

# America Connects to Europe (ACE) (Award #0962973) Year 6 Annual Report 1-Mar-2015 through 29-Feb-2016 Jennifer M. Schopf – Principal Investigator

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## Summary

During the sixth year of the America Connects to Europe (ACE) project, March 2015 through February 2016, the project continued its networking support and engineering activities to support international research. This report outlines collaborations, software and systems work, operational activities, and usage statistics for the project. Highlights include adaptations to the circuits in response to GEANT's new 100G offering, small perfSONAR node training in Africa, and participation in a broad set of meetings and workshops.

## 1. ACE Overview

The America Connects to Europe (ACE) project supports a series of circuits and services between the US East coast and Europe. In the current set up, these circuits are:

- Three 10G circuits between WIX (McLean, VA) and Frankfurt. These circuits are lagged together and load balanced for performance, and sometimes they are reported on as a 30G single unit. Currently, all three of these are funded by NSF.
- Three 10G circuits between MAN LAN (New York City) and Amsterdam. These circuits were lagged together and load balanced for performance, and sometimes they are reported on as a single unit. One of these links was funded by NSF and the other two were in-kind contributions by GEANT. The two GEANT circuits were decommissioned in July, after which the traffic was moved to a new 100G under GEANT management. We kept the remaining 10G circuit for research use, but was decommissioned at the end of November due to lack of interest from the community.
- A separate circuit between Chicago and Amsterdam was decommissioned on May 30, 2015, congruent with the initial project timeframe. This link was used for experimental purposes, but was not actively monitored and appeared to be under subscribed. The decommissioning of this circuit did not impact any active science or research projects.

- GÉANT's Paris to MAN LAN 100G circuit was fully commissioned in July. GÉANT is still working toward full inclusion of their circuit in the Advanced North Atlantic consortium.

These circuits are used in production to support a wide variety of science applications, including but not limited to physics (LHC), astronomy (e-VLBI), and biomedical research (GENIUS). In addition, through a supplement to the award, the ACE project directly supports application use of 100G test beds and tool development for 100G links. Overall, this award supports tool development, software defined networking (SDN) experimental work, and measurement and security activities.

Please note that some of the activities (outreach to Africa, perfSONAR training, etc.) are also included in the TransPAC quarterly report project, as appropriate, as joint funding supports these efforts.

## 2. Staffing

At the start of the project year, project staff partially supported by ACE consisted of:

- Jennifer Schopf, Director
- Andrew Lee, primary ACE senior network engineer
- Arvind Gopu, application support staff
- Abinav Thota, 100G Lustre support
- Robert Henschel, 100G consultant in IU Research Technologies
- Scott Chevalier, perfSONAR Everywhere main support
- Dan Doyle, International and 100G perfSONAR support
- Michael Johnson, International and 100G perfSONAR support
- Matt Robinson, primary contact for GlobalNOC support desk
- Alice Jackson, administration

In Quarter 4, the funding for the staff that was working on the supplemental 100G work was wrapped up, so Gopu, Thota, Henschel, Doyle, and Johnson completed their work. In addition, in February, Jackson moved to a new project at IU.

Current staffing is:

- Jennifer Schopf, Director
- Andrew Lee, primary ACE senior network engineer
- Scott Chevalier, perfSONAR Everywhere main support
- Matt Robinson, primary contact for GlobalNOC support desk

It is possible that additional staffing will be reduced as the project ramps down in its final year.

### 3. Collaborations, Travel, and Training

ACE staff continued to grow collaborations in Europe over the year with the goal of better understanding collaborative science use of the ACE links and supporting use of emerging network technologies.

During Year 6, trips partially funded by ACE included:

- Lee traveled to Washington DC March 23, 2015, to attend the co-located GEC 22 and GLIF Tech 23 meetings (<http://groups.geni.net/geni/wiki/GEC22Agenda> and <https://www.glif.is/meetings/2015/spring/>)
- Lee and Addleman attended the Internet2's Focused Technical Workshop on OpenFlow and SDN Testbeds (<https://meetings.internet2.edu/2015-ftw-international-openflow-sdn-testbeds/>) March 31-April 2 in Miami.
- Schopf attended the Coalition for Academic Scientific Computation (CASC) Meeting held March 31-April 4 in Arlington, VA (<http://casc.org/meetings/15mar/Agenda-Mar-Apr-2015.pdf>).
- The ACE project team attended the Internet2 Global Summit in Washington, DC, April 26- April 30 (<http://meetings.internet2.edu/2015-global-summit/>).
- Chevalier and Addleman attended the North American Network Operators' Group meeting (NANOG64), on May 30 – June 3, in San Francisco, CA (<http://www.nanog.org/meetings/nanog64>).
- Lee, Schopf, and Addleman attended TERENA (<https://tnc15.terena.org/>), in Porto Portugal, June 12-19.
- Chevalier attended a perfSONAR Deep Dive 4-day training session on June 15th, held at University of California Santa Cruz (<https://www.perfsonar.net/about/training-materials/20150616-dd/>).
- Addleman and Chevalier attended Asia Pacific Advance Network (APAN 40) (<http://www.apan.net/meetings/KualaLumpur2015/>) conference August 7-14, APAN 40, in Malaysia. Schopf had planned to attend but could not due to illness.
- September 4-17, Chevalier traveled to Nairobi, Kenya with KENET and Network Startup Resource Center (NSRC), University of Oregon to conduct perfSONAR Everywhere training (<https://nsrc.org/workshops/2015/kenet-perfsonar/wiki/Agenda>).
- Schopf attended part of the HubBub meeting in Indianapolis, September 15, (<https://hubzero.org/hubbub>).
- Lee attended the Global Network Architecture meeting in Copenhagen, Denmark Sept 23-24, 2015 (<https://events.nordu.net/display/GNA2015/Welcome>).
- September 27-29, Lee attended the GLIF meeting in Prague, Czech Republic (<http://glif2015.cesnet.cz/>).
- Schopf, Lee, Chevalier, Johnson, and Doyle attended the Internet2 TechX event in Cleveland, OH, October 4-9 (<https://meetings.internet2.edu/2015-technology-exchange/>).

