



NOAA N-Wave

The N-Wave Enterprise Network Services Branch, under the NOAA Office of the Chief Information Officer, Service Delivery Division, supports both operations and research, enabling NOAA's mission of science, stewardship and service 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, stewardship, and service.



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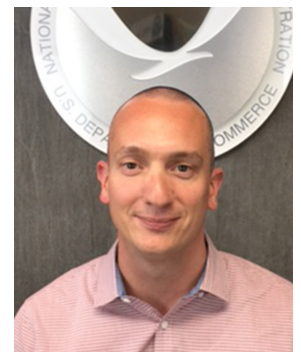
From the N-Wave Program Manager

As N-Wave expands its geographic network presence and services, there is an increased risk for the introduction of “network customization” that could affect long term operations and management.

One of my goals for the program is to minimize overly complex network configurations and to remove the need for ad-hoc or one-off provisioning scenarios. Through the exceptional engineering of the N-Wave NOAA and GlobalNOC teams, great strides have been made towards the standardization of configurations for provided services and customer connectivity. This rings equally true for the great deal of work that has gone into NOAA's Trusted Internet Connection Access Points and the X-Wave infrastructure, in addition to customer connection methods to ensure access to, and availability of all N-Wave provided services.

How customers connect to N-Wave has never been more important than now, and therefore the need for a more standardized approach is paramount. Prior to enterprise service offerings like TICAP, it was not as critical to define a customer connection model. Each customer connection to the N-Wave infrastructure could vary along with the configuration at the provider edge (PE) and customer edge (CE). Most customer transport was intra-customer - for example CLASS data archive between Suitland, MD, Asheville, NC and Boulder, CO or customer to defined resource like as the case of GFDL to the Theia supercomputer in Fairmont WV.

When Jason Iannone, a senior N-Wave network engineer with the Indiana University GlobalNOC, was working on the TICAP X-Wave infrastructure, it became apparent to him that access to and delivery of NOAA-wide transport to Internet and public resources would require each connected customer site to be configured in a manner to interoperate with, and gain access to these resources. With Jason's leadership on this effort, wider team discussions were held and new approaches for standardizing customer connections were deployed.



Jason Iannone

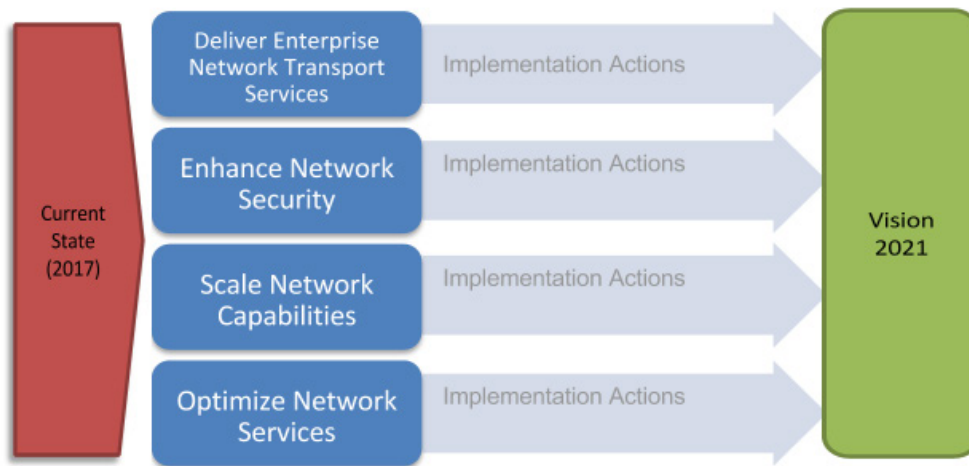
I want to thank Jason for his expertise not only with the remarkable work on the X-Wave/TICAP resiliency engineering, but being part of the extended team of conscious-minded engineers who progress N-Wave forward while continuing to examine and optimize the current state.

Please read more about Customer Connection Standardization in this 2017 spring edition of the N-Wave newsletter.

N-Wave Enterprise Network Services Branch

In Issue 6 of the N-Wave Newsletter we announced “On October 1, 2015, the N-Wave program transitioned from the NOAA Office of Oceanic and Atmospheric Research, Earth System Research Laboratory Office of the Director, to the NOAA Office of the Chief Information Officer (CIO).”

This move aligned with the 2013-2017 NOAA Strategic Plan for Network Optimization and Transport and set the stage for supporting and executing on goals outlined in the revised, 2017-2021 Enterprise Network Services Strategic Plan. The vision of the revised strategy is to transform NOAA’s networks into an enterprise-managed, secure, agile, and reliable resource that enables NOAA’s mission through four main goals:



N-Wave either directly executes on solutions to meet these goals or cooperatively supports other programs to meet these goals. One directly executed action was the integration of N-Wave and the Silver Spring Network Operations center traditionally known as the NOAA NOC. In January of 2017, management of the NOAA NOC was moved under the N-Wave program manager in order to integrate, optimize and consolidate services while expanding a portfolio of Enterprise Network Services.

With this integration, NOAA N-Wave engineering in Boulder Colorado, the GlobalNOC team in Indianapolis and Bloomington Indiana, along with Silver Spring and Seattle NOC engineers, are now a single program; the N-Wave Enterprise Network Services Branch, under the NOAA Office of the Chief Information Officer, Service Delivery Division. Per the N-Wave program manager this integrated team:



- Operate as one team of professionals supporting a diverse portfolio of enterprise network services
- Integrate, modernize and expand network services via updated service catalog
- Be a driving force and influence for NOAA wide Networking

The initial program structure will be centered on four teams under the N-Wave program management office.



