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N-WaveNews

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NOAA N-Wave
N-Wave is NOAA's science network. Built on partnerships and relationships among NOAA and the Academic and State research network communities, N-Wave connects researchers to the data and resources needed to advance environmental science.

Mission
N-Wave is committed to provide innovative networking capabilities with integrity, excellence, value, and flexibility, to enable NOAA's science and research through reliable high-performance networking.

Our Vision
A consolidated, agency-wide network resource that meets NOAA's research connectivity requirements and where appropriate, supplements NOAA's operational connectivity requirements.

From the N-Wave Network Manager

Robert Sears

Along with engineering and support projects for both current and new connecting NOAA programs, your N-Wave team has been heavily vested this fiscal year in the design, engineering, and deployment of resilient Trusted Internet Connection Access Provider or Access Points (TICAP). N-Wave, in partnership with the NOAA Cyber Security Center (NCSC), is dedicated to ensuring that NOAA's TICAPs in Hawaii, Seattle, Denver, Dallas, and the DC Metro area have a resilient network infrastructure and foundation from which to support the robust enclave of TIC security services. I would like to highlight the efforts of both the Boulder Network Operations Center and N-Wave team members Alex Hsia and Will O'Brien, who provide critical support to the TICAP project. **Mr. Hsia** has directly supported this effort by designing the architecture of the TICAP network infrastructure and establishing the resilient network foundation to include the "X-Wave" concept.

Alex Hsia

Mr. O'Brien has used his range of skills in network and security engineering to support the testing and integration of TIC security components such as firewalls and management infrastructure, and has played a key role in the deployment of the Inouye Regional Center (IRC) TICAP. Mr. Hsia's and Mr. O'Brien's efforts, coupled with the work of the wider N-Wave team, N-Wave NOC and provider partners will ensure we meet our TICAP goals for NOAA. Please read more about the TICAP project on pages 2–5.

Will O'Brien

N-Wave Network Manager

N-Wave TICAP Status Update

A TICAP is defined as a Trusted Internet Connection Access Provider

Last year, N-Wave initiated a project to build out several new TICAP 2.0 locations to provide NOAA TICAP services. Initially, four sites were planned: Washington D.C., Seattle, Dallas, and Boulder. As the project progressed, a fifth TICAP was added to service facilities in Hawaii.

Trusted Internet Connections (TIC) are required by OMB mandate. A TICAP is defined as a Trusted Internet Connection Access Provider and from a deployment stance can also be defined as an "Access Point". These sites provide the security analytics required to ensure secure communication with untrusted networks. A TICAP must meet or exceed requirements as specified by the Department of Homeland Security (DHS) in order to become a certified TICAP installation.

In conjunction with the NOAA Cyber Security Center, N-Wave has defined specific goals to ensure the optimal deployment of each NOAA TICAP, which are:

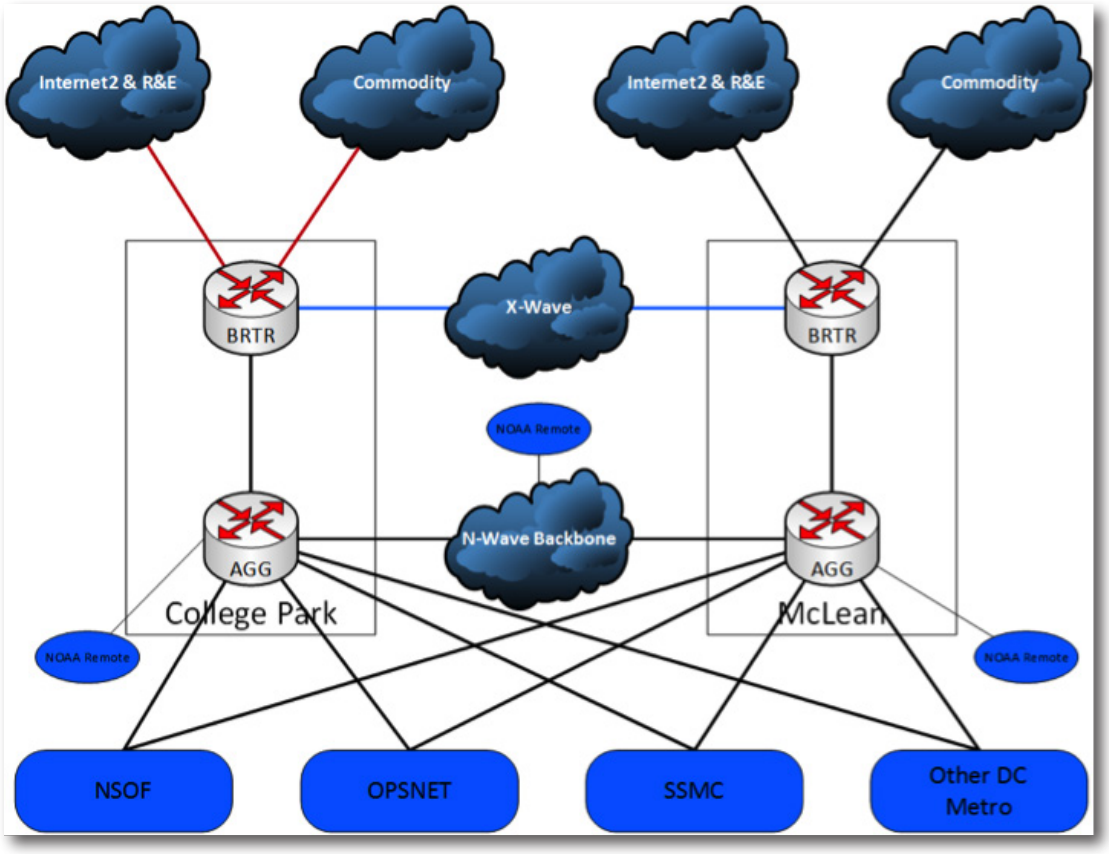
- Engineer and deploy resilient network infrastructures at TICAP locations to host TIC stack security components and avoid single points of failure within TICAP individual locations and across all NOAA TICAPs
- Test and install TIC stack security component to ensure network connectivity and interoperability
- Meet TIC requirements, including traffic symmetry, and to maintain the ability to scale, grow, and change
- Ensure efficient utilization of network circuits and resources
- Provide cost-effective solutions for both smaller and larger NOAA offices

The N-Wave team reviews each installation location in detail to ensure that it meets various requirements for networking, power, equipment cooling, and even physical security controls.