- Addleman attended NANOG 65 in Montreal, October 5-7 (<https://www.nanog.org/meetings/nanog65/home>).
- On October 20, Addleman attended Operating Innovative Networks (OIN) in St. Louis, MO (<http://oinworkshop.com/3/miscellaneous3.htm>).
- Lee attended the Large Hadron Collider Open Networking Environment (LHCONE) meeting October 26-30, Amsterdam, Netherlands (<http://lhcone.net>).
- November 15-20, Addleman, Lee, Chevalier, and Schopf attended SC15 in Austin, TX (<http://sc15.supercomputing.org/>).
- January 11-16, 2016, Lee attended the GNA meeting in Amsterdam. This meeting focused on planning and strategy for networking policy, and updates were given about the timing of the existing ACE circuits.
- Schopf attended the Pacific Telecommunications Council meeting (PTC) (<https://www.ptc.org/ptc16>) January 17-20. Several discussions took place about current US-Europe cable and circuit planning.
- February 15-17, Lee and Hans Addleman visited the ACE WIX facility and deployed a loaned brocade router and some additional equipment in ESNet co-location space to begin the direct collection of ACE flow data. The anonymized results of this will also be shared with the IRNC NetSage project.

## 4. Software and Systems Work

### A. Tool Development

The development of GlobalNOC tools, funded in small part by ACE, continued with patches and upgrade to existing tools.

ACE staff are involved in the continued development of perfSONAR. As part of the larger perfSONAR development team, Version 3.5 of perfSONAR, was released at the end of September. Michael Johnson has been the lead developer on a complete overhaul of the web services and user interface for the perfSONAR toolkit, which includes a new default user interface a new architecture paving the way for a number of future enhancements that weren't possible under the old system. Dan Doyle has been the lead developer on the testing and automation system for perfSONAR. Throughout September, Johnson and Doyle tested and finalized the 3.5 release, along with documentation and testing of a "small, inexpensive node" for endpoint testing. After the release, Johnson and Doyle continued to provide support and bug fixes based on user feedback. In Quarter 4 Johnson and Doyle completed their perfSONAR development work under ACE project. They will continue the work that this funding has started under different projects.

For the Lustre over 100G project, a paper summarizing this effort is now available from: <https://scholarworks.iu.edu/dspace/handle/2022/20645>. It summarizes the work over the last 2 years, and discusses many real world situations and includes data for readers to use in deciding which route to take for their data transfer and application needs.

## B. Software Defined Networking (SDN) Activities

Currently, the ACE network supports SDN and OpenFlow as part of our partnership with Internet2 and GÉANT. There are currently an Inter Domain Controllers (IDCs) at MAN LAN and WIX, which makes it possible to create dynamic circuits on ACE related circuits through those exchanges using OSCARS. This enables us to provide Layer 2 Virtual Circuits dynamically instead of relying on static services. US researchers using the Internet2 AL2S network are able to create dynamic circuit to Europe using the ACE networks. GÉANT offers a similar service to AL2S called AutoBAHN that allows users to dynamically provision services across the GÉANT network.

## C. PerfSONAR Everywhere and Small Nodes

Small perfSONAR nodes to support smaller, cheaper, and more portable testpoints. As part of the funding refactorization, ACE support has enabled Chevalier, and to a lesser extent Gopu, to do testing of several small nodes for use in training and deployments.

