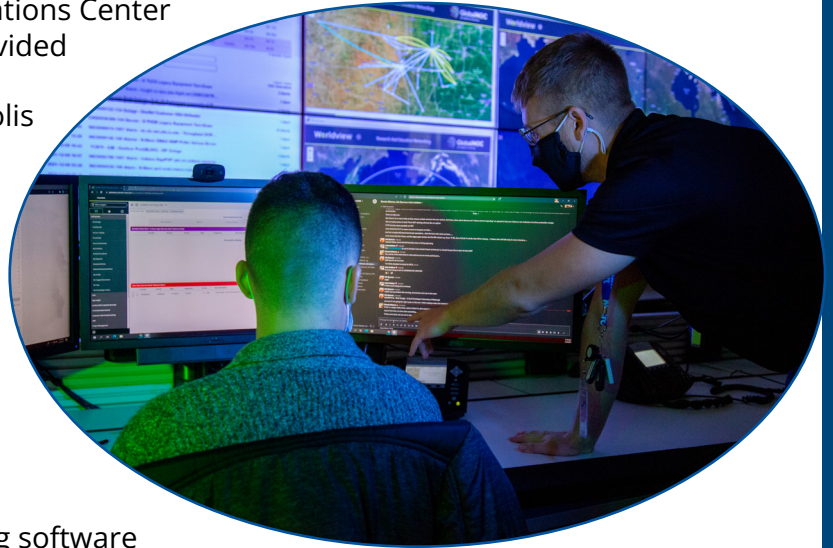
N-Wave's growth has introduced unique development opportunities for the Service Desk. As the network grows and the service catalog expands, so does the demand for a more personalized customer experience. GlobalNOC's customer-first mindset has led to many initiatives to improve overall customer service. The N-Wave notification system recently underwent a complete renovation and reimagining. Customers now have the ability to subscribe to a Notification Subscription Portal, and sign-up for targeted notifications based on the services they're interested in and FISMA IDs they are associated with. This is a significant change from the traditional operations list model that was far less tailored to the individual user.

As we expand into the future, we are continuing to look at methods that enhance customer service. Recently, the Service Desk has kicked off a broad initiative called the 'SDRP' or Service Desk Renewal Project.

This project's aim is to review longstanding and new service desk processes and investigate for process improvements.

Part of the project also includes obtaining both internal and external feedback and implementing initiatives based on this feedback.

The N-Wave NOC Service Desk looks forward to future years of growth and development within the N-Wave network.



N-Wave Joint Engineering & Technical Interchange (JETI) Meetings

JETI Annual Meeting

JETI meetings are focused on fostering collaboration within the Department of Commerce network engineering community and are hosted by N-Wave. The annual N-Wave JETI meeting was held virtually on August 9-10, 2022.

More than 135 N-Wave customers and partners registered for this year's event with cross-bureau collaborative discussions focused on cloud technology, IPv6 transition, data movement and updates from N-Wave. Informative speakers highlighted the following topics:

- NOAA Open Data Dissemination (NODD) Program (formerly known as the NOAA Big Data Program)
- N-Wave Cloud services and Landing Zone functionality
- Using Globus to move data efficiently and reliably
- Updates from N-Wave and the Department of Energy/Energy Science Network (ESnet) on its IPv6-only initiatives

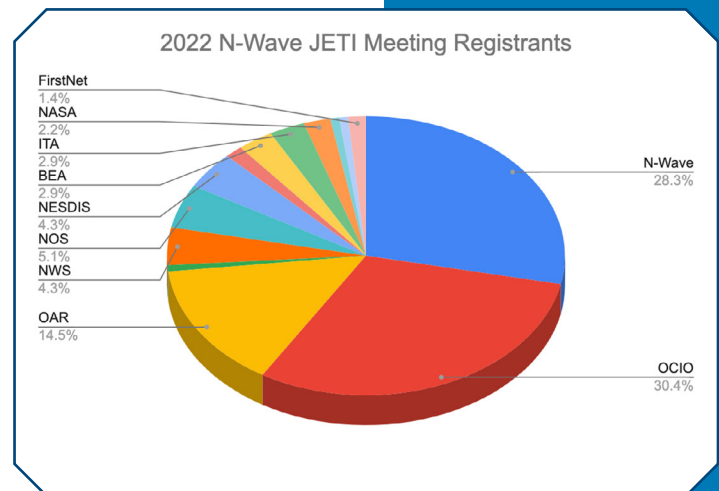
Additional information about the JETI meeting is available to JETI members in the "Events" portion of the JETI Google site.

JETI Technical Crosstalk Sessions

In February 2022, the JETI community expanded its offerings with a new one-hour monthly JETI Technical Crosstalk session. These monthly Google Meet sessions are very informal and provide a forum for all who use N-Wave to raise issues and concerns, discuss questions and problems, and generally share ideas in a collaborative manner with other participants on the call. Technical Crosstalk is held on the second Wednesday of every month from 2:30-3:30 p.m. Eastern Time. In addition to the monthly meeting, a Google Space was created to foster ad-hoc conversation outside of the monthly Google Meet session. If you would like to be invited and receive the calendar and Google Space invitation, please send an email to: nwave-jeti@noaa.gov.

JETI Path Meeting


The ad-hoc JETI Path meetings are intended to be short one-day events focused on a particular area of interest where deeper dives into technical topics can be covered. Based on feedback from the JETI Annual meeting, the planning committee is considering hosting a JETI Path event focused on Cloud topics in late January 2023. If you have an interest in leading any sessions on a Cloud-focused JETI Path event, or on another topic, please send an e-mail to nwave-jeti@noaa.gov. JETI is intended to be community-driven both, in areas of interest, and contribution of content. The survival of future JETI events relies on active participation among its members. To become a JETI member and be added to the invite list for information about the upcoming event, send an email to nwave-jeti@noaa.gov.



Notification Subscription Portal Update - Improving Customer Notifications

In June of this year, N-Wave launched a new Notification Subscription Portal. The subscription portal provides customers with individual control for tailoring their preferred notifications across any subscribed N-Wave service. Via the portal, participants can filter to receive notifications by location, FISMA ID and service. This provides customers with the ability to select any location, their FISMA and any service for notifications about outages or maintenance events that may impact them.