- Federal Oversight
- Program accountability
- Program and staff advocate
- Business Development
- Retention, recruitment, development



Operations and Logistics

- Project Portfolio management
- Service inquiry/Service requests
- Architectural Compliance
- Contracting (COR) Services
- Property, Maintenance, purchasing
- Budget and agreements



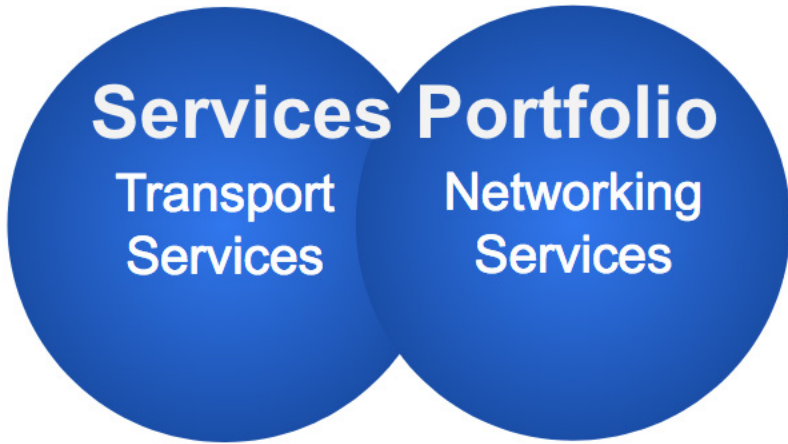
Security

- Compliance/Assessment and authorization
- Service security review
- Continuous monitoring
- Security architecture and guidance



Network Operations

- 24x7 Service desk
- Tier 1-3 engineering support
- Ticketing, Change Control/Management
- Monitoring, management, measurement
- Network standardization and guidance



Transport Services

- Layer 1-3 Transport
- MAN/WAN
- TICAP
- Peering services
- Consulting

Networking Services

- Campus LAN
- Remote access/ VPN
- Enterprise Wireless
- Firewall
- IPAM
- Consulting

- Services will be developed through direct customer interaction.
- All services will follow the N-Wave provisioning model and be highly available and fully supported.
- No Service will be deployed unless it can meet N-Wave standards.

With the newly integrated team the near term steps are to define roles and responsibilities and assign leads and engineers for the various teams. Cross training, further defining the portfolio of services and project planning will also occur.

The Long term strategy is to enhance the program with two new teams those being research and development and customer engagement.



Standardizing Connections to N-Wave

As part of moving NOAA's traffic through a Trusted Internet Connection Access Point (TICAP) when going or coming from the outside world, N-Wave has worked to normalize how connections are made between it and its participating sites. This ensures that the complex interactions of the internal network (N-Wave), the external network (X-Wave), and the in-line security enclave function correctly when unexpected network events occur. (As a reference NOAA's external network, X-Wave, is our "peering" network. The connections to our commodity ISPs as well as science & research networks such as Internet2, ESnet, and GÉANT are all being moved to connect to X-Wave rather than to a site or NOC. X-Wave will also interconnect all of NOAA's CONUS TICAPs.)

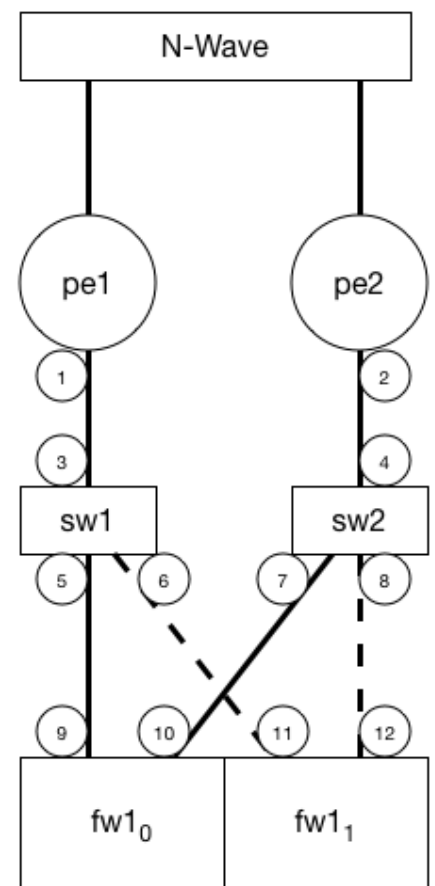
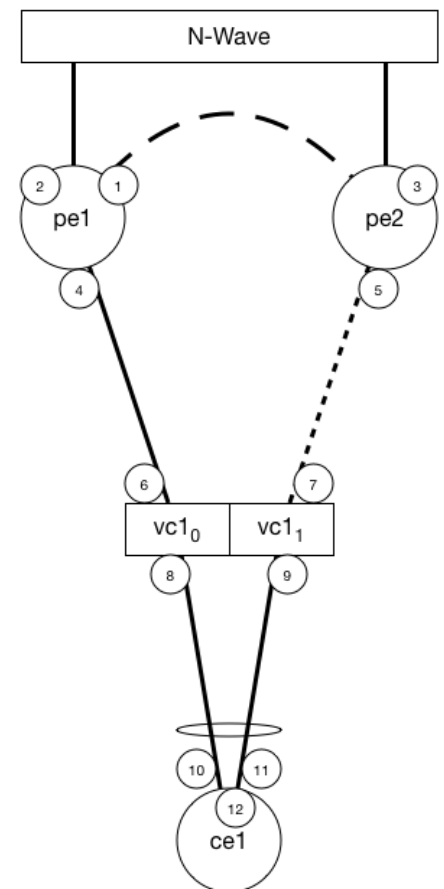
N-Wave engineers at the GlobalNOC at Indiana University and in Boulder have identified 10 different scenarios. These range from the basic single Ethernet connection between a site's edge device and the corresponding N-Wave device, to one with redundant circuits, to one with redundant N-Wave devices, site firewalls, and circuits between. The goal is to give a range of options to the site or LO that fit the site and offer increased depth of protection at different cost.