In September, Chevalier traveled to Nairobi, Kenya, in September with staff from the Network Startup Resources Center (NSRC) and KENET engineers to conduct perfSONAR Everywhere training (<https://nsrc.org/workshops/2015/kenet-perfsonar/wiki/Agenda>). Chevalier worked with Chandler and Okui, both of the NSRC, and delivered 11 perfSONAR nodes and training to the KENET engineers. Prior to the workshop training, the KENET team was able to install 5 nodes that gave the group experience on which to build. Then, the group setup a MadDash on a VM Measurement Archive. KENET provided the archive and Chevalier and NSRC staff set it up. An additional three days after the workshop were spent in Eldoret interfacing with the AMPATH academic health center (<http://www.ampathkenya.org/>), visiting their outreach clinics, and installing a perfSONAR node.

In addition, small perfSONAR nodes were used in a hands-on training session at the August 2015 APAN meeting. 15 nodes were handed out to TEIN members, with the goal of creating a TEIN-wide perfSONAR deployment. This travel was funded by TransPAC, but leaned heavily on prior work in ACE.

In November, Chevalier deployed a perfSONAR “flock” of 12 small-form perfSONAR nodes at SC’15, in tandem with the larger form usual pS deployment. Chevalier gathered data on BRIX, LIVA, NUC, and ZBOX hardware and found the NUC and ZBOX to demonstrate the best performance and ease of use for of the models tested. In Quarter 4, the writeup of this project began, with the goal of submitting the results to SC17’s State of the Practice session.

Additional perfSONAR deployments were discussed in meetings at TechX, OIN, and SC15.

## **D. Application Support over 100G**

One of the problems in applications using more than 10G networks is the lack of an endpoint reachable at that speed from the backbone exchange point. Toward this end, we have been upgrading the testlab at the IU data center to allow applications to experiment with that as a US end point. Several lab upgrades were done this quarter, and Gopu worked with several applications to use this set up in the future.

Outreach to potential applications proved difficult in this year. There was, however, a nice demonstration of the use of the ACE links between University of Chicago and the European Bioinformatics Institute (EBI), which performed a demonstration at the GLIF meeting. Work in this area will continue in the final year of the project.

## **5. Operational Activities**

### **A. Circuit Procurement/Decommission**

Several major changes took place during Year 6 of the ACE project. GEANT announced their intention to shift their support from three 10G links shared with ACE to a single 100G link to run between MAN LAN and Paris, complementary to the ANA links. This meant that the two 30G lags would be left with only 10G out of MAN LAN and 20G out of WIX. Instead of this, we arranged to take over the previously GEANT-supported 10G out of WIX to leave that 30G lag intact. IU took over the responsibility of the EU-procured link, run by T-Systems, on April 1, and ran it until November 30th. At that point, we procured a third link from the provider of the other 2 10G's on that path, Hibernia, for improved cost savings. This 30G lag is now funded through the end of the 2016 calendar year.

In June, GÉANT procured a new 100G circuit between the MAN LAN switch and their POP in Paris, France. They are still working on formal procedures to re-join the ANA consortium.

The 10G link out of MAN LAN remained in place for several months as an experimental link, but was decommissioned in Q3 due to lack of use.

The Chicago-Amsterdam link was decommissioned on May 31, 2015. This circuit was inherited from the EU-circuit award prior to ACE, and had never been able to be fully incorporated into the production monitoring system. By all accounts, the use of that link was very small, and there was verification that shutting it down would not affect any research or science work currently active.

## B. Graphs

Figures 1 and 2 show the aggregated traffic for the three 10G circuits from ManLan to Amsterdam. Figures 3 and 4 show the aggregated traffic for the three 10G circuits from WIX to Frankfurt. Figures 5 and 6 show the traffic for the GÉANT 100G circuit between MAN LAN and Paris.