Figure 1: Example of Rule Selection



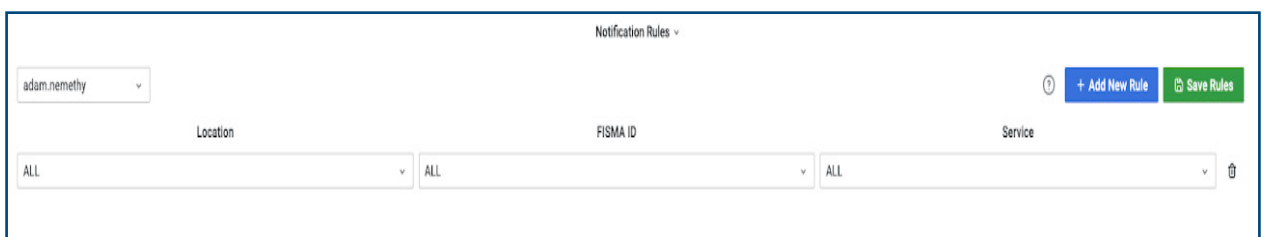
The screenshot shows a web interface for "Notification Rules". At the top, there is a user dropdown menu with "adam.nemethy" selected. To the right are two buttons: "+ Add New Rule" (blue) and "Save Rules" (green). Below these are three filter dropdown menus: "Location" with "ALL" selected, "FISMA ID" with "NOAA0550" selected, and "Service" with "ALL" selected. A trash icon is visible to the right of the "Service" dropdown.

Most importantly, being able to tailor the notifications based on a customer's preferences ensures they receive only relevant notifications with information pertinent to their network and prevents unnecessary notifications that do not apply to them. Overall, this new system saves time, provides more efficiency and increases the value of the communications received from N-Wave.

One of the most beneficial features of the new notification system is that it eliminates duplicate notifications. In the past, customers might receive two or more duplicate notifications for a single event depending on the various types of lists they were subscribed to in the system. With the new Subscription Portal, users only get a single notification. This is especially beneficial internally as N-Wave would normally get three to five copies of each notification. Now, we get just one, which is much more tenable!

N-Wave recently kicked off Phase 2 of the notification project where we analyze input from the community and our own experience to make improvements. Based on feedback from customers, N-Wave has learned that some users were selecting the "N-Wave FISMA ID" believing this would allow them to receive all notifications. This isn't correct. To get all notifications, you would select "ALL" for "Location", "ALL" for "FISMA ID" and "ALL" for "Service". However, N-Wave does not recommend this action, as it will become difficult to determine notifications affecting the individual customer.

Figure 2: Example of "All" Selection



The screenshot shows the same "Notification Rules" interface as Figure 1. In this instance, all three filter dropdown menus ("Location", "FISMA ID", and "Service") are set to "ALL". The rest of the interface, including the user dropdown and buttons, remains the same.

More feedback and other tips for getting the best results with the Notification Subscription Portal will be in future edition's of the newsletter. If you haven't signed up for notifications, make sure you sign up today at <https://notifications.nwave.noaa.gov>.

N-Wave's Journey With Automation

The N-Wave network has grown substantially over the years and the progress toward automating the network is an important effort inside the program - and continues to be an important topic of conversation inside the industry. The momentum towards N-Wave's automation goals are a result of the ongoing partnership and collaboration with Indiana University's Global Network Operations Center (GlobalNOC). The engineering expertise with this partnership has led to many developments and achievements, building off the custom open-source tools created by the GlobalNOC.

One thing to highlight about automation is identifying the fundamental problems that automation looks to achieve. Conversations around automation involve questions such as: "How do we deploy this as a service?", "What is a service?" and "What process or piece(s) are we missing?". These questions are of great importance, because executing meaningful automation directly correlates with, and may impact aspects of engineering, security, operations and user requirements. The breadth in which automation can influence an organization's operations for the better cannot be understated.

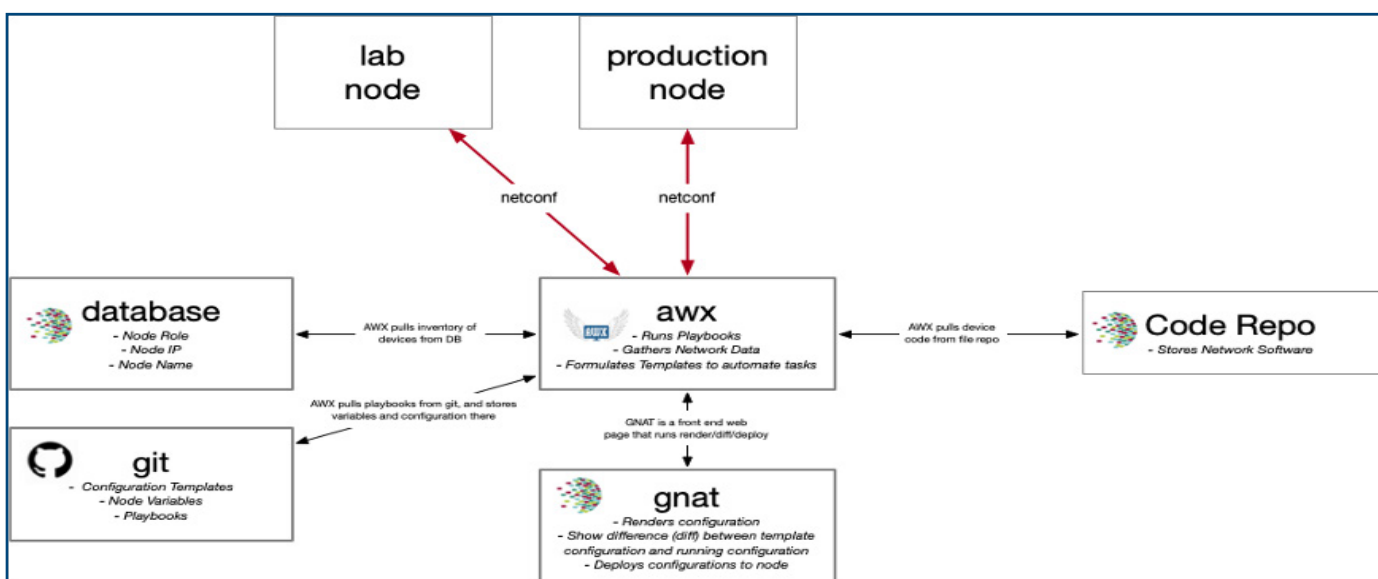
A significant amount of the efficiency gains N-Wave has created with automation started by identifying "low hanging fruit" tasks. Essentially the tasks that occur on a regular basis, and require small, yet timely, engineering effort. Tasks such as deploying a baseline configuration, or the laborious (but essential) nature of documenting an interface description. This transformation from human process, to automated process, reduces human-to-machine deployment time and increases the overall efficiency and accuracy of device configuration and documentation. Utilizing these automation tools brings together various cohesive aspects of a service's lifecycle and delivers that service more efficiently. In the end, the development and integration of automated tools and tasks produce a large output of configurability, serviceability and customization with significantly reduced human effort.