To give a flavor of the more complex designs, here are two, "Scenario 5 - CE Multihoming with Active-Standby VPL and VRRP on the PE and Switched Infrastructure to CE LAG for Static Routing" and "Scenario 9 - PE & CE Protection with CE Firewall Cluster with BGP". The technical details aren't important – rather the idea is to show how far the connections can expand from that simple, single Ethernet between N-Wave's PE and the site's CE. (In-depth technical details can be discussed within the NOAA Networking Committee)

The 10 identified connectivity scenarios address the majority of N-Wave participant requirements. Some N-Wave participants will bring unique needs that require exceptions to the identified connectivity methods. Unique solutions will be addressed on an individual case basis with additional data gathering between N-Wave personnel and the staff at the participant site.

Participant desire for node and link protection drives variance in interconnection methods. In a single homed scenario, a single link provides access between PE and CE nodes. When protection is required, the intricacies of customer networks come into play generating multiple possible interconnection methods. This means a jump from 1 (single homing) rapidly to 10 (9 forms of multihoming) scenarios rapidly.

The most widely supported multihoming scenarios require the BGP routing protocol. The lack of BGP features in the customer network equipment tends to be a limiting factor for many participants. BGP often comes as a licensed feature requiring an additional unbudgeted purchase from the on-boarding participant. Without BGP, redundancy solutions substantially increase in complexity.



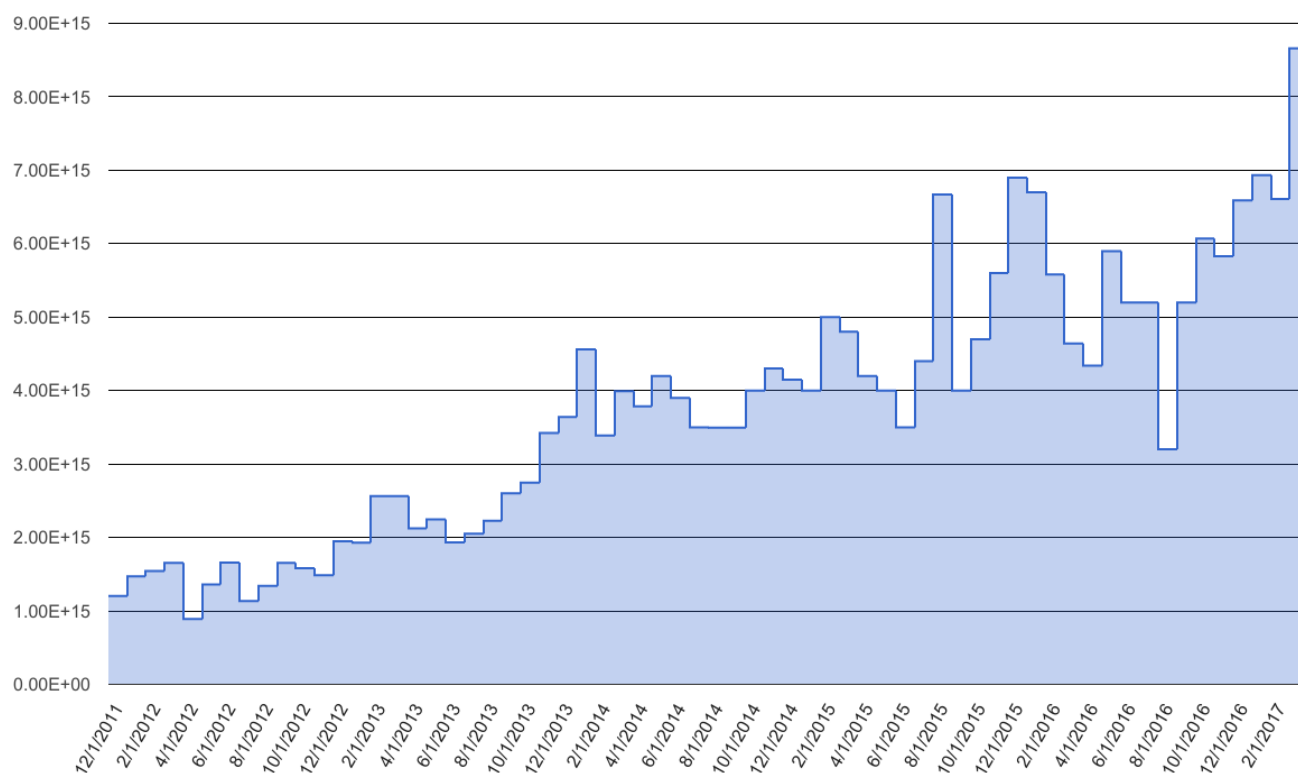
N-Wave Network and Performance Metrics - Spring 2017 Edition

Welcome to the Spring 2017 edition of the network performance metrics discussion. As Figure 1 illustrates, N-Wave traffic levels have increased and surpassed the peak levels as seen in late 2015, due to more WCOSS and RDHPCS traffic, as well as more X-Wave traffic via the TICAP 2.0 stacks.

The increase seen the past few months is due to East Coast programs transitioning traffic off the legacy TICAP 1.0 Internet access infrastructure to the new TICAP 2.0 stack. This moved several gigabits-per-second worth of traffic over to N-Wave, and added to the monthly transport counts. Similar efforts are underway in the Denver area to move all agency traffic to TICAP 2.0 and X-Wave.