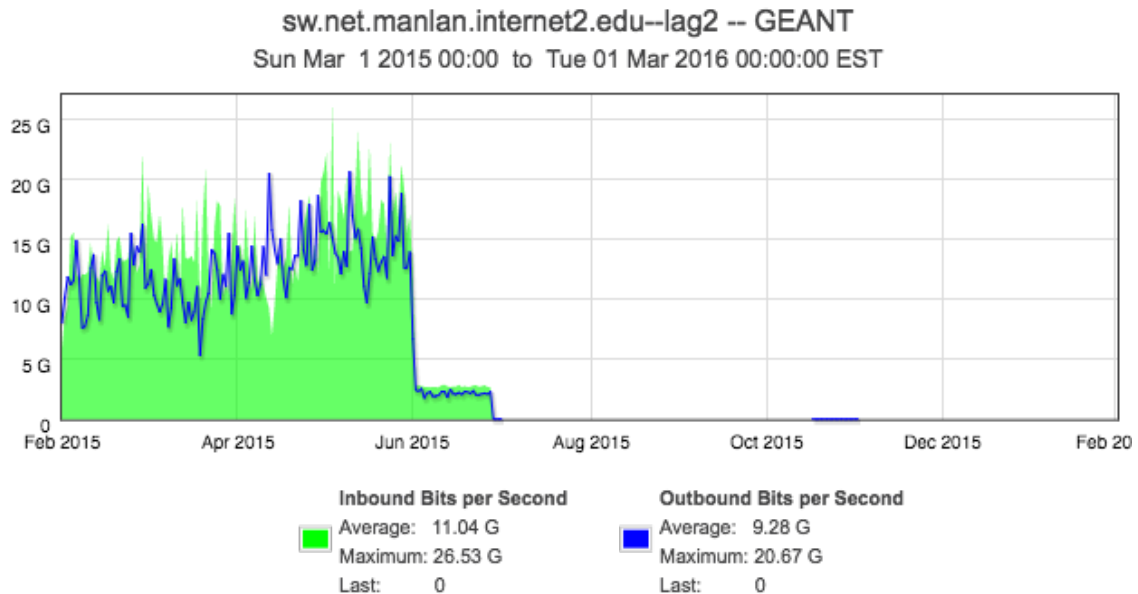


Figure 1: Aggregated traffic using maximum daily values on the 30G Lag between ManLan and Amsterdam for March 1, 2015, through February 29, 2016.

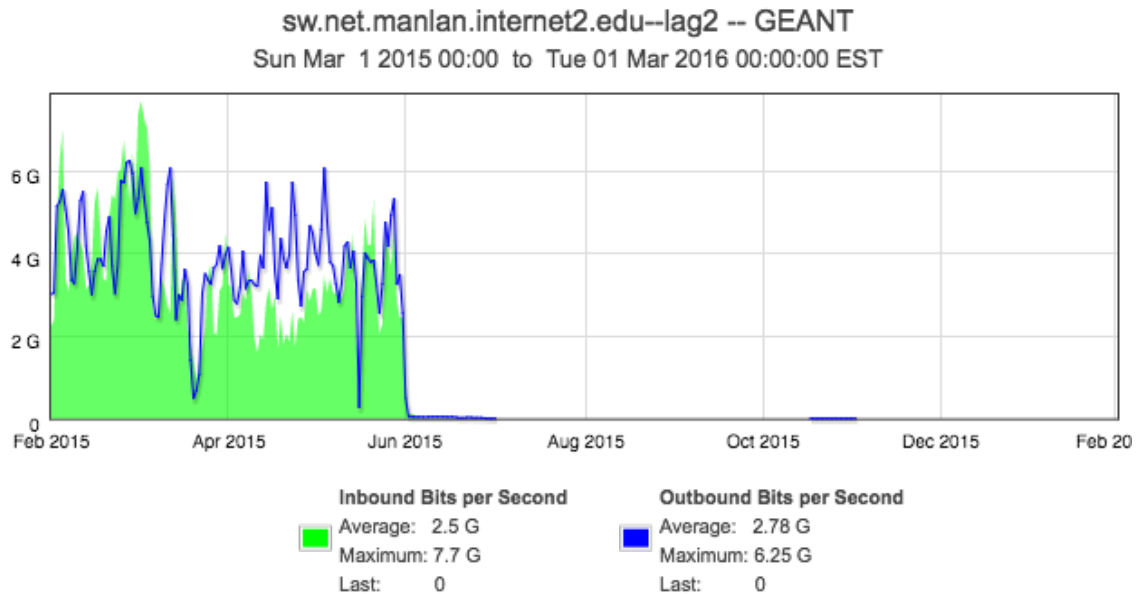


Figure 2: Aggregated traffic using smoothed average daily values on the 30G Lag between ManLan and Amsterdam for March 1, 2015, through February 29, 2016.

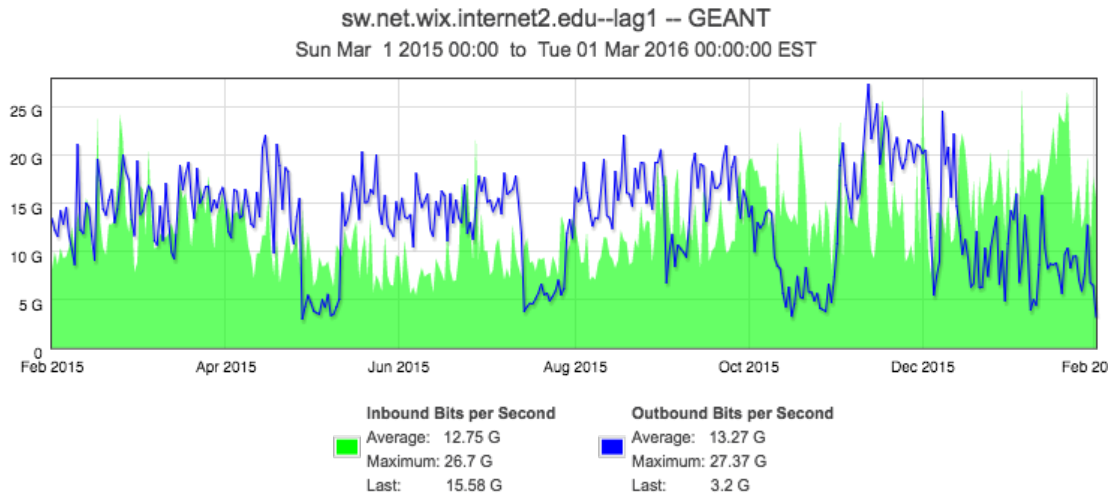


Figure 3: Aggregated traffic using maximum daily values on the 30G Lag between WIX and Frankfurt for March 1, 2015, through February 29, 2016.