N-Wave has identified various cost-saving automation measures by identifying these "low hanging fruit" tasks, and turned them into fully-automated and pseudo-automated tasks. These tasks were validated via rigorous testing in N-Wave's Lab.

N-Wave's High Level View of the Automation Suite

At the heart of creating the solution are the tools themselves. Figure 1 displays the high level view of N-Wave's automation suite, and its various interactions.

Figure 1: N-Wave Automation Architecture



N-Wave's Journey with Automation (Cont.)

Ansible Tower (AWX) sits in the middle of the diagram, and is the orchestrator of nearly all automated tasks. AWX allows you to start tasks initiated by a network operator (ad hoc) or to act on a routine basis, such as rotating log files or gathering data for a report. AWX knows what, and how to run a task by connecting with external data sources. One is the GlobalNOC database which is used to facilitate what to run tasks on and even sometimes how. Utilizing the data stored in the database, there are many ways to shape and create tasks to perform functions on various parameters. The other external repository, Git, acts as the central repository for playbook templates, network device configuration and variable data. The GlobalNOC Automation Tool (GNAT) is a web front end tool for deploying and managing configuration baselines across network devices. GNAT is heavily utilized inside the N-Wave environment to maintain a baseline configuration across the network infrastructure.

N-Wave Accomplishments

N-Wave has achieved several automation accomplishments over the course of 2022 and since the publication of the spring newsletter. These include:

- N-Wave Services group creating a working playbook for automating Junos software upgrades on Juniper EX and QFX series switches. The playbook was used to upgrade a fleet of 250 network switches over the course of two weeks. The N-Wave Services group also deployed the third iteration of their baseline configuration using GNAT. GNAT implements checks for discrepancies that reside “outside” the baseline and alarms for those nodes that fail those checks. As an added bonus, a Slack channel was created for any deployments or updates to the baseline. This channel receives messages that include what devices were updated, and the URLs to AWX and Git.
- N-Wave Transport made additions to its baseline configuration, in particular preparing the templates for the rollout of IPv6 on the N-Wave Management Network. N-Wave Transport is also in the process of developing a revised playbook for upgrading its fleet of Juniper MX routers by automatically upgrading each routing engine in an MX and then facilitating seamless routing engine switchover.



N-Wave's Path Forward

N-Wave is paving the way for an exciting future using automation. There are many aspects of deployments under consideration to be turned into an automation-minded approach. One of these is developing a system to deploy a network node with near zero amount of human configuration. This is referred to in the network space as Zero Touch Provisioning (ZTP). Another area N-Wave is planning to use extensively is the automated deployment of unique services by utilizing automated configuration deployments. This encompasses a large amount of operational and documentation efficiencies. The GlobalNOC Service Configuration System (GSCS) will play a pivotal role in creating and building these automated configuration deployments. The conversations around automation continue to be a focal point in N-Wave's discussions and decisions toward developing a robust and efficient network environment.

Network Changes and New Participants

(April 1 - September 30, 2022)

N-Wave Upgrades

- **N-Wave Core Infrastructure Upgrade** - N-Wave recently completed the Core backbone upgrade by migrating it from 100G to 400G capacity. This significant upgrade to capacity will help support the growing N-Wave customer base.
- **Colorado Improvements - Boulder To Denver Diverse Backbone Upgraded To 200G** - N-Wave recently completed the Boulder to Denver backbone upgrade project to provide an increase in bandwidth from diverse 100G to diverse 200G. This increase will help support customer bandwidth requirements at the David Skaggs Research Center in Boulder.
- **University of Hawaii at Mānoa - Equipment Upgrades, Data Center Move - Honolulu, HI** - N-Wave is in the process of redesigning and upgrading the equipment in Hawaii. The first part of this process has been completed on the University's (UH Manoa) campus where N-Wave migrated to the new UH Manoa data center. N-Wave is now in the process of upgrading equipment at the site.

Office of the Chief Information Officer (OCIO)

- **Critical Solutions for IT Professionals (CSP) Enterprises Site - Frederick, MD** - OCIO/SDD/CORPSRV transitioned their laptop imaging process to the CSP Enterprises facility to allow CORPSRV managed devices to ship directly with the CORPSRV image installed.

Office of Marine and Aviation Operations (OMAO)

- **University of New Hampshire Judd Gregg Marine Research Pier - Newcastle, NH** - N-Wave installed a new 20 Mbps connection to the head of the pier to support marine operations in the area. This was a migration from the previous Network circuit.

National Environmental Satellite, Data, and Information Service (NESDIS)

- **NASA Goddard Visitor Center - Greenbelt, MD** - N-Wave recently completed the install of diverse dark fiber circuits into the Goddard Point of Presence (PoP). This installation is in support of NESDIS programs at the facility.

National Ocean Service (NOS), Office of National Marine Sanctuaries (ONMS)

ONMS has an ongoing project to migrate all sites to N-Wave connectivity.

- **Florida Keys National Marine Sanctuary (FKNMS) - Key Largo, FL** - The FKNMS at Key Largo migrated from an existing Network connection to a new, N-Wave 100 Mbps connection.

Department of Commerce (DOC)

- **Commerce Business Solutions Center (CSC) - Gaithersburg, MD** - CSC migrated to diverse connectivity to N-Wave by adding a second 500 Mbps Trusted Internet Connection (TIC).



N-Wave NOC Metrics & Updates

(April 1 - September 30, 2022)

N-Wave partners with GlobalNOC at Indiana University to provide advanced network operations, offering support 24 hours a day, 365 days a year and is integrated within the N-Wave Federal Information Security Modernization Act (FISMA) High system controls. N-Wave NOC support includes tier's I, II and III engineering, along with monitoring, measurement and analysis.

Support metrics gathered from April through September 2022 indicate the N-Wave NOC opened 17,547 tickets. These tickets encompass 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 (33%) and communication records (48%) make up the bulk of those tickets, while incidents and changes together account for 19% of tickets.