The N-Wave team continues to study options for increasing the capacity over the wide-area backbone. Today, the backbone utilizes 10 Gbps and 20 Gbps (Denver, Chicago, Mclean) links between the various core nodes. Multiple 10 Gbps links, as well as 40 or 100 Gbps links are on the list of options. These upgrades, as well as new routing technologies will meet the growing demand of NOAA's networking needs for the next few years, and bring new services, such as Traffic Engineering and Software Defined Networking to N-Wave.

Figure 1 (In Petabytes)



The NOAA Networking Committee

The NOAA Network Committee (NNC) was established in 2003 as a standing committee reporting directly to the NOAA CIO Council. The mission of the NNC is the establishment of a common NOAA network infrastructure through planning, management, and deployment of network resources. The NNC serves as the principal technical forum for providing management and direction for the evolution of NOAA's Enterprise IT networks. The NNC provides technical guidance and policy recommendations to the CIO Council, supports NOAA-wide development projects, and serves as a review board and a vehicle for technical coordination.

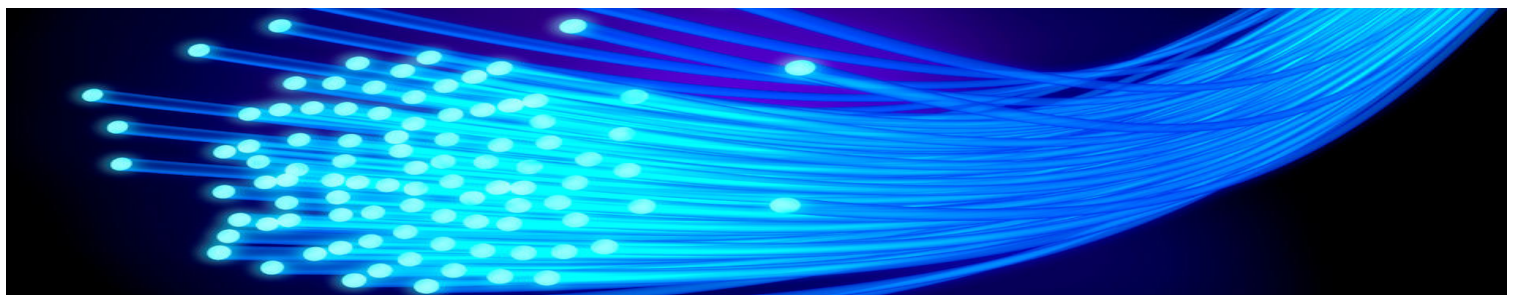
The NNC consists of representatives from every line office in NOAA, plus many of the staff offices. The representatives are subject matter experts in the fields of communications, networking, IT Operations, and security. They are tasked with collaborating on guidance and standards to enhance infrastructure value.

Areas that the NNC have been involved with include NOAA backbone network development, consolidation and standardization of Network Operations Centers (NOCs), MPLS networking, Research & Education (R&E) network utilization, Security, IPv6, and DNS. Over the years, several working groups have been established within the NNC to address specific technical challenges or situations.

One of the highlights of the NNC was the design and implementation of the NOAA N-Wave network. Initially, this complex project received support from the American Recovery and Reinvestment Act (ARRA) of 2009. Stimulus funds from ARRA allowed for the design and initial rollout of the new high-bandwidth backbone network utilizing R&E networks and carrier class equipment. This network was designed to provide high-bandwidth connections for activities such as communications for supercomputers and weather forecast modeling. It also allowed for the consolidation of diverse low-speed connections going into a single campus that supported different line offices. Network Management and Engineering Support for N-Wave are supplied by the GlobalNOC, located at Indiana University.

The NNC conducts conference calls twice each month, and meets as a group at least twice a year. The group meetings rotate among strategic NOAA sites, or partner locations. Usually, one of the meetings is held in Silver Spring, MD. NOAA's headquarters and many of the NNC Line Office representatives are located in the area. The other group meetings are rotated among operational NOAA sites that usually have a major network project taking place. Partner locations have also included the GlobalNOC, DOE, NASA NCAR, and various service providers, industry conference and major meeting locations.

In 2014, NOAA established the Enterprise Network Program Office (ENPO). The mission of the ENPO is to improve networking efficiency at NOAA. The NNC is now supporting the ENPO to identify and resolve networking challenges and risks. The ENPO is also responsible for coordinating Agency level activities, such as the transition from the expiring GSA Networkx contract to the new GSA Enhanced Infrastructure Solutions (EIS) contract vehicle for all telecommunications services. Many of the representatives on the NNC are also members of the EIS Transition Core team for NOAA.



An Overview of the Integrated Network Operations Center

The NOAA Integrated Network Operations Center (INOC) began supporting the historical “NOAA NOC” located in Silver Spring as the Tier 1 NOC on December 14, 2016. INOC staff provide 24/7/365 phone, email and web-form ticketing support for customers who receive networking services via the NOAA NOC in both Silver Spring and other locations across the nation. Incoming customer requests and issues reported by email and phone are now being routed to the INOC Service Desk for triage and assignment to the Silver Spring NOC Engineering team for completion.

Regularly scheduled, recurring operations status calls with the Silver Spring NOC engineering and operations have maintained open lines of communication and have increased the quality and accuracy of event processing as INOC continues to make improvements to its support procedures.