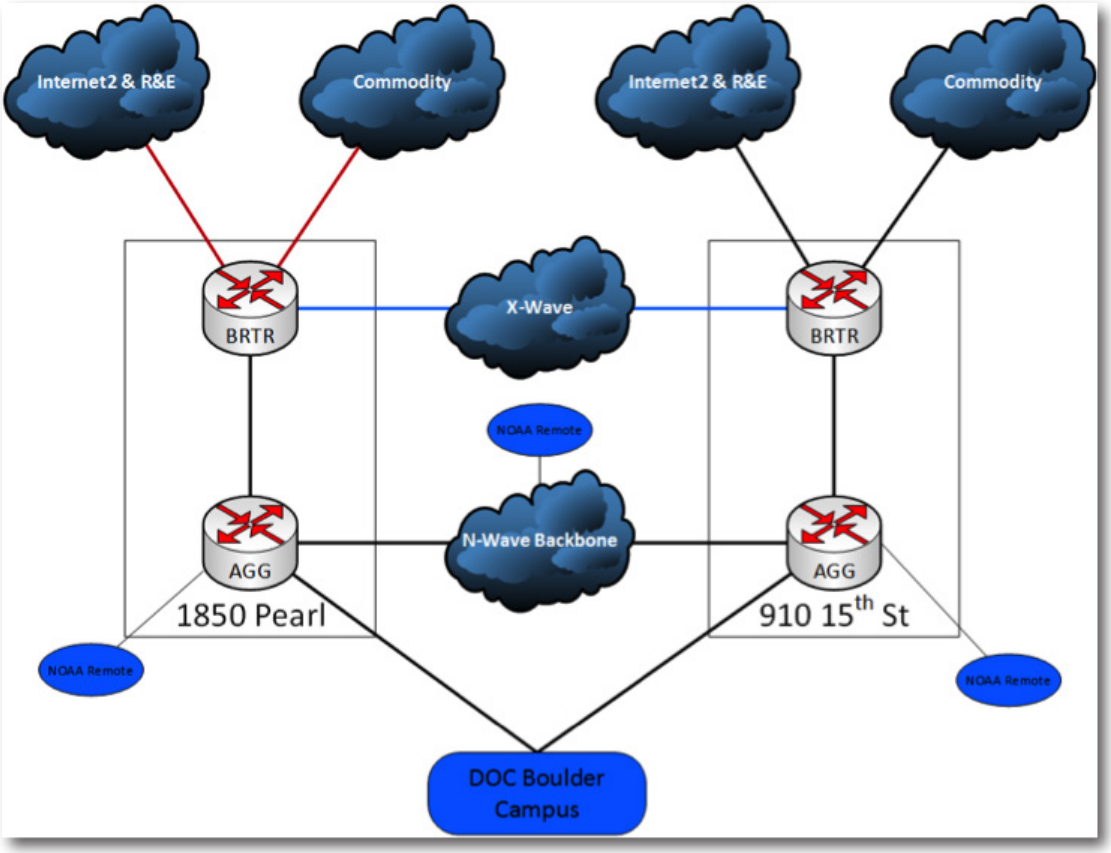
To complete a TICAP deployment, there are two phases: the network infrastructure phase and the TIC security component installation phase. The base network architecture at each TICAP location requires a significant amount of site engineering.

The Denver and DC Metro area are the larger NOAA TICAPs and will complement each other in resiliency, capacity and redundancy (Denver and DC Metro TICAPs will back each other up for failover) with the following attributes:

- TICAP Network equipment components will be housed at key telecom colocation facilities where fiber optic, commodity, and R&E transport providers exist
- Network designed for geographic diversity — TICAP Network equipment installed across two separate physical colocation facilities providing:
    - -Hardware redundancy (external routers, internal routers)
    - -Internet/R&E peering redundancy
- Diverse, redundant fiber connectivity (dual-homed) from NOAA sites to resilient TICAPs