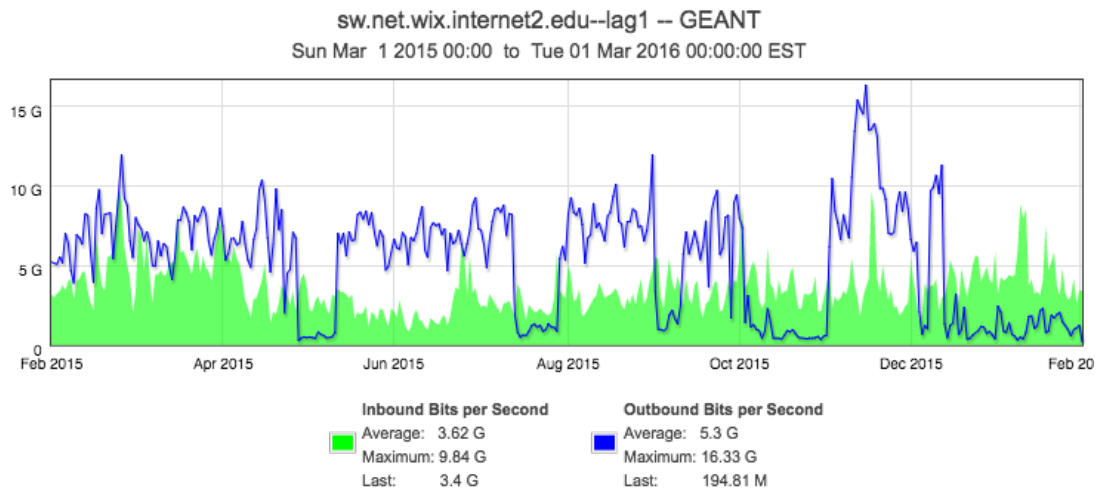


Figure 4: Aggregated traffic using smoothed average daily values on the 30G Lag between WIX and Frankfurt for March 1, 2015, through February 29, 2016.

**.manlan.internet2.edu--ethernet7/2 -- GEANT/Paris | MAN-NEWY32AOA-PARIS-100GE-01667 | MAN-S**  
Sun Mar 1 2015 00:00 to Tue 01 Mar 2016 00:00:00 EST

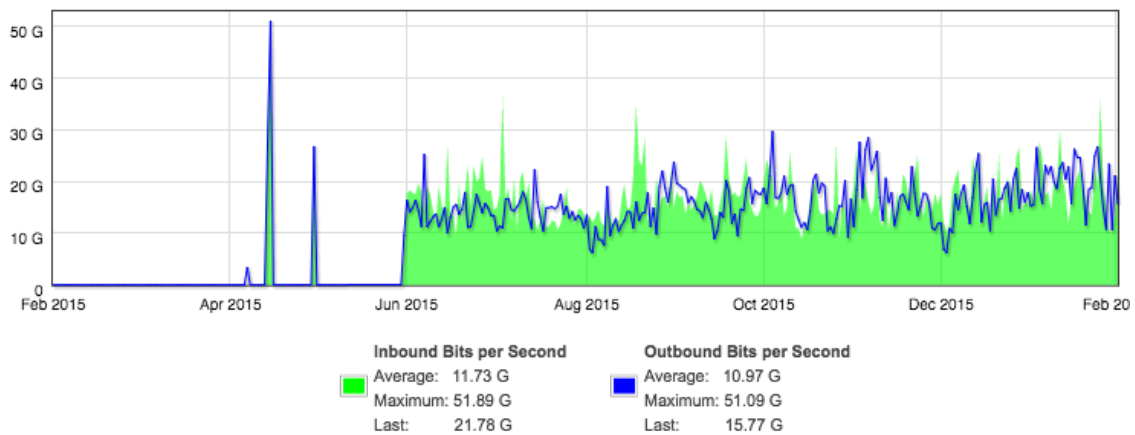


Figure 5: Aggregated traffic using maximum daily values on the GEANT 100G between MAN LAN and Paris for March 1, 2015, through February 29, 2016.