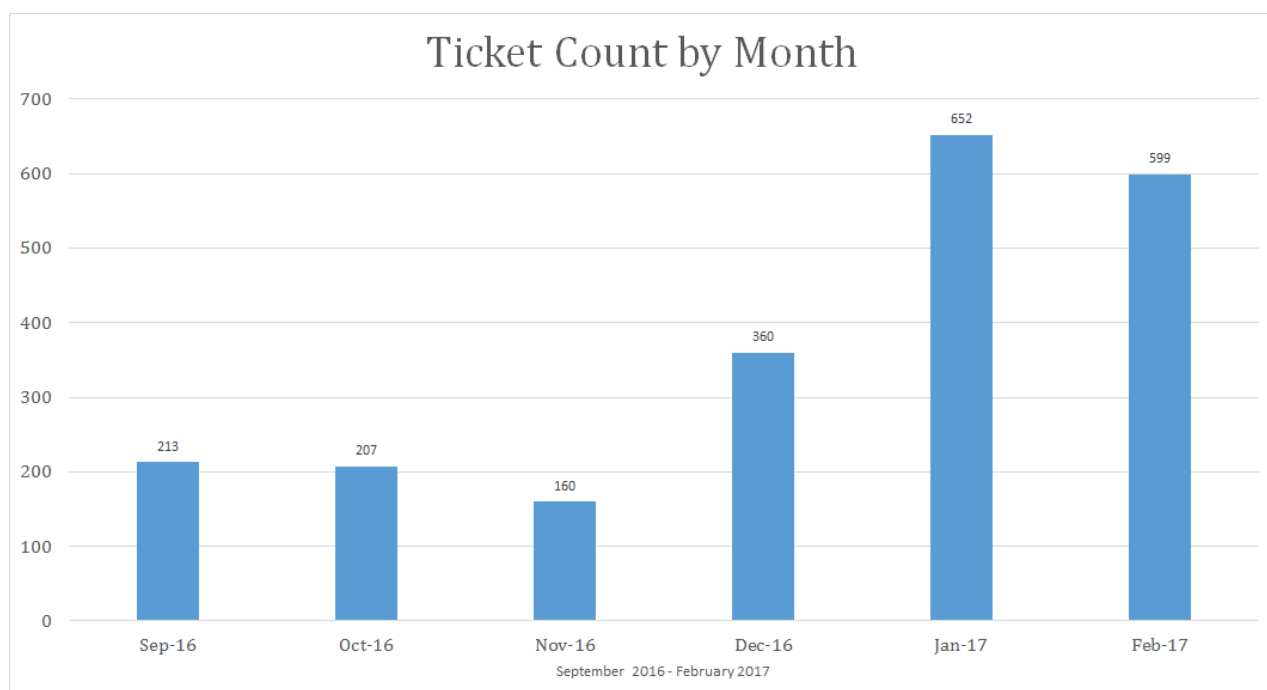
INOC began Tier 1 support of the Boulder NOC in Colorado last July. With the addition of Silver Spring, the N-Wave and NOAA Integrated Network Operations Center is now functioning as a centralized point of contact for users across the N-Wave and NOAA network, regardless of location. This allows INOC to interface with multiple engineering, vendor, and support groups to inform, update, and resolve incidents by directly communicating and coordinating triage and response efforts.

The graph below shows monthly totals handled by INOC. The jump in mid-December and again in January-February reflect the inclusion of tickets from Silver Spring.

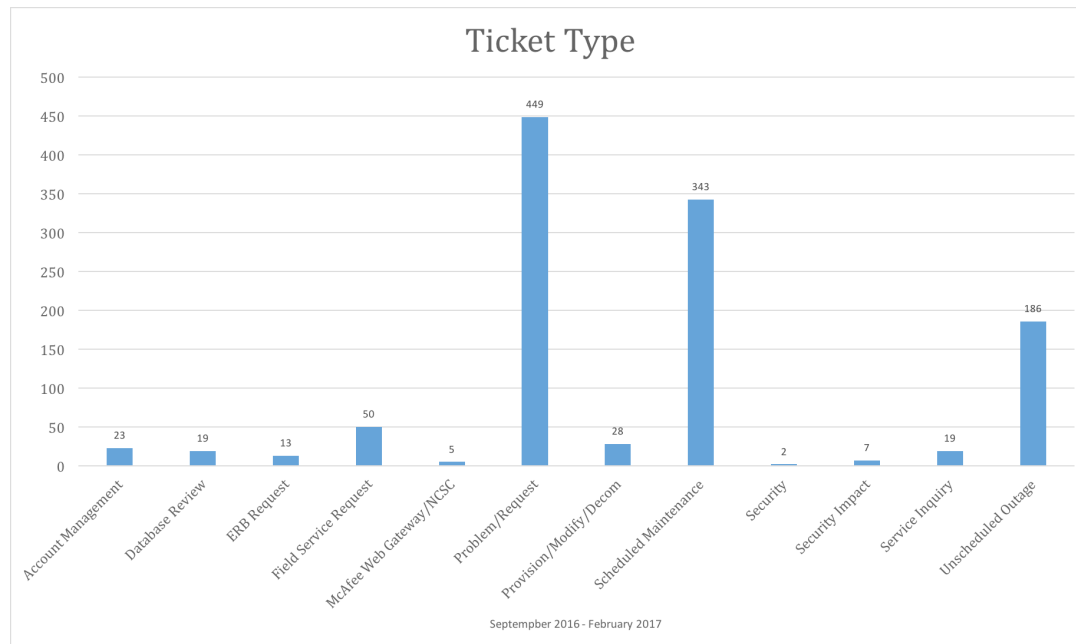
The N-Wave Network Operations Center, Integrated Network Operation Center is available 24 hours a day, 365 days a year at 812-856-7477 and nwave-noc@noaa.gov.