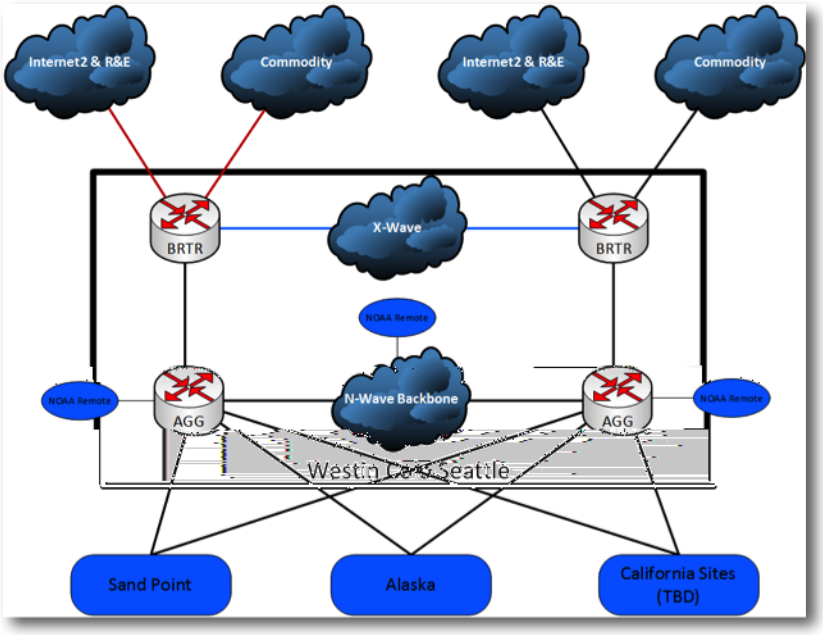


DC Metro Resilient TICAP Network Architecture

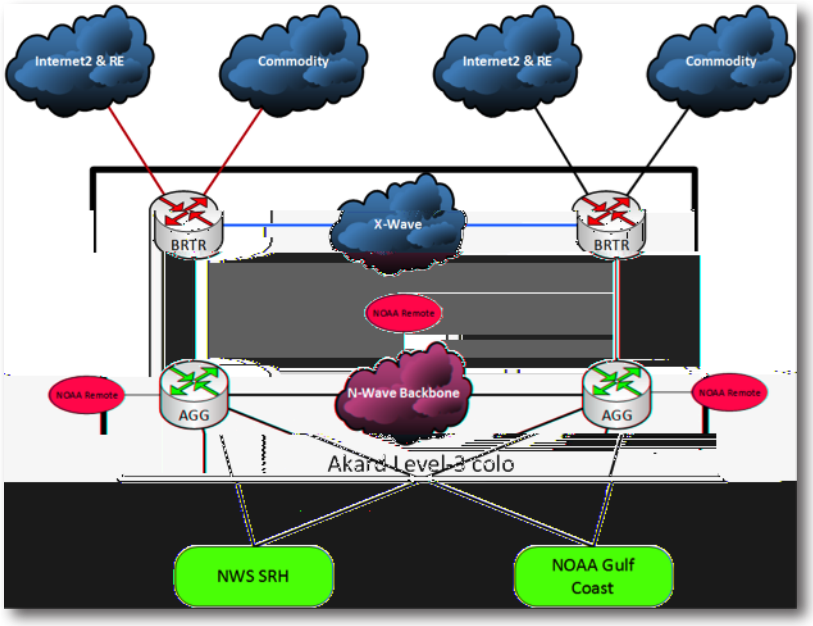


Denver Resilient TICAP Network Architecture

The Seattle and Dallas smaller NOAA TICAPs will be engineered exactly the same way as Denver and the DC metro TICAPs. However, initially they will not be geographically diverse, but will have hardware and connectivity resiliency at the single colocation site with failover capability to larger NOAA TICAPs.



Seattle Resilient TICAP Network Architecture



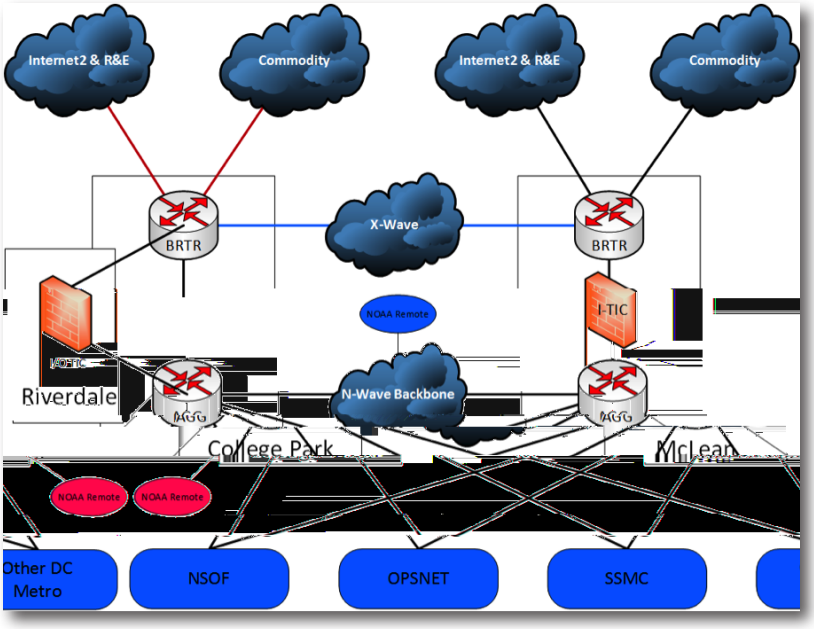
Dallas TICAP Network Architecture

Upon completed deployment and testing of the network infrastructure at each TICAP location, the TICAP security component enclave can be deployed.

Each TICAP Security Stack has Inline (I-TIC) and Out of Line (O-TIC) components. I-TICs include firewalls and web proxy gateways. O-TICs include RSA Netwitness Packet Flow capture, ArcSight Logger Fireeye (Application layer IPS), and Einstein–DHS.

- DC Metro and Denver have I-TIC Stack installed across two separate physical co-location facilities providing:
  -Hardware redundancy (External Router, Firewall, Internal router)
  -Internet/R&E peering redundancy
- DC Metro and Denver have O-TIC installed in a single location

- Seattle I-TIC Stack components will be housed at the Westin telecom co-location facility with O-TIC components at the Sand Point facility
- Dallas I-TIC and O-TIC components will be located at the Akard telecom co-location facility.

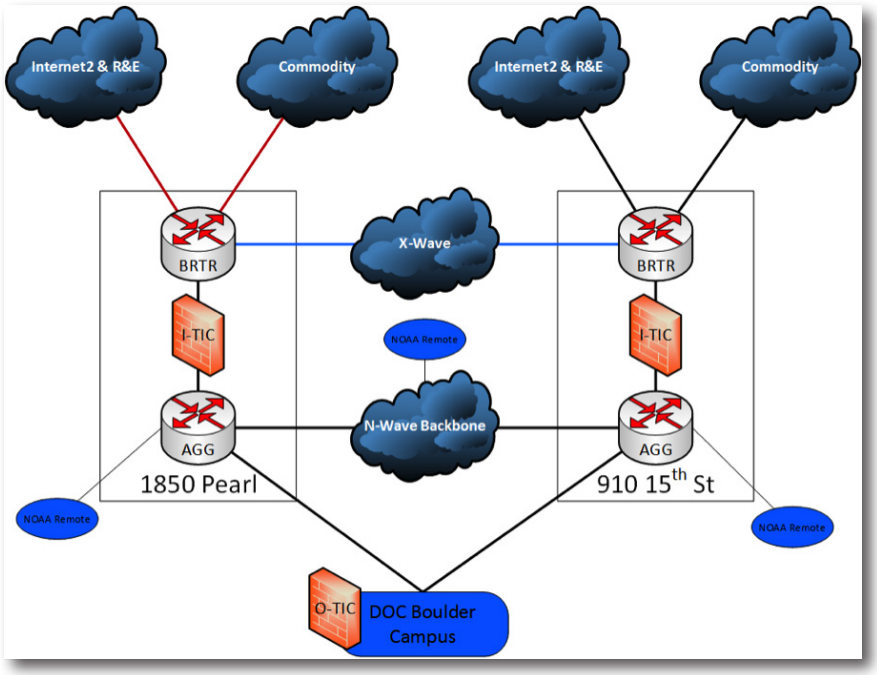


DC Metro Seattle Resilient TICAP

The requirement for government systems traffic to cross through a TICAP to reach the Internet (both the commodity Internet & Internet2) has significant logistical implications for NOAA. For instance, placing a TICAP on Ford Island, HI helps support the NOAA mission by keeping locally destined network traffic within the islands, rather than sending traffic to and from the mainland to access local resources.