.manlan.internet2.edu--ethernet7/2 -- GEANT/Paris | MAN-NEWY32AOA-PARIS-100GE-01667 | MAN-S  
Sun Mar 1 2015 00:00 to Tue 01 Mar 2016 00:00:00 EST

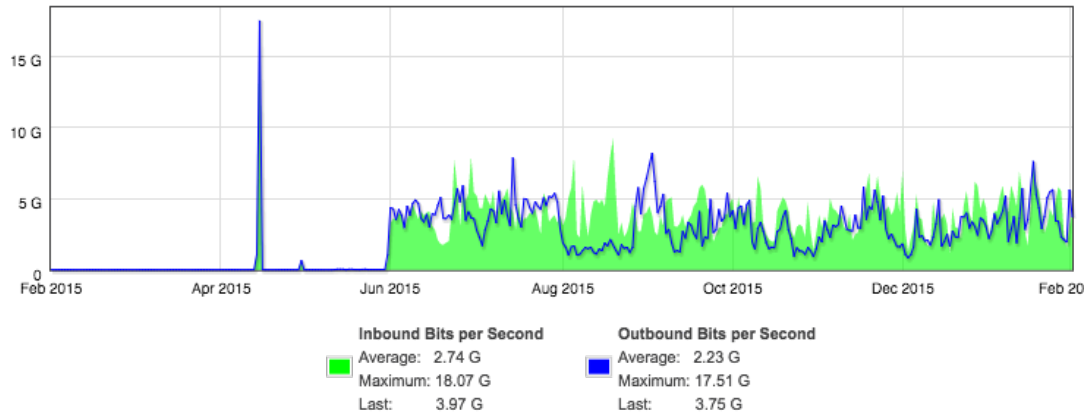


Figure 6: Aggregated traffic using smoothed average daily values on the GÉANT 100G between MAN LAN and Paris for March 1, 2015, through February 29, 2016.

Table 1 shows full volume of traffic transferred over the ACE links during the 4th quarter. Over 15 Petabytes of traffic has been transferred over the ACE links during the 3 months. Table 2 shows the full volume of traffic over all of Year 6, more than 68 Petabytes.

**Table 1: Traffic in terabytes transferred over ACE links, December 1, 2015 through February 29, 2016 (Quarter 4).**

	<b>December</b>	<b>January</b>	<b>February</b>	<b>Total</b>
<b>Frankfort-&gt;WIX</b>	1,420	1,168	1,378	3,966
<b>WIX-&gt;Frankfort</b>	1,078	870	1,225	3,173
<b>Paris-&gt;MAN LAN</b>	1,239	1,296	1,428	3,963
<b>MAN LAN-&gt;Paris</b>	3,278	978	363	4,619
<b>Total:</b>	7,014	4,312	4,394	15,720

**Table 2: Traffic in terabytes transferred over ACE links, March 1, 2015 through February 29, 2016.**

	<b>Mar-May</b>	<b>Jun-Aug</b>	<b>Sep-Nov</b>	<b>Dec-Feb</b>	<b>TOTAL</b>
<b>Frankfort-&gt;WIX</b>	3,680	2,496	3,382	3,966	<b>13,524</b>
<b>WIX-&gt;Frankfort</b>	5,494	5,305	4,637	3,173	<b>18,609</b>
<b>Amsterdam-&gt;MAN LAN</b>	3,389	1,053	0	0	<b>4,442</b>
<b>MAN LAN-&gt;Amsterdam</b>	3,731	1,176	0	0	<b>4,907</b>
<b>Paris-&gt;MAN LAN</b>	0	178	3,898	4,619	<b>8,695</b>
<b>MAN LAN-&gt;Paris</b>	0	181	2,636	15,720	<b>18,537</b>
<b>TOTAL</b>	16,294	10,389	14,554	27,478	<b>68,715</b>

### C. Trouble Tickets

During the year, there were 34 tickets for unscheduled maintenance, detailed in Table 3, and 25 tickets for scheduled maintenance, detailed in Table 4. Additional trouble ticket information is available at

[https://tick.globalnoc.iu.edu/fp\\_tools/public\\_ticket\\_viewer/index.cgi](https://tick.globalnoc.iu.edu/fp_tools/public_ticket_viewer/index.cgi).

**Table 3: Unscheduled maintenance tickets for the ACE circuits, March 1, 2015 – February 29, 2016.**

<b>Ticket Num</b>	<b>Customer Impact</b>	<b>Network Impact</b>	<b>Outage Type</b>	<b>Source Of Impact</b>	<b>Start Time (UTC)</b>	<b>End Time (UTC)</b>
<a href="#">546</a>	2-High	2-High	Circuit - Damaged Fiber	Vendor	3/10/15 11:17	3/11/15 6:06
<a href="#">552</a>	2-High	2-High	Circuit - Bumped Fiber	Vendor	3/18/15 12:39	3/18/15 14:10
<a href="#">569</a>	2-High	2-High	Circuit - Damaged Fiber	Vendor	4/8/15 8:59	4/9/15 8:46
<a href="#">571</a>	2-High	2-High	Circuit - Damaged Fiber	Vendor	4/8/15 8:59	4/9/15 8:46
<a href="#">580</a>	4-Normal	2-High	Hardware	Vendor	4/20/15 10:46	4/20/15 15:04
<a href="#">592</a>	2-High	2-High	Circuit - Damaged Fiber	Vendor	5/1/15 9:55	5/2/15 7:47
<a href="#">598</a>	2-High	2-High	Circuit - Damaged Fiber	Vendor	5/12/15 12:11	5/12/15 22:45
<a href="#">611</a>	2-High	2-High	Circuit - Damaged Fiber	Vendor	5/26/15 14:33	5/26/15 21:39
<a href="#">616</a>	4-Normal	2-High	Undetermined	Vendor	6/3/15 10:44	6/3/15 10:45
<a href="#">643</a>	4-Normal	2-High	Undetermined	Vendor	7/9/15 14:33	7/9/15 14:34
					7/9/15 14:35	7/9/15 14:36
<a href="#">652</a>	2-High	2-High	Undetermined	Vendor	8/5/15 4:06	8/5/15 16:39
<a href="#">654</a>	2-High	2-High	Undetermined	Vendor	8/12/15 10:07	8/12/15 10:08
<a href="#">664</a>	2-High	2-High	Power	Vendor	8/21/15 15:15	8/21/15 17:59
<a href="#">665</a>	2-High	2-High	Circuit - Damaged Fiber	Vendor	8/22/15 23:14	8/23/15 21:12