To report a problem use the INOC webform: <http://noc.nwave.noaa.gov/nwave/support/trouble-ticket-request-form.html>

Total trouble tickets for past 6 months including Silver Spring as it integrated into INOC



N-Wave Trouble Tickets

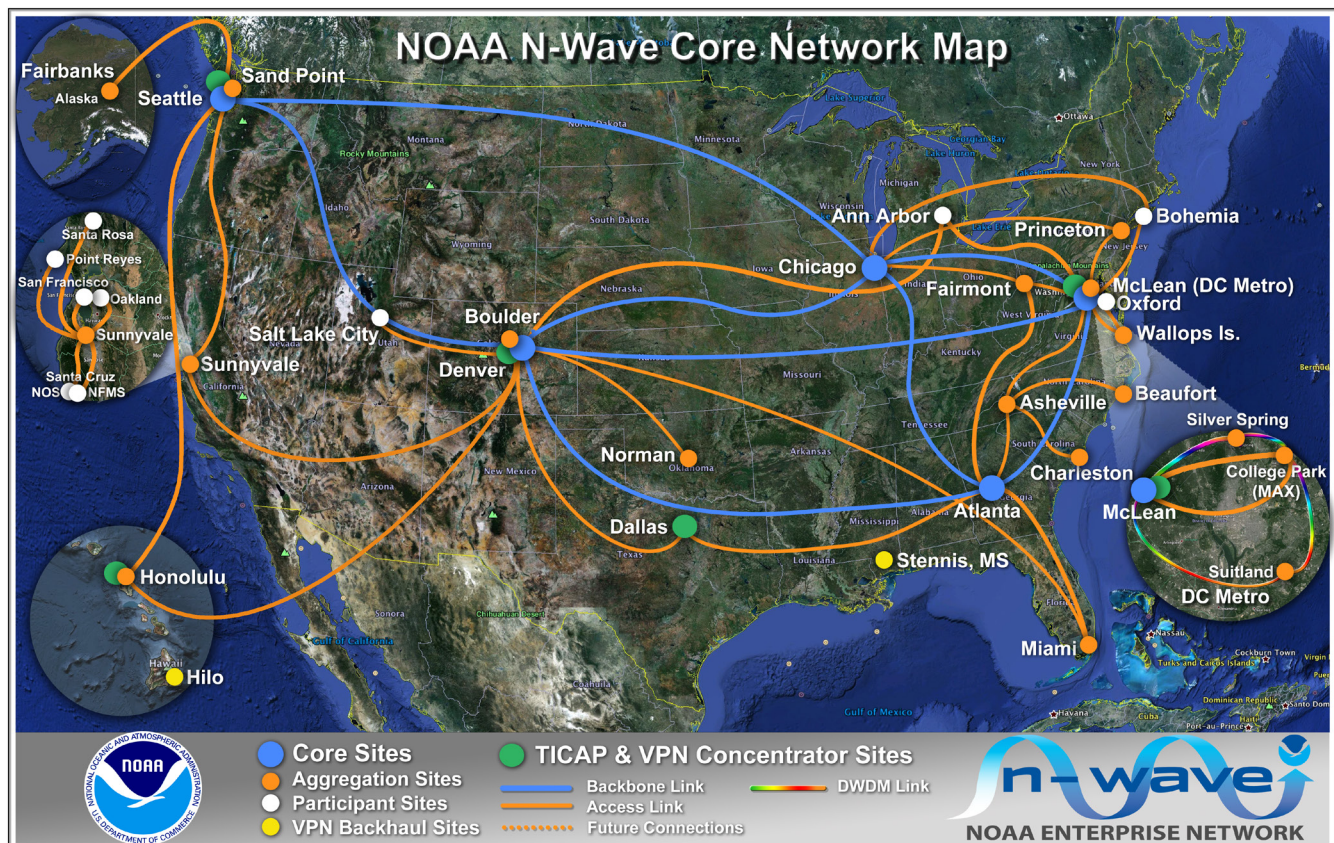


Network Changes and New Participants

- N-Wave has completed its core router refresh. All routers located in the N-Wave core POPs located in Atlanta, Chicago, Denver, McLean, and Seattle have been updated to Juniper MX series routers.
- In order to provide increase network resiliency for the National Weather Service (NWS) Eastern Region Headquarters in Bohemia, NY, a second, diverse 1G connection via the N-Wave Chicago core node had been brought online.
- NOAA Trusted Internet Connection updates:
 - All N-Wave customers utilizing the Seattle TICAP infrastructure have been fully migrated and brought inline with the new security infrastructure.
 - The Southern Region Headquarters of the National Weather Service has been migrated to the N-Wave Dallas TICAP and brought inline with the new security infrastructure..
 - Work continues to migrate N-Wave customer located in the eastern United States to the new TICAP infrastructure located in Mclean, VA and College Park, MD. Several sites; GFDL in Princeton, NJ, NCDC in Asheville, NC and the NOS offices located in North and South Carolina have migrated to the new infrastructure and will soon be moved inline behind the TICAP.
 - Work continues to migrate the NOAA Boulder campus to the new TICAP infrastructure located in Denver, CO.
- Working with the NOAA Cyber Security Center (NCSC), N-Wave implemented a firewall and the VPN infrastructure required to meet the Department of Homeland Security's EINSTEIN 3 Accelerated mandate.
- A new N-Wave presence was installed in Oxford, MD to facilitate connectivity for the National Centers for Coastal Ocean Science's Cooperative Laboratory.
- The National Marine Sanctuaries office, located in Point Reyes, CA was brought online. This site leverages the partnership between the California state-wide RON, CENIC, and NOAA via the Western Region Network consortium to help connect smaller NOAA offices throughout California.
- The NOAA Great Lakes Environmental Research Laboratory in Ann Arbor, MI was upgraded from a VPN tunnel to a full N-Wave aggregation node connected at 1Gb/s.
- N-Wave completed connectivity for the remaining NESDIS sites for the NESDIS Administrative Local Area Network (LAN). 1 Gbps connectivity was provided to STAR at the National Center for Environmental Prediction