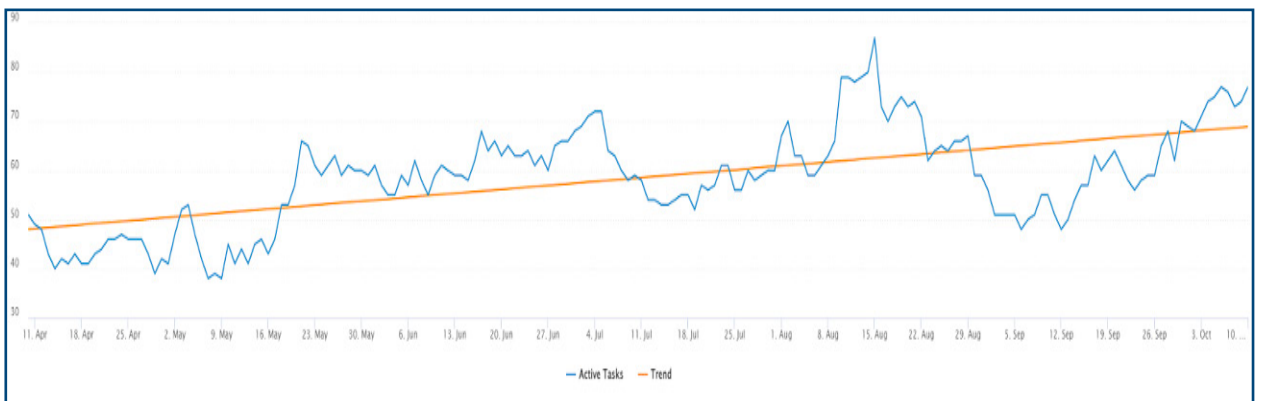
Trends in Requests and Incidents

The trend lines for customer requests and for incidents is slightly increasing, reflecting the growth of the network (in the two graphs below the value of vertical axes are incident counts).

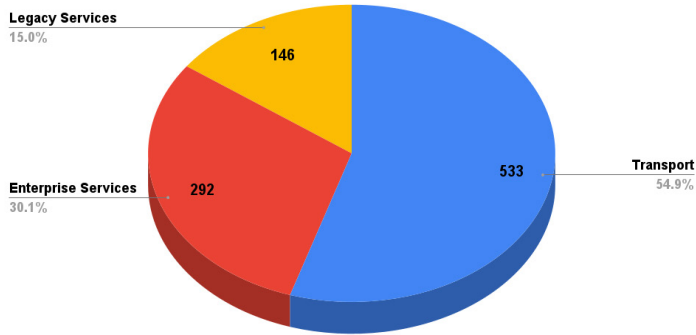
The Active Requests metric below shows the trend of all catalog tasks active on any given day.



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



N-Wave NOC Metrics & Updates (Cont.)

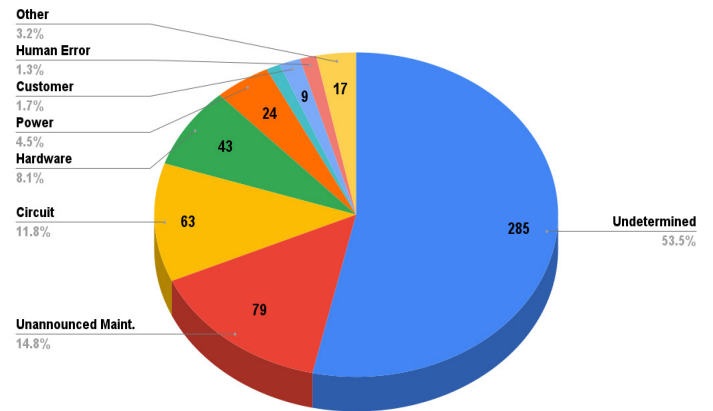


Incidents by Service Portfolio

This graph represents 971 total incidents, broken down by service portfolio: N-Wave Transport, N-Wave Enterprise Services and NOAA Silver Spring Legacy Services.

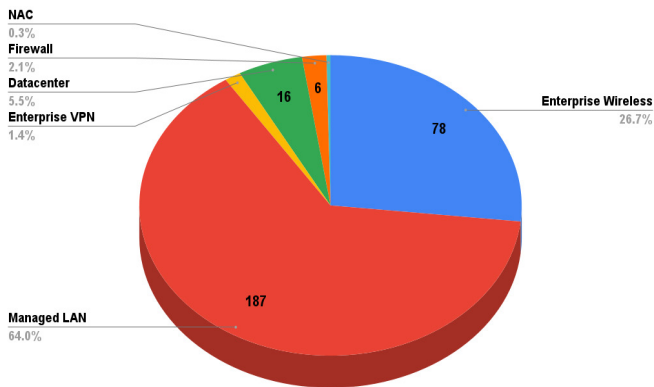
Transport Incidents by Category

This graph shows the 533 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. Circuit incidents are outages caused by fiber damage, bumped fiber, vandalism or cut fiber.



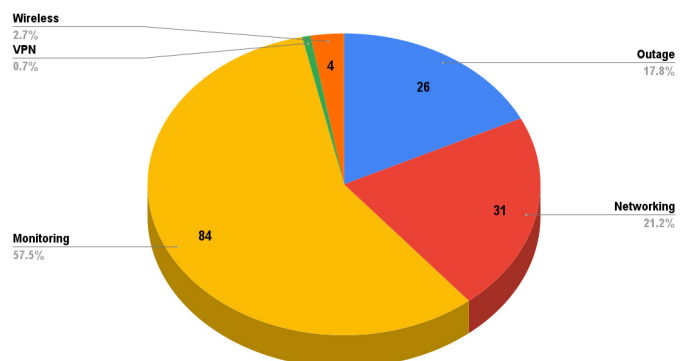
Enterprise Service Incidents

This graph shows the 292 total incidents related to N-Wave Enterprise Services, broken down by specific service: Datacenter, Enterprise Remote Access VPN (ERAV), Enterprise Wireless, Managed LAN, and Firewall.



Legacy NOC Incidents by Category

This graph shows 146 total incidents related to NOAA Silver Spring Legacy NOC, broken down by category: Outage, Networking, Wireless, VPN and Monitoring (incidents where N-Wave's monitoring system has triggered an investigation into an event that didn't necessarily cause an impact on the network).