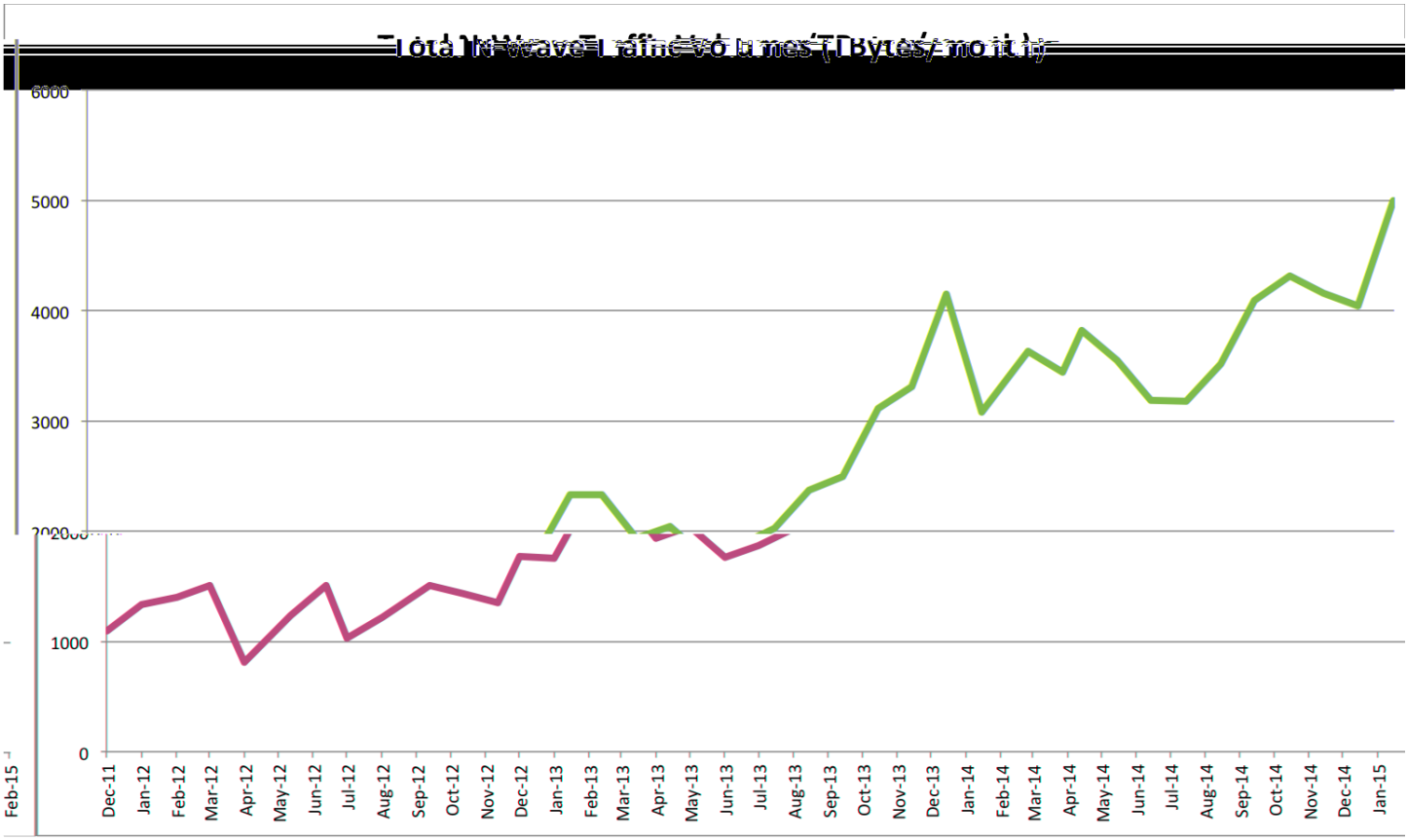
Late in 2014, the Hawaii TICAP was installed at the Daniel K. Inouye Regional Center on Ford Island in Oahu. The new installation is currently pending acceptance by both the NCSC and DHS to become a production multi-agency TICAP.

The next TICAP 2.0 site to be installed will be Dallas, TX. N-Wave engineers installed network equipment to support the new Dallas TICAP during March 2015. Once the network installation is complete, the installation of the TICAP-specific equipment will follow. After Dallas, N-Wave engineers will work to install TICAP 2.0 sites to serve the Washington D.C. area, Seattle, and Denver.



Denver Resilient TICAP

Total N-Wave Traffic Volumes (TBytes/month)



N-Wave Network and Performance Metrics

First quarter of FY15 sees highest traffic levels ever

In February 2015, N-Wave saw its highest traffic levels ever, approaching 5 PB of data moved for the month, mainly due to increases in traffic from the Research and Development High-Performance Computing System (RDHPCS) and the National Centers for Environmental Prediction (NCEP)– Weather and Climate Operational Supercomputing Systems (WCOSS). WCOSS uses the archive system run by RDHPCS in Fairmont, WV, and RDHPCS continues to flow large volumes of data between Fairmont, Boulder, and NOAA's Geophysical Fluid Dynamics Laboratory in Princeton, NJ. N-Wave has plans to increase the total network capacity into Fairmont to 50 Gbps in Fiscal Year 15.

National Environmental Satellite Data and Information Service (NESDIS) programs continue to connect to N-Wave and, in 2014, new and additional connections were made to the next-generation satellite systems, JPSS and GOES-R, as well as the NESDIS Office of Satellite and Product Operations and the Environmental Satellite Processing Center programs. These programs are still in development and have yet to yield high volumes of data flow. The Comprehensive Large-Array Data Stewardship System (CLASS) continues to be the highest- volume NESDIS program, moving around 220 TB of data in February, 2015. NOAA's National Climatic Data Center moved over 220 TB of data onto N-Wave with the Trusted Internet Connection service. In addition, N-Wave installed service into Fairbanks, AK, at the Fairbanks Command and Data Acquisition Station, and this service continues to add programs such as the European Space Agency meteorological satellite system and the Deep Space Climate Observatory.