					8/24/15 9:47	8/24/15 15:42
<a href="#">671</a>	2-High	2-High	Circuit - Damaged Fiber	Vendor	9/7/15 3:47	9/7/15 16:13
<a href="#">678</a>	4-Normal	2-High	Unannounced Maintenance	Vendor	9/28/15 23:11	9/28/15 23:12
<a href="#">679</a>	2-High	2-High	Circuit - Damaged Fiber	Vendor	9/30/15 10:26	10/2/15 15:02
<a href="#">690</a>	2-High	2-High	Undetermined	Vendor	10/13/15 16:31	10/13/15 17:26
<a href="#">696</a>	2-High	2-High	Circuit - Other	Vendor	10/27/15 21:10	10/27/15 22:17
<a href="#">697</a>	2-High	2-High	Circuit - Damaged Fiber	Vendor	11/2/15 4:05	11/2/15 7:22
<a href="#">699</a>	4-Normal	2-High	Circuit - Bumped Fiber	Vendor	11/4/15 2:07	11/4/15 2:08
<a href="#">700</a>	2-High	2-High	Unannounced Maintenance	Vendor	11/5/15 5:00	11/5/15 5:33
<a href="#">702</a>	4-Normal	2-High	Circuit - Damaged Fiber	Vendor	11/6/15 2:45	11/6/15 2:46
					11/7/15 20:20	11/7/15 20:21
<a href="#">704</a>	2-High	2-High	Undetermined	Vendor	11/13/15 10:04	11/13/15 15:09
<a href="#">705</a>	2-High	2-High	Hardware	Vendor	11/13/15 23:28	11/14/15 5:04
<a href="#">710</a>	4-Normal	2-High	Circuit - Other	Vendor	12/1/15 17:39	12/1/15 17:40
<a href="#">711</a>	4-Normal	2-High	Power	Vendor	12/8/15 5:51	12/8/15 7:04
<a href="#">712</a>	4-Normal	2-High	Unannounced Maintenance	Vendor	12/10/15 20:17	12/10/15 21:00
<a href="#">714</a>	4-Normal	2-High	Undetermined	Undet.	12/21/15 0:55	12/21/15 0:56
					12/21/15 1:05	12/21/15 1:06

					12/21/15 2:06	12/21/15 2:07
					12/21/15 3:42	12/21/15 3:43
<a href="#">716</a>	4-Normal	2-High	Hardware	Vendor	1/3/16 5:36	1/3/16 16:18
<a href="#">720</a>	4-Normal	2-High	Hardware	Vendor	1/14/16 15:45	1/14/16 15:46
<a href="#">721</a>	4-Normal	2-High	Circuit - Bumped Fiber	Vendor	1/16/16 0:22	1/16/16 0:24
<a href="#">725</a>	4-Normal	2-High	Circuit - Damaged Fiber	Vendor	1/23/16 17:09	1/24/16 0:07
					1/25/16 9:11	1/26/16 2:05
<a href="#">726</a>	4-Normal	2-High	Unannounced Maintenance	Vendor	1/29/16 0:54	1/29/16 0:55

Table 4: Tickets for scheduled maintenance on ACE circuits, March 1, 2015 – February 29, 2016.