N-Wave Enterprise Services Updates

(April 1 - September 30, 2022)

N-Wave Services Team

The N-Wave Services Team consists of engineers across multiple disciplines including, switching, routing, firewalls, network architecture and design, wireless, cabling infrastructure, and associated support across the portfolio. The N-Wave Services Team, as with all N-Wave portfolios, consists of highly skilled professionals with a rich diversity of backgrounds, experiences and approaches. These bring great influence to the value of N-Wave services. Each member of the team brings a unique set of skills, knowledge and perspective to every project. Cross training and information sharing is critical to the success and growth of the team. Engineers are always looking for ways to improve implementations and deployments as well as staying up to date with technology and industry trends. The team is spread out across multiple locations - Colorado, Seattle, South Carolina, Maryland, West Virginia and Virginia - giving extensive coverage at major campuses to provide quick responses.

Enterprise Wireless

In the last newsletter, this column discussed the project to replace the older generation Access Points which is just wrapping up. Going forward, N-Wave will only be deploying the 802.11ax supporting Wifi 6 and Wifi 6e Access Points. According to Aruba, the equipment provider for Enterprise Wireless, *"Arguably the most important new feature in the 802.11ax standard is an enhanced multi-user feature called OFDMA (Orthogonal Frequency Division Multiple Access). Multiple devices with varying bandwidth needs can be served simultaneously instead of the existing model where devices compete with one another to send data. With 802.11ax there is no contention as each device is simultaneously scheduled to transmit data in parallel. Handling data packets in this way improves performance, as a large number of packets – especially those that are latency sensitive such as voice traffic – can be transmitted simultaneously. In dense environments, instead of using a single vehicle to carry traffic, it's like using a carpool model. Traffic is pooled into a transport allowing for multiple conversations to happen at once. This allows access points to handle traffic from multiple 802.11ax devices more efficiently."* (<https://www.arubanetworks.com/resource/introduction-to-802-11ax-wi-fi-6/>).

N-Wave is excited about the new capabilities and performance increases this new technology will provide for users of Enterprise Wireless.

Managed LAN

As part of the Office of Management and Budget's (OMB) mandated migration of federal networks to IPv6-only, N-Wave is working on making the management plane on all its devices IPv6-only. The process has many parts that need to be in place. To smoothly accomplish this, N-Wave is planning to use automation tools to roll out much of the needed configuration changes (See automation article on pp. 11-12). N-Wave can currently handle any IPv6 traffic that consumers of the service need. In support of Managed LANs, N-Wave has begun deploying a slightly newer model of hardware to protect the investments and receive the maximum life out of the installed devices. The N-Wave lab tested the hardware with great success. When evaluating new product lines, engineers look for indicators of how vendors are structuring their portfolios trying to glean any indicators of instability in the life of products. While this is a moving target, N-Wave works closely with vendors to protect its investments of hardware.

Enterprise Remote Access VPN (ERAV)

In the [spring newsletter article](#) (see p.13), N-Wave discussed deploying a VPN node in Hawaii within six months and is still working towards getting that node deployed. There are several major projects happening in Hawaii and we are combining the physical installs together. While not within our six month goal, we do plan to have the node online before summer 2023.

N-Wave has also begun migrating customers to use posture control, which is technology that verifies whether a user is on a Government Furnished Equipment (GFE) computer, with great success. In the next several months, N-Wave will continue to migrate customers using posture control and distribute instructions to all VPN administrators on how to prepare for posture control on their groups. N-Wave moves groups into a state where posture control is checking, but not restricting access. After logs are reviewed and any issues that arise are worked out, N-Wave enforces the restriction working closely with the VPN administrators to ensure minimal disruption to the users. Posture

N-Wave Enterprise Services Updates (Cont.)

control does require an installation of an additional software module that can be installed at any time without impact to users. The NOAA Chief Information Officer (CIO) memo has a deadline of March 2023 for all groups to be using posture control.

Enterprise Firewall (FW)

N-Wave continues to build on the Enterprise FW service as new customers come online. Currently, N-Wave manages 42 appliance and virtual firewalls centrally through FortiManager. Using a firewall manager is beneficial in the patching and baselining of devices. N-Wave continues to deploy FW's as needed to support customer needs.

High Availability Enterprise Services (HAES) and Enterprise Data Center (EDC) IPv6 CCure Network:

The EDC team contacted N-Wave about a joint project they are working on with HAES and the desire to use IPv6-only. This service spans across Enterprise FW and Managed LAN.

Brian Cox, the EDC Program Manager said, *"The Enterprise Data Center (EDC) team within the Service Delivery Division (SDD) of OCIO is working to migrate all of their systems, devices and applications to native IPv6-only operations. The first of these systems that will achieve this is the SSMC Physical Access Control System (PACS). The CCure system used in NOAA's SSMC (Silver Spring, MD) campus also supports the NOAA Satellite Operations Facility (Suitland, MD) and the NOAA Center for Weather and Climate Prediction (College Park, MD) locations. Collaboration with SDD's High Availability Enterprise Services (HAES) team and N-Wave has made this effort possible. Through modernization and rearchitecting the CCure application, EDC will be able to achieve an Enterprise grade PACS system running on the latest OS and application versions that operates solely on IPv6. This system will also be expanded to incorporate management of the CCure PACS functions at the RMRC facility in Fairmont, WV. The major benefit to NOAA other than a secure, centralized PCAS solution that runs on IPv6 is that this system will be able to incorporate any other CCURE site into its management architecture through N-Wave's network. EDC is also working with N-Wave and HAES to update and move the DSX PACS system supporting the Western Regional Center (WRC) in Seattle, WA, to an IPv6 network. Both of these initiatives are expected to be completed in FY 2023."*

The N-Wave Services Team will continue its progress on these many fronts and look for new ways to improve existing services for its federal agency partners and customers.

ERAV

65 VPN groups

6 NOAA Line Offices use ERAV

2 other federal entities use ERAV

10,000+ registered users

Firewall

6 service locations spanning the U.S.

16 firewalls including cloud firewall deployments

24 virtual firewall instances

Managed LAN

42 service locations spanning the U.S.

5 NOAA Line Offices use Managed LAN

340+ switches deployed

Wireless

26 service locations spanning the U.S.