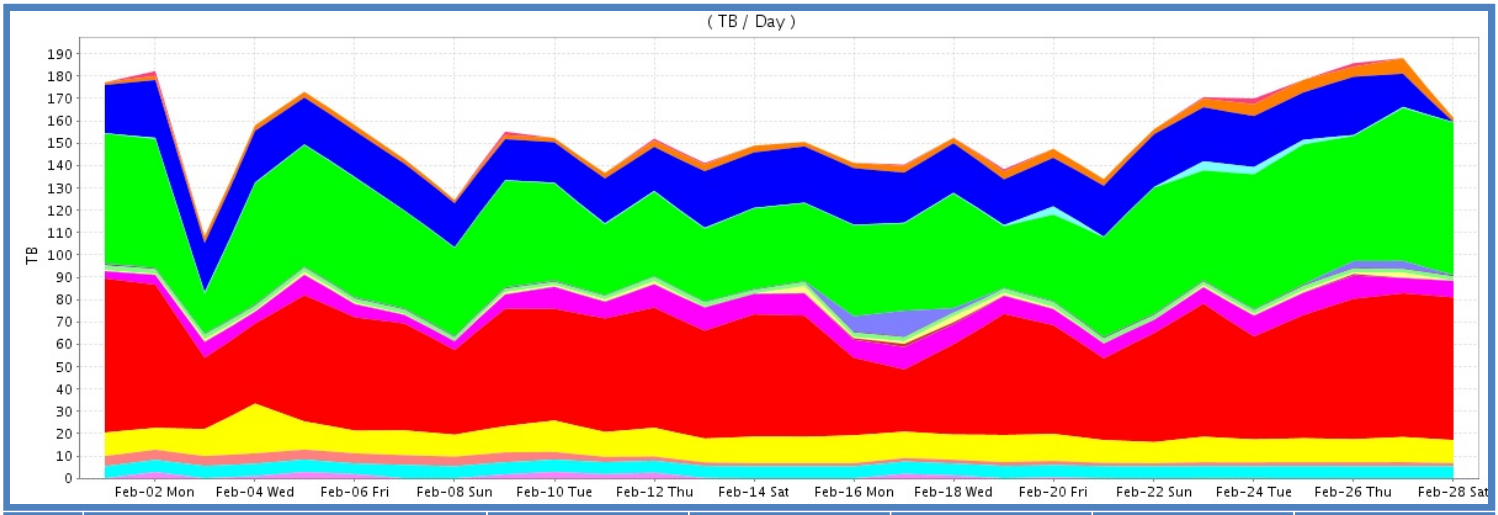
These traffic volumes are expected to increase in 2015, as more sites and line offices transition to N-Wave. With the agency's adoption of TIC, and as new supercomputing and next-generation satellite programs come online in the next few years, traffic will grow even more. N-Wave is making plans to increase backbone capacity to 100 Gbps, and recently began deployment of 100 Gbps in the DC area.

IdeaData
TOTAL NETWORK VISIBILITY

CostCentre Source Traffic Monthly

Period From: Sun 2015-02-01 00:00:00 MDT
To: Sat 2015-02-28 23:59:59 MDT

Source Account		<>	NWAVE	



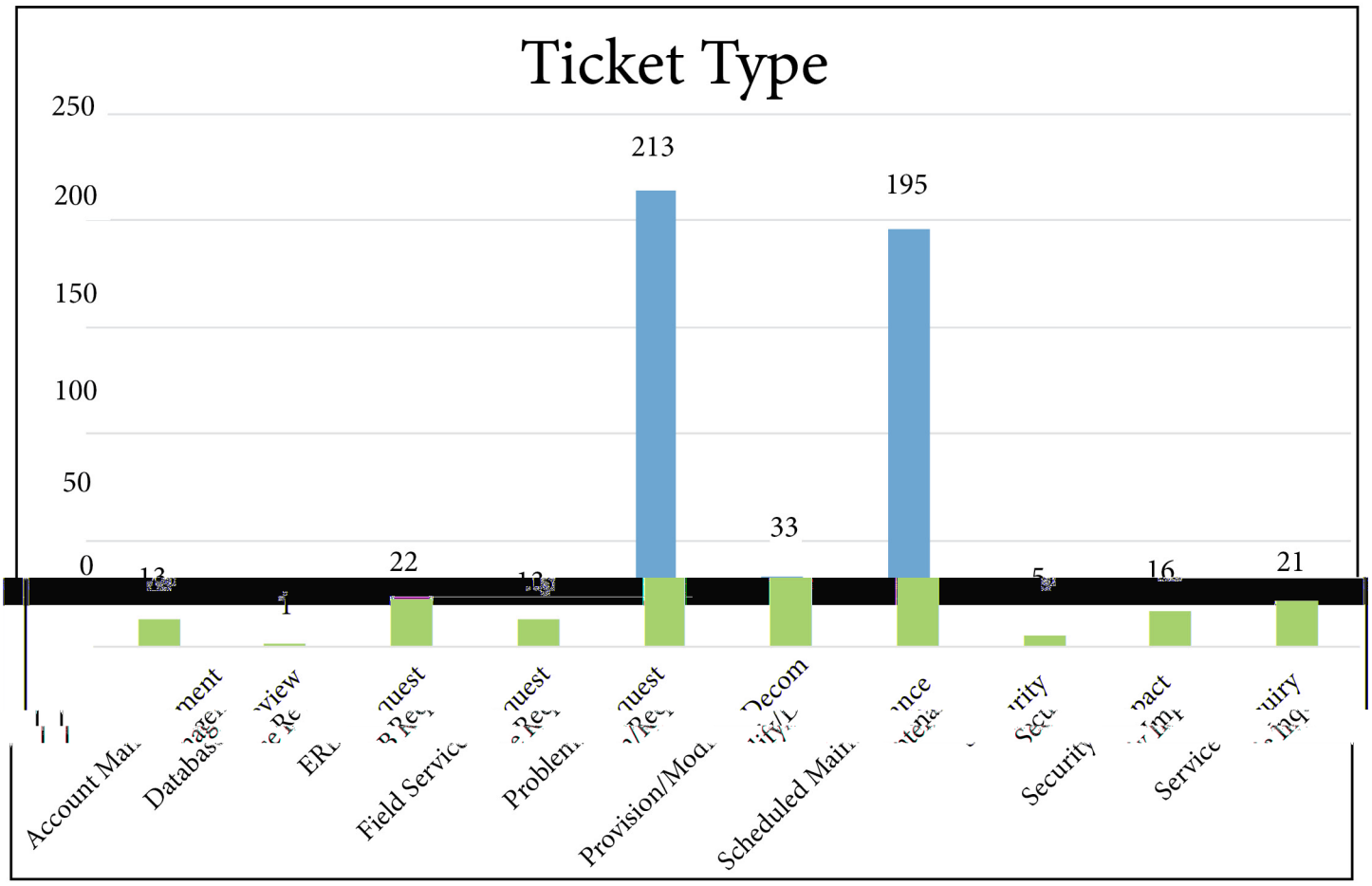
No.	Source CostCentre	TB sum	TB avg	TB max	G.Pkts sum	M.Flows sum
1	NCEP-WCOSS-RESTON	1,400.295	50.011	68.898	185.246	1.499
2	RDHPCS-FAIR	1,306.412	46.658	68.382	289.780	3.502
3	RDHPCS-ORNL	593.240	21.187	26.062	68.799	0.246
4	NCEP-WCOSS-ORLANDO	326.808	11.672	22.204	43.858	0.619
5	NESDIS-NCDC	211.099	7.539	10.409	166.976	19.700
6	CLASS-NSOF	149.421	5.336	5.879	100.050	1.132
7	Undefined	83.273	2.974	6.987	113.178	38.078
8	Layer2 Transport	73.466	2.624	4.679	72.860	0.261
9	NSSL	51.856	1.852	2.305	55.431	4.449
10	RDHPCS-BOUL	31.309	1.118	11.562	8.399	0.374
11	NOAA-GFDL	24.710	0.882	3.141	22.065	2.664
12	CLASS-ASH	21.954	0.784	2.873	29.312	0.570
13	RDHPCS-GFDL	21.769	0.777	4.179	32.386	1.049
14	WISC-EDU	12.115	0.433	2.538	9.495	0.223
15	NWS-ROC	7.819	0.279	0.448	8.251	2.109
16	NOAA-Boulder	4.635	0.166	1.406	10.213	1.426
17	CLASS-BLDR	2.575	0.092	0.137	19.784	0.860
18	NOAA-AOML	2.158	0.077	0.134	2.859	1.475
19	NOS-HILO	0.078	0.003	0.011	0.159	0.094
20	RDHPCS-CLPK	0.026	0.001	0.005	0.034	0.010
	Total (26)	4,325.018	154.465	188.062	1,239.135	80.340