(NCWCP) in College Park, MD and additional redundant connections to NCEI-Maryland at NOAA Silver Spring Metro Center Building 1 (SSMC1). The SSMC1 connectivity provides redundancy for critical services at SSMC3

- N-Wave completed initial connectivity for the new TCP/IP network for NWS Emergency Managers Weather Information Network (EMWIN). This new network is an upcoming replacement of the legacy GOES serial network in preparations for the new GOES-16 (formerly GOES-R) data.
- The N-Wave portion of the GOES-16 satellite Ground System network has been updated from the previous 1GE N-Wave to GOES-16 interfaces to 10GE at NSOF (NOAA Satellite Operations Facility in Suitland, MD), WCDAS (Wallops Command and Data Acquisition System at Wallops Island, VA) and CBU (Consolidated Backup Unit in Fairmont, WV)
- The upgrade of the Northern Path (Wallops to McLean) 10 Gbps is complete and currently running in parallel with the existing dual 1 Gbps. Northern 1GE path will be decommissioned April 1.
- Initial connectivity for the NESDIS Secure Active Directory project has been completed.
- MetOp NOAA-EUMETSAT Initial Joint Polar Satellite (iJPS) program migrated their High Resolution Picture Transmission operational data flow between WCDAS (Wallops) and NSOF (Suitland) onto N-Wave and off of their legacy point-to-point domestic communications satellite connection. Since this is an operational data flow, much engineering, security and change management planning went into effort. Test results confirm that making this migration benefits the OSPO iJPS program by providing high-speed throughput over the N-Wave 10Gbps infrastructure, with fast failover redundancy, and also significantly reducing network latency in comparison to the legacy satellite link. With the combined efforts of Harris and N-Wave network engineering and the NESDIS ACIO-S and OSPO iJPS program management teams, this migration was a smooth and jointly beneficial transition.
- WCDAS (Wallops Command and Data Acquisition System) at Wallops Island, VA, has migrated its Data Collection System (DCS) to N-Wave for its TIC services as well as Private VRF connectivity between WCDAS and NSOF from its legacy commercial point-to-point DS3 circuit as well as a T1 backup circuit. This effort was part of the NESDIS Circuits Decommissioning/Consolidation project that is removing outdated technology while reducing costs.



JEUNO (Joint EUMETSAT and NOAA) - Operational Infrastructure for Satellite Data Exchange

In the 6th issue (November 2015) of the N-Wave News we reported that in June 2015, N-Wave provisioned its first international connection across the NOAA TICAP in Silver Spring, MD and existing Internet2 and GÉANT Layer 3 infrastructure, between the NOAA Satellite Operations Facility (NSOF) in Suitland, MD and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) in Darmstadt, Germany. This connection was established as an official NOAA and EUMETSAT Proof of Concept project with joint collaboration between N-Wave, NESDIS Office of the Assistant Chief Information Officer - Satellites (ACIO-S), the Office of Satellite and Product Operations (OSPO) and the international partners at EUMETSAT.

This effort was the initial phase of the overall NESDIS and EUMETSAT Future Comms Roadmap for forthcoming architecture and consolidation for the transatlantic links that support operational meteorological satellite data communications. Current architecture utilizes very expensive point-to-point links to support the various satellite missions. Understanding the enhanced capabilities of next generation satellites such as the GOES-R through U Series, Joint Polar Satellite System (JPSS) and others, it became clear that the current network architecture would not be able to support the demand for the high-bandwidth data transmission requirements based on new instrumentation on these satellites. New generation satellites are expected to produce more than 20 terabytes of weather data per day. Therefore NOAA and EUMETSAT are working on a sustainable architecture and a roadmap for transatlantic communications that would help consolidate the existing point-to-point connections as well as provide an infrastructure that can support the data communications for the new generation satellites.

Since the initial Proof of Concept (PoC) implementation and testing, the PoC has been tested at various speeds and also moved to the operational routers backing up the EUMETSAT commercial point-to-point link for some of the interagency connectivity.

Based on the success of the ongoing PoC, NOAA and EUMETSAT have established dedicated and redundant connections across the transatlantic GÉANT and Internet2 infrastructure to establish two landing points at the edge of the NOAA networks - College Park, MD and Denver, CO. EUMETSAT has the responsibility for the two transatlantic circuits with their relationship with GÉANT. The Transatlantic circuits traverse two diverse cables and landing points via GÉANT - one in Paris, France and second in London, England. Current bandwidth for EUMETSAT JEUNO links is redundant 5Gbps via Germany's national provider DFN, however GÉANT, Internet2 and MAX GigaPOP connections are at 10Gbps and 100Gbps. EUMETSAT plans to upgrade their current 2x5Gbps DFN connectivity to 2x10GE in the near future. College Park, MD and Denver, CO serve as the two landing sites on the U.S. side where EUMETSAT VPN tunnels interface directly with the X-Wave border routers before entering the NOAA networks, traversing the NOAA Trusted Internet Connection Access Points (TICAPs) and the X-Wave infrastructure before being distributed to the various NESDIS satellite missions that are connected to N-Wave and/or other NOAA networks.

As part of the JEUNO architecture, EUMETSAT is using Cisco's iWAN (WAN Optimization and Acceleration technology) to provide fully bulk encrypted and WAN Accelerated connectivity across the GÉANT and Internet2 infrastructure as part of their communications service.

EUMETSAT is currently working through TRR (Test Readiness Review) and ORR (Operational Readiness Review) processes in order to declare the new JEUNO infrastructure operational. As soon as ORR is completed EUMETSAT will begin migrating their existing operational data flows onto this new network infrastructure.