15 states with service locations

1,050+ wireless access points

Alaska Federal Networking Coordination Meeting



Alaska Federal Networking Coordination Meeting September 13-15, 2022 | Anchorage, AK



The National Atmospheric and Oceanic Administration's (NOAA) N-Wave program office, the National Marine Fisheries Service (NMFS) and the National Weather Service (NWS) hosted a meeting for federal agencies, tribal organizations and partners with an interest in broadband access and networking services in Alaska. The meeting was held from September 13-15, 2022, in the Federal Building in Anchorage, AK. This meeting drew the interest of more than 50 participants, either attending in person or remotely, and was the COVID-delayed follow-up from an

initial May 2019 meeting. The weather was unseasonably rainy and wet even for

Anchorage in September, but it was a welcome opportunity for participants to be face-to-face with colleagues and partners - for many, the first time since before COVID. The overarching goal of the meeting was to find partners and opportunities for synergy in Alaska to benefit from sharing information about infrastructure and the availability of network services. Since the 2019 meeting, N-Wave has expanded into Alaska and has successfully built out a high performance, geographically-diverse network in the state, and is presently supporting all major locations for the National Environmental, Satellite, Data and Information Service (NESDIS) and NMFS with locations from Utqiagvik (Barrow) to Kodiak and Juneau.



The meeting was divided into two main sections, day one was a "vendor day" with presentations and discussions by commercial vendors serving Alaska, and the next two days followed with presentations and discussions by federal agencies, tribal organizations and partners operating in Alaska. A total of 10 companies presented their service offerings during the vendor day. Satellite services vendors Telesat Solutions, Starlink, Atlas Space Operations, and OneWeb Technologies outlined their new Low Earth Orbiting

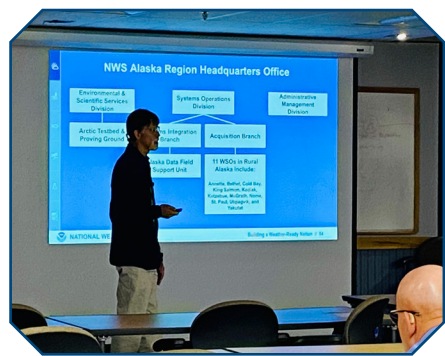


(LEO) satellite-based offerings and how their low latency, high-capacity services will change the telecom landscape versus a terrestrial-based infrastructure. Alaska-focused telecommunications companies MTA Solutions, Quintillion Networks, GCI, Alaska Communications (ACS) and the Arctic Slope Telephone Association Cooperative (ASTAC) along with national telecom, AT&T, presented major new initiatives. The land-based fiber connection back to the contiguous U.S. (CONUS) and the build-out of improved telecommunications in western Alaska received substantial interest.

Alaska Federal Networking Coordination Meeting (Cont.)

The main portion of the meeting was introduced by N-Wave's Director, Robert Sears, who provided a general overview of the N-Wave program and the overarching goals of the meeting. In subsequent presentations, he outlined the status of the N-Wave network in Alaska and future plans for upgrades and expansions of the network, including the possible installation of a NOAA multi-agency Trusted Internet Connection Access Point (TICAP) in Alaska.

Agency networking updates were provided by NOAA Line Offices which have a substantial presence in Alaska - NMFS, NWS, Office of Marine and Aviation Operations (OMAO) and NESDIS. The Federal Aviation



Administration (FAA) presented their networking architecture as well as the Weather Camera Program, so critical to aviation safety in the state where most areas are roadless. Other presentations by the Rural Development Program of the U.S. Department of Agriculture (USDA), the State of Alaska's new Broadband Office, Tanana Chiefs Energy Conference, Denali Commission and the Yukon-Kuskokwim Delta Tribal Broadband Consortium provided valuable insights on rural infrastructure expansions now becoming possible via new federal infrastructure spending legislation.

The U.S. Coast Guard affiliated Marine Exchange of Alaska presented

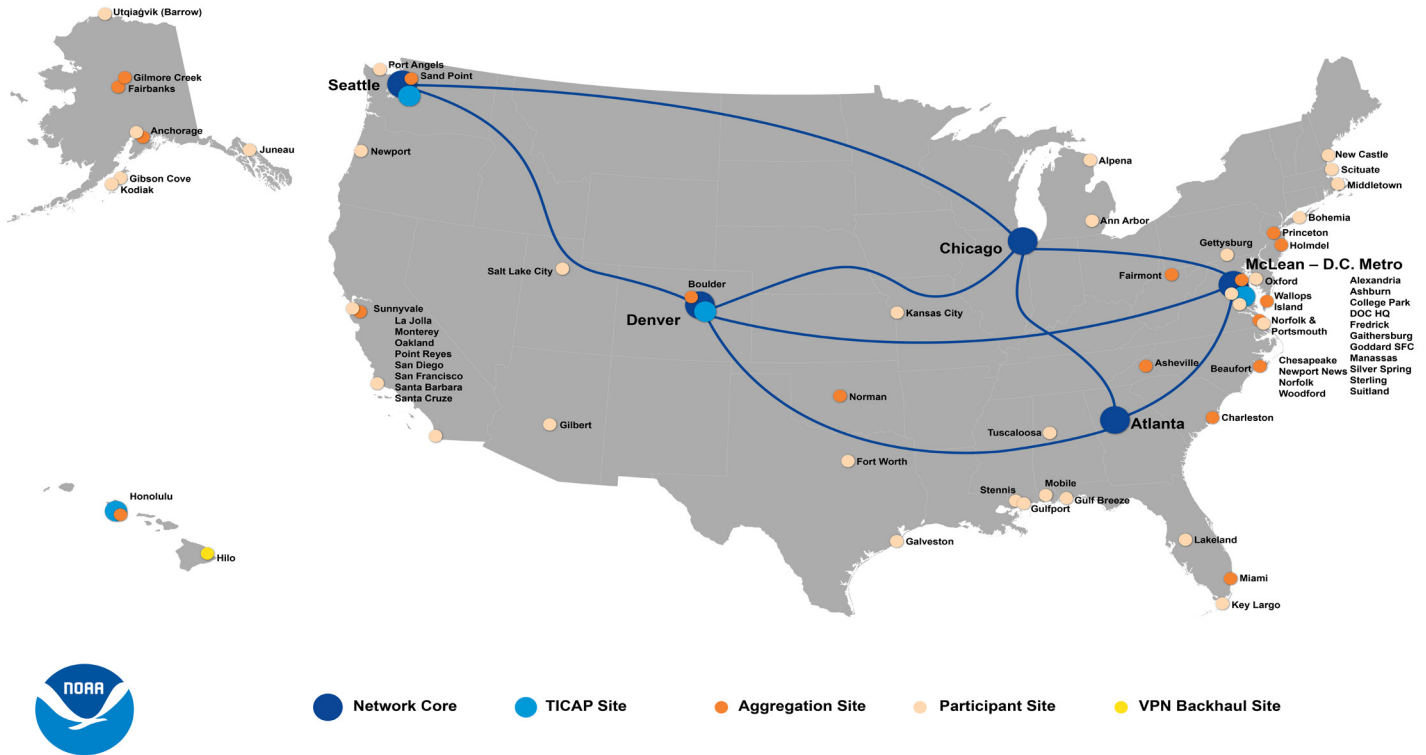
updates on their programs supporting marine safety in the state that has more coastline than the Lower 48 combined. The Department of Defense presented their Defense Meteorological Satellite Program (DMSP), critical for weather forecasting in Alaska, and the new and very interesting Space Force Satellite Control Network program.