Note: TB = 1000^4 Bytes, G.Pkts = 1000^3 Packets, M.Flows = 1000^2 Flows

If you would like to subscribe to the outbound traffic information, please go to: noc.nwave.noaa.gov to submit a service inquiry and fill in a request.

N-Wave NOC Tickets Report October through March 2015

This report contains data from 619 Tickets



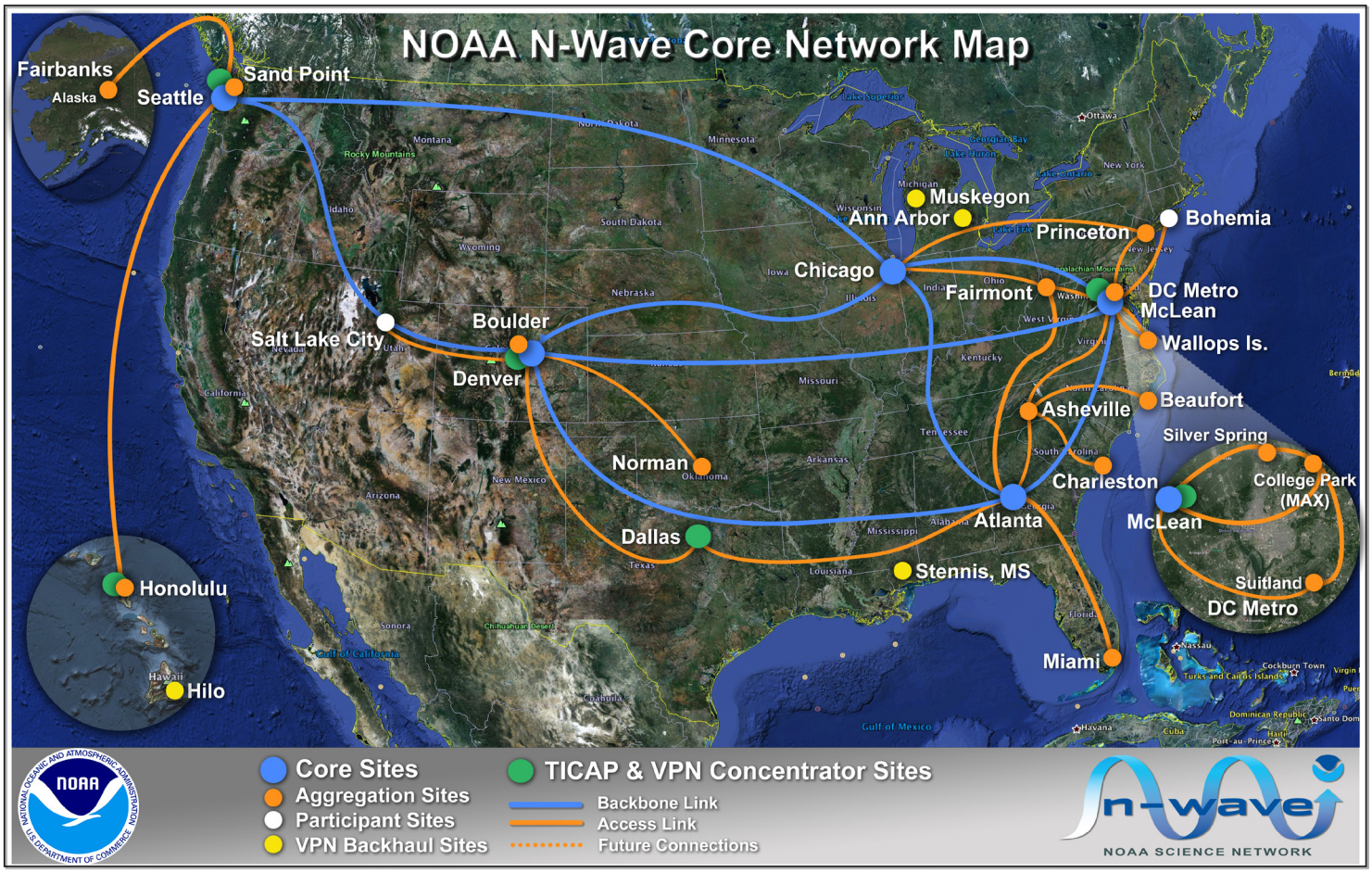
This N-Wave tickets report tracks various ticket types* that are used to support the N-Wave Network.

This N-Wave tickets report tracks various ticket types that are used to support the N-Wave Network. In this issue, we will feature and discuss one of these ticket types and its associated workflows: the Critical Weather Day (CWD) Ticket.