<b>Ticket Num</b>	<b>Customer Impact</b>	<b>Network Impact</b>	<b>Maint. Type</b>	<b>Source Of Impact</b>	<b>Start Time (UTC)</b>	<b>End Time (UTC)</b>
<a href="#">553</a>	3-Elevated	3-Elevated	Circuit	Vendor	3/28/15 4:55	3/28/15 7:52
<a href="#">573</a>	3-Elevated	3-Elevated	Circuit	Vendor	4/17/15 21:06	5/18/15 5:09
<a href="#">581</a>	3-Elevated	3-Elevated	Circuit	Vendor	4/22/15 23:17	4/22/15 23:34
<a href="#">584</a>	3-Elevated	3-Elevated	Circuit	Vendor	5/6/15 22:03	5/7/15 23:42
<a href="#">594</a>	3-Elevated	3-Elevated	Circuit	Vendor	5/15/15 22:00	5/16/15 1:18
<a href="#">600</a>	3-Elevated	3-Elevated	Circuit	Vendor	5/22/15 4:18	5/22/15 4:19
<a href="#">603</a>	3-Elevated	3-Elevated	Circuit	Vendor	5/30/15 4:01	5/30/15 5:53
<a href="#">621</a>	3-Elevated	3-Elevated	Circuit	Vendor	6/6/15 19:04	6/6/15 23:39
					6/7/15 0:11	6/7/15 0:12
<a href="#">624</a>	3-Elevated	3-Elevated	Circuit	Vendor	6/15/15 22:01	6/15/15 23:55
<a href="#">619</a>	3-Elevated	3-Elevated	Circuit	Vendor	6/21/15 2:21	6/21/15 13:30
<a href="#">631</a>	3-Elevated	3-Elevated	Software	Vendor	7/1/15 4:11	7/1/15 4:16
<a href="#">634</a>	3-Elevated	3-Elevated	Circuit	Vendor	7/14/15 23:06	7/15/15 1:24
<a href="#">666</a>	3-Elevated	3-Elevated	Circuit	Vendor	8/25/15 3:18	8/25/15 16:58
<a href="#">661</a>	3-Elevated	3-Elevated	Circuit	Vendor	8/27/15 3:00	8/27/15 6:09
<a href="#">653</a>	3-Elevated	3-Elevated	Power	Vendor	8/29/15 3:42	8/29/15 4:14

<a href="#">668</a>	3-Elevated	3-Elevated	Power	Vendor	8/29/15 18:29	8/29/15 19:30
<a href="#">674</a>	3-Elevated	3-Elevated	Circuit	Vendor	9/26/15 4:20	9/26/15 5:56
<a href="#">677</a>	3-Elevated	3-Elevated	Circuit	Vendor	9/29/15 23:04	9/29/15 23:05
<a href="#">683</a>	3-Elevated	3-Elevated	Circuit	Vendor	10/16/15 20:14	10/17/15 3:50
<a href="#">691</a>	3-Elevated	3-Elevated	Circuit	Vendor	11/5/15 3:24	11/5/15 5:00
<a href="#">694</a>	3-Elevated	3-Elevated	Circuit	Vendor	11/10/15 4:17	11/10/15 4:55
<a href="#">709</a>	3-Elevated	3-Elevated	Circuit	Vendor	12/9/15 23:08	12/10/15 5:04
<a href="#">715</a>	3-Elevated	3-Elevated	Circuit	Vendor	1/12/16 0:04	1/12/16 1:36
<a href="#">718</a>	3-Elevated	3-Elevated	Circuit	Vendor	1/19/16 0:12	1/19/16 4:51
<a href="#">730</a>	3-Elevated	3-Elevated	Hardware	Vendor	2/17/16 3:01	2/17/16 3:12

#### D. Downtime and Availability

Table 5 below displays downtime for core nodes on the project. Table 6 lists downtime for the project's circuits.

**Table 5: Downtime and availability for ACE core nodes March 1, 2015-Feb 29 2016.**

ACE Core Nodes	Down Time	Reporting Period Availability	52 Week Availability
	0 hr 0 min	100.00%	100.00%
<b>Aggregate ACE Core Nodes</b>	0 hr 0 min	100.00%	100.00%

**Table 6: Downtime and availability for ACE backbone circuits March 1 2015, through February 29, 2016.**

ACE Backbone Circuits	Down Time	Reporting Period Availability	52 Week Availability
GLOBAL-ACE-MANLAN-O192-01500	0 hr 0 min	100.00%	99.54%
GLOBAL-ACE-MANLAN-O192-01501	0 hr 0 min	100.00%	100.00%
GLOBAL-ACE-WIX-O192-01502	8 hr 54 min	99.59%	97.93%
GLOBAL-ACE-WIX-O192-01504	0 hr 0 min	100.00%	98.00%
GLOBAL-ACE-MANLAN-O192-01505	0 hr 0 min	100.00%	100.00%
GLOBAL-FRK-WASH2-10GE-01507	11 hr 41 min	99.47%	98.10%
GLOBAL-FRK-WASH2-10GE-01510	28 hr 44 min	98.68%	99.67%
MAN-NEWY32AOA-PARIS-10GE-01618	0 hr 0 min	100.00%	100.00%
<b>Aggregate All ACE Backbone Circuits</b>	49 hr 19 min	99.72%	99.16%

## **6. Security Events and Activities**

Basic security measures were maintained during this quarter and no security incidences were reported. Basic security work is included as part of the ongoing funded support ACE receives from the GlobalNOC.

## **7. Financial Reporting Details for Year 6**

Financial updates will be given directly to NSF.