The primary two-day section was concluded by general networking discussions and presentations from the Department of Energy's Energy Sciences Network (ESnet), Internet2, the Hawaii Intranet Consortium, and a panel discussion on peering, including the Pacific Northwest Gigapop and Internet2.



The new N-Wave Alaska core network with high-speed connectivity to CONUS and the proposed Alaska multi-agency TICAP sets the stage for substantially improved telecommunications in the state where modern communications historically has been behind the times, represents a wonderful opportunity for federal agencies and partners to join forces and gain cost effective and reliable telecommunications. Future efforts include forming a collaborative consortium with these participants and others with a vested interest in Alaska broadband access and networking efforts within the state. Plans are for the group to collaborate in an informal and voluntary way through periodic meetings and continue to look for opportunities for synergies in this arena.

N-Wave Map



N-Wave Federal Agency Partners/Customers - How To Submit a Service Inquiry

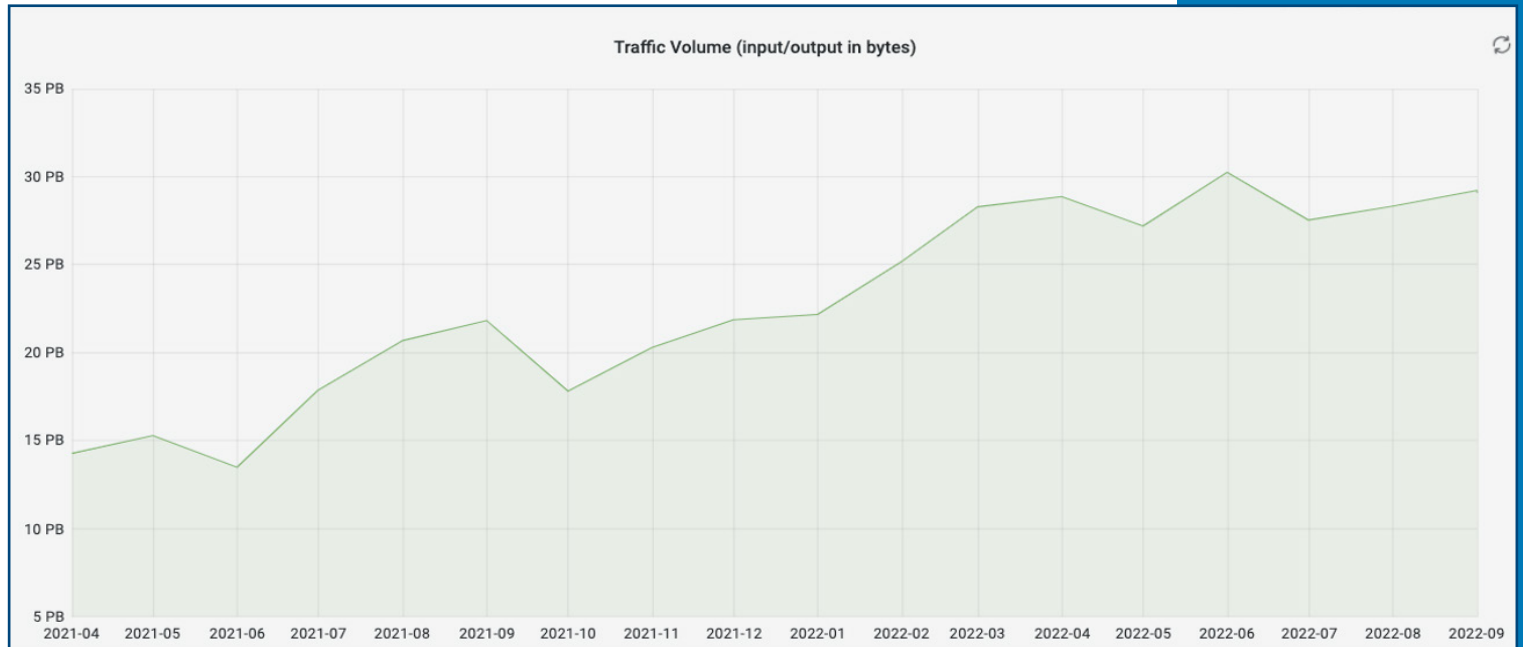
The N-Wave Network Operations Center can be reached 24 hours a day, 365 days a year to provide assistance to federal agency partners/customers by:

- **Phone:** (812) 856-7477
- **Email:** nwave-noc@noaa.gov

Federal agency partners/customers can submit a [Service Inquiry](#) for one of three types of requests:

- **Change Request** - Select this option if you currently have a service and would like to modify or expand the service, i.e. Add/Remove/Change ERAV Group Membership, Change VLAN on a Port, Update Prefix List
- **New Service** - Select this option if you need a service you do not currently have, i.e. New WAN Connectivity, New ERAV VPN Group, Managed LAN Service Inquiry, Wireless Service Inquiry
- **Request Support** - Select this option if you require assistance with an existing service, i.e. Service Outage, Service Degradation, Service Quality Issues, Routine Maintenance

N-Wave Network Performance Metrics



As mentioned in past newsletters, N-Wave will be updating the graph above for each newsletter with the start date remaining at April 2021. This will provide a cumulative timeline for network traffic information. For reference, the cumulative total from N-Wave's inception through March 2021 can be found on page 15 of the [spring 2021 newsletter](#).