Critical Weather Day (CWD) Tickets, a scheduled maintenance subtype, are created to track and notify weather-related maintenance freezes. The N-Wave Network Operations Center (NOC) is subscribed to the NOAA CWD mailing list. NOAA usually announces CWDs for particular NWS region(s) within the United States for various severe weather events such as hurricanes and snowstorms. It is the N-Wave NOC's responsibility to track these events, determine impact to N-Wave services (especially services N-Wave provides for the National Weather Service (NWS) and the National Centers for Environmental Prediction (NCEP)), and announce a targeted maintenance freeze for affected N-Wave services and infrastructure.

According to N-Wave's policy, N-Wave will honor CWDs by freezing maintenance in a targeted fashion to minimize impact on critical NOAA services. N-Wave NOC will create a maintenance freeze ticket after verifying impact with N-Wave Management and then notify the community and contact vendors, requesting that any non-critical maintenance be cancelled or postponed to mitigate impact.

*Ticket type is a categorization of events that may not necessarily affect customers. The robust engineering, design, operations and management of N-Wave has yielded 100% customer availability on the back bone and dual backbone connected customer sites since January 2011.



NESDIS and N-Wave Continue to Deploy 100-Gbps DWDM Ring Network in DC Area

The ring network will connect three sites in Maryland and one in Virginia

N-Wave is continuing its efforts to deploy a 100-gigabits per second (Gbps) ring optical network in the DC Metro area as part of the GOES-R Phase 2 Network Refresh effort. At the beginning of 2015, with the support of partners Ciena and Ronco, Inc., the DWDM (Dense Wave Division Multiplexing) optical nodes were installed and powered up at the four N-Wave PoPs (Points of Presence) in the DC Metro area: Silver Spring, MD (SSMC); College Park, MD (the University of Maryland Mid-Atlantic Crossroads (MAX) co-location facility); Suitland, MD (NSOF-NOAA Satellite Operations Facility); and McLean, VA (Internet2–Level 3 co-location facility).

During the last week of February, the N-Wave team worked with Ciena partners to complete testing and cutover of two of the four 100 Gbps paths: Silver Spring–College Park and College Park–Suitland. After successful bit-error rate testing, production N-Wave traffic was transitioned to the new 100-Gbps optical paths with no impact on services.

The N-Wave NOC (supported by the GlobalNOC at Indiana University) is providing operational support for this new network. GlobalNOC has experience in and tools for operating optical networks for various regional and national networks such as Internet2 and I-Light (the Indiana State optical network).

N-Wave is continuing to work on the final phases of this project, with the Silver Spring to McLean path scheduled to be completed in March, and the Suitland to McLean path for completion later this summer. Once the ring is completed, the theoretical maximum capacity is expected to be in the terabit-per-second (Tbps) range. Additional 10, 40, or 100 Gbps optical channels can be added to the system as needed. The ring will provide additional capacity and redundancy, not only to NESDIS programs, but also to the Trusted Internet Connections (TIC) project.

Any program or project interested in gaining access or capacity to the ring network (or N-Wave) should contact N-Wave administration by submitting a Service Inquiry on the N-Wave NOC website: **http://noc.nwave.noaa.gov/nwave/support/service-inquiry-form.html.**

N-Wave Updates

Network Changes and New Participants

- The National Weather Service (NWS) Eastern Region Headquarters in Bohemia, NY is now using N-Wave via a 1-Gigabits per sec (Gbps) circuit to the DC Metro area for TICAP Internet access.
- N-Wave deployed the network and security infrastructure at the IRC to support the TICAP in Hawaii operated by NOAA.
- Virtual Private LAN Service (VPLS) was enabled on N-Wave, allowing support for Ethernet-based, multi-point Layer 2 services for N-Wave customers.
- DC metro N-Wave sites are now using a newly installed and N-Wave managed 100-Gigabit DWDM network.
- A new, redundant 10-Gb/s link was brought online from the NOAA Satellite Operations facility in Suitland, MD to the N-Wave core location in McLean, VA.
- A third 10-Gb/s backbone circuit was activated from the NOAA Environmental Security Computing Center facility in Fairmont, WV to the N-Wave core location in Atlanta, GA, to provide additional redundancy for the Joint Polar Satellite System (JPSS) program.
- A JPSS CGS (Common Ground System) to DoD (Navy) network integration was completed. This was a network integration project for the JPSS Common Ground System at CBU (Fairmont, WV) to send data to the Department of Defense (Navy) via N-Wave peering with NCEP at College Park. (See related article.)
- A MetOp (iJPS) connection from FCDAS (Fairbanks, AK) to NSOF (Suitland, MD) was established. This connection facilitates the transfer of MetOp Satellite data from the Fairbanks FCDAS Ground station to Darmstadt, Germany for our European Meteorological Satellites partners (EUMETSAT–European Organization for the Exploitation of Meteorological Satellites).This is the 2nd connection over the 100-mbps circuit established by N-Wave to Fairbanks.
- A new 1GE circuit was installed from Melbourne, FL to McLean, VA to support GOES-R/Harris development access to the NOAA Satellite Operations facility in Suitland, MD.

NWS Eastern Regional Headquarters (ERH) Update

One of the first NWS sites to use N-Wave for connectivity

The National Weather Service (NWS) Eastern Region (ERH) Headquarters in Bohemia, NY, has recently connected to N-Wave with a 1 Gigabit per second Ethernet service, providing access to the N-Wave national backbone and transport to the Silver Spring Trusted Internet Connection Access Point (TICAP) for Internet connectivity. This connection greatly increases capacity over the previous T-3 45 Megabit per second service.

The NWS ERH started using N-Wave to meet their Trusted Internet Connection requirements and now has the increased capacity to support data synchronization to the ERH backup data center at the NWS Central Regional Headquarters in Kansas City, KS. The NWS ERH provides administration and technology support for 23 Warning and Forecast Offices, three River Forecast Offices, and four Center Weather Services Units.

The NWS ERH is a transport hub for non-satellite data that disseminates weather model and radar data to their Forecast Offices, as well as to partners such as the United States Army Corps of Engineers.

The NWS ERH started using N-Wave to meet their Trusted Internet Connection requirements and now has the ability to do data synchronization to their backup data center.

The NWS regional office is working with the National Centers for Environmental Prediction to model the East Coast probabilistic winter snowfall. The goal is to increase snowfall prediction accuracy and lead time for issuing winter weather warnings.

Partnering with Regional Optical Networks (RONs)

RONs work with regional partners in education, research, government, and industry

Building on a long history of collaboration and communication, Regional Optical Networks (RONs) were formed by universities, research institutions, government, and private industry to advance their missions by providing cost-effective networking services and access to high-performance computing resources, big data storage, and streaming media.

RONs work with regional partners in education, research, government, and industry to build and operate the high-performance network services needed to advance missions across a region. By collaborating with neighboring RONs, regional and national consortiums such as Internet2, and other national Research and Education (R&E) networks such as ESnet (the Department of Energy's research and engineering network) and DREN (the Defense Research and Engineering Network), RONs expand their partners' reach to access additional resources across the country and the world.

RONs provide their members with a variety of services, including high-speed optical data transfer between members, peering with intra-regional, national and international networks, and Internet access and collocation. RONs run these network operations services to ensure continued operations and provide the expertise to develop cost-effective services while pursuing the technological advances needed to meet the demand for network resources.

In much the same way that NOAA partners with joint and cooperative institutes, NOAA also partners with RONs across the country to help advance its mission to monitor and predict the environment and share resources with the research community. This article profiles some of the RON partnerships that support NOAA.

Three Rivers Optical Exchange **(3ROX)** is a regional, high-speed network hub providing research network access and services to partners in Western and Central Pennsylvania and West Virginia. 3ROX is based at Carnegie Mellon University and is operated and managed by the Pittsburgh Supercomputing Center (PSC). While the primary focus of 3ROX is to provide cost-effective, high-capacity, state-of-the-art network connectivity to the university community, this infrastructure also provides well-defined network services to K–12, government and commercial entities. 3ROX has been providing network services for more than 25 years, pooling the requirements of many groups to offer services that are less expensive and more stable than could be if offered individually. 3ROX is a member of Internet2 and a partner in the National Science Foundation (NSF) Extreme Science and Engineering Discovery Environment (XSEDE) project.

3ROX has been a key partner in establishing connectivity for the NOAA Environmental Security Computing Center (NESCC) in Fairmont, WV. This site supports NOAA's environmental modeling and IT security programs. Working with the West Virginia Network (WVNet), the Ohio Academic Resources Network (OARnet), and industry partners, N-Wave and 3ROX have been able to provide high-bandwidth connectivity to this important site and reliable network access for NOAA's programs.

MCNC is a technology non-profit that builds, owns, and operates a leading-edge broadband infrastructure, NCREN

(North Carolina Research and Education Network), for North Carolina's research, education, non-profit, healthcare, and other community institutions. NCREN was one of the nation's first statewide education and research networks. It provides broadband communications technology services and support to K–12 school districts, higher education campuses and academic research institutions across North Carolina. MCNC offers NCREN technology tools and services to guarantee equal access to 21st century learning by providing a future-proof technology network that is the foundation for change and innovation in the state's educational systems.

MCNC was the recipient of two grants under the NTIA Broadband Technology Opportunities Program (BTOP) that enabled acquisition and construction of over 2600 miles of fiber across North Carolina. This support capacity of up to 100 Gbps serves 81 of 100 counties in the state, directly supporting community anchor institutions and aiding economic development and deployment of advanced broadband services to areas of the state that could not otherwise be served.

MCNC partners with N-Wave to provide high-speed, reliable, network connectivity to the National Climatic Data Center (NCDC) in Asheville, NC and National Ocean Service (NOS) facilities in Beaufort, NC and Charleston, SC. NCDC maintains the world's largest climate data archive and provides climatological services and data to every sector of the United States economy and to users worldwide. Records in the archive range from paleoclimatology data to centuries-old journals to data less than an hour old. The Center's mission is to preserve these data and make them available to the public, business, industry, government, and researchers.

An NCCOS diver conducts a fish transect census off the coast of La Parguera, Puerto Rico. Photo: NOAA

NOS National Centers for Coastal Ocean Science **(NCCOS)** in Beaufort, NC and Charleston, SC conduct coastal marine research used to protect coastal communities from harmful algae, water contamination, and climate impacts. NCCOS science provides coastal managers the information and tools they need to balance society's environmental, social, and economic goals. MCNC connectivity helps link the public, business, government and researchers to the data and services they need.

Co-located with the NCDC is the Cooperative Institute for Climate and Satellites **(CICS)**. Leadership of CICS comes from the University of Maryland College Park and North Carolina State University and is administered as part of the NOAA/NESDIS/STAR Cooperative Research Program institutes.

The University of Hawaii **(UH), f**ounded in 1907, is a leading force in the development of networking and providing connectivity to organizations throughout the state of Hawaii and across the Pacific Rim. UH continues to forge new partnerships, offer leading-edge networks and advance research and education connectivity. The UH network spans the islands, connecting the western-most point of Kokee on the island of Kauai to the eastern-most point of Hilo, including the ten campuses of the UH system. Their collaborations connect partners from Hawaii to the continental United States (CONUS) and around the Pacific Rim. UH has had a long collaboration with NOAA in Hawaii and provides support for the recently completed Inouye Regional Center (IRC), located on historic Ford Island Naval Station Pearl Harbor in Honolulu, HI. The IRC is home to a number of NOAA line offices including National Marine Fisheries Service (NMFS); NOAA's National Environmental Satellite Data and Information Service (NESDIS); and NOS. Programs supported at the IRC include the Papahanaumokuakea Marine National Monument, Hawaiian Islands Humpback Whale National Marine Sanctuary and the Pacific Islands Fisheries Science Center (PIFSC).

UNIVERSITY of HAWAI'I SYSTEM

Internet2 is holding its annual meeting of members, the 2015 Global Summit, the last week of April in Washington, DC. These meetings bring together the researchers, network engineers, presidents, and CIOs from Internet2's members (academic, research and education network, affiliate, and industry), collaborating international research and education networks, and federal agencies that may require high-performance networks to support mission applications and disciplines.

NOAA speakers include:

David Hartzell & Robert Sears, *Side meetings: Joint Engineering Team*
Jerry Janssen, *Executive Track*
Robert Sears, *Applied Research & Scholarship Panel: How Federal Agencies Leverage Internet2 to Meet Their Missions*

Photos: (Top and middle) Inouye Regional Center, Ford Island, Honolulu, HI. (Bottom)NOAA Environmental Security Computing Center at Fairmont, WV.

NOAA SCIENCE NETWORK

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