EUMETSAT is planning to migrate all of their existing data flows within a year. NESDIS plans to start migrating their data flows and decommissioning the legacy point-to-point circuits within the next one to two years. As soon as GOES-16 and JPSS are considered operational and data is available, NESDIS will begin to utilize JEUNO to flow data to EUMETSAT through NESDIS' new Environmental Satellite Processing and Distribution System (ESPDS).

This new joint communication system will not only serve as the common network infrastructure for operational satellite data exchange between NOAA and EUMETSAT, but could also serve as an International Gateway for NOAA/ NESDIS to exchange data with other international partners.

Figure 1: JEUNO Joint EUMETSAT-NOAA Trans-Atlantic Links Diagram

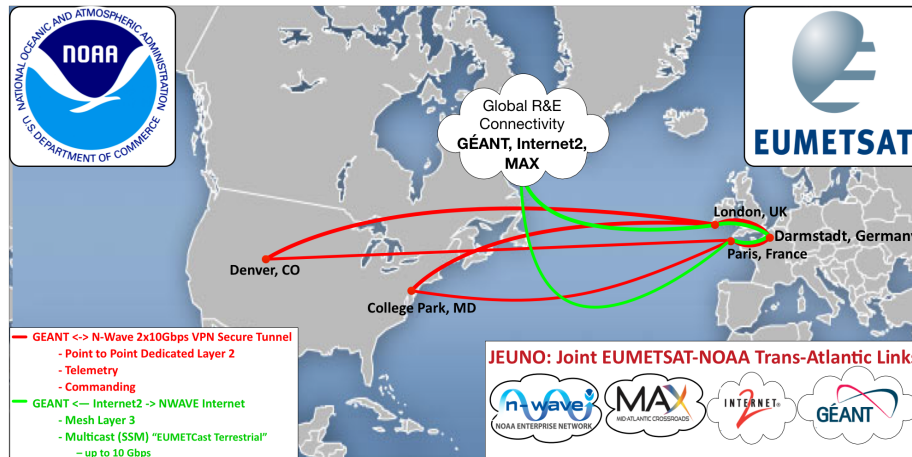
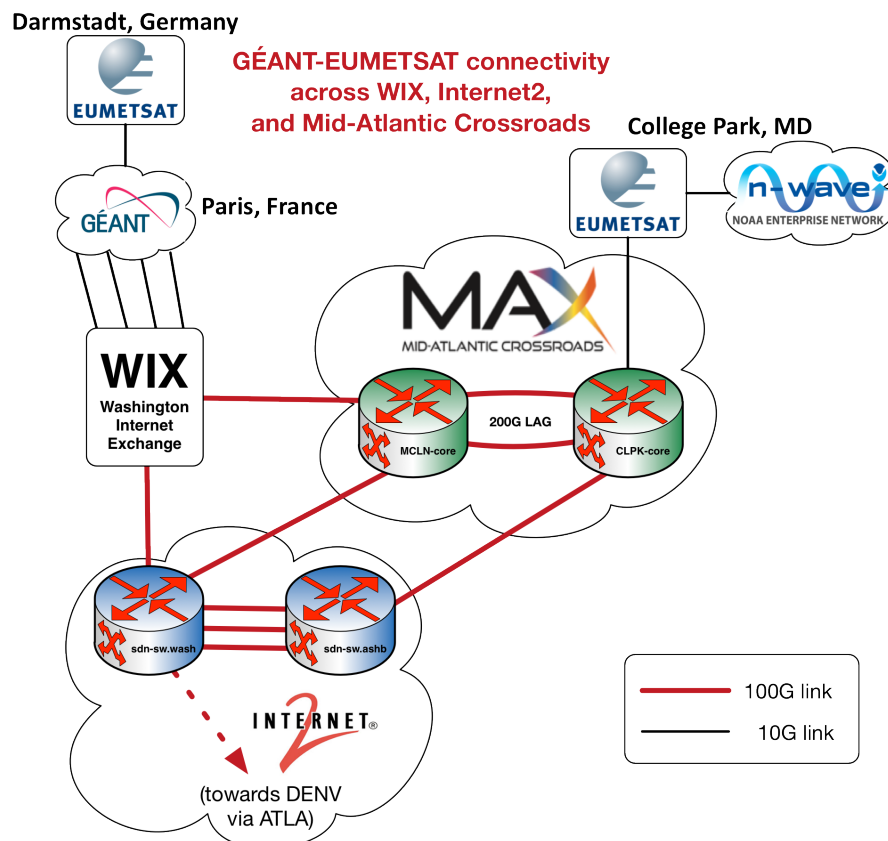


Figure 2: EUMETSAT Connectivity to College Park via GÉANT, Internet2 and MAX





April 23-26
Washington DC

During the last week of April, Internet2's Global Summit in Washington, D.C., will bring together various U.S. academic & research groups that require high-performance networking to support their missions. These groups, along with their collaborating international colleagues and the supporting industry entities, will have three days of meetings and informal side discussions. Many of NOAA's partner RONS in N-Wave, as well as Internet2 & Indiana University's GlobalNOC, will be attending.

NOAA attendees Rob Sears, Mark Mutz, Matt Smith, Paul Love, Dave Mauro and Jerry Janssen will participate in various sessions and side meetings.

NOAA speakers include:

Rob Sears, Mark Mutz, Matt Smith & Paul Love, *Side meeting of NCO/NITRD's Joint Engineering Team*

Rob Sears, Western Regional Network (WRN): *Enhancing Advanced Research and Education Across the West*

N-WaveNews

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NOAA ENTERPRISE NETWORK

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