Please note from October 17, 2021 - November 8, 2021, there was an issue with data collection and it is the reason for a slight decrease during that specific time period. N-Wave backbone traffic continues to grow at a steady rate, and with the recent 400Gbps backbone upgrade, there is plenty of capacity.



N-Wave New Staff

Andrew Lee



Andrew Lee joined the N-Wave Transport team in June 2022 as a Network Engineer at GlobalNOC where he's based in Bloomington, IN. Andrew's role focuses on helping with higher level architecture and automation. Andrew joined the GlobalNOC in 2004 and has worked on most of the major networks that it supports before moving to N-Wave, most recently with Internet2 in helping to select and deploy its Next Generation Infrastructure (NGI) network. Prior to that, he worked at a variety of commercial internet providers and data center companies. Outside of work, Andrew helps with his son's Scout troop, and has hobbies involving everything up in the sky - astrophotography, plane spotting, weather (he has been a NWS Skywarn storm spotter every year since 2006), and model plane and rocket building.

Ronette Pratt



Ronette Pratt joined the N-Wave Business Operations team as a Management & Program Analyst in April 2022. She is based in Boulder, CO. Her primary function within the team is to support N-Wave Infrastructure Acquisitions (both hardware and software) through coordination with senior engineers and customers alike in IT modernization and consolidation to maximize cost savings. Immediately prior to this assignment, she had been supporting the N-Wave program for almost eight years as a Contract Specialist working in NOAA's Acquisition and Grants Office, High Performance Computing & Communications Division with N-Wave's suite of Network Operation and Transport Contracts. She spent more than 25 years supporting the Department of Defense in the Acquisition/Contracting career field, in many locations around the country and overseas. This new chapter is filled with exciting challenges and she's looking forward to broadening her technical knowledge base and building relationships - both personally and professionally!

Ben Shively



Ben Shively recently transitioned to the role of N-Wave Network Data Administrator with the GlobalNOC's Network Engineering team. Prior to that, he supported N-Wave as a Specialized Support Technician (SST) with the GlobalNOC's Service Desk since 2019, after first joining GlobalNOC in 2013. Ben has enjoyed his time working with research and education network operations, and is currently enjoying the opportunity to work more intimately with the network's data. When away from his desk, Ben is likely working on his homestead, supporting his wife's hair salon business, or just spending time with his wife and two young children.



N-Wave Outreach and Events



SC22 - November 13-18, 2022, in Dallas, TX

This year the SC conference, formerly known as Supercomputing, returns in full force to Dallas, TX. While remote participation will be used by some attendees, thousands are expected to be in Dallas. SC22 will include a peer reviewed technical program, panels, workshops, Birds of a Feather (BoF) sessions and exhibits about the latest supercomputers, their technology, high performance networks, storage and demonstrations of these items from many parts of the globe. Those traveling to Dallas from NOAA to learn about the new technologies include Frank Indiviglio, Bill Cushman and members of the NOAA Research & Development team, and Robert Sears, N-Wave's Director. Additionally, Tran Nguyen and Paul Love from N-Wave are members of SCinet – the SC team that builds the network supporting SC inside the Dallas Convention Center and the wide area network that connects

the convention center to the rest of the internet (it's anticipated that total connectivity to this year's SC22 will be 4.72Tb comprised primarily of 400G and 100G circuits.)

On Tuesday, November 15, Robert Sears will be a session leader co-hosting the "Global Migration to IPv6 and Real World Applications" BoF with Ron Bewtra from Hewlett Packard Enterprise (HPE). Dynamic quick talks on IPv6 themes surrounding global impacts, real world applications, best practices and lessons learned will guide a robust and interactive discussion with the audience. If you're attending this year and can join us for this BoF, it is scheduled from 5:15 - 6:45 p.m. CST in Room D173 of the Kay Bailey Hutchison Convention Center. For details, visit sc22.supercomputing.org/presentation/?id=bof142&sess=sess330. A schedule of events along with more information about the overall SC22 can be found at sc22.supercomputing.org/.

2023 N-Wave Stakeholders and Science Engagement Summit - March 28-30, 2023, in Silver Spring, MD

Planning is underway for the 2023 N-Wave Stakeholders and Science Engagement Summit scheduled for March 28-30 at the Doubletree by Hilton Silver Spring DC North in Silver Spring, MD (formerly the Sheraton). To provide the best experience for all attendees, a hybrid event will be offered to allow for both in-person and remote attendance. While many details are still being worked out, you can expect updates from new and existing N-Wave federal agency partners, with a range of topic discussions about cloud access and options, progress on the migration to IPv6-only, N-Wave's new services along with the current status and planned upgrades of existing services and the future growth outlook for N-Wave's network.

Joint Engineering & Technical Interchange (JETI) Events

- JETI Technical Crosstalk monthly sessions (virtual) - Second Wednesday of each month from 2:30 - 3:30 p.m. ET.
- JETI Annual Meeting - Tentatively scheduled for summer 2023
- JETI Path Workshop - Tentatively scheduled for January 2023

See p. 9, for more specific details about JETI events.

Visit the following webpages for more information about N-Wave meetings and events:

- N-Wave's Joint Engineering & Technical Interchange (JETI) meetings - noaa.gov/organization/information-technology/n-wave-joint-engineering-and-technical-interchange-jeti
- N-Wave's Annual Stakeholders & Science Engagement Summit - noaa.gov/information-technology/n-wave-stakeholders-and-science-engagement-summit

Send an email to nwave-communications@noaa.gov to be added to the invite list for information about N-Wave outreach events.

IPv6 Transition Resources

Federal IPv6 Task Force

For federal staff, additional resources, including templates, tools and training resources are available on the IPv6 Federal Task Force Office of Management and Budget (OMB) [MAX](#) webpage.

These materials are available to those with .gov or .mil email addresses. Information about the Task Force is maintained through both the Fedv6 Deploy listserv and the CIO Council's Cloud & Infrastructure Community of Practice (C&I CoP).

To contact the Task Force directly, send an email to dccoi@gsa.gov.

N-Wave JETI Resources

- Internal Google Drive (must have a .gov or .mil email address to obtain access) - <https://sites.google.com/noaa.gov/nwave-jeti/>
- NOAA JETI Public Site - <https://www.noaa.gov/organization/information-technology/n-wave-joint-engineering-and-technical-interchange-jeti>



N-WAVE NEWS

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- NOAA N-Wave Program
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- NOAA Office of the Chief Information Officer
<https://www.noaa.gov/information-technology